The Development and Evaluation of an Avatar-Based Education Application for Improving the Knowledge and Response of Patients with Symptoms of Acute Coronary Syndromes

by

Jintana Tongpeth

Thesis
Submitted to Flinders University
for the degree of

Doctor of Philosophy

College of Nursing and Health Sciences

November 2018

No academic knowledge can be acquired all at once. One has to gradually accumulate the knowledge until it is broad-based and comprehensive. In learning, it is necessary gradually to build up what is learnt, as the base for higher and more in-depth knowledge.

His Majesty the late King Bhumibol Adulyadej
(1967–2016)

CONTENTS

Contents ..... **ii**
List of Figures ..... **v**
List of Tables ..... **vi**
List of Abbreviations ..... **vii**
Glossary ..... **ix**
Summary ..... **xi**
Declaration ..... **xiii**
Acknowledgements ..... **xiv**
Funding ..... **xvi**
Anthology of Publications and Presentations ..... **xvii**
Published Papers xvii
Paper Under Review xvii
Published Abstracts xvii
Conference Presentations xviii
Concurrent Published Works Not Included in This Thesis xx
Chapter 1: Introduction and Background **1**
1.1 Introduction 1
1.2 Background 1
1.2.1 Cardiovascular Disease 1
1.2.2 Acute Coronary Syndrome 3
1.2.3 Symptoms of Acute Coronary Syndrome 5
1.2.4 Phases of Acute Coronary Syndrome Management 6
1.2.5 Delay in Acute Coronary Syndrome Management 6
1.2.6 Factors Associated with Decision Delay 13
1.2.7 Knowledge of Acute Coronary Syndrome Symptoms and Delay in Seeking Medical Attention 16
1.2.8 Patient Education and Interactive Technology 20
1.2.9 Avatar-Based Technology 21
1.2.10 Conclusion 23
1.3 My unique contribution to the study 23
1.4 Thesis Aims and Objectives 24
1.4.1 Aims 24
1.4.2 Objectives 24
1.5 Structure of the Thesis 25
1.6 Overview of the Thesis 26
1.7 References 27
Chapter 2: Review of the Literature and Conceptual Frameworks **48**
2.1 Introduction 48
2.2 Section 1: Interventions That Aim to Improve Knowledge, Attitudes and Beliefs Among Patients with Acute Coronary Syndrome 48
2.2.1 Objectives of the Review 48
2.2.2 Methods 48
2.2.3 Criteria for Selecting Studies 49
2.2.4 Selection of Studies 49
2.2.5 Methodological Quality Assessment 52

2.2.6 Results 52
2.2.7 Discussion 55
2.2.8 Conclusion 57
2.3 Section 2: Avatar-Based Technologies in Patient Education: An Integrative Review 58
2.3.1 Introduction 58
2.3.2 Aims 59
2.3.3 Methods 60
2.3.4 Criteria for Selecting Studies 60
2.3.5 Search Strategies 61
2.3.6 Methodological Quality Assessment 61
2.3.7 Results 63
2.3.8 Discussion 67
2.3.9 Conclusion 71
2.3.10 Relevance to Clinical Practice 72
2.4 Section 3: Conceptual Framework 73
2.4.1 Introduction 73
2.4.2 Social Cognitive Theory 73
2.4.3 Conceptual Framework for this Study 77
2.4.4 Conclusion 79
2.5 Chapter Summary 79
2.6 References 80
Chapter 3: Research Design and Methodology 96
3.1 Introduction 96
3.2 Aims 96
3.3 Objectives 96
3.4 Research Design 96
3.4.1 Mixed-Methods Research Design 97
3.5 Study 1: Development and Feasibility Testing of an Avatar-Based Heart Attack Education Application 98
3.5.1 Introduction 98
3.5.2 Aim 98
3.5.3 Objectives 98
3.5.4 Participatory Action Research 99
3.5.5 Avatar-Based Education Application Development 100
3.6 Study 2: Evaluation of the Effectiveness of an Avatar-Based Heart Attack Education Application: A Pragmatic Randomised Controlled Trial 110
3.6.1 Introduction 110
3.6.2 Rationale for the Pragmatic Randomised Controlled Trials 110
3.6.3 Protocol of Pragmatic Randomised Controlled Trial 112
An Avatar-Based Education Application to Improve Patients' Knowledge of and Response to Heart Attack Symptoms: A Pragmatic Randomized Controlled Trial Protocol 114
3.7 Ethics Approval 134
3.7.1 Ethical Considerations 134
3.8 Chapter Summary 137
3.9 References 139
Chapter 4: Results 146
4.1 Introduction 146
4.2 Results of Study 1 146
4.2.1 Preamble 146

4.2.2 Development and Feasibility Testing of an Avatar-Based Education Application for Patients with Acute Coronary Syndrome 148
4.3 Results of Study 2 173
4.3.1 Preamble 173
4.3.2 Evaluation of an Avatar-Based Education Application for Improving Knowledge of and Response to Symptoms of People with Acute Coronary Syndrome: A Pragmatic Randomised Controlled Trial 175
Chapter 5: Conclusions and Implications for Practice, Policy and Research 207
5.1 Introduction 207
5.2 Context of the Study 207
5.2.1 Acute Coronary Syndrome Facts 207
5.2.2 Delay in Response to Symptoms of Acute Coronary Syndrome 208
5.3 New Knowledge 208
5.3.1 Avatar-Based Technology and Patient Education 208
5.4 Limitations 209
5.5 Implications for Practice 211
5.6 Implications for Policy 211
5.7 Implications for Research 212
5.8 Conclusion 212
5.9 References 213
Appendices 214
Appendix 1: Appraisal Instruments 215
Appendix 2: Summary of Quality Appraisal (Literature Review Section 1) 221
Appendix 3: Summary of Quality Appraisal (Literature Review Section 2) 222
Appendix 4: Ethics Approval Letter (Study 1) 223
Appendix 5: Site Specific Assessment Approval Letter (Study 1) 225
Appendix 6: Participant Information/Consent Form Focus Group (Study 1 - Consumers) 226
Appendix 7: Participant Information/Consent Form Focus Group (Study 1 - Cardiovascular Experts) 232
Appendix 8: Participant Information/Consent Form Pre-Test Post-Test (Study 1) 237
Appendix 9: Data Collection (Pre-Test Post-Test) (Study 1) 243
Appendix 10: Ethics Approval Letter (Study 2) 249
Appendix 11: Site Specific Assessment Approval Letter (Study 2) 250
Appendix 12: Participant Information Sheet/Consent Form (Study 2) 251
Appendix 13: General Research Application 258
Appendix 14: Intervention Documents 277
Appendix 15: Data Collection Form (Study 2) 287
Appendix 16: Screenshots and Dialogue of the SAVE App 338
Bibliography 350

LIST OF FIGURES

Figure 1.1: Coronary Heart Disease in People Aged 18 and Over, 2014−15 2
Figure 1.2: Working Diagnosis of Acute Coronary Syndromes 4
Figure 1.3: Phases of Delay in Seeking Medical Care 7
Figure 2.1: PRISMA Flowchart Showing Identification of Studies (Section 1 of Literature Review) 53
Figure 2.2: PRISMA Flowchart Showing the Identification of Studies (Section 2 of the Literature Review) 63
Figure 2.3: Key Concepts and Dimensions of Social Cognitive Theory 74
Figure 2.4: The Components of Observational Learning 75
Figure 2.5: The Conceptual Framework for This Study 77
Figure 3.1: Mixed-Methods Research Design of this Study 98
Figure 3.2: The Four Steps of the Action Research Cycle 100
Figure 3.3: Heart Attack Action Plan 102
Figure 3.4: The Action Research Cycles to Develop the Avatar-Based Heart Attack Education Application 104
Figure 3.5: Core Characteristics of Pragmatic Randomised Controlled Trials 112
Figure 3.6: A Screen Picture of the SAVE App 120
Figure 3.7: CONSORT Flow Diagram of the Study Procedure 123
Figure 3.7: Flowchart of Ethics Considerations and Approvals 137
Figure 4.1: Participatory Action Research Cycles of the Development of the Avatar-Based Education Application 153
Figure 4.2: Heart Attack Action Plan 158
Figure 4.3: Examples of Screens Shots from the SAVE App 159
Figure 4.4: Evolution of Avatar (Cora Nurse) 159
Figure 4.5: Heart Attack Action Plan 183
Figure 4.6: CONSORT Flow Diagram of the Study 186
Figure 4.7: Comparison of ACS Response Index Scores and the Percentage Changes at Baseline, One Month and Six Months Between Groups and Within Groups, Tobit Growth Curve Model 189

LIST OF TABLES

Table 1.1: Common Signs and Symptoms of Acute Coronary Syndrome 6
Table 1.2: Definition of the Phases of Delay in Seeking Medical Attention 8
Table 1.3: Delay Times and Findings from Studies from the Past Two Decades 10
Table 1.4: Factors Associated with Delay in Seeking Medical Attention 15
Table 2.1: Summary of the Included Studies (Section 1 of Literature Review) 50
Table 2.2: Summary of the Included Studies (Section 2 of Literature Review) 62
Table 2.3: Summary of Primary and Secondary Outcomes 65
Table 3.1: Topics to Assess the Cycles of the Avatar-Based Education Application Development 107
Table 3.2: Inclusion and Exclusion Criteria 119
Table 3.3: Timeline of Study Measurements (see Appendix 15) 121
Table 4.1: Status of the Manuscripts 146
Table 4. 2: Characteristics of Consumers (Phase I) 157
Table 4.3: Characteristics of Consumers (Phase II) 161
Table 4.4: Changes in ACS Response Index Scores 162
Table 4.5: Consumer Satisfaction 163
Table 4.6: Baseline Characteristics of Participants 187
Table 4.7: Case Review of the 16 Participants Who Had Further Episodes of ACS During the Six-Month Study Period 191
Table 4.8: Intention to Implement the Heart Attack Action Plan 192
Table 4.9: Secondary Outcome—Healthcare Use 193

LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACS	Acute coronary syndrome
AIHW	Australian Institute of Health and Welfare
AMI	Acute myocardial infarction
CASP	Critical Appraisal Skills Programme
CCU	Coronary care unit
CHD	Coronary heart disease
CINAHL	Cumulative Index of Nursing and Allied Health Literature
CONSORT	Consolidated Standards of Reporting Trials
CSANZ	The Cardiac Society of Australia and New Zealand
CVD	Cardiovascular disease
ED	Emergency department
EMS	Emergency medical services
GP	General practitioner
GRACE	Global Registry of Acute Coronary Events
HRQoL	Health-related quality of life
IG	Intervention group
IT	Information technology
JBI	Joanna Briggs Institute
LOS	Length of hospital stay
MI	Myocardial infarction
NHF	National Heart Foundation of Australia
NSTEMI	Non–ST-elevation myocardial infarction
OAB	Overactive bladder
PAR	Participatory action research
pRCT	Pragmatic randomised controlled trial
PRISMA	Preferred reporting items for systematic reviews and meta-analysis
RCT	Randomised controlled trial
REALM-SF	Rapid Estimate of Adult Literacy in Medicine—Short Form
SAC HREC	Southern Adelaide Clinical Human Research Ethics Committee

SAVE app	**S**imple **A**vatar-based application for impro**V**ing acute coronary syndrome **E**ducation
SCT	Social cognitive theory
SD	Standard deviation
SPIRIT	Standard Protocol Recommendations for Intervention Trial
STEMI	ST-segment elevation myocardial infarction
TIDier	Template for Intervention Description and Replication
UA	Unstable angina
UG	Usual care group
USA	United States of America
WHO	World Health Organization

GLOSSARY

Acute coronary syndrome

The spectrum of acute clinical presentations resulting from underlying coronary heart disease, including heart attack and angina (National Heart Foundation of Australia [NHF] and Cardiac Society of Australia and New Zealand [CSANZ] 2016).

Avatar-based technologies

Computer-generated, human-like pedagogical agents that are used in digital learning to provide individualised instruction, learning motivation and a more interesting and effective learning environment (Wiederhold 2013).

Coronary artery bypass graft

A surgical procedure using blood vessel grafts to bypass blockages in the coronary arteries and restore adequate blood flow to the heart muscle (NHF and CSANZ 2016).

Coronary heart disease

Caused by a slow build-up of fatty deposits on the inner wall of blood vessels that supply the heart muscle with blood (i.e., coronary arteries). These fatty deposits gradually clog the arteries and reduce blood flow to the heart (NHF and CSANZ 2016).

Electrocardiogram

A non-invasive test that records the electrical activity of the heart. A 12-lead electrocardiogram simultaneously records 12 different electrical ‘views’ of the heart. This test is performed to diagnose an ST-elevation myocardial infarction (NHF and CSANZ 2016).

Non–ST-elevation myocardial infarction

A type of myocardial infarction identified by what is observed on an electrocardiogram. In a non–ST-elevation myocardial infarction, the artery is only partly blocked so only part of the heart muscle being supplied by that artery is affected (NHF and CSANZ 2016).

Non–ST-segment elevation acute coronary syndrome

A condition in which patients have acute chest pain but do not have persistent ST-segment elevation in their electrocardiogram. Non–ST-segment elevation acute coronary syndrome is further divided into unstable angina and non–ST-elevation myocardial infarction (NHF and CSANZ 2016).

Percutaneous coronary intervention

An invasive procedure that restores blood flow through a blocked coronary artery. A special balloon is used to open the blocked artery at the point of narrowing without the need for heart surgery. After the procedure is performed, a stent (i.e., an expandable metal tube such as a coil or wire mesh) is delivered to the newly dilated site where it is expanded and left in place to keep the artery open (NHF and CSANZ 2016).

Reperfusion

The restoration of blood flow (and, thus, oxygen supply) to an area of heart muscle that has been deprived of circulation for a period of time (e.g., as a result of a heart attack) (NHF and CSANZ 2016).

Pre-hospital delay time

Time from the onset of symptoms to the arrival at the emergency department (NHF and CSANZ 2016).

SUMMARY

Background: A patient's ability to recognise and respond to symptoms of acute coronary syndrome (ACS) is imperative for seeking timely medical intervention. Delay in seeking medical treatment is associated with a poor understanding and difficulty in the recognition of heart attack symptoms and is associated with preventable death and complications. Innovative patient education interventions are needed to educate and support patient education and self-management.

Aims: This study aims to develop and evaluate the effectiveness of a **S**imple **A**vatar-based application for impro**V**ing ACS **E**ducation (SAVE app) on knowledge and response to ACS symptoms.

Methods: A mixed-methods design. *Study 1.* Participatory action research was used to engage 10 consumers and 12 cardiovascular clinical and gaming IT experts to design and develop the education application. Ten additional consumers were recruited to test the SAVE app. *Study 2.* A prospective, pragmatic, randomised, non-blinded, single-centre study was used to undertake the research. Seventy patients with documented CVD who had previously experienced heart attack symptoms consented to participate in the study and were randomised, and 66 patients completed the follow-up. The usual care group received routine ACS discharge education. The intervention group received routine ACS discharge education plus the SAVE app. The ACS Response Index was used to collect data for both groups on knowledge, attitudes, beliefs, actions and help-seeking behaviour about ACS at baseline, one month and six months.

Results: *Study 1.* Using the PAR method, ten consumers with ACS and 12 cardiovascular experts from clinical and information technology fields participated in the design and development of the education application. Ten additional consumers (mean age of 52.2 ±10.4 years) were recruited to test the feasibility of the SAVE app for improving ACS knowledge. A high level (87.3%) of satisfaction with using the application was reported. After using the SAVE app, there was an increase in the sub-scale scores of the ACS Response Index of 15.7 per cent for knowledge, 25.7 per cent for beliefs and 24.2 per cent for attitudes. *Study 2.* Among the 66 participants who completed the six-month follow-up, participants in the intervention group showed significant improvements in knowledge of ACS symptoms ($p < .001$), attitudes ($p = .009$) and beliefs ($p < .001$) sustained at the six-month follow-up. As was the intention in the implementation of the Heart Attack Action Plan, the between-

group differences were statistically significant at both the one-month (p = .001) and six-month follow-ups (p = .027). The number of cardiac emergency department visits by ambulance (p = .154) was not statistically significant (intervention group = 89% and control group = 43%). Finally, the majority (94.23%) of participants were satisfied with the SAVE app.

Conclusion: The SAVE app is feasible and has the potential to support patient education by enhancing their engagement and improving their knowledge, attitudes and beliefs of ACS symptoms and response actions to symptoms and their intention to use ambulance services. The education application has the potential to reduce mortality and morbidity among patients with ACS. Future studies with a larger sample size and longer follow-up are necessary to evaluate the effect of this intervention on clinical outcomes.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university, and to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: Jintana Tongpeth .....

Jintana Tongpeth

Date: 27.07.2018 .....

ACKNOWLEDGEMENTS

I wish to acknowledge and extend my sincerest thanks to the following people for their valuable contribution and support during my PhD journey and completion of this thesis.

First and foremost, I would like to express my deepest gratitude to and profound respect for my principal supervisor, Professor Robyn Clark of the College of Nursing and Health Sciences, Flinders University, for her invaluable support, timely and thoughtful advice, critical feedback and constant encouragement. I also extend my sincere gratitude and indebtedness to my associate supervisor, Dr Huiyun Du of the College of Nursing and Health Sciences, Flinders University, for her unceasing support, timely and knowledgeable advice and incisive criticism. Her expertise in cardiovascular care, insightful comments and invaluable supervision contributed enormously to the success of this research.

I would also like to show my gratitude to Dr Narelle Berry, Dr Julie Franzon and Dr Constance Kourbelis of the acute care and cardiovascular research team for their guidance and support. I would like to express my deepest gratitude to Tracey Barry, a wonderful research assistant, who helped me to undertake the randomised controlled trial at the study site.

I would like to express my genuine appreciation and gratitude to Pawel Skuza for his valuable consultation on statistical issues. I also give special thanks to Peter Newman and Raechel Damarell, the wonderful librarians at Flinders University, who contributed their great expertise to my thesis. I would also like to extend my gratitude to Dr Lindy King, Dr Linda Sweet, Sandra Taheny and all the staff at the College of Nursing and Health Sciences.

I would like to express my sincerest appreciation and gratitude to Sharon Burn at the Cardiac Care Unit, Flinders Medical Centre, for her assistance during the randomised controlled trial and data collection.

I am also deeply indebted to the clinical cardiac nurse managers, cardiac rehabilitation nurses, nurses and administration staff at the research sites for their cooperation, support and friendliness during the data collection phase of the study. Without their great support and hard work, this research project might not have been completed smoothly.

I would like to express my deepest gratitude to the patients who participated so willingly in this study. Their commitment and interest in this research made the study possible.

It is my genuine pleasure to express my deep sense of love and boundless thanks to all the brilliant and delightful PhD fellows, Dr Philippa Rokkas, Dr Anna Hall, Dr Ting Liu, Parichat Wonggom, Daya Ram Parajuli, Omar Smadi, Qiang (Tony) Tu and my friends in the College of Nursing and Health Sciences for their support, warm caring and sincere sharing along our PhD roads from the beginning and into the future.

I am thankful to the Royal Thai Government scholarship, the Prachomklao College of Nursing, Praboromarajchanok, and the Institute for Health Workforce Development, Ministry of Public Health, Thailand, that supported me to pursue my PhD.

Most importantly, my heartfelt gratitude and immeasurable appreciation goes to my dedicated and passionate dear friends, Jane Suwantinprapa, Chompunut Kangkhun and Natkritta Chaowararak for their encouragement, relentless support, loyal friendship and the many laughs over the course of this thesis and beyond.

My deepest gratitude goes to my family—my parents, my sisters, Benja and Jurarat, and my niece Kwintida for their incalculable sacrifice and unconditional support throughout my journey. Their sincere love, inspiration and encouragement strengthened my confidence to reach my goal. The fact that they are always standing by me is the greatest part of my success. Without them, it would certainly have been much harder to finish my PhD. I thank them for their love and making my world full of joy. It is to them that I dedicate this thesis.

FUNDING

2016 Student Conference Travel Fund, Faculty of Medicine Nursing and Health Science, Flinders University. Presentation at the 64th Cardiac Society of Australia and New Zealand Annual Scientific Meeting, 4−7 August 2016, Adelaide, AUD500.

2016 Council on Cardiovascular and Stroke Nursing Early Career Research Travel Stipend. Presentation at the American Heart Association's Scientific Session 2016, 12−16 November, 2016, New Orleans, USD600.

2016 Royal Thai Government Conference Travel Fund. Presentation at the American Heart Association's Scientific Session 2016, 12−16 November, 2016, New Orleans, AUD5,525.

2016 Flinders University Student Association Development Grant. Presentation at Acute Cardiovascular Care 2016, 15−17 October, 2016, Lisbon, AUD750.

2017 Student Conference Travel Fund, Faculty of Medicine Nursing and Health Science, Flinders University. Presentation at the 27th Australian Cardiovascular Health and Rehabilitation Association Annual Scientific Meeting, 7−9 August 2017, Perth, AUD500.

2018 Royal Thai Government Conference Travel Stipend. Presentation at the EuroHeartCare Congress 2018, 7−9 June 2018, Dublin, AUD1,000.

2018 Travelling Fellowship, Cardiac Society of Australia and New Zealand, Presentation at the CSANZ Annual Scientific Meeting, 2-5 August 2018, Brisbane, AUD1,000.

ANTHOLOGY OF PUBLICATIONS AND PRESENTATIONS

Published Papers

Tongpeth, J, Du, H & Clark, R 2018, 'Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome', *Journal of Clinical Nursing*, <https://doi.org/10.1111/jocn.14528>. (Impact Factor 1.635)

Tongpeth, J, Du, H & Clark, R 2018, 'An avatar-based education application to improve patients' knowledge of and response to heart attack symptoms: A pragmatic randomized controlled trial protocol', *Journal of Advanced Nursing*, <https://doi.org/10.1111/jan.13767>. (Impact Factor 2.267)

Tongpeth, J, Du, H, Clark, R 2016, 'The evaluation of an avatar-based education application for improving knowledge on symptom recognition and response management in patients with acute coronary syndrome', *Australian New Zealand Clinical Trials Registry*, <https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=370641>. Trial Id: ACTRN12616000803493 on 20 June 2016.

Paper Under Review

Tongpeth, J, Du, H & Clark, R 2018, 'Evaluation of an avatar-based education application for improving knowledge of and response to symptoms of acute coronary syndrome: A pragmatic randomised controlled trial', submitted on May 2018 to the *Journal of Advanced Nursing.* (Impact Factor 2.267)

Tongpeth, J, Du, H & Clark, R 2018, 'Avatar-based technology interventions in patient education: an integrative review', submitted on August 2018 to the *Journal of Patient Education and Counseling.* (Impact Factor 2.429)

Published Abstracts

Tongpeth, J, Du, H, & Clark, R 2018, 'The effectiveness of an avatar-based education application on knowledge and response to heart attack symptoms-A pragmatic randomised trial in patients with acute coronary syndrome', *European Journal Of Cardiovascular Nursing,* vol,17, suppl, <https://journals.sagepub.com/doi /pdf/10.1177/1474515118787764>

Tongpeth, J, Du, H, and Clark, R, 2018, 'The Effectiveness of an Avatar-based education application on improving knowledge and response to heart attack symptoms: a pragmatic randomised trial in patients with acute coronary syndrome', *Heart, Lung and Circulation*, vol, 27, suppl, p.S388. <https://doi.org/10.1016/j.hlc.2018.06.776>

Tongpeth, J, Du, H, & Clark, R 2016, 'Using participatory action research to develop an avatar-based education application for improve knowledge of symptom recognition and response for patients with acute coronary syndromes', *Heart, Lung and Circulation*, vol. 25, suppl, 2, <https://doi.org/10.1016/j.hlc.2016.06.715>.

Tongpeth, J, Du, H, Clark, RA, 2016, 'Development and acceptability evaluation of an avatar-based education application for improving knowledge of symptom recognition and response for patients with acute coronary syndromes', *European Heart Journal: Acute Cardiovascular Care*, vol. 5, no. 1, <https://doi.org/10.1177/2048872616663431>.

Tongpeth, J, Du, H & Clark, R, 2016, 'Collaborative development of an avatar-based application for improving knowledge on symptom recognition and management in patients with acute coronary syndrome', *European Journal of Preventive Cardiology*, vol. 23, no. 2, <https://insights.ovid.com/european-preventive-cardiology/ejpc/2016/10/001/collaborative-development-avatar-based-application/25/01631686>.

Tongpeth, J, Du, H, & Clark, R, 2016, 'Development and preliminary evaluation of an avatar-based educational application for improving knowledge on symptom recognition and management in patients with acute coronary syndromes', *Circulation: Journal of the American Heart Association*, vol. 134, suppl, 1, <http://circ.ahajournals.org/content/134/Suppl_1/A12172.short>.

Conference Presentations

Tongpeth, J, Du, H & Clark, R 2018, 'The effectiveness of an avatar-based education application on knowledge and response to heart attack symptoms—a pragmatic randomised trial in patients with acute coronary syndrome', Oral presentation at the 64th Cardiac Society of Australia and New Zealand Annual Scientific Meeting, 2-5 August, Brisbane.

Tongpeth, J, Du, H & Clark, R 2018, 'The effectiveness of an avatar-based education application on knowledge and response to heart attack symptoms—a pragmatic randomised trial in patients with acute coronary syndrome', oral presentation of abstract at to the EuroHeartCare Congress for the doctoral students' prize session, Dublin, 7−9 June.

Tongpeth, J, Du, H & Clark, R 2017, 'A patient centred approach to develop an avatar-based education application for improving knowledge on symptom recognition and response management in patients with acute coronary syndrome', poster presented to the inaugural South Australian Cardiovascular Research Showcase, hosted by the Heart Foundation and South Australian Medical Research Institute (SAHMRI), Adelaide, 27 October.

Tongpeth, J, Du, H & Clark, R 2017, 'The effectiveness of an avatar-based education application to improve knowledge and response to heart attack symptoms in acute coronary syndrome (ACS) patients: Interim one-month results from pragmatic randomised trial', poster presented to the inaugural South Australian Cardiovascular Research Showcase, hosted by the Heart Foundation and South Australian Medical Research Institute (SAHMRI), Adelaide, 27 October.

Tongpeth, J, Du, H & Clark, R, 2017, 'An avatar-based education application to improve knowledge and response to heart attack symptoms in acute coronary syndrome (ACS) patients: Interim one-month results from a single-centre, non-blinded, pragmatic randomised controlled trial', oral presentation at to the 27th Australian Cardiovascular Health and Rehabilitation Association Annual Scientific Meeting, Perth, 7−9 August.

Tongpeth J, Du, H & Clark, R, 2016, 'Using participatory action research to develop an avatar-based education application for improve knowledge of symptom recognition and response for patients with acute coronary syndromes', oral presentation at the 64th Cardiac Society of Australia and New Zealand Annual Scientific Meeting, 4−7 August, Adelaide.

Tongpeth, J, Du, H & Clark, R 2016, 'Using consumer participation to develop an avatar-based application for teaching recognition and response to heart attack symptoms in elderly acute coronary syndrome', oral presentation at the 26th Australian Cardiovascular Health and Rehabilitation Association Annual Scientific Meeting, 1−3 August, Adelaide.

Tongpeth, J, Du, H & Clark R, 2016, 'Development and acceptability evaluation of an avatar-based education application for improving knowledge of symptom recognition and response for patients with acute coronary syndromes', paper presented to the Acute Cardiovascular Care 2016, 15−17 October, Lisbon.

Tongpeth, J, Du, H & Clark, R, 2016, 'Development and preliminary evaluation of an avatar-based education application for improving knowledge of symptom recognition and management in patients with acute coronary syndromes', oral presentation at the American Heart Association's Scientific Sessions 2016, 12−16 November, New Orleans.

Tongpeth, J, Du, H & Clark, R 2015, 'The development and evaluation of a simple avatar-based application for improving chest pain education', oral presentation at the Virtual Health Colloquium, School of Health Sciences, Flinders University in association with the Public Health Association of Australia (SA Branch), 30 October, Adelaide.

Concurrent Published Works Not Included in This Thesis

Franzon, J, Berry, NM, Wonggom, P, Astley, C, Du, H, **Tongpeth, J**, Parajuli, DR, Nicholls, SJ and Clark, RA 2018, 'Patients' satisfaction with information at discharge', *British Journal of Cardiac Nursing*, vol. 13, no. 4, pp. 182−9.

Du, H, Wonggom, P, **Tongpeth, J** & Clark, R 2017, 'Six-minute walk test for assessing physical functional capacity in chronic heart failure'. *Current Heart Failure Reports*, vol. 14, no. 3, pp. 158−66.

Wonggom, P, **Tongpeth, J**, Newman, P, Du, H & Clark, R 2016, 'Effectiveness of using avatar-based technology in patient education for the improvement of chronic disease knowledge and self-care behavior: A systematic review protocol', *JBI Database of Systematic Reviews and Implementation Reports*, vol. 14, no. 9, pp. 3−14.

Berry, N, Astley, C, Du, H, Wechkunanukul, K, **Tongpeth, J**, Wonggom, P & Clark, R 2016, 'Perceptions from cardiac and stroke patients of the information provided by health professionals at discharge from hospital (2012−2014)', *Heart, Lung and Circulation*, vol. 25, p. S301.

Franzon, J, Berry, N, Wonggom, P, Astley, C, Du, H, **Tongpeth, J**, Parajuli, D, Nicholls, S & Clark, R 2017, 'Demographics and satisfaction with discharge information in cardio- and cerebrovascular patients', *Heart, Lung and Circulation*, vol. 26, suppl. 2, p. S345.

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter provides an overview of cardiovascular disease (CVD) and acute coronary syndrome (ACS), as well as the current global status of these diseases. The symptoms and management of ACS are then described, followed by a discussion of the delays in seeking medical care for patients with ACS, the factors associated with such delays and knowledge about ACS symptoms. Next, the association between innovative technologies and patient education is described and an overview of avatar-based technologies is provided. Finally, the aims, objectives and structure of the thesis are presented.

1.2 Background

1.2.1 Cardiovascular Disease

CVD is the number one cause of death worldwide. In 2015, an estimated 17.7 million people died from CVD, representing 31 per cent of all deaths globally (World Health Organization [WHO] 2017a). More people died from CVD when compared to any other cause (WHO 2017b). In Australia, CVD was the main cause of hospitalisations in 2014−15, an increase of 8 per cent from 2004−05 to 2014−15 (Australian Institute of Health and Welfare [AIHW] 2016b).

Coronary heart disease (CHD) is the most common form of CVD and covers a spectrum of clinical presentations, including ACSs (i.e., unstable angina [UA], myocardial infarction [MI], silent ischemia and sudden death), stable angina and cardiac failure (Zorca & Mizuguchi 2017). Angina occurs through a restriction in blood flow and temporary imbalance in the supply and demand of oxygen (Worrall & Fletcher 2018). As the narrowing of the coronary arteries progresses, blood flow decreases further or stops, causing permanent damage to the myocardium that is called MI or, more commonly, heart attack (Spinler & de Denus 2016).

Despite a decline in global mortality rates attributed to CHD, 42 per cent of all deaths are still associated with CVDs (WHO 2017a). In the United States of America (USA), 16.5 million people over the age of 20 have CHD (Benjamin et al. 2017) and each year in Europe, 45 per cent of all deaths (more than 4 million) are attributable to CHD (Townsend et al. 2016). In Australia, CHD was the single leading cause of death in 2013, accounting for 19,800

deaths and representing 13 per cent of all deaths and almost one in two cardiovascular deaths. CHD is more prevalent in older people—17 per cent of people aged 75 and over have CHD, 10 times that of people aged 45−55 (1.7%) (AIHW 2016a) (see Figure 1.1).

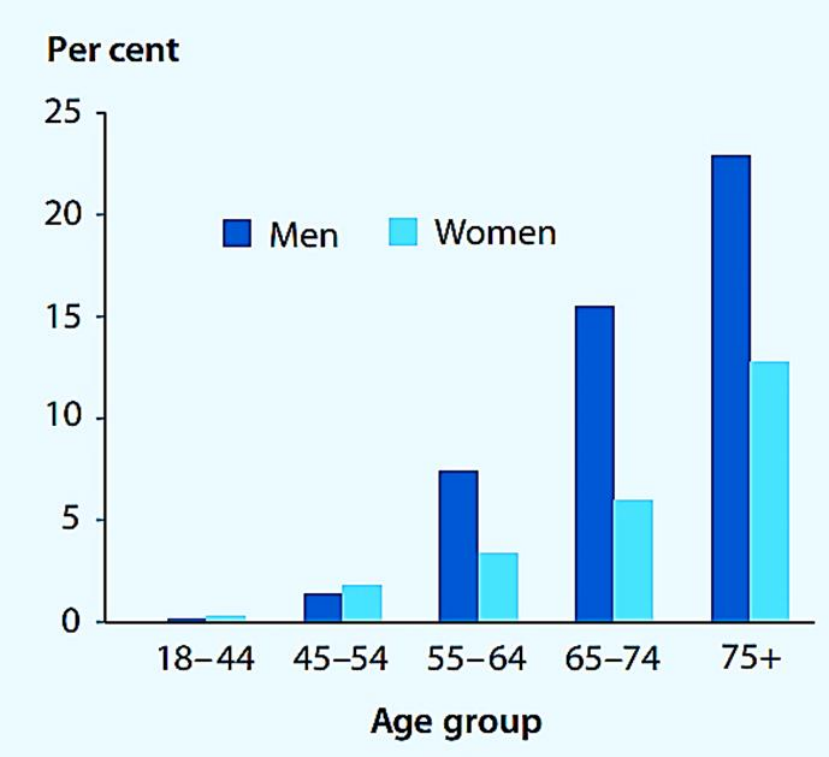


Figure 1.1: Coronary Heart Disease in People Aged 18 and Over, 2014−15

Note: Figure by age and sex; self-reported data

Source: AIHW 2016a

While the prevalence of CHD is alarming, public awareness of this condition is low. A survey of 2,379 females and 1,152 males aged 55 years or younger who were hospitalised for MI showed that only 45.1 per cent of females and 49.2 per cent of males recalled being told they were at risk of CHD or that they had a heart problem (Benjamin et al. 2017). Only 45.9 per cent of females and 54.7 per cent of males reported discussing CHD risk factors and their management with their health care providers (Leifheit-Limson et al. 2015).

The primary feature of CHD is insufficient blood supply to the myocardium due to narrowing of the coronary arteries (Zorca & Mizuguchi 2017). The most important underlying pathologic process that affects the coronary arteries and leads to CHD is atherosclerosis (Furie et al. 2010). The coronary artery consists of three main layers: the intima (i.e., inner layer), the media (i.e., layer between the internal and external elastic laminae) and the adventitia (i.e., outer layer) (Zorca & Mizuguchi 2017). Atherosclerosis starts as a protective process

resulting from an inflammatory fibroproliferative response to endothelial injury within the intima, involving lipid deposition, cellular infiltration and degenerative and inflammatory changes (Anderson & Morrow 2017; Crea & Libby 2017; Spinler & de Denus 2016). Atherosclerosis has been considered a chronic inflammatory, degenerative and proliferative process affecting medium- and large-sized arteries throughout the cardiovascular system (Crea & Liuzzo 2013; Santos-Gallego, Picatoste & Badimón 2014). The common consequences of this progressive inflammatory process are thickened and less elastic blood vessels, leading to compromised blood flow, obstruction of the arteries and the stepwise progression of disease severity, leading to occlusion and occasional vessel rupture in larger vessels (Anderson & Morrow 2017; Zorca & Mizuguchi 2017). Thrombus formation and occlusion is caused by the adhesion, activation and aggregation of superimposed platelets as a result of plaque rupture (Santos-Gallego, Picatoste & Badimón 2014; Spinler & de Denus 2016). MI occurs if the occlusive thrombus evolves into complete occlusion of the coronary artery, while a partially occlusive thrombus causes UA (Anderson & Morrow 2017; Giugliano & Braunwald 2014; Zorca & Mizuguchi 2017).

Atherosclerosis is a common finding in autopsies in people of all ages—including in children aged less than one year—and with or without CHD and the rate of atherosclerosis progression is variable and related to risk factors (Ross 1999). Even though CHD may not develop in the early stage of life, the early formation of atherosclerosis has a significant association with adult coronary risk factors (Hennink-Schadenberg & Preckel 2018; Zorca & Mizuguchi 2017).

CHD is the largest cause of death globally yet more people live with than die of coronary atherosclerosis (Benjamin et al. 2017; Giugliano & Braunwald 2014; WHO 2017b). This leads to the question of why a previously stable plaque of atherosclerosis suddenly becomes more vulnerable and ruptures, becoming more thrombogenic and causing life-threatening ACS (Giugliano & Braunwald 2014).

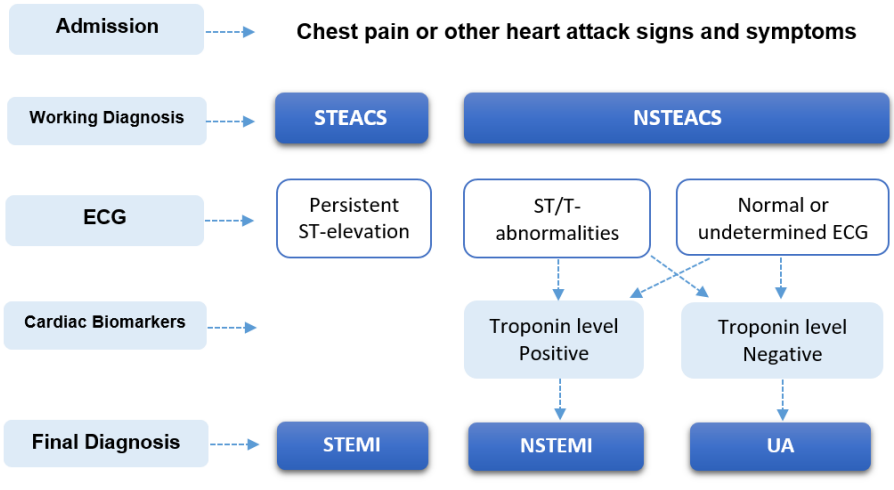
1.2.2 Acute Coronary Syndrome

ACSs are usually acute ischemic events that are primarily caused by a sudden blockage that reduces blood from the heart arteries (Smith et al. 2015; Spinler & de Denus 2016; Worrall & Fletcher 2018). The most common cause of ACS is atherosclerosis or coronary artery disease in which fatty deposits build-up on the inside walls of the blood vessels that supply the heart (Sanchis-Gomar et al. 2016; Santos-Gallego, Picatoste & Badimón 2014).

In the USA, one person has a MI every 40 seconds (Benjamin et al. 2017). In any given year, approximately 36 per cent of the USA population who experiences a coronary event will die because of it and around 14 per cent who experiences a MI will die of the condition (Benjamin et al. 2017).

In 2015, ACS claimed the lives of 8,443 Australians (Australian Bureau of Statistics [ABS] 2016). It is estimated that 430,000 Australians have had a MI at some time in their lives (ABS 2015) and that that 428,000 adults experienced a MI in 2014−15 (AIHW 2016a).

ACS is defined as a spectrum of conditions associated with an abrupt reduction in coronary blood flow, including acute myocardial ischemia or infarction (Anderson & Morrow 2017; Santos-Gallego, Picatoste & Badimón 2014). With respect to a working diagnosis, ACS includes the diagnosis of MI, including ST-segment elevation MI (STEMI) and non–ST-segment elevation ACS, which refers to any ACS that does not show ST-segment elevation. Non–ST-segment elevation ACS is further subdivided into non–ST-segment elevation MI (NSTEMI) and UA according to blood tests of cardiac biomarkers to confirm myocardium damage (Anderson & Morrow 2017; Santos-Gallego, Picatoste & Badimón 2014). STEMI is a type of MI with ST-segment elevation on an electrocardiogram (Chew et al. 2016; Fihn et al. 2014; Howard & Wenger 2016) (see Figure 1.2). NSTEMI is a MI without ST-segment elevation but with elevation in serum troponin levels (Amsterdam et al. 2014; Chew et al. 2016; Rodriguez & Mahaffey 2016).



STEMI: ST- segment Evaluation Myocardial Infarction
NSTEMI: Non-ST- segment Evaluation Myocardial Infarction
NSTEACS: Non-ST-segment Evaluation Acute Coronary Syndrome
UA: Unstable angina
ECG: Electrocardiogram

Figure 1.2: Working Diagnosis of Acute Coronary Syndromes

UA is a sudden and worsening chest pain due to reduced blood flow to the myocardium without an apparent trigger, as opposed to stable angina, which is chest pain during extreme

emotion or physical activity that disappears immediately after a few minutes of rest (Crea & Libby 2017). UA represents a small but significant proportion (<4%) of patients presenting with possible chest pain without abnormalities in their cardiac biomarkers and electrocardiogram (Smith et al. 2015). UA is measured against a patient's usual pattern of 'stable angina' that is commonly classified according to the New York Heart Association's Functional Classification of angina (Amsterdam et al. 2014). A new onset of angina should be first considered unstable and a high-priority case (Chew et al. 2016).

1.2.3 Symptoms of Acute Coronary Syndrome

A patient begins experiencing the warning signs and symptoms of ACS when the coronary arteries become so narrowed that the coronary blood supply is insufficient to meet the metabolic demands of the myocardium cell, resulting in ischemia (Anderson & Morrow 2017; Santos-Gallego, Picatoste & Badimón 2014). The symptoms often result from too much exertion or physical or emotional stress (Anderson & Morrow 2017; Worrall & Fletcher 2018). It is important to consider that not all myocardial ischemia patients experience any signs, symptoms or chest discomfort (DeVon et al. 2017; Kreatsoulas et al. 2016). Further, when patients present with symptoms of central chest pain, it is not always cardiac originated (Hennink-Schadenberg & Preckel 2018; Shenoy & Kumar 2014). The typical signs and symptoms may include pain in the upper body areas, including in one or both arms, the jaw, neck or stomach, tightness, pressure, burning or heaviness in the chest and complaints of a 'squeezing' feeling, sweating or shortness of breath (DeVon et al. 2017; Shenoy & Kumar 2014). Other signs and symptoms may include numbness, diaphoresis, fullness, indigestion, nausea and vomiting and irregular heartbeats (Riegel et al. 2010). Patients may also report a feeling of anxiety, a general feeling of unwellness or unusual fatigue (Crea & Libby 2017; Spinler & de Denus 2016).

The literature reveals that many patients who experience a MI may not recognise the symptoms (Basu & Sharma 2016; DeVon et al. 2017; Dracup et al. 2008). Nearly one third of confirmed MI patients had symptoms other than chest pain. Those patients were more likely to be older, female and have CVD risk factors, such as diabetes, smoking or a family history of the disease (DeVon et al. 2017; Diercks et al. 2010; Farquharson, Johnston & Bugge 2012; Lichtman et al. 2015). Other atypical presentations of ACS include nausea, vomiting, fatigue, cold sweats, becoming pale and headache (see Table 1.1).

Table 1.1: Common Signs and Symptoms of Acute Coronary Syndrome

Typical symptoms	Atypical symptoms
Chest pain/pressure	Dyspnoea
Neck pain/pressure	Diaphoresis
Back and shoulder pain/pressure	Fainting
Jaw pain/pressure	Cold sweats
Arm pain/pressure	Dizziness
Stomach pain/pressure	Nausea/vomiting
Discomfort/tightness in upper body	Becoming pale
Shortness of breath	Fatigue
	Light-headedness

Sources: Bruno 2013; DeVon et al. 2017; Jaffery et al. 2009; Khan et al. 2017; Kreatsoulas et al. 2016; Lichtman et al. 2015; World Heart Federation 2013

It is important to realise that 76 per cent of deaths associated with MI occur outside the hospital setting. Early arrival to an emergency department (ED) after the onset of symptoms and an optimum course of treatment is essential for patients' survival (DeVon et al. 2010; Sorita et al. 2014; Youssef et al. 2017).

1.2.4 Phases of Acute Coronary Syndrome Management

The goal of ACS management is to maximise patients' recovery and reduce their risk of a future cardiac event. Management of ACS can be divided into four phases (Roffi et al. 2016). The first phase involves early diagnosis and rapid risk stratification, pain relief and cardiac arrest prevention (Shand & Menown 2010). In the second phase, reperfusion therapy is initiated to limit the size of the infarct and prevent the extension and expansion of the infarcted area. In this phase, immediate complications such as acute heart failure, carcinogenic shock and life-threatening arrhythmias are also treated (National Heart Foundation of Australia [NHF] 2012; Mol et al. 2016). Subsequent care for complications is addressed in the third phase. These three phases each correspond to pre-hospital emergency care, the ED or coronary care unit (CCU) and the post-CCU, respectively (Chew et al. 2016; Roffi et al. 2016). The survival of people who experience a MI is dependent on timely diagnosis and treatment, with rates improving by 5.5 per cent if treatment begins within one hour (Wang et al. 2011). Therefore, early identification of ACS symptoms and diagnosis is essential for timely treatment and optimal patient outcomes.

1.2.5 Delay in Acute Coronary Syndrome Management

As explained above, the delay in time between symptom onset and the initiation of diagnosis and treatment is strongly associated with increased mortality, morbidity and preventable

complications (Cullen et al. 2016; DeVon et al. 2017; Dracup et al. 2008; Giugliano & Braunwald 2014; Makam et al. 2016). The timeframe of the delay in seeking medical care for ACS symptoms begins from the initiation of symptom onset through to the administration of therapy (see Figure 1.3).

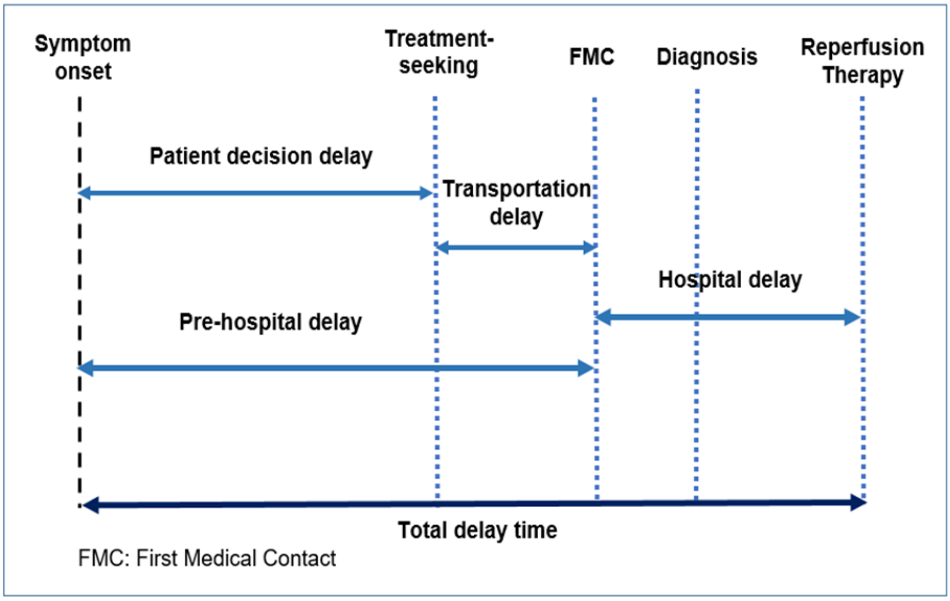


Figure 1.3: Phases of Delay in Seeking Medical Care

When a patient suffers from ACS, the most important step is deciding whether they should go to hospital, call an ambulance or stay and wait for a while. This is called decision time; it is the first part of the process and involves patients and bystanders and the time between symptom onset to seek medical attention (Baxter & Allmark 2013; Dracup et al. 1995; McKinley et al. 2004). The second part of the delay consists of travelling or transportation time in which most of this time is spent on transportation between the location of the cardiac episode and the ED (Bahall & Legall 2017; Baxter & Allmark 2013; Dracup et al. 1995). The first two parts of the framework are defined as 'patient decision delay' and 'transportation delay', or the time to seek care during the 'pre-hospital delay' time (AlHabib et al. 2016; Alonzo 1984; Baxter & Allmark 2013; Darawad et al. 2016; Dracup et al. 1995).

The patient's arrival and triage at the ED until they receive a definitive therapy involves the health care system and clinical practices. The interval between arriving for triage and being examined by an ED doctor is defined as the 'time to treatment'. The amount of time that the patient waits for definitive therapy is defined as 'door-to-balloon time' or 'door-to-needle time'. This last time component is called 'in-hospital delay', in which health professionals and clinical governance play a vital role in the process (AlHabib et al. 2016; Alonzo 1984; Correia et al. 2013; Dracup et al. 1995; Rollando et al. 2012).

This entire process is the delay in seeking medical assistance for the onset of chest pain. The total amount of time the patient spends from symptom onset to the initiation of definitive therapy is defined as ‘delay time’. The entire framework involves patients, bystanders, paramedics, clinical staff and the health care system. The definition of delay time is described in Table 1.2.

Table 1.2: Definition of the Phases of Delay in Seeking Medical Attention

Term	Definition
Symptom onset	Time during which the patient reported becoming acutely or severely ill, prompting the patient to seek medical attention (Goldberg et al. 2009)
Treatment seeking	The time of first contact between the patient and ED doctor initially responsible for their care (Atzema et al. 2011; Darawad et al. 2016; Lee 2015)
Patient delay	The interval time between the time of symptom onset and the decision to seek medical attention (Moser et al. 2007; Nielsen et al. 2016; Youssef et al. 2017)
First medical contact	The point at which the patient is either initially assessed by a paramedic, physician or other emergency medical personnel in the pre-hospital setting or the patient arrives at the hospital ED (Dodin 2014; Hafiz et al. 2013)
Pre-hospital delay	The delayed time from symptom onset to the arrival at the ED (Australian Commission on Safety and Quality in Health Care 2014; Dracup et al. 2009; Goldberg et al. 2009)
Transportation delay	The interval time between the time the patient seeks help and first medical contact (Lee 2015; Ma et al. 2017)
Hospital delay	The interval time between first medical contact, working diagnosis and reperfusion therapy (Ayrik et al. 2006; Hafiz et al. 2013)
Total delay time	The interval time from the onset of symptoms to definitive medical care initiation (i.e., reperfusion therapy) (AlHabib et al. 2016; Goldberg et al. 2002; Mackay et al. 2014)

Note: ED = emergency department

However, there has been no minimal improvement in the delay in ACS management over the past two decades (Ayrik et al. 2006; Bahall & Legall 2017; Baxter & Allmark 2013; Dracup, McKinley & Moser 1997; Mooney et al. 2014; Ottesen et al. 1996). The median pre-

hospital delay time in seeking medical assistance varies from country to country and ranges from one hour and 50 minutes (Yan et al. 2009) to 12.9 hours (Alshahrani et al. 2014). From 26 studies, the median pre-hospital delay time was 3.54 hours. Only three studies reported a pre-hospital delay time of shorter than two hours: 1.78 hours (Ottesen et al. 2004), one hour and 50 minutes (Ayrik et al. 2006; Yan et al. 2009) and 1.62 hours (Mussi et al. 2014) (see Table 1.3). Several studies also reported that the decision time, consisting of delay time and median decision time, was 1.23 hours (Ottesen et al. 2004), 60 minutes (Taylor et al. 2005; Yan et al. 2009) and 2.5 hours (Alshahrani et al. 2013). Perkin-Porras et al. (2009) revealed that 60 per cent of participants' delay in seeking medical attention is attributed to decision time and 60.8 per cent of patients had decision times shorter than 60 minutes (see Table 1.3). Six of 26 studies noted that the decision time was responsible for the major part of pre-hospital delay time, ranging from 50 to 83 per cent (Alshahrani et al. 2013; Mussi et al. 2014; Perkins-Porras et al. 2009; Tabriz et al. 2012; Yan et al. 2009). Most studies found that only one quarter of patients presented to the ED within two hours of the onset of symptoms.

Table 1.3: Delay Times and Findings from Studies from the Past Two Decades

	Author(s) Year	Setting Study size	Pre-hospital delay time (median)	Finding	Ambulance use (%)
1	Ottesen et al. (1996)	Denmark n = 5,978	3.25 hrs	34% of patients arrived at hospital within two hrs 68% of patients arrived at hospital within six hrs 40.3% of patients were admitted for thrombolytic treatment	N/A
2	Dracup, McKinley and Moser (1997)	Australia n = 317	6.4 hrs	41% of patients were delayed fewer than four hrs 54% of patients were delayed more than six hrs 61% of patients were transported by ambulance	61.0%
3	Horne et al. (2000)	United Kingdom n = 88	2.20 hrs	45% of patients were transported by ambulance Longer delay time was associated with failure to call ambulance	45%
4	Luepker et al. (2000)	USA n = 20,364	2.33 hrs	No significant differences in delay time between intervention and control group 33% of patients were transported by ambulance	33%
5	Ottesen et al. (2004)	Denmark n = 250	1.78 hrs	Median decision time was 1.23 hrs	N/A
6	Fukuoka et al. (2005)	Japan n = 145	3 hrs and 34 mins	12% of patients arrived at hospital within one hr 40% of patients were delayed more than six hrs 46% of patients called emergency 45% of patients were transported by ambulance	45.0%
7	Taylor et al. (2005)	Australia n = 150	3.17 hrs	52.7% patients arrived at hospital in more than three hrs Mean decision time was one hr	
8	Pitsavos et al. (2006)	Greece n = 2,172	3.5 hrs	38% of patients were delayed more than six hrs 22% of patients arrived at hospital within two hrs Patients delayed more than two hrs had a mortality rate 2.5 times higher than those that arrived within two hrs	N/A
9	Ayrik et al. (2006)	Turkey n = 178	1 hr and 50 mins	22% of patients arrived at hospital within one hr 74% of patients were delayed more than one hr 21% of patients were transported by ambulance	21.0%

	Author(s) Year	Setting Study size	Pre-hospital delay time (median)	Finding	Ambulance use (%)
10	Noureddine et al. (2006)	Lebanon n = 204	4.52 hrs	24.8% of patients were delayed more than 12 hrs 31.8% of patients were delayed 1−3 hrs 11.9% of patients arrived at hospital in under one hr	N/A
11	Khan et al. (2007)	Pakistan n = 720	3.04 hrs	36% of patients arrived at hospital within two hrs 34% of patients arrived at hospital ≥6 hrs	N/A
12	Srimahachota et al. (2007)	Thailand n = 9,373	4 hrs	52.6% of patients received reperfusion therapy 34% of percutaneous coronary interventions were performed within 90 mins 9% of thrombolysis were performed within 30 mins	N/A
13	Perkins-Porras et al. (2009)	United Kingdom n = 228	2 hrs	60% of delay was attributed to decision time 60.8% of patients had a decision time ≤60 mins 53.7% of patients had a home-to-hospital delay of ≤60 mins 45% of patients were transported by ambulance	45.0%
14	Yan et al. (2009)	China n = 498	1 hr and 50 mins	Median decision time was 60 mins 57.2% of patients were delayed within two hrs 37.3% of patients were transported by ambulance	37.3%
15	Ting et al. (2010)	USA n = 104	2.6 hrs	59% of patients were delayed more than two hrs Delay time has not changed significantly from 2001−06 Patients presented during weekday and weekend night had 25% shorter delay than those who presented during weekday daytime	N/A
16	Atzema et al. (2011)	Canada n = 4,403	2.00 hrs	46.3% of patients arrived at hospital in fewer than two hrs 73.6% of patients arrived at hospital in more than six hrs 41.75% of patients were transported by ambulance	41.7%
17	Tabriz et al. (2012)	Iran n = 513	2.45 hrs	19% of patients arrived at hospital within two hrs Decision time was responsible for 83% of entire delay time	Emergency medical services only
18	Eshah (2013)	Jordan n = 150	4 hrs	28% of patients arrived at hospital within two hrs 58.7% of patients arrived at hospital within six hrs	N/A
19	Alshahrani et al. (2013)	Saudi Arabia n = 189	5 hrs (male) 12.9 hrs (female)	Median decision time was 2.5 hrs The decision time of females was longer than that of males 8% of patients were transported by ambulance	8.0%

	Author(s) Year	Setting Study size	Pre-hospital delay time (median)	Finding	Ambulance use (%)
20	Mussi et al. (2014)	Brazil n = 97	1.62 hrs	Geometric mean decision time was 0.94 hrs 96.9% of patients arrived at hospital by private car 3.1% of patients (all were women) were transported by ambulance	3.1%
21	Mooney et al. (2014)	Ireland n = 1,944	4.04 hrs	Median pre-hospital delay time was 1.7 hrs in the intervention group and 7.1 hrs in the control group 39% of patients were transported by ambulance	39%
22	Peng et al. (2014)	China n = 1,088	2.16 hrs	38% of patients were delayed more than six hrs 48.6% of patients arrived at hospital within two hrs 59.1% of patients were transported by ambulance	59.1%
23	Tummala and Farshid (2015)	Australia n = 100	2.25 hrs	No significant differences in delay time between encountered National Heart Foundation of Australia advertisement and those who had not (2.21 hrs v 2.28 hrs) 34% of patients were transported by ambulance	34%
24	Rivero et al. (2016)	Spain n = 444	4.02 hrs	89 % of patients age > 75 years were delayed more than 110 minutes 24% of woman were delayed more than 110 minutes	N/A
25	Youssef et al. (2017)	Egypt n = 315	8.7 hrs	22% of patients were delayed fewer than two hrs 78%of patients were delayed more than two hrs	N/A
26	Lavery et al. (2017) Range Average	Australia n = 247	2.2 hrs (by ambulance) 3.7 hrs (not ambulance) 51 mins−6.4 hrs 3.54 hrs	9.7% of patients arrived at hospital within one hr 49.4% of patients were transported by ambulance	49.4%

Ambulance use and emergency medical services play a critical role in the management of ACS (Nehme et al. 2017; Neubeck & Maiorana 2015). Thirteen studies reported the percentage of ambulance use (see Table 1.3). Ambulance use ranged between 3.1 and 61 per cent, with most studies reporting that less than 50 per cent of patients were transported to hospital by ambulance. Studies in Brazil revealed only 3 per cent of patients used an ambulance service (Mussi et al. 2014). This was substantially different from 61 per cent of patients in Australia who called an ambulance when they experienced acute MI (Dracup, McKinley & Moser 1997).

Today, the ambulance is both a mode of transport and a place for initial diagnosis, including electrocardiogram administration and transmission to the hospital, triage and treatment (Lavery et al. 2017). Guidelines from Australia, Europe and the USA strongly recommend the activation of emergency medical services by patients who have symptoms consistent with ACS (Mathews et al. 2011; O'Connor et al. 2014; Tubaro 2010). Ambulance use leads to a faster initial reperfusion intervention (Ma et al. 2017; Bray et al. 2015; Mooney et al. 2016). Decisions relating to treatment, the preparation of a potential reperfusion at hospital and acute transfer to reperfusion facilities in an intervention centre can be more effective with shorter treatment delay (Carstensen et al. 2007; Ma et al. 2017; Mathews et al. 2011; O'Connor et al. 2014).

1.2.6 Factors Associated with Decision Delay

Individual decision time is a major component of the total delay in seeking medical attention for a heart attack. Consequently, improvements aimed at lessening patient delay may help in diminishing the delay to hospital, thereby shortening the time to treatment and leading to better patient outcomes. Ambulance use is a significant factor that improves pre-hospital delay and warrants increased public awareness and knowledge of emergency medical care for a heart attack (Andersson et al. 2017; DeVon et al. 2010; Lavery et al. 2017).

In a study of people with CHD, 44 per cent had low knowledge of ACS symptoms (Dracup et al. 2008). Among the participants, 43 per cent underestimated their risk of a future MI (males 47% and females 36%) (Dracup et al. 2008). A study in Australia reported that only 26 per cent of patients recognised that they were having an acute MI and an ambulance was called in 34 per cent of cases. Only 22 per cent of patients could identify all their personal acute MI risk factors (Tummala & Farshid 2015). However, there was no significant difference in the median pre-hospital delay time between patients who, on recognising MI

symptoms, encountered the NHF advertisements and those who had not (133 minutes v. 137 minutes, p = .809) (Tummala & Farshid 2015).

In addition to the use of ambulance services, there are other potential factors that contribute to pre-hospital delay for a heart attack that vary from study to study, with actual delay times differing between these studies (Ma et al. 2017; Mooney et al. 2016; Neubeck & Maiorana 2015; Savage et al. 2014; Song, Yan & Hu 2010) (see Table 1.4).

A number of studies have demonstrated that the factors influencing delay consist of three distinct domains associated with pre-hospital delay time: 1) socio-demographic and clinical factors, 2) cognitive and emotional factors and 3) situational factors (DeVon et al. 2010; Farshidi et al. 2013; Herlitz et al. 2010; Khan 2011; Khraim & Carey 2009; Lavery et al. 2017; Peng et al. 2014; Perkins-Porras et al. 2009; Roberts et al. 2018). Apart from socio-demographic characteristics, other studies have concluded that the cognitive and emotional response of patients to ACS symptoms plays a crucial role in delay (Contreras 2010; Deshmukh et al. 2011; Dodin 2014; Farquharson, Johnston & Bugge 2012; Farshidi et al. 2013; Herlitz et al. 2010; Hwang et al. 2009; Khan 2011; Lavery et al. 2017; Perkins-Porras et al. 2009; Roberts et al. 2018; Sullivan et al. 2009) (see Table 1.4).

Table 1.4: Factors Associated with Delay in Seeking Medical Attention

Socio-demographic and clinical factors	Marital status
	Age
	Gender
	Employment status
	Education level of patient
	Illiteracy
	Financial status
	History of chronic disease
	History of previous MI
	History of angina
	Family history
Cognitive and emotional factors	Severity of pain
	Symptom assessment
	Symptom appraisal
	Symptom attribution
	Symptom knowledge
	Symptom recognition
	Waiting for pain to ease
	Embarrassed to seek help
	Worried about bothering others
	Fear of seeking help
Situational factors	Episode setting
	Witness of episode
	Time of onset
	Knowledge of bystanders
	Attitude of bystanders
	Response from others

Sources: Bahall & Legall 2017; Contreras 2010; Darawad et al. 2016; Farquharson, Johnston & Bugge 2012; Farshidi et al. 2013; Ghazawy, Seedhom & Mahfouz 2015; Hafiz et al. 2013; Khan 2011; Mata, Frank & Gigerenzer 2014; O'Donnell et al. 2012; Sullivan et al. 2009; Wang et al. 2011

Many studies have indicated that family members and bystanders who witness a cardiac event are influencing factors in reducing pre-hospital delay (see Table 1.4). Patients' and bystanders' recognition and knowledge of the symptoms of ACS and their complications are also considered potential influencing factors in pre-hospital delay (Ayrik et al. 2006; Bahall & Legall 2017; Deshmukh et al. 2011; Dodin 2014; Farshidi et al. 2013; Ghazawy, Seedhom & Mahfouz 2015; Herlitz et al. 2010; Lavery et al. 2017).

Further, witnesses or bystanders tend to favour calling an ambulance over a patient who experiences ACS symptoms if they do not know each other. Herlitz et al. (2010) noted that relatives are more eager to seek help than victims, resulting in shorter decision times. Nevertheless, Cartledge et al. (2017) found that the majority of relatives preferred a private car to an ambulance because they thought a car was a faster mode of transport, which differs from the findings of previous studies.

Despite research into delays in seeking medical care for ACS, pre-hospital delay time has not improved worldwide in the past two decades (Dracup et al. 2003; Goldberg et al. 2009; McGinn et al. 2005; Peng et al. 2014; Wechkunanukul, Grantham & Clark 2017; Youssef et al. 2017). Researchers have recommended further research be carried out to gain an accurate insight into factors influencing pre-hospital delay, such as cognitive factors, including knowledge on ACS symptoms and appropriate responses (Dracup et al. 2003; Goff Jr et al. 1999; Goldberg et al. 2009; Peng et al. 2014; Walters 2015) (see Table 1.4).

In a health care setting, patient education plays an important role in improving cognitive factors, especially materials that focus on improving communication between patients and health care providers and changing the design of educational materials (Roberts et al. 2018; Treskes et al. 2018; Välimäki et al. 2012; Weibel et al. 2016; Wynn Jr 2013; Yousuf et al. 2016).

1.2.7 Knowledge of Acute Coronary Syndrome Symptoms and Delay in Seeking Medical Attention

People with documented CHD are five to seven times more likely to have a MI or die compared to people without a history of CHD (Benjamin et al. 2017). Despite a higher risk of ACS, the literature consistently reports that this population has a low level of knowledge on ACS symptoms. Patients with ACS did not have good knowledge of heart attack symptoms, while many individuals failed to recognise the typical signs and symptoms of heart attack, such as neck pain and sweating (Basu & Sharma 2016; Fang et al. 2011; Jaffery et al. 2009; Tummala & Farshid 2015). Delay in seeking medical assistance when faced with ACS symptoms has been associated with this knowledge deficiency (Neubeck & Maiorana 2015; O'Donnell et al. 2014; Peng et al. 2014; Perkins-Porras et al. 2009; Swanoski et al. 2012).

A qualitative study conducted in Western Australia using open-ended questions directed at 255 participants showed that 23 per cent of the participants did not promptly recognise the symptoms of ACS. They described their experience as being dissimilar to anything they had ever before experienced, not quite right or not feeling well. While 10 per cent of the participants recognised the symptoms, they waited a couple of days before seeking medical assistance (Coventry et al. 2017). This result is consistent with an earlier study of 30 hospitalised women with MI in the USA (Lichtman et al. 2015). Tullmann and Dracup (2005) measured the knowledge of ACS symptoms in 115 older adults (i.e., 65 years or older) who had a history of CHD using an ACS response questionnaire and only 9 per cent correctly

identified chest pain or pressure as a symptom of ACS. In total, 90 per cent of the respondents correctly identified that shortness of breath, arm or shoulder pain, palpitations and sweating were also ACS symptoms, while more than one third did not know about symptoms such as jaw, neck and back pain. This is concerning, and groups of people, especially the elderly, should be educated to understand and recognise these atypical symptoms to decrease the barriers to early help-seeking (Banharak 2017; Bell et al. 2009; Bruno 2013; Chau et al. 2018; Duber et al. 2018; Fernandez, Everett & Sundar 2016; Gillis, Arslanian-Engoren & Struble 2014).

Recognising symptoms of ACS is challenging, as different people experience different symptoms. For example, people older than 65 years of age are less likely to experience cardiac chest pain and more likely to experience atypical symptoms (Banharak 2017; Bruno 2013; Chau et al. 2018), signifying the need for specific education in this area. Moreover, people with a history of ACS had no greater knowledge of ACS than those with no prior history of a MI (Dracup et al. 2008). This issue should be targeted through educating those who are at greatest risk of a repeat ACS event (Tullmann & Dracup 2005).

A study conducted in the USA, Australia and New Zealand by Dracup et al. (2008) used face-to-face interviews to collect data from 3,522 participants using a 26-item instrument focusing on ACS symptom knowledge and appropriate behaviour in seeking medical treatment. The results showed a mean knowledge score of 71 per cent for their sample (range, 8−100%). Of the participants, 44 per cent scored less than 70 per cent on knowledge. Only 69 per cent of relatively high-risk participants reported that they would call an emergency phone number during an ACS event (Dracup et al. 2008).

Another study by Hwang et al. (2009) used face-to-face interviews with both open-ended and structured questions to measure ACS symptom knowledge among 116 Korean immigrants in Chicago. The study reported that knowledge levels were particularly low. Only 50 per cent correctly identified at least one heart attack symptom. Only 15 per cent of participants correctly identified two or more symptoms, with 33 per cent identifying chest pain as the most commonly recognised symptom of ACS. When presented with a list of symptoms and asked again, participants showed greater signs of symptom recognition. On this occasion, 89 per cent identified chest pain as an ACS symptom (Hwang et al. 2009).

A qualitative study from Canada conducted by Cytryn et al. (2009) explored the relationship between ACS knowledge and response actions to the symptoms. The study used a semi-structured interview with three scenarios that were developed based on factors known to

induce delays in seeking medical help. In total, 30 participants were recruited from an academic hospital. The results showed that 80 per cent of the participants identified chest pain (93%) and dyspnoea (53%) as symptoms. All participants (n = 30) identified rapid action in calling an emergency number and getting to an ED as an appropriate response to ACS symptoms. Therefore, there should be a focus on teaching about clusters of ACS symptoms to increase accuracy in decision-making to seek medical help (Basu & Sharma 2016; Sorita et al. 2014; Tanner et al. 2006).

In 2010, Poomsrikaew, Ryan and Zerwic (2010) conducted a street survey of 192 participants in Thailand. The results showed that 22 per cent did not identify chest discomfort as a symptom of ACS. More than 50 per cent of the participants identified more or all ACS symptoms from a list of correct and incorrect symptoms. The most commonly recognised symptoms were fatigue (79.7%), chest discomfort (78%), dizziness (76%) and shortness of breath (71%). Conversely, 66.7 per cent of participants mistakenly believed that chest discomfort would be severe, sharp and stabbing. This also suggests the need for education. This is similar to other studies that reported that half of their participants had selected incorrect symptoms as being related to ACS (Fang et al. 2011; Swanoski et al. 2012).

The largest study examining the public's knowledge of ACS symptoms was conducted in 2012 in the USA (Swanoski et al. 2012). A sample of 103,262,115 adults aged 18 years and over were identified using a random digit-dialled telephone survey using a predetermined list of symptoms (five correct and one incorrect symptom) on the Behavioral Risk Factor Surveillance Survey. Participants were asked to identify which symptoms they would associate with ACS. Swanoski et al. (2012) also reported on data from three surveys carried out in 2005, 2007 and 2009 in 25 states in the USA and used a composite score from all three surveys to report the results. Chest pain or discomfort was recognised by 93 per cent of the respondents, arm or shoulder pain by 87 per cent, shortness of breath by 85 per cent, pain in the jaw, neck or back by 54 per cent and feeling weak, light-headed and faint by 63 per cent. When the participants were asked to identify the first thing they should do if they thought someone was having a heart attack, 87 per cent indicated that they would call the emergency telephone number 911 (Swanoski et al. 2012).

In 2012, a multi-centre descriptive and comparative design study conducted in Sweden used open-ended questions to compare the levels of ACS knowledge. Patients were aged under 75 and either had been discharged with an ACS diagnosis from one of six hospitals within the last year (n = 246) or were the general population who had no previous experience with

ACS. Participants were matched on age, gender and catchment area (n = 418). The study revealed that there was no significant difference in levels of ACS symptom knowledge between the two groups. In total, 97 per cent of the patient group and 98 per cent of the general public correctly identified chest pain or chest discomfort as a symptom of ACS, 84 per cent of patient group and 85 per cent of the general public correctly identified arm pain and 69 per cent of both the patient group and the general public identified nausea as a symptom of ACS (Henriksson et al. 2012).

Another study in England surveyed 418 patients who had no history of ACS. Only 75 per cent correctly identified chest pain or discomfort as a symptom of ACS. Arm pain was correctly identified by 40 per cent and shortness of breath by 35 per cent. Eight per cent identified nausea and only 3 per cent identified back pain as a symptom of ACS (Whitaker et al. 2011).

A cross-sectional study conducted in Ireland in 2013 reported that only 49.5 per cent of patients demonstrated high levels of knowledge (>70% correct) about heart attack symptoms. While 98.9 per cent recognised chest pain or pressure and 90.2 per cent recognised left arm pain as symptoms, 44.7 per cent failed to associate heartburn, indigestion or jaw pain, 47.6 per cent failed to recognise nausea and vomiting and 42.5% failed to associate neck pain (42.5%) with a heart attack. In this study, those that would positively react and decisively respond to symptoms of ACS had higher levels of knowledge that were associated with higher levels of education ($p = .007$), attitudes ($p < .001$) and beliefs ($p < .001$) (O'Brien et al. 2013).

In 2016, a cross-sectional population-based study using a survey questionnaire was conducted in five Elderly Health Centres in Hong Kong among 1,804 individuals. The study revealed that 80.2 per cent of participants identified chest pain, 75.8 per cent identified palpitations and 71.9 per cent identified fainting as heart attack symptoms. Some participants were unsure about sweating (49.4%), headaches (44.9%) and neck pain (40.6%) (Chau et al. 2018). Future health education should seek to increase knowledge and symptom recognition among varied groups of patients and in the general population (Chau et al. 2018; Contreras 2010; Makam et al. 2016; Tullmann et al. 2007).

Compounding the problem of ACS knowledge and symptom recognition is the need to choose the best method of seeking medical care. The main reason why patients do not dial an emergency number for help is their misunderstanding of ACS symptoms (Neubeck & Maiorana 2015). Educational efforts need to focus on improving knowledge about symptom

recognition and on how to access prompt, effective treatment for acute MI (AlHabib et al. 2016).

1.2.8 Patient Education and Interactive Technology

Patient education is a core component of health care quality (Commodore-Mensah & Himmelfarb 2012; Tsai & Chou 2012), as well as providing quality health information and education that will give patients greater control over their disease and symptoms through changing their behaviour (Commodore-Mensah & Himmelfarb 2012; Flanders 2018; Sax 2017). Patient education enables improved outcomes and reduced mortality and morbidity (Ahmed et al. 2017).

This new concept to health education can be attributed to a range of factors. This includes educational resources and materials distributed by health care professionals (Bernhardt et al. 2013; List 2013; Veneri & Zdanis 2018), the abundance of medical and health information found on the Internet and increased involvement of clinicians and health care professionals in patient education (Jack et al. 2009; Jones et al. 2014; List 2013).

Technology can be incorporated into patient education in many ways to improve teaching strategies (Bauer et al. 2014; List 2013; Tait et al. 2014; Yousuf et al. 2016). Innovative technology can provide alternative ways to provide information to educate and solve the barriers to education, such as time shortages and patients' spoken language (Bickmore, Pfeifer & Paasche-Orlow 2009; Clifton et al. 2018; Jack et al. 2009; List 2013; Neubeck et al. 2015).

One systematic review reported that computer-based education is effective in changing health behaviours and improving clinical outcomes in patients with chronic illness. However, the effectiveness of such an intervention needs to be further evaluated (McDermott & While 2013). Another systematic review demonstrated a positive effect on knowledge from using a computer-based patient education intervention and high levels of patient satisfaction. This review also recommended that more research be undertaken to assess the long-term effect on knowledge (Beranova & Sykes 2007). Nevertheless, multimedia educational tools have shown evidence of improving the complex medical information provision to patients and caregivers. Multimedia health decision-making aids could become an effective resource for interaction between patients and health care professionals (Beranova & Sykes 2007).

Another systematic review compared standard forms of education with computer-based education for cancer patients and reported that computer-based education improved the

information delivered to patients with limited levels of literacy. These patients increased their understanding and recall and improved their adherence to medical instruction. Computer-based education also assisted and improved the decision-making of cancer patients (Wilson et al. 2010). With respect to educational materials, these helped patients to understand medical complexities, while reducing anxiety and increasing compliance with instructions (Azevedo et al. 2015; Boyde & Peters 2014).

There is support for patient education resources that have the ability to change communication because they add value to the management of various diseases and disorders (Anttila, Koivunen & Välimäki 2008; Chiou & Chung 2012; Jones et al. 2014; Kooij et al. 2017; Pfaeffli et al. 2016). As a consequence, patients should receive education and training specific and appropriate to the care, treatment and services provided (Sorathiya, Kapupara & Shah 2016).

Patient education content should be personalised to each patient depending on cultural differences and their specific needs (Fernon et al. 2016), such as content at an appropriate reading level and customised to the individual (Jibaja-Weiss et al. 2011). Successful patient education is the result of comprehensive, proven solutions that are thoughtfully set-up by health care providers and integrated into the patient health care delivery system (Sarkis & Mwanri 2014).

1.2.9 Avatar-Based Technology

As mentioned in the previous section, the use of interactive technology has recently emerged in the context of patient education (Sorathiya, Kapupara & Shah 2016). Avatar-based technologies are innovative interactive technologies that have been used in both general and health education (Isern & Moreno 2016; Or, Tao & Wang 2017). An avatar is an imitated human character in a digital technology (Anam, Andrade & Ruiz 2016; Wiederhold 2013). It mimics natural and innate human facial expressions, body language and speech to engage and ‘communicate’ with the user (An et al. 2013; Anam, Andrade & Ruiz 2016). An avatar is able to deliver a health dialogue via a computer, tablet or smart phone that is engaging, motivating and persuasive (Abbott & Shaw 2016; Chattaraman, Kwon & Gilbert 2012). It is a novel and effective teaching style that uses ‘face-to face’ communication and is patient-centred (An et al. 2013; Bickmore, Pfeifer & Paasche-Orlow 2009; Clark et al. 2015; Gabarron et al. 2012).

Avatar-based technology has been used for patient education to aid in the delivery of health information for improving knowledge (Andrade et al. 2015), promoting behaviour change (An

et al. 2013) and enhancing self-care behaviours to help patients with their decision-making (Pinto et al. 2013). The majority of avatar-based technologies available for patients or health consumers have focused on health literacy (Bickmore, Pfeifer & Paasche-Orlow 2009; Bickmore, Schulman & Sidner 2013) and a range of health conditions, such as heart failure (Clark et al. 2015), diabetes mellitus (Fuchslocher et al. 2011), obesity (Napolitano et al. 2013), mental health (Burton et al. 2016; Pinto et al. 2013), and lifestyle change behaviours such as physical activity and exercise, quitting smoking and healthy eating habits (An et al. 2013; Bickmore, Schulman & Sidner 2013). In a randomised controlled trial (RCT) conducted by Bickmore, Pfeifer and Paasche-Orlow (2009), it was reported that avatar-based technology interventions were effective in delivering health information to patients with low literacy levels and that participants were generally able to use them without difficulty. Improvements in knowledge scores were observed when information was communicated through an avatar compared to face-to-face communication or self-study instruction (Bickmore, Pfeifer & Paasche-Orlow 2009). The findings from previous studies also demonstrated positive outcomes for patient education in clinical practice. For instance, an avatar-based self-management intervention embedded into an online program improved in women their knowledge of overactive bladder symptoms and their health-related quality of life (Andrade et al. 2015). In another study, an avatar-based technology improved in hospitalised patients with a new colostomy their self-efficacy in their knowledge of ileostomy management and care (Bedra et al. 2013).

Avatar-based technology interventions also reduced symptoms of depression over time in a group of young adults (Pinto et al. 2013) and in another study, prevented smoking relapse in young adult smokers (An et al. 2013). Six studies also reported that avatar-based technologies were popular and effective in delivering information without being difficult to use (An et al. 2013; Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009; Bickmore, Schulman & Sidner 2013; Clark et al. 2015 Edwards et al. 2013). Two studies demonstrated improvements in health knowledge scores through the use of such technologies (Andrade et al. 2015; Bedra et al. 2013). The effect of the knowledge acquisition process on overall health information or knowledge was evaluated by two studies. It was reported that knowledge presented by educational interventions with avatar-based methods resulted in improved health knowledge compared to conventional patient education methods (Andrade et al. 2015; Bedra et al. 2013; Bickmore, Pfeifer & Paasche-Orlow 2009).

Previous studies have shown the effectiveness of using an avatar as a health guidance or health coach for promoting positive health behavioural change. One RCT compared elderly participants who interacted with a human-like avatar health coach with a control group who received educational handouts about exercise and pedometer tracking devices. The study demonstrated that with the use of an avatar health coach, the elderly group had a greater daily step count than the control group (Bickmore et al. 2013).

The use of avatar-based technologies in cardiovascular health is growing significantly (Clark et al. 2015; Fredericks et al. 2013). However, few avatar-based technologies have been rigorously evaluated over time (An et al. 2013; Andrade et al. 2015; Bickmore, Schulman & Sidner 2013; Pinto et al. 2013). While the positive outcomes of avatar-based interactive education in different conditions have been demonstrated in the literature, there are no published studies that have focused on the development and evaluation of interactive education interventions for people at risk of a heart attack.

1.2.10 Conclusion

The knowledge of ACS symptoms and the delay in seeking medical care could be improved through an appropriate format of delivering information. This may decrease the cognitive factors that are associated with the decision to delay and develop the knowledge, attitudes, beliefs and response actions to symptoms. New and innovative technologies for educating patients are rapidly emerging. The current study will adopt an avatar-based technology to develop interactive educational material that is evidence-based, patient-centred and technology-based to provide critical information using engaging, emphasising, reinforcing and motivating techniques to enhance knowledge transfer into action.

1.3 My unique contribution to the study

Although this study was part of a team of researchers, I undertook ownership and total responsibility for developing and evaluation of an avatar-based education application using a participatory action research (PAR) and pragmatic randomised controlled trial (pRCT) approach to improve knowledge, attitudes, beliefs and responses to ACS symptoms among people with ACS. My unique contribution included:

- Making a significant contribution to the preparation and submission of the research proposal and trial ptotocol to the Human Research Ethic Committee.
- The preparation and submission of applications for ethical approval.

- Developing the SAVE app's content storyboard based on evidence-based guidelines from the 'Heart Attack Action Plan
- Recruiting and preparing participants for focus group discussion
- Designing focus group question, audio recording, transcribing and content analysis.
- Training the interventionists with respect to patient recruitment, intervention delivery, data collection and data management.
- Providing information meetings with the medical, nursing staff and nursing administration at research site.
- Presenting the trail protocol with the cardiology grand round at research site.
- Collecting baseline, 1 and 6 month data and delivering the avatar-based educational intervention to participants recruited at research site.
- Ensuring that the trial was conducted rigorously and that trial fidelity was upheld.
- Collating all data collected for this study. This included data inputting, data cleansing and proofing and data analysis.
- Local, national and international dissemination of the study results.

1.4 Thesis Aims and Objectives

1.4.1 Aims

This research project aims to improve the knowledge of and responses to ACS symptoms among patients with ACS through an innovative **S**imple **A**vatar-based application for impro**V**ing ACS **E**ducation (SAVE app). This aim was achieved through two sub-studies.

1.4.2 Objectives

1.4.2.1 Study 1

To develop and test the feasibility of an avatar-based education application using a participatory action research (PAR) approach to improve knowledge, attitudes, beliefs and responses to ACS symptoms among people with ACS.

1.4.2.2 Study 2

To evaluate the effectiveness of the SAVE app among a group of patients with ACS through a pragmatic RCT (pRCT). The details of the methodology for each of the two sub-studies are presented in Chapter 3.

1.5 Structure of the Thesis

This thesis is divided into five chapters.

Chapter 1 describes the epidemiology of CVD, ACSs, phases of and delay in ACS management, knowledge of ACS symptoms and delay in seeking medical attention. Patient education and interactive technology, as well as avatar-based technology is also described in this chapter.

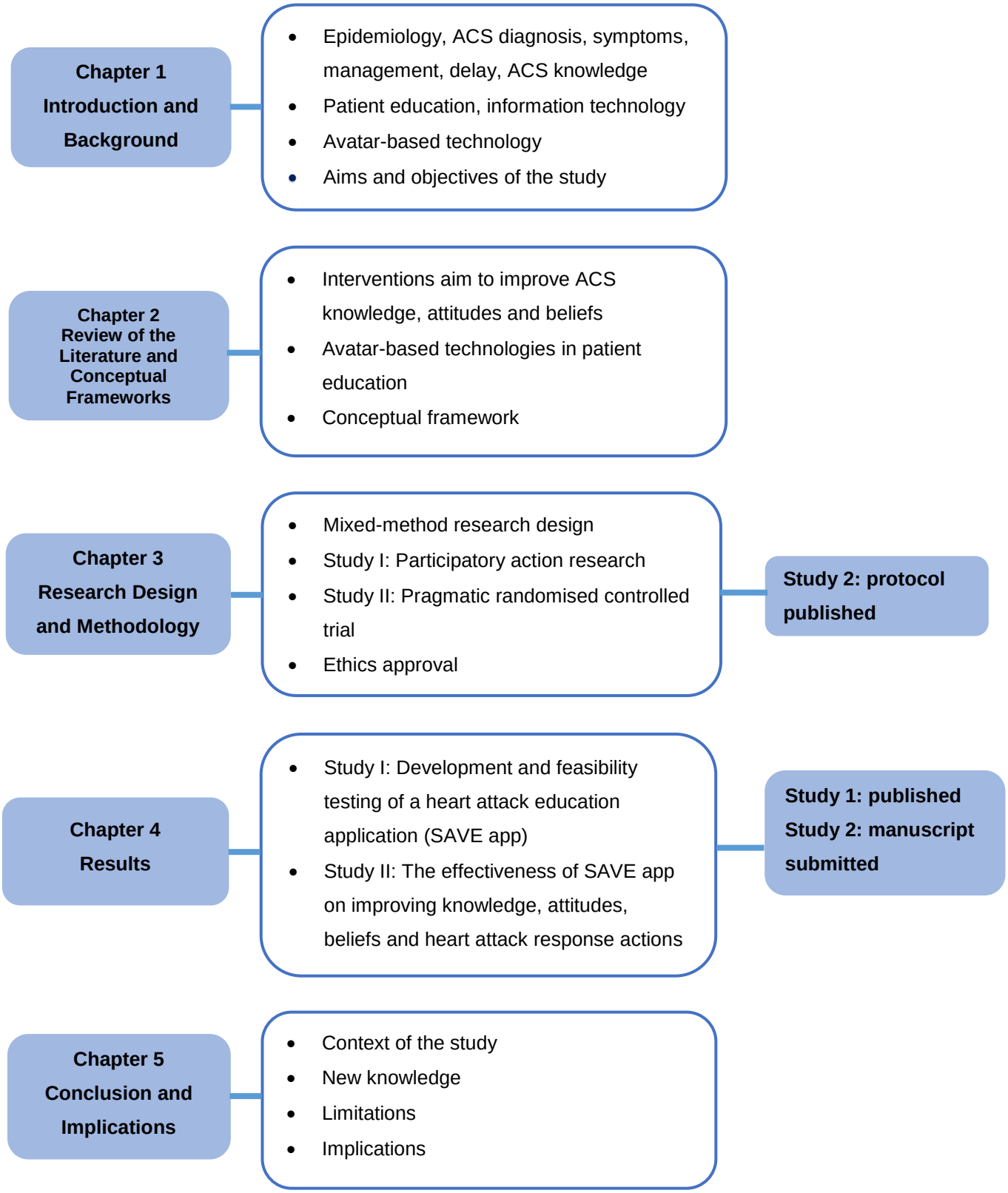
Chapter 2 provides a review of the current literature and consists of three sections. The first section includes a review of the interventions to improve ACS knowledge, attitudes and beliefs. Section two presents a review of avatar-based technology interventions in patient education. The conceptual framework that underpins this thesis is then discussed in the third section.

Chapter 3 discusses the methods used to conduct this mixed-methods project, including PAR and a pRCT. The rationale of the overall study design and methodology are presented first. This is followed by a detailed description and justification of the study's methods, including the settings, sample, intervention procedures, data collection and data analysis processes of each sub-study. Data management and ethical considerations are also discussed in this chapter.

Chapter 4 reports on the findings of the study, which are presented as two manuscripts. The first manuscript reports on the outcomes of the development of the avatar-based education application and feasibility testing using the PAR method. The second manuscript provides the results from the pRCT through which the effectiveness of the intervention using the avatar-based heart attack education application was evaluated.

Chapter 5 concludes the thesis with a new knowledge of the findings, the strengths and limitations of the study and the challenges faced in improving the knowledge and response to signs and symptoms of people with ACS. This chapter also discusses the implications of the study's results on clinical practice, research and policy.

1.6 Overview of the Thesis



1.7 References

Abbott, MB & Shaw, P 2016, 'Virtual nursing avatars: Nurse roles and evolving concepts of care', *OJIN: The Online Journal of Issues in Nursing*, vol. 21, no. 3, (online PubMed).

Ahmed, MM, El Degwy, HM, Ali, MI & Hegazy, NH 2017, 'The effect of educational intervention on knowledge, attitude and glycemic control in patients with type 2 diabetes mellitus', *International Journal of Community Medicine and Public Health*, vol. 2, no. 3, pp. 302−7.

AlHabib, KF, Sulaiman, K, Al Suwaidi, J, Almahmeed, W, Alsheikh-Ali, AA, Amin, H, Al Jarallah, M, Alfaleh, HF, Panduranga, P & Hersi, A 2016, 'Patient and system-related delays of emergency medical services use in acute ST-elevation myocardial infarction: Results from the third Gulf Registry of Acute Coronary Events (Gulf RACE-3Ps)', *PloS One*, vol. 11, no. 1, p. e0147385.

Alonzo, AA 1984, 'An illness behavior paradigm: A conceptual exploration of a situational-adaptation perspective', *Social Science & Medicine*, vol. 19, no. 5, pp. 499−510.

Alshahrani, H, McConkey, R, Wilson, J, Youssef, M & Fitzsimons, D 2014, 'Female gender doubles pre-hospital delay times for patients experiencing ST-segment elevation myocardial infarction in Saudi Arabia', *European Journal of Cardiovascular Nursing*, vol. 13, no. 5, pp. 399−407.

Amsterdam, EA, Wenger, NK, Brindis, RG, Casey, DE, Ganiats, TG, Holmes, DR, Jaffe, AS, Jneid, H, Kelly, RF & Kontos, MC 2014, '2014 AHA/ACC guideline for the management of patients with non–ST-elevation acute coronary syndromes: Executive summary: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines', *Journal of the American College of Cardiology*, vol. 64, no. 24, pp. 2645−87.

An, LC, Demers, MR, Kirch, MA, Considine-Dunn, S, Nair, V, Dasgupta, K, Narisetty, N, Resnicow, K & Ahluwalia, J 2013, 'A randomized trial of an avatar-hosted multiple behavior change intervention for young adult smokers', *Journal of the National Cancer Institute. Monographs*, vol. 2013, no. 47, p. 209−15.

Anam, R, Andrade, AD & Ruiz, JG 2016, 'Promoting lifestyle change through medical avatars', in MM Cruz-Cuhna, IM Miranda, R Martinho & R Rijo (eds.), *Encyclopedia of e-health and telemedicine*, IGI Global, Hershey, USA, pp. 316−30.

Anderson, JL & Morrow, DA 2017, 'Acute myocardial infarction', *New England Journal of Medicine*, vol. 376, no. 21, pp. 2053−64.

Andersson, H, Ullgren, A, Holmberg, M, Karlsson, T, Herlitz, J & Sundström, BW 2017, 'Acute coronary syndrome in relation to the occurrence of associated symptoms: A quantitative study in prehospital emergency care', *International Emergency Nursing*, vol. 33, pp. 43−7.

Andrade, AD, Anam, R, Karanam, C, Downey, P & Ruiz, JG 2015, 'An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy', *Urology*, vol. 85, no. 3, pp. 561−7.

Anttila, M, Koivunen, M & Välimäki, M 2008, 'Information technology-based standardized patient education in psychiatric inpatient care', *Journal of Advanced Nursing*, vol. 64, no. 2, p. 147.

Atzema, CL, Austin, PC, Huynh, T, Hassan, A, Chiu, M, Wang, JT & Tu, JV 2011, 'Effect of marriage on duration of chest pain associated with acute myocardial infarction before seeking care', *Canadian Medical Association Journal*, vol. 183, no. 13, pp. 1482−91.

Australian Bureau of Statistics 2015, *Australian health survey: First results, 2014/2015*, cat. no. 4364.0, Australian Bureau of Statistics, Canberra.

Australian Bureau of Statistics 2016, *Causes of death, Australia*, *2016*, cat. no. 3303.0, Australian Bureau of Statistics, Canberra.

Australian Commission on Safety and Quality in Health Care 2014, *Acute coronary syndromes clinical care standard*, Australian Commission on Safety and Quality in Health Care, Sydney.

Australian Institute of Health and Welfare 2016a, *Australia's health 2016.* Australia's health series no.15, cat. no. AUS 199.

Australian Institute of Health and Welfare 2016b, *Australian hospital statistics 2014–15.* Health services series no. 54, cat. no. HSE 145.

Ayrik, C, Ergene, U, Kinay, O, Nazli, C, Unal, B & Ergene, O 2006, 'Factors influencing emergency department arrival time and in-hospital management of patients with acute myocardial infarction', *Advances in Therapy*, vol. 23, no. 2, pp. 244−55.

Azevedo, R, Bernardes, M, Fonseca, J & Lima, A 2015, 'Smartphone application for rheumatoid arthritis self-management: Cross-sectional study revealed the usefulness, willingness to use and patients' needs', *Rheumatology International*, vol. 35, no. 10, pp. 1675−85.

Bahall, MU & Legall, G 2017, 'Pre-hospital care in stable patients with acute coronary syndrome: Factors and predictors of pre-hospital delays in a tertiary public health institute', *International Journal of Community Medicine and Public Health*, vol. 5, no. 1, pp. 12−20.

Banharak, S 2017, 'Knowledge, belief, and decision making about acute myocardial infarction among younger and older adult Thai and Laotian immigrants in the United States', PhD thesis, St Louis University, St Louis, USA.

Basu, JBMAM & Sharma, SMDFF 2016, 'Early recognition vital in acute coronary syndrome', *Practitioner*, vol. 260, no. 1797, pp. 19−23.

Bauer, AM, Thielke, SM, Katon, W, Unützer, J & Areán, P 2014, 'Aligning health information technologies with effective service delivery models to improve chronic disease care', *Preventive Medicine*, vol. 66, pp. 167−72.

Baxter, SK & Allmark, P 2013, 'Reducing the time-lag between onset of chest pain and seeking professional medical help: A theory-based review', *BMC Medical Research Methodology*, vol. 13, no. 15, pp. 1−15.

Bedra, M, Wick, E, Brotman, D & Finkelstein, J 2013, 'Avatar-based interactive ileostomy education in hospitalized patients', *Informatics, Management and Technology in Healthcare*, vol. 190, pp. 83−5.

Bell, M, Lommel, T, Fischer, JG, Lee, JS, Reddy, S & Johnson, MA 2009, 'Improved recognition of heart attack and stroke symptoms after a community-based intervention for older adults, Georgia, 2006−2007', *Preventing Chronic Disease*, vol. 6, no. 2, pp. A41−52.

Benjamin, EJ, Blaha, MJ, Chiuve, SE, Cushman, M, Das, SR, Deo, R, Floyd, J, Fornage, M, Gillespie, C & Isasi, C 2017, 'Heart disease and stroke statistics—2017 update: A report from the American Heart Association', *Circulation*, vol. 135, no. 10, pp. e146−603.

Beranova, E & Sykes, C 2007, 'A systematic review of computer-based softwares for educating patients with coronary heart disease', *Patient Education and Counseling*, vol. 66, no. 1, pp. 21−8.

Bernhardt, JM, Chaney, JD, Chaney, BH & Hall, AK 2013, 'New media for health education: A revolution in progress', *Health Education & Behavior*, vol. 40, no. 2, pp. 129−32.

Bickmore, TW, Pfeifer, LM & Paasche-Orlow, MK 2009, 'Using computer agents to explain medical documents to patients with low health literacy', *Patient Education and Counseling*, vol. 75, no. 3, pp. 315−20.

Bickmore, TW, Schulman, D & Sidner, C 2013, 'Automated interventions for multiple health behaviors using conversational agents', Patient Education & Counseling, vol. 92, no. 2, pp. 142-8.

Bickmore, TW, Silliman, RA, Nelson, K, Cheng, DM, Winter, M, Henault, L & Paasche-Orlow, MK 2013, 'A randomized controlled trial of an automated exercise coach for older adults', *Journal of the American Geriatrics Society*, vol. 61, no. 10, pp. 1676−83.

Boyde, M & Peters, R 2014, 'Education material for heart failure patients: What works and what does not?', *Current Heart Failure Reports*, vol. 11, no. 3, pp. 314−20.

Bray, JE, Straney, L, Barger, B & Finn, J 2015, 'Effect of public awareness campaigns on calls to ambulance across Australia', *Stroke*, vol. 46, no. 5, pp. 1377−80

Bruno, CM 2013, 'Understanding symptom experiences of older individuals with acute coronary syndrome', PhD thesis, The University of Arizona, Tuscon, USA.

Burton, C, Szentagotai Tatar, A, McKinstry, B, Matheson, C, Matu, S, Moldovan, R, Macnab, M, Farrow, E, David, D & Pagliari, C 2016, 'Pilot randomised controlled trial of Help4Mood, an embodied virtual agent-based system to support treatment of depression', *Journal of Telemedicine and Telecare*, vol. 22, no. 6, pp. 348−55.

Carstensen, S, Nelson, GC, Hansen, PS, Macken, L, Irons, S, Flynn, M, Kovoor, P, Soo Hoo, SY, Ward, MR & Rasmussen, HH 2007, 'Field triage to primary angioplasty combined with emergency department bypass reduces treatment delays and is associated with improved outcome', *European Heart Journal*, vol. 28, no. 19, pp. 2313−19.

Cartledge, S, Finn, J, Straney, L, Ngu, P, Stub, D, Patsamanis, H, Shaw, J & Bray, J 2017, 'The barriers associated with emergency medical service use for acute coronary syndrome: The awareness and influence of an Australian public mass media campaign', *Emergency Medicine Journal*, vol. 34, no. 7, pp. 466−71.

Chattaraman, V, Kwon, W-S & Gilbert, JE 2012, 'Virtual agents in retail web sites: Benefits of simulated social interaction for older users', *Computers in Human Behavior*, vol. 28, no. 6, pp. 2055−66.

Chau, PH, Moe, G, Lee, SY, Woo, J, Leung, AY, Chow, C-M, Kong, C, Lo, WT, Yuen, MH & Zerwic, J 2018, 'Low level of knowledge of heart attack symptoms and inappropriate anticipated treatment-seeking behaviour among older Chinese: A cross-sectional survey', *Journal of Epidemiology and Community Health*, vol. 72, no. 7, pp. 645−52.

Chew, DP, Scott, IA, Cullen, L, French, JK, Briffa, TG, Tideman, PA, Woodruffe, S, Kerr, A, Branagan, M & Aylward, PE 2016, 'National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Australian clinical guidelines for the management of acute coronary syndromes 2016', *The Medical Journal of Australia*, vol. 205, no. 3, pp. 128−33.

Chiou, CP & Chung, YC 2012, 'Effectiveness of multimedia interactive patient education on knowledge, uncertainty and decision-making in patients with end-stage renal disease', *Journal of Clinical Nursing*, vol. 21, no. 9−10, pp. 1223−31.

Clark, RA, Fredericks, B, Buitendyk, N, Adams, M, Howie-Esquivel, J, Dracup, K, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3231.

Clifton, DC, Benjamin, RW, Brown, AR, Ostrovsky, DA & Narayan, AP 2018, 'A tablet-based educational tool: Toward more comprehensive pediatric patient education', *Clinical Pediatrics*, (online PubMed).

Commodore-Mensah, Y & Himmelfarb, CRD 2012, 'Patient education strategies for hospitalized cardiovascular patients: A systematic review', *Journal of Cardiovascular Nursing*, vol. 27, no. 2, pp. 154−74.

Contreras, JP 2010, 'Factors associated with delayed pre-hospital time in patients with suspected acute coronary syndrome: Effect of gender', MS thesis, Sackler School of Graduate Biomedical Sciences (Tufts University), Boston, USA.

Correia, LCL, Brito, M, Kalil, F, Sabino, M, Garcia, G, Ferreira, F, Matos, I, Jacobs, P, Ronzoni, L & Noya-Rabelo, M 2013, 'Effectiveness of a myocardial infarction protocol in

reducing door-to-balloon time', *Arquivos Brasileiros de Cardiologia*, vol. 101, no. 1, pp. 26−34.

Coventry, LL, Schalkwyk, JW, Thompson, PL, Hawkins, SA & Hegney, DG 2017, 'Myocardial infarction, patient decision delay and help-seeking behaviour: A thematic analysis', *Journal of Clinical Nursing*, vol. 26, no. 13−14, pp. 1993−2005.

Crea, F & Libby, P 2017, 'Acute coronary syndromes: The way forward from mechanisms to precision treatment', *Circulation*, vol. 136, no. 12, pp. 1155−66.

Crea, F & Liuzzo, GN 2013, 'Pathogenesis of acute coronary syndromes', *Journal of the American College of Cardiology*, vol. 61, no. 1, pp. 1−11.

Cullen, L, Greenslade, JH, Menzies, L, Leong, A, Than, M, Pemberton, C, Aldous, S, Pickering, J, Dalton, E & Crosling, B 2016, 'Time to presentation and 12-month health outcomes in patients presenting to the emergency department with symptoms of possible acute coronary syndrome', *Emergency Medicine Journal*, vol. 33, no. 6, pp. 390−5.

Cytryn, KN, Yoskowitz, NA, Cimino, JJ & Patel, VL 2009, 'Lay public's knowledge and decisions in response to symptoms of acute myocardial infarction', *Advances in Health Sciences Education*, vol. 14, no. 1, p. 43−59.

Darawad, MW, Alfasfos, N, Saleh, Z, Saleh, AM & Hamdan-Mansour, A 2016, 'Predictors of delay in seeking treatment by Jordanian patients with acute coronary syndrome', *International Emergency Nursing*, vol. 26, pp. 20−5.

Deshmukh, M, Joseph, MA, Verdecias, N, Malka, ES & Larosa, JH 2011, 'Acute coronary syndrome: Factors affecting time to arrival in a diverse urban setting', *Journal of Community Health*, vol. 36, no. 6, pp. 895−902.

DeVon, HA, Burke, LA, Vuckovic, KM, Haugland, T, Eckhardt, AL, Patmon, F & Rosenfeld, AG 2017, 'Symptoms suggestive of acute coronary syndrome: When is sex important?', *Journal of Cardiovascular Nursing*, vol. 32, no. 4, pp. 383−92.

DeVon, HA, Hogan, N, Ochs, AL & Shapiro, M 2010, 'Time to treatment for acute coronary syndromes: The cost of indecision', *Journal of Cardiovascular Nursing*, vol. 25, no. 2, pp. 106−14.

Diercks, DB, Owen, KP, Kontos, MC, Blomkalns, A, Chen, AY, Miller, C, Wiviott, S & Peterson, ED 2010, 'Gender differences in time to presentation for myocardial infarction before and after a national women's cardiovascular awareness campaign: A temporal analysis from the Can Rapid Risk Stratification of Unstable Angina Patients Suppress ADverse Outcomes with Early Implementation (CRUSADE) and the National Cardiovascular Data Registry Acute Coronary Treatment and Intervention Outcomes Network–Get with the Guidelines (NCDR ACTION Registry–GWTG)', *American Heart Journal*, vol. 160, no. 1, pp. 80−7.e3.

Dodin, R 2014, 'Identification of factors that impact door-to-balloon time in patients with ST-elevation myocardial infarction (STEMI)', DHA thesis, Central Michigan University, Michigan, USA.

Dracup, K, McKinley, S, Doering, LV, Riegel, B, Meischke, H, Moser, DK, Pelter, M, Carlson, B, Aitken, L, Marshall, A, Cross, R & Paul, SM 2008, 'Acute coronary syndrome: What do patients know?', *Archives of Internal Medicine*, vol. 168, no. 10, pp. 1049−54.

Dracup, K, McKinley, SM & Moser, DK 1997, 'Australian patients' delay in response to heart attack symptoms', *Medical Journal of Australia*, vol. 166, no. 5, pp. 233−6.

Dracup, K, McKinley, S, Riegel, B, Moser, DK, Meischke, H, Doering, LV, Davidson, P, Paul, SM, Baker, H & Pelter, M 2009, 'A randomized clinical trial to reduce patient prehospital delay to treatment in acute coronary syndrome', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 6, pp. 524−32.

Dracup, K, Moser, DK, Eisenberg, M, Meischke, H, Alonzo, AA & Braslow, A 1995, 'Causes of delay in seeking treatment for heart attack symptoms', *Social Science and Medicine Journal*, vol. 40, no. 3, pp. 379−92.

Dracup, K, Moser, DK, McKinley, S, Ball, C, Yamasaki, K, Kinm, C-J, Doering, LV & Caldwell, MA 2003, 'An international perspective on the time to treatment for acute myocardial infarction', *Journal of Nursing Scholarship*, vol. 35, no. 4, pp. 317−23.

Duber, HC, McNellan, CR, Wollum, A, Phillips, B, Allen, K, Brown, JC, Bryant, M, Guptam, R, Li, Y & Majumdar, P 2018, 'Public knowledge of cardiovascular disease and response to acute cardiac events in three cities in China and India', *Heart*, vol. 104, no. 1, pp. 67−72.

Edwards, RA, Bickmore, T, Jenkins, L, Foley, M & Manjourides, J 2013, 'Use of an interactive computer agent to support breastfeeding', *Maternal and Child Health Journal*, vol. 17, no. 10, pp. 1961−8.

Eshah, NF 2013, 'Seeking medical attention among Jordanian patients with acute myocardial infarction', *European Scientific Journal*, vol. 9, no. 21.

Fang, J, Gillespie, C, Keenan, NL & Greenlund, KJ 2011, 'Awareness of heart attack symptoms among US adults in 2007, and changes in awareness from 2001 to 2007', *Future Cardiology*, vol. 7, no. 3, pp. 311−20.

Farquharson, B, Johnston, M & Bugge, C 2012, 'Appraisal and illness delay with symptoms of ACS: A questionnaire study of illness representations', *British Journal of Cardiac Nursing*, vol. 7, no. 10, pp. 493−9.

Farshidi, H, Rahimi, S, Abdi, A, Salehi, S & Madani, A 2013, 'Factors associated with pre-hospital delay in patients with acute myocardial infarction', *Iranian Red Crescent Medical Journal*, vol. 15, no. 4, pp. 312−6.

Fernandez, RS, Everett, B & Sundar, S 2016, 'Predictors of heart disease knowledge among older and younger Asian Indian adults', *Journal of Immigrant and Minority Health*, vol. 18, no. 6, pp. 1378−85.

Fernon, A, Nguyen, A, Baysari, M & Day, R 2016, 'A user-centred approach to designing an etool for gout management', in A Georgiou, LK Schaper & S Whetton (eds.), *Digital health innovation for consumers, clinicians, connectivity and community*, vol. 227, IOS Press Ebooks, Amsterdam, pp. 28−33.

Fihn, SD, Blankenship, JC, Alexander, KP, Bittl, JA, Byrne, JG, Fletcher, BJ, Fonarow, GC, Lange, RA, Levine, GN & Maddox, TM 2014, '2014 ACC/AHA/AATS/PCNA/SCAI/STS focused update of the guideline for the diagnosis and management of patients with stable ischemic heart disease', *Circulation*, vol. 130, pp. 1749−67.

Flanders, SA 2018, 'Effective patient education: Evidence and common sense', *Medsurg Nursing*, vol. 27, no. 1, pp. 55−8.

Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure

self-care amongst indigenous Australians: A pilot study', *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, p. 40−60.

Fuchslocher, A, Niesenhaus, J & Krämer, N 2011, 'Serious games for health: An empirical study of the game "Balance" for teenagers with diabetes mellitus', *Entertainment Computing*, vol. 2, no. 2, pp. 97−101.

Fukuoka, Y, Dracup, K, Rankin, SH, Froelicher, ES, Kobayashi, F, Hirayama, H, Ohno, M & Matsumoto, D 2005, 'Prehospital delay and independent/independent construal of self among Japanese patients with acute myocardial infarction', *Social Science & Medicine*, vol. 60, pp. 2025−34.

Furie, KL, Kasner, SE, Adams, RJ, Albers, GW, Bush, RL, Fagan, SC, Halperin, JL, Johnston, SC, Katzan, I & Kernan, WN 2010, 'Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack. A guideline for healthcare professionals from the American Heart Association/American Stroke Association', *Stroke*, vol. 42, pp. 227−76.

Gabarron, E, Serrano, JA, Wynn, R & Armayones, M 2012, 'Avatars using computer/smartphone mediated communication and social networking in prevention of sexually transmitted diseases among north-Norwegian youngsters', *BMC Medical Informatics and Decision Making*, vol. 12, no. 120, pp. 1−5.

Ghazawy, ER, Seedhom, AE & Mahfouz, EM 2015, 'Predictors of delay in seeking health care among myocardial infarction patients, Minia District, Egypt', *Advances in Preventive Medicine*, vol. 2015, pp. 1−6.

Gillis, NK, Arslanian-Engoren, C & Struble, LM 2014, 'Acute coronary syndromes in older adults: A review of literature', *Journal of Emergency Nursing*, vol. 40, no. 3, pp. 270−5.

Giugliano, RP & Braunwald, E 2014, 'The year in acute coronary syndrome', *Journal of the American College of Cardiology*, vol. 63, no. 3, pp. 201−14.

Goff Jr, DC, Feldman, HA, McGovern, PG, Goldberg, RJ, Simons-Morton, DG, Cornell, CE, Osganian, SK, Cooper, LS & Hedges, JR 1999, 'Prehospital delay in patients hospitalized with heart attack symptoms in the United States: The REACT trial', *American Heart Journal*, vol. 138, no. 6, pp. 1046−57.

Goldberg, RJ, Spencer, FA, Fox, KA, Brieger, D, Steg, PG, Gurfinkel, E, Dedrick, R & Gore, JM 2009, 'Prehospital delay in patients with acute coronary syndromes (from the Global Registry of Acute Coronary Events [GRACE])', *American Journal of Cardiology*, vol. 103, no. 5, pp. 598−603.

Goldberg, RJ, Steg, PG, Sadiq, I, Granger, C, Jackson, EA, Buddaj, A, Brieger, D, Avezum, A & Goodman, S 2002, 'Extent of and factors associated with delay to hospital presentation in patients with acute coronary syndrome (The GRACE Registry)', *The American Journal of Cardiology*, vol. 89, pp. 791−6.

Hafiz, AM, Naidu, SS, DeLeon, J, Islam, S, Alkhatib, B, Lorenz, M, D'Elia, A, Rosenthal, B & Marzo, K 2013, 'Impact of first contact on symptom onset-to-door time in patients presenting for primary percutaneous coronary intervention', *The American Journal of Emergency Medicine*, vol. 31, no. 6, pp. 922−7.

Hennink-Schadenberg, S & Preckel, B 2018, 'The patient with acute coronary syndrome', in J-L Fellahi & M Leone (eds.), *Anesthesia in high-risk patients*, Springer, Cham, Switzerland, pp. 3−17.

Henriksson, C, Larsson, M, Arnetz, J, Herlitz, J, Karlsson, J-E, Svensson, L, Thuresson, M, Zedigh, C, Wernroth, L & Lindahl, B 2012, 'Knowledge about acute myocardial infarction (AMI) and attitudes to medical care seeking—a comparison between patients and the general public', *Open Journal of Nursing*, vol. 2, pp. 372−8.

Herlitz, J, Thuresson, M, Svensson, L, Lindqvist, J, Lindahl, B, Zedigh, C & Jarlov, M 2010, 'Factors of importance for patients' decision time in acute coronary syndrome', *International Journal of Cardiology*, vol. 141, pp. 236−42.

Howard, BG & Wenger, NK 2016, 'Review of the 2014 AHA/ACC guideline for the management of patients with non−ST-elevation acute coronary syndromes: What is new and why?', *Current Cardiovascular Risk Reports*, vol. 10, no. 4, pp. 1−8.

Hwang, SY, Park, EH, Shin, ES & Jeong, MH 2009, 'Comparison of factors associated with atypical symptoms in younger and older patients with acute coronary syndromes', *Journal of Korean Medical Science*, vol. 24, no. 5, pp. 789−94.

Isern, D & Moreno, A 2016, 'A systematic literature review of agents applied in healthcare', *Journal of Medical Systems*, vol. 40, no. 2, p. 43.

Jack, BW, Chetty, VK, Anthony, D, Greenwald, JL, Sanchez, GM, Johnson, AE, Forsythe, SR, O'Donnell, JK, Paasche-Orlow, MK & Manasseh, C 2009, 'A reengineered hospital discharge program to decrease rehospitalization: A randomized trial', *Annals of Internal Medicine*, vol. 150, no. 3, pp. 178−87.

Jaffery, Z, Hudson, MP, Khanal, S, Ananthasubramaniam, K, Kim, H, Greenbaum, A, Kugelmass, A, Jacobsen, G & McCord, J 2009, 'The recognition of acute coronary ischemia in the outpatient setting', *Journal of Thrombosis and Thrombolysis*, vol. 27, no. 1, pp. 18−23.

Jibaja-Weiss, ML, Volk, RJ, Granchi, TS, Neff, NE, Robinson, EK, Spann, SJ, Aoki, N, Friedman, LC & Beck, JR 2011, 'Entertainment education for breast cancer surgery decisions: A randomized trial among patients with low health literacy', *Patient Education and Counseling*, vol. 84, no. 1, pp. 41−8.

Jones, SS, Rudin, RS, Perry, T & Shekelle, PG 2014, 'Health information technology: An updated systematic review with a focus on meaningful use', *Annals of Internal Medicine*, vol. 160, no. 1, pp. 48−54.

Khan, JA 2011, 'Factors causing delayed presentation of patients with acute myocardial infarction to the hospital', *Pakistan Armed Forces Medical Journal*, vol. 61, no. 4, pp. 20−4.

Khan, MS, Jafary, FH, Faruqui, AM, Rasool, SI, Hatcher, J, Chaturvedi, N & Jafar, TH 2007, 'High prevalence of lack of knowledge of symptoms of acute myocardial infarction in Pakistan and its contribution to delayed presentation to the hospital', *BMC Public Health*, vol. 7, no. 1, p. 284.

Khan, NA, Daskalopoulou, SS, Karp, I, Eisenberg, MJ, Pelletier, R, Tsadok, MA, Dasgupta, K, Norris, CM & Pilote, L 2017, 'Sex differences in prodromal symptoms in acute coronary syndrome in patients aged 55 years or younger', *Heart*, vol. 103, no. 11, pp. 863−9.

Khraim, FM & Carey, MG 2009, 'Predictors of pre-hospital delay among patients with acute myocardial infarction', *Patient Education and Counseling*, vol. 75, no. 2, pp. 155−61.

Kooij, L, Groen, WG & van Harten, WH 2017, 'The effectiveness of information technology-supported shared care for patients with chronic disease: A systematic review', *Journal of Medical Internet Research*, vol. 19, no. 6, p. e221.

Kreatsoulas, C, Crea-Arsenio, M, Shannon, HS, Velianou, JL & Giacomini, M 2016, 'Interpreting angina: Symptoms along a gender continuum', *Open Heart*, vol. 3, p. e00376.

Lavery, T, Greenslade, JH, Parsonage, WA, Hawkins, T, Dalton, E, Hammett, C & Cullen, L 2017, 'Factors influencing choice of pre-hospital transportation of patients with potential acute coronary syndrome: An observational study', *Emergency Medicine Australasia*, vol. 29, no. 2, pp. 210−6.

Lee, I 2015, 'Health-seeking behavior of Korean women with myocardical infarction', PhD thesis, University of Washington, Washington, USA.

Leifheit-Limson, EC, D'Onofrio, G, Daneshvar, M, Geda, M, Bueno, H, Spertus, JA, Krumholz, HM & Lichtman, JH 2015, 'Sex differences in cardiac risk factors, perceived risk, and health care provider discussion of risk and risk modification among young patients with acute myocardial infarction: The VIRGO study', *Journal of the American College of Cardiology*, vol. 66, no. 18, pp. 1949−57.

Lichtman, JH, Leifheit-Limson, EC, Watanabe, E, Allen, NB, Garavalia, B, Garavalia, LS, Spertus, JA, Krumholz, HM & Curry, LA 2015, 'Symptom recognition and healthcare experiences of young women with acute myocardial infarction', *Circulation: Cardiovascular Quality and Outcomes*, vol. 8, no. 2, suppl. 1, pp. S31−8.

List TP 2013, *How technology is shaping patient education*, Surrey, <http://www.pmlive.com/pmhub/medical_communications/fti_consulting/white_papers_and_resourcer/how_technology_is_shaping_patient_education>.

Luepker, RV, Raczynski, JM, Osganian, S, Goldberg, RJ, Finnegan Jr, JR, Hedges, JR, Goff Jr, DC, Eisenberg, MS, Zapka, JG & Feldman, HA 2000, 'Effect of a community intervention on patient delay and emergency medical service use in acute coronary heart disease: The Rapid Early Action for Coronary Treatment (REACT) Trial', *Journal of the American Medical Association*, vol. 284, no. 1, pp. 60−7.

Ma, J, Wang, J, Zheng, W, Zheng, J, Wang, H, Wang, G, Zhang, H, Xu, F & Chen, Y 2017, 'Usage of ambulance transport and influencing factors in acute coronary syndrome: A cross-sectional study at a tertiary centre in China', *BMJ Open*, vol. 7, no. 8, pp. 1−8.

Mackay, MH, Ratner, PA, Nguyen, M, Percy, M, Galdas, P & Grunau, G 2014, 'Inconsistent measurement of acute coronary syndrome patients' pre-hospital delay in research: A review of the literature', *European Journal of Cardiovascular Nursing*, vol. 13, no. 6, pp. 483−93.

Makam, RP, Erskine, N, Yarzebski, J, Lessard, D, Lau, J, Allison, J, Gore, JM, Gurwitz, J, McManus, DD & Goldberg, RJ 2016, 'Decade long trends (2001–2011) in duration of pre-hospital delay among elderly patients hospitalized for an acute myocardial infarction', *Journal of the American Heart Association*, vol. 5, no. 4, p. e002664.

Mata, J, Frank, R & Gigerenzer, G 2014, 'Symptom recognition of heart attack and stroke in nine European countries: A representative survey', *Health Expectations*, vol. 17, no. 3, pp. 376−87.

Mathews, R, Peterson, ED, Li, S, Roe, MT, Glickman, SW, Wiviott, SD, Saucedo, JF, Antman, EM, Jacobs, AK & Wang, TY 2011, 'Use of emergency medical service transport among patients with ST-segment elevation myocardial infarction: Clinical perspective: Findings from the National Cardiovascular Data Registry Acute Coronary Treatment Intervention Outcomes Network Registry—Get with the Guidelines', *Circulation*, vol. 124, no. 2, pp. 154−63.

McDermott, MS & While, AE 2013, 'Maximizing the healthcare environment: A systematic review exploring the potential of computer technology to promote self-management of chronic illness in healthcare settings', *Patient Education and Counseling*, vol. 92, no. 1, pp. 13−22.

McGinn, AP, Rosamond, WD, Goff, DC, Jr, Taylor, HA, Miles, JS & Chambless, L 2005, 'Trends in prehospital delay time and use of emergency medical services for acute myocardial infarction: Experience in 4 US communities from 1987-2000', *American Heart Journal*, vol. 150, no. 3, pp. 392−400.

McKinley, S, Dracup, K, Moser, DK, Ball, C, Yamasaki, K, Kim, CJ & Barnett, M 2004, 'International comparison of factors associated with delay in presentation for AMI treatment', *European Journal of Cardiovascular Nursing*, vol. 3, no. 3, pp. 225−30.

Mol, K, Rahel, B, Meeder, J, van Casteren, B, Doevendans, P & Cramer, M 2016, 'Delays in the treatment of patients with acute coronary syndrome: Focus on pre-hospital delays and non−ST-elevated myocardial infarction', *International Journal of Cardiology*, vol. 221, pp. 1061−6.

Mooney, M, McKee, G, Fealy, G, O'Brien, F, O'Donnell, S & Moser, D 2014, 'A randomized controlled trial to reduce prehospital delay time in patients with acute coronary syndrome (ACS)', *The Journal of Emergency Medicine*, vol. 46, no. 4, pp. 495−506.

Mooney, M, O'Brien, F, McKee, G, O'Donnell, S & Moser, D 2016, 'Ambulance use in acute coronary syndrome in Ireland: A cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 15, no. 5, pp. 345−54.

Moser, DK, Kimble, LP, Alberts, MJ, Alonzo, A, Croft, JB, Dracup, K, Evenson, KR, Go, AS, Hand, MM & Kothari, RU 2007, 'Reducing delay in seeking treatment by patients with acute coronary syndrome and stroke: A scientific statement from the American Heart Association Council on Cardiovascular Nursing and Stroke Council', *Journal of Cardiovascular Nursing*, vol. 22, no. 4, pp. 326−43.

Mussi, FC, Mendes, AS, Queiroz, TLd, Costa, ALS, Pereira, Á & Caramelli, B 2014, 'Pre-hospital delay in acute myocardial infarction: Judgement of symptoms and resistance to pain', *Revista da Associação Médica Brasileira*, vol. 60, no. 1, pp. 63−9.

National Heart Foundation of Australia 2012, *A system of care for STEMI: Reducing time to reperfusion for patients with ST-segment elevation myocardial infarction*, National Heart Foundation of Australia, Canberra.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, 'Using avatars to model weight loss behaviors: Participant attitudes and technology development', *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057−65.

Nehme, Z, Andrew, E, Bernard, S, Patsamanis, H, Cameron, P, Bray, JE, Meredith, IT & Smith, K 2017, 'Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates', *European Heart Journal*, vol. 38, pp. 1666−73.

Neubeck, L, Lowres, N, Benjamin, EJ, Freedman, SB, Coorey, G & Redfern, J 2015, 'The mobile revolution—using smartphone apps to prevent cardiovascular disease', *Nature Reviews Cardiology*, vol. 12, no. 6, p. 350−60.

Neubeck, L & Maiorana, A 2015, 'Time to get help? Acute myocardial infarction and delay in calling an ambulance', *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 1−3.

Nielsen, CG, Laut, KG, Jensen, LO, Ravkilde, J, Terkelsen, CJ & Kristensen, SD 2016, 'Patient delay in patients with ST-elevation myocardial infarction: Time patterns and predictors for a prolonged delay', *European Heart Journal: Acute Cardiovascular Care*, vol. 6, no. 7, pp. 583−91.

Noureddine, S, Adra, M, Arevian, M, Dumit, NY, Puzantian, H, Shehab, D & Abchee, A 2006, 'Delay in seeking health care for acute coronary syndromes in a Lebanese sample', *Journal of Transcultural Nursing*, vol. 17, no. 4, pp. 341−8.

O'Brien, F, O'Donnell, S, McKee, G, Mooney, M & Moser, D 2013, 'Knowledge, attitudes, and beliefs about acute coronary syndrome in patients diagnosed with ACS: An Irish cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 12, no. 2, pp. 201−8.

O'Connor, RE, Nichol, G, Gonzales, L, Manoukian, SV, Moyer, PH, Rokos, I, Sayre, MR, Solomon, RC, Wingrove, GL, Brady, WJ & McBride, S 2014, 'Emergency medical services management of ST-segment elevation myocardial infarction in the United States—a report from the American Heart Association Mission: Lifeline Program', *The American Journal of Emergency Medicine*, vol. 32, no. 8, pp. 856−63.

O'Donnell, S, McKee, G, Mooney, M, O'Brien, F & Moser, DK 2014, 'Slow-onset and fast-onset symptom presentations in acute coronary syndrome (ACS): New perspectives on prehospital delay in patients with ACS', *Journal of Emergency Medicine*, vol. 46, no. 4, pp. 507−15.

O'Donnell, S, McKee, G, O'Brien, F, Mooney, M & Moser, DK 2012, 'Gendered symptom presentation in acute coronary syndrome: A cross sectional analysis', *International Journal of Nursing Studies*, vol. 49, no. 11, pp. 1325−32.

Or, CK, Tao, D & Wang, H 2017, 'The effectiveness of the use of consumer health information technology in patients with heart failure: A meta-analysis and narrative review of randomized controlled trials', *Journal of Telemedicine and Telecare*, vol. 23, no. 1, pp. 155−66.

Ottesen, M, Køber, L, Jørgensen, S, Torp-Pedersen, C & Group, TS 1996, 'Determinants of delay between symptoms and hospital admission in 5978 patients with acute myocardial infarction', *European Heart Journal*, vol. 17, no. 3, pp. 429−37.

Ottesen, MM, Dixen, U, Torp-Pedersen, C & Køber, L 2004, 'Prehospital delay in acute coronary syndrome—an analysis of the components of delay', *International Journal of Cardiology*, vol. 96, no. 1, pp. 97-103.

Peng, YG, Feng, JJ, Guo, LF, Li, N, Liu, WH, Li, GJ, Hao, G & Zu, XL 2014, 'Factors associated with prehospital delay in patients with ST-segment elevation acute myocardial

infarction in China', *The American Journal of Emergency Medicine*, vol. 32, no. 4, pp. 349−55.

Perkins-Porras, L, Whitehead, DL, Strike, PC & Steptoe, A 2009, 'Pre-hospital delay in patients with acute coronary syndrome: Factors associated with patient decision time and home-to-hospital delay', *European Journal of Cardiovascular Nursing*, vol. 8, no. 1, pp. 26−33.

Pfaeffli, DL, Dobson, R, Whittaker, R & Maddison, R 2016, 'The effectiveness of mobile-health behaviour change interventions for cardiovascular disease self-management: A systematic review', *European Journal of Preventive Cardiology*, vol. 23, no. 8, pp. 801−17.

Pinto, MD, Hickman Jr, RL, Clochesy, J & Buchner, M 2013, 'Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults', *Applied Nursing Research*, vol. 26, no. 1, pp. 45−8.

Pitsavos, C, Kourlaba, G, Panagiotakos, DB & Stefanadis, C 2006, 'Factors associated with delay in seeking health care for hospitalized patients with acute coronary syndromes: The GREECS study', *Hellenic Journal of Cardiology*, vol. 47, no. 6, pp. 329−36.

Poomsrikaew, O, Ryan, CJ & Zerwic, JJ 2010, 'Knowledge of heart attack symptoms and risk factors among native Thais: A street-intercept survey method', *International Journal of Nursing Practice*, vol. 16, no. 5, pp. 492−8.

Riegel, B, Hanlon, AL, McKinley, S, Moser, DK, Meischke, H, Doering, LV, Davidson, P, Pelter, MM & Dracup, K 2010, 'Differences in mortality in acute coronary syndrome symptom clusters', *American Heart Journal*, vol. 159, no. 3, pp. 392−8.

Rivero, F, Bastante, T, Cuesta, J, Benedicto, A, Salamanca, J, Restrepo, JA, Aguilar, R, Gordo, F, Batlle, M & Alfonso, F 2016, 'Factors associated with delays in seeking medical attention in patients with ST-segment elevation acute coronary syndrome', *Revista Española de Cardiología* (English edition), vol. 69, no. 3, pp. 279–85.

Roberts, M, Healey, C, Garcia, C, Fazzari, M & Naidu, S 2018, 'Factors associated with prehospital delay in patients with ST-elevation myocardial infarction', *Journal of the American College of Cardiology*, vol. 67, no. 13, p. S627.

Rodriguez, F & Mahaffey, KW 2016, 'Management of patients with NSTE-ACS: A comparison of the recent AHA/ACC and ESC guidelines', *Journal of the American College of Cardiology*, vol. 68, no. 3, pp. 313−21.

Roffi, M, Patrono, C, Collet, J-P, Mueller, C, Valgimigli, M, Andreotti, F, Bax, JJ, Borger, MA, Brotons, C & Chew, DP 2016, '2015 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC)', *European Heart Journal*, vol. 37, no. 3, pp. 267−315.

Rollando, D, Puggioni, E, Robotti, S, De Lisi, A, Ferrari Bravo, M, Vardanega, A, Pattaro, I, de Benedetti, F & Brignole, M 2012, 'Symptom onset-to-balloon time and mortality in the first seven years after STEMI treated with primary percutaneous coronary intervention', *Heart*, vol. 98, no. 23, p. 1738−42.

Ross, R 1999, 'Atherosclerosis—an inflammatory disease', *The New England Journal of Medicine*, vol. 340, no. 2, pp. 115−26.

Sanchis-Gomar, F, Perez-Quilis, C, Leischik, R & Lucia, A 2016, 'Epidemiology of coronary heart disease and acute coronary syndrome', *Annals of Translational Medicine*, vol. 4, no. 13, pp. 1−12.

Santos-Gallego, CG, Picatoste, B & Badimón, JJ 2014, 'Pathophysiology of acute coronary syndrome', *Current Atherosclerosis Reports*, vol. 16, no. 4, p. 401.

Sarkis, N & Mwanri, L 2014, 'The role of information technology in strengthening human resources for health', *Health Education*, vol. 114, no. 1, pp. 67−79.

Savage, ML, Poon, KK, Johnston, EM, Raffel, OC, Incani, A, Bryant, J, Rashford, S, Pincus, M & Walters, DL 2014, 'Pre-hospital ambulance notification and initiation of treatment of ST-elevation myocardial infarction is associated with significant reduction in door-to-balloon time for primary PCI', *Heart, Lung and Circulation*, vol. 23, no. 5, pp. 435−43.

Sax, HC 2017, 'Healthcare transformation: What are the challenges?', in HC Sax (ed.), *Measurement and analysis in transforming healthcare delivery*, Springer, Los Angeles, USA, pp. 1−6.

Shand, JA & Menown, IB 2010, 'A timely diagnosis of myocardial infarction', *Biomarkers in Medicine*, vol. 4, no. 3, pp. 385−93.

Shenoy, R & Kumar, P 2014, 'Clinical presentation, management and outcome of acute coronary syndromes', *Indian Journal of Respiratory Care*, vol. 3, no. 2, pp. 512−6.

Smith, JN, Negrelli, JM, Manek, MB, Hawes, EM & Viera, AJ 2015, 'Diagnosis and management of acute coronary syndrome: An evidence-based update', *The Journal of the American Board of Family Medicine*, vol. 28, no. 2, pp. 283−93.

Song, L, Yan, H & Hu, D 2010, 'Patients with acute myocardial infarction using ambulance or private transport to reach definitive care: Which mode is quicker?', *Internal Medicine Journal*, vol. 40, no. 2, pp. 112−6.

Sorathiya, V, Kapupara, P & Shah, K 2016, 'Technology-based patient education information system', *Research Journal of Pharmacy and Technology*, vol. 9, no. 1, pp. 101−7.

Sorita, A, Ahmed, A, Starr, SR, Thompson, KM, Reed, DA, Prokop, L, Shah, ND, Murad, MH & Ting, HH 2014, 'Off-hour presentation and outcomes in patients with acute myocardial infarction: Systematic review and meta-analysis', *BMJ*, vol. 348, p. f7393.

Spinler, SA & de Denus, S 2016, *Acute coronary syndrome,* <https://basicmedicalkey.com/acute-coronary-syndromes/>.

Srimahachota, S, Kanjanavanit, R, Boonyaratavej, S, Boonsom, W, Veerakul, G & Tresukosol, D 2007, 'Demograghic, management practices and in-hospital outcomes of Thai Acute Coronary Syndrome Registry (TACSR): The difference from the western world', *Journal of the Medical Association of Thailand*, vol. 90, no. 1, pp. 1−11.

Sullivan, MD, Ciechanowski, PS, Russo, JE, Soine, LA, Jordan-Keith, K, Ting, HH & Caldwell, JH 2009, 'Understanding why patients delay seeking care for acute coronary syndromes', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 3, pp. 148−54.

Swanoski, MT, Lutfiyya, MN, Amaro, ML, Akers, MF & Huot, KL 2012, 'Knowledge of heart attack and stroke symptomology: A cross-sectional comparison of rural and non-rural US adults', *BMC Public Health*, vol. 12, no. 1, p. 283.

Tabriz, AA, Sohrabi, M-R, Kiapour, N & Yazdani, S 2012, 'Factors associated with delay in thrombolytic therapy in patients with ST-elevation myocardial infarction', *The Journal of Tehran Heart Center*, vol. 7, no. 2, p. 65−71.

Tait, AR, Voepel-Lewis, T, Chetcuti, SJ, Brennan-Martinez, C & Levine, R 2014, 'Enhancing patient understanding of medical procedures: Evaluation of an interactive multimedia program with in-line exercises', *International Journal of Medical Informatics*, vol. 83, no. 5, pp. 376−84.

Tanner, H, Larsen, P, Lever, N & Galletly, D 2006, 'Early recognition and early access for acute coronary syndromes in New Zealand: Key links in the chain of survival', *The New Zealand Medical Journal (Online)*, vol. 119, no. 1232, p. U1927.

Taylor, DM, Garewal, D, Carter, M, Bailey, M & Aggarwal, A 2005, 'Factors that impact upon the time to hospital presentation following the onset of chest pain', *Emergency Medicine Australasia*, vol. 17, no. 3, pp. 204−11.

Ting, HH, Chen, AY, Roe, MT, Chan, PS, Spertus, JA, Nallamothu, BK, Sullivan, MD, DeLong, ER, Bradley, EH, Krumholz, HM & Peterson, ED 2010, 'Delay from symptom onset to hospital presentation for patients with non–ST-segment elevation myocardial infarction', *Archives of Internal Medicine*, vol. 170, no. 20, pp. 1834−41.

Townsend, N, Wilson, L, Bhatnagar, P, Wickramasinghe, K, Rayner, M & Nichols, M 2016, 'Cardiovascular disease in Europe: Epidemiological update 2016', *European Heart Journal*, vol. 37, no. 42, pp. 3232−45.

Treskes, R, van der Velde, E, Schoones, JW & Schalij, MJ 2018, 'Implementation of smart technology to improve medication adherence in patients with cardiovascular disease: Is it effective?', *Expert Review of Medical Devices*, vol. 15, no. 2, pp. 119−26.

Tsai, S-T & Chou, F-H 2012, 'The effectiveness of multimedia nursing education on reducing illness-related anxiety and uncertainty in myocardial infarction patients after percutaneous coronary intervention', *Hu Li Za Zhi*, vol. 59, no. 4, p. 43−53.

Tubaro, M, 2010, 'An organized system of emergency care for patients with myocardial infarction: A reality?', *Future Cardiology*, vol. 6, no. 4, pp. 483−89.

Tullmann, DF & Dracup, K 2005, ‘Knowledge of heart attack symptoms in older men and women at risk for acute myocardial infarction’, *Journal of Cardiopulmonary Rehabilitation and Prevention*, vol. 25, no. 1, pp. 33−9.

Tullmann, DF, Haugh, KH, Dracup, KA & Bourguignon, C 2007, ‘A randomized controlled trial to reduce delay in older adults seeking help for symptoms of acute myocardial infarction’, *Research in Nursing & Health*, vol. 30, no. 5, pp. 485−97.

Tummala, SR & Farshid, A 2015, ‘Patients’ understanding of their heart attack and the impact of exposure to a media campaign on pre-hospital time’, *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 4−10.

Veneri, DA & Zdanis, K 2018, ‘Are technology-informed methods better than traditional approaches in educating patients? A meta-analysis’, *Health Education Journal*, <http://journals.sagepub.com/>.

Walters, GA 2015, ‘Women and pre-hospital delays associated with myocardial infarction’, PhD thesis, The University of North Carolina at Greensboro, Greensboro, USA.

Wang, TY, Nallamothu, BK, Krumholz, HM, Li, S, Roe, MT, Jollis, JG, Jacobs, AK, Holmes, DR, Peterson, ED & Ting, HH 2011, ‘Association of door-in to door-out time with reperfusion delays and outcomes among patients transferred for primary percutaneous coronary intervention’, *Journal of the American Medical Association*, vol. 305, no. 24, pp. 2540−7.

Wechkunanukul, K, Grantham, H & Clark, RA 2017, ‘Global review of delay time in seeking medical care for chest pain: An integrative literature review’, *Australian Critical Care*, vol. 30, no. 1, pp. 13−20.

Whitaker, S, Baldwin, T, Tahir, M, Choudhry, O, Senior, A & Greenfield, S 2011, ‘Public knowledge of the symptoms of myocardial infarction: A street survey in Birmingham, England’, *Family Practice*, vol. 29, no. 2, pp. 168−73.

Weibel, L, Massarotto, P, Hediger, H & Mahrer-Imhof, R 2016, ‘Early education and counselling of patients with acute coronary syndrome. A pilot study for a randomized controlled trial’, *European Journal of Cardiovascular Nursing*, vol. 15, no. 4, pp. 213−22.

Wiederhold, BK 2013, ‘Avatars: Changing behavior for better or for worse?’, *Cyberpsychology, Behavior, and Social Networking*, vol. 16, no. 5, pp. 319−20.

Wilson, EA, Park, DC, Curtis, LM, Cameron, KA, Clayman, ML, Makoul, G, vom Eigen, K & Wolf, MS 2010, 'Media and memory: The efficacy of video and print materials for promoting patient education about asthma', *Patient Education and Counseling*, vol. 80, no. 3, pp. 393−8.

World Health Organization 2017a, *Fact sheet on cardiovascular diseases*, viewed 1 December 2017, <http://www.who.int/cardiovascular_diseases/en/>.

World Health Organization 2017b, *Top 10 causes of death worldwide, fact sheet* <http://www.who.int/mediacentre/factsheets/fs310/en/>.

World Heart Federation 2013, *Warning sign*, viewed 15 September 2017, <http://www.world-heart-federation.org/cardiovascular-health/heart-disease/warning-signs/>.

Worrall, A & Fletcher, G 2018, 'Acute coronary syndromes—assessment and interventions', *Stroke*, vol. 13, p. 57.

Wynn Jr, RE 2013, 'The effects of an educational program on recognition of atypical signs and symptoms of acute coronary syndrome in women in the emergency room', DNP thesis, West Virginia University, West Virginia, USA.

Yan, H, Song, L, Yang, J, Sun, Y & Hu, D 2009, 'The association between pre-infarction angina and care-seeking behaviors and its effects on early reperfusion rates for acute myocardial infarction', *International Journal of Cardiology*, vol. 135, no. 1, pp. 86−92.

Youssef, G, Kassem, H, Ameen, O, Al Taaban, H & Rizk, H 2017, 'Pre-hospital and hospital delay in patients with non–ST-elevation acute coronary syndromes in tertiary care', *The Egyptian Heart Journal*, vol. 69, no. 3, pp. 177−81.

Yousuf, G, Kianoush, S, Kelli, HM, Misra, S, Urrea, B, Blaha, MJ, Graham, G, Marvel, FA & Martin, SS 2016, 'The role of mHealth for improving medication adherence in patients with cardiovascular disease: A systematic review', *European Heart Journal. Quality of Care and Clinical Outcomes*, vol. 2, no. 4, pp. 237−44.

Zorca, SM & Mizuguchi, KA 2017, 'Coronary artery disease', in LS Aglio & RD Urman (eds.), *Anesthesiology*, Springer, Boston, USA. pp. 3−11.

CHAPTER 2: REVIEW OF THE LITERATURE AND CONCEPTUAL FRAMEWORKS

2.1 Introduction

This literature review aims to explore interventions that have focused on improving acute coronary syndrome (ACS) knowledge, attitudes and beliefs among patients with ACS, as well as avatar-based technology interventions in a patient education setting that have been able to improve knowledge and self-management or self-care behaviours. The review section of this chapter describes the structure of the review, objectives, methods and data collection and analysis. It provides a summary of the critical appraisals and concludes with a discussion of the pertinent issues arising from the review.

2.2 Section 1: Interventions That Aim to Improve Knowledge, Attitudes and Beliefs Among Patients with Acute Coronary Syndrome

2.2.1 Objectives of the Review

This review of nursing interventions in the cardiovascular disease (CVD) population has been undertaken to determine the effects of these interventions in improving the knowledge, attitudes and beliefs of patients with CVD and ACS. What differentiates this review from others is its focus on whether and how individualised educational interventions are effective. This review brings out the differences between the educational interventions, the variability of the instruments, the effects and potential explanations. This is an attempt to explore the evidence to inform further development of educational interventions to increase ACS knowledge, attitudes and beliefs among patients with ACS.

2.2.2 Methods

An integrative review was used to examine the effectiveness of educational interventions to improve ACS patients' knowledge, attitudes and beliefs. The methodology for the integrative review, as recommended by Whittemore and Knafl (2005), was used to apply rigour to the processes used to conduct the studies reported in this review section. Specifically, this related to preparing the guiding question, searching or sampling the literature, data collection, critical analysis of the included studies and discussion of the results, presentation of the integrative review and analysis of the data.

2.2.3 Criteria for Selecting Studies

2.2.3.1 Type of Studies

Any intervention study that consisted of a measure of knowledge, attitudes or beliefs of ACS patients was included. This included randomised controlled trials (RCTs), controlled clinical trials and quasi-experimental and pre-test post-test studies that consisted of either a parallel group or cross-over design in which the follow-up was one month or more after the start of the intervention.

2.2.3.2 Type of Participants

Individuals aged 18 years and over with coronary heart disease (CHD) or ACS due to any aetiology were included.

2.2.3.3 Type of Interventions

Included were interventions that targeted improvements in ACS knowledge, attitudes, beliefs or heart attack response actions.

2.2.3.4 Type of Outcomes

Studies were selected that reported on outcomes related to knowledge, attitudes, beliefs or response actions to ACS symptoms.

2.2.4 Selection of Studies

A review was conducted of research undertaken between 2004 and 2018. The databases searched were MEDLINE, Psych INFO, Cochrane and CINAHL. A search of the literature was independently conducted by the first reviewer and then a medical librarian using electronic database search engines. The titles of the articles identified in the search were initially considered and any that were obviously irrelevant were excluded. The specific search keywords used were ‘acute coronary syndrome’, ‘heart attack’, ‘knowledge, attitude, belief’ and ‘intervention OR clinical trial OR pilot study OR outcomes OR randomised controlled trial’. There was also an additional manual search of references identified in the selected studies. The final search results were de-duplicated within EndNote. Articles were initially screened by reviewing titles and keywords. Two independent reviewers then screened the retrieved articles independently using predetermined inclusion criteria. Full versions of the studies considered potentially relevant were agreed on by consensus. Disagreements on inclusion were also resolved by consensus with a third reviewer. A summary of the selected articles is provided in Table 2.1.

Table 2.1: Summary of the Included Studies (Section 1 of Literature Review)

Study	Methods Sample	Intervention Follow-up	Data measurement Instruments	Results
Goff et al. (2004) USA 1996−97	RCT Pre-intervention n = 1,294 Post-intervention n = 1,204	18-month broadcasting media combined with public education by a health professional 20 communities Symptom recognition and the need to act fast by calling 911 Follow-up at 5−8 months, 12−15 months and 18 months	Knowledge of ACS symptoms Open-ended questions Random digit survey via telephone	Significant increase in knowledge of symptoms in intervention communities ($p < .001$) No significant differences between communities' change in knowledge
Meischke et al. (2004) USA 2001−02	RCT Age over 65s n = 323 Intervention = 176 Control = 147	Individualised education with information package about ACS symptom knowledge and importance of calling emergency telephone number Three- and 12-month follow-ups	Knowledge of ACS symptoms Response action intentions to ACS symptoms Telephone survey with open-ended questionnaire	No significant differences in knowledge of ACS symptoms or intention to call emergency telephone number between groups
Buckley et al. (2007) Australia 2001	RCT Reinforced one month later History of CHD n = 200 Intervention = 105 Control = 95	Individualised education and counselling intervention (40 minutes) Three- and 12-month follow-ups	Knowledge, attitudes and beliefs The ACS Response Index	Significantly improved knowledge of ACS over time ($p = .02$) No significant differences in attitudes and beliefs between groups over time
Tullmann et al. (2007) USA 2001	RCT Over 65s with history of CHD n = 115 Intervention = 58 Control = 57	Individualised education and counselling intervention (40−60 minutes) Reinforced at one and two months Three-month follow-up	Knowledge, attitudes, beliefs, perceived control and anxiety The AMI Response Questionnaire	Significant increase in knowledge ($p < .001$) and beliefs ($p = .002$) in the IG compared to the control group at three months No significant differences in attitudes between groups at three months
Bell et al. (2009) USA 2007	Pre-test post-test Over 60s n = 693 (from 40 senior centres)	Group educational intervention (45−60 minutes) Post-test at 1−2 months	Knowledge of ACS symptoms Response actions The Behavioural Risk Factor Surveillance System	Significant improvement in knowledge of symptoms ($p < .001$) Significant improvement in knowledge of response actions to symptoms ($p < .001$)

Study	Methods Sample	Intervention Follow-up	Data measurement Instruments	Results
McKinley et al. (2009) USA, Australia and New Zealand 2001−03	RCT History of CHD n = 3,522 Intervention = 1,777 Control = 1,745	Individualised education and counselling (40 minutes) Reinforced at one month Three- and 12-month follow-ups	Knowledge, attitudes, and beliefs about ACS The ACS Response Index	Significant increase in knowledge (p = .0005), attitude (p = .0005) and belief (p = .0005) scores in the IG over time compared to the control group
DeVon et al. (2010) USA December 2006 to March 2008	Pilot RCT Diagnosis CHD with elective PCI n = 64 Intervention = 32 Control = 32	Slide presentation on computer (5−15 minutes) Viewed three times pre-discharge Repeated at two and four months post-discharge Four-month follow-up	ACS knowledge ACS symptoms Help-seeking behaviour questionnaire 20-item identified symptoms	Knowledge of ACS symptoms and help-seeking behaviour increased significantly in the IG compared to the control group (p < .001)
Gallagher et al. (2013) Australia March 2010 to March 2011	Pre-test post-test History of CHD n = 137	Individualised education intervention (15−25 minutes) Two-month follow-up	Knowledge of ACS and response actions The ACS Response Index	Significant increase in knowledge of symptoms (p < .0001) Significant improvement in response action knowledge (p < .001)
O'Brien et al. (2014) Ireland October 2007 to November 2010	RCT ACS diagnosis n = 1,947 Intervention = 974 Control = 973	Individualised education (40 minutes) Three- and 12-month follow-ups	Knowledge, attitudes and beliefs The ACS Response Index	Significant increase in knowledge (p < .001), attitude (p = .003) and belief (p < .001) scores in the IG over time compared to the control group
Singh et al. (2016) Malaysia 2016	Single group quasi-experimental CHD n = 60	Nurse education program Group education on ACS symptoms, rapid response to ED and lifestyle modification with flipchart One-month follow-up	Knowledge, attitudes and beliefs The ACS Response Index	Significant improvement in knowledge (p < .001), attitude (p < .001) and belief scores (p = .015) after intervention

Note: ACS = acute coronary syndrome; AMI = acute myocardial infarction; CHD = coronary heart disease; ED = emergency department; IG = intervention group; RCT = randomised controlled trial

2.2.5 Methodological Quality Assessment

A total of 10 studies were included for appraisal of methodological quality. All 10 studies were determined to be of adequate quality after assessment using one of two measures. The first tool was the Critical Appraisal Skills Programme (CASP) checklist (see Appendix 1) that measured RCTs (CASP 2018). The second measure was the Joanna Briggs Institute (JBI) critical appraisal checklist (JBI 2017) (see Appendix 15) that assessed non-randomised experimental studies that achieved 'yes' on at least 50 per cent of the applicable questions. The quality appraisal scores for the RCT studies were 81.8-90.9 per cent (see Appendix 2) and 66.7-100 per cent of the applicable questions for the non-randomised experimental studies (see Appendix 2).

2.2.6 Results

2.2.6.1 Search Outcomes

The initial search identified a total of 2,890 articles, while a manual search of other sources (i.e., Google search and the grey literature) identified a further 92 articles. After the removal of duplicates, 2,225 articles remained for screening, of which 2,207 articles were excluded. Full-text articles were obtained for the remaining 18 articles. Based on a full-text review, a further eight articles were excluded. After review against the inclusion criteria, six RCTs (Buckley et al. 2007; Goff et al. 2004; McKinley et al. 2009; Meischke et al. 2004; O'Brien et al. 2013; Tullmann et al. 2007), one pilot RCT (DeVon et al. 2010), two pre-test post-test studies (Bell et al. 2009; Gallagher et al. 2013) and one single group quasi-experimental study (Singh et al. 2016) were identified (see Table 2.1). Figure 2.1 presents a preferred reporting items for systematic reviews and meta-analysis (PRISMA) flow diagram describing the overall process.

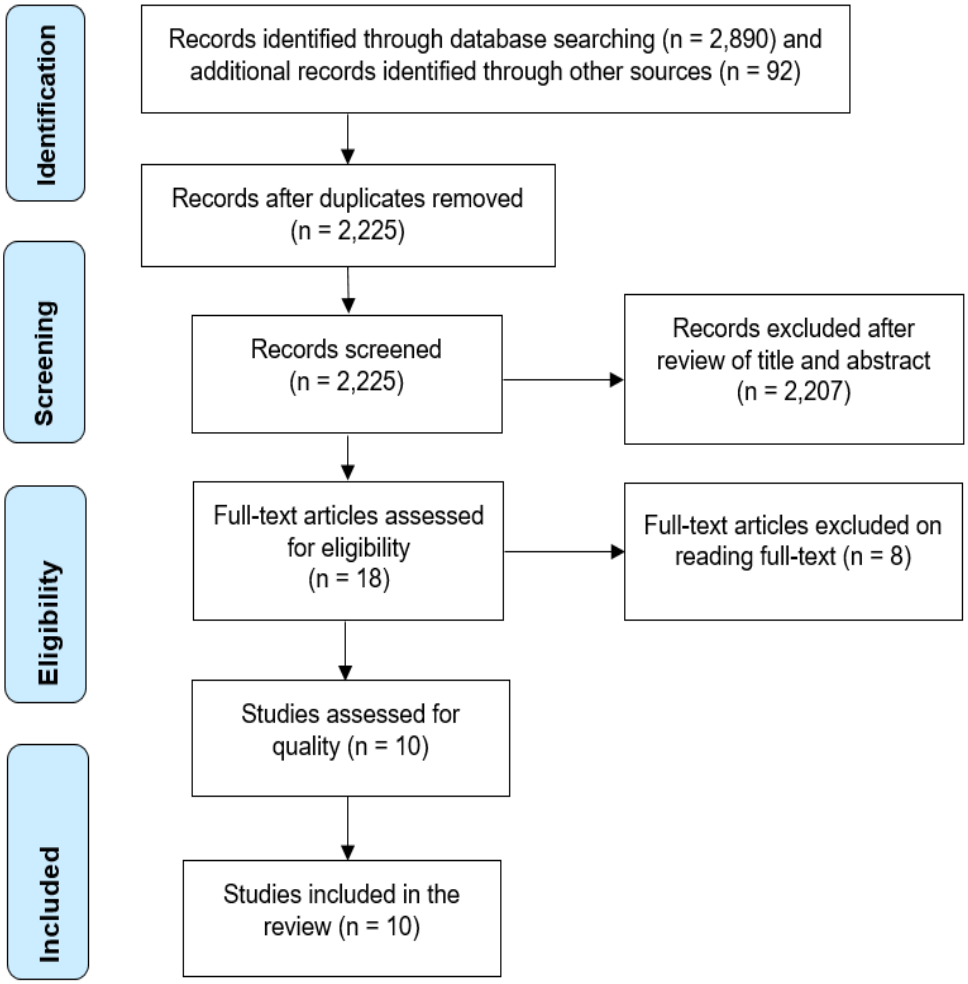


Figure 2.1: PRISMA Flowchart Showing Identification of Studies (Section 1 of Literature Review)

2.2.6.2 Study Characteristics

The 10 studies represent a total of 8,243 participants with a mean age of 68.4 years. The sample size of the studies ranged from 60 to 3,522 participants. Gender was reported in all studies with a slight weighting towards men (57%). In six of the 10 studies, participants were recruited from CHD patients (Buckley et al. 2007; DeVon et al. 2010; Gallagher et al. 2013; McKinley et al. 2009; Singh et al. 2016; Tullmann et al. 2007). One study recruited only women aged over 60 years with CHD (Bell et al. 2009). One study recruited patients who had a diagnosis of ACS (O'Brien et al. 2014). The majority of interventions were conducted in the United States of America (USA). One study covered the USA, Australia and New Zealand. There was also one study conducted in each of Ireland, Australia and Malaysia. The characteristics of the included studies are presented in Table 2.1.

2.2.6.3 Methodological Attributes

The purpose of all the interventions was to improve ACS and CHD knowledge, as well as response actions to ACS symptoms (Bell et al. 2009; Buckley et al. 2007; DeVon et al. 2010; Gallagher et al. 2013; McKinley et al. 2009; Mosca et al. 2013; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007). Some interventions also incorporated the variables of attitudes and beliefs (Buckley et al. 2007; McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007). In relation to the intervention delivery method, five of the studies exclusively evaluated individualised education (Buckley et al. 2007; Gallagher et al. 2013; McKinley et al. 2009; O'Brien et al. 2014; Tullmann et al. 2007), while two used a combination of both methods (Goff et al. 2004; Meischke et al. 2004). Goff et al. (2004) delivered a multi-component intervention, including mass media and interpersonal methods such as one-to-one interaction to high-risk CHD individuals who attended cardiac clinics. Two studies used group education to deliver the interventions (DeVon et al. 2010; Singh et al. 2016). DeVon et al. (2010) conducted a pilot RCT and delivered content through a slide presentation via a computer prior to the patients' discharge. Singh et al. (2016) conducted a quasi-experimental study and delivered information on ACS symptoms, rapid response and lifestyle modification via nurse-led group education (Singh et al. 2016). Meischke et al. (2004) delivered an ACS information package to participants' homes. Six individualised education interventions reported successful outcomes (Buckley et al. 2007; Gallagher et al. 2013; Goff et al. 2004; Meischke et al. 2004; O'Brien et al. 2014; Tullmann et al. 2007). Two group education interventions revealed positive effects on outcomes in the intervention group (IG) (DeVon et al. 2010; Singh et al. 2016).

Sample sizes varied across the 10 reviewed studies, ranging from 60 participants (Singh et al. 2016) to 3,522 (McKinley et al. 2009). The pilot study by DeVon et al. (2010) and the single group quasi-experimental study by Singh et al. (2016) had 64 and 60 participants, respectively, representing small sample sizes. Only two studies reported a power analysis to calculate the estimated sample size (Gallagher et al. 2013; O'Brien et al. 2014). This is important because power analysis calculations are useful for verifying the validity of the statistical conclusions (Claydon 2015; Polit & Beck 2017). A number of studies had no reference to a power analysis of sample size (Bell et al. 2009; Buckley et al. 2007; DeVon et al. 2010; Tullmann et al. 2007). Three studies calculated the sample size based on the primary outcomes of seeking to reduce pre-hospital delay time (n = 1,294, n = 3,522 and n = 1947, respectively) (Goff et al. 2004; McKinley et al. 2009; O'Brien et al. 2014). Finally, one study used different samples at each data collection time point, indicating that baseline

and post-intervention data were not recorded for the same participants (Goff et al. 2004). Consequently, this point should be of concern in developing future interventions.

2.2.6.4 Measurement of Knowledge, Attitudes and Beliefs

Five studies used the ACS Response Index (Riegel et al. 2007), which has been evaluated for both validity and reliability (Buckley et al. 2007; McKinley et al. 2009) to assess knowledge, attitudes and beliefs (Buckley et al. 2007; Gallagher et al. 2013; McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016). Two studies used checklist questionnaires (Yes = related or No = not related to a heart attack) of identified symptoms to assess knowledge of ACS (Bell et al. 2009; Tullmann et al. 2007). Goff et al. (2004) combined the ACS Response Index (Riegel et al. 2007) and open-ended questions to measure CVD risk and prevention. Only two studies reported on the validity and reliability of the questionnaire (DeVon et al. 2010; O'Brien et al. 2014). These findings demonstrate that there are inconsistencies in measuring patient knowledge, attitudes and beliefs about ACS through the ACS Response Index (Riegel et al. 2007).

2.2.6.5 Effectiveness in Improving Knowledge, Attitudes and Beliefs

The results of this review suggest that attitudes and beliefs may be less easily improved than knowledge (Glattacker, Heyduck & Meffert 2012). Among the studies that measured ACS knowledge, nine studies reported statistically significant positive effects of the study interventions on ACS knowledge (Bell et al. 2009; Buckley et al. 2007; DeVon et al. 2010; Gallagher et al. 2013; Goff et al. 2004; McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007). Only the study by Meischke et al. (2004) did not demonstrate a positive effect of their education intervention. Three studies reported a statistically significant positive effect on participants' attitudes (McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016). Four studies reported statistically significant effects of their interventions on beliefs (McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007).

2.2.7 Discussion

This review contributes to a deeper understanding of how to improve ACS knowledge by examining the types and effectiveness of the interventions in the selected studies on three domains of outcomes measures, as well as the intervention delivery modes that were used to improve knowledge, attitudes and beliefs in ACS patients. The findings from this review demonstrate increases in knowledge, attitude and belief scores among the IGs (Bell et al. 2009; Buckley et al. 2007; DeVon et al. 2010; Gallagher et al. 2013; Goff et al. 2004;

McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007). This finding supports the effectiveness of augmented ACS patient education.

Another point of concern is the duration of the interventions. In this review, four RCT studies used individual education interventions with durations ranging from 40 minutes to one hour (Buckley et al. 2007; McKinley et al. 2009; O'Brien et al. 2014; Tullmann et al. 2007) that were then reinforced one month later by telephone. Moreover, these studies measured the effects of the intervention at a three-month follow-up, and three studies (Buckley et al. 2007; McKinley et al. 2009; O'Brien et al. 2014) also measured and sustained their intervention effects at 12 months. All the studies reported significant improvements in knowledge, attitudes or beliefs in the IGs. The RCT conducted by Meischke et al. (2004) did not demonstrate any significant effects of the intervention on outcome measures. This intervention was delivered by leaving the ACS information package at participants' homes, so it is unknown whether the participants actually read the ACS information package. The researcher did not disclose the duration between the delivery of the intervention and the outcome data measures. Thus, the results of this study cannot determine whether knowledge of ACS symptoms would differ from one time point to another.

The literature (Ahmed et al. 2017; Flanders 2018; Wynn 2013) suggests that for educational interventions to be effective, there must be evidence that a knowledge gap exists in the target group (Ting & Bradley 2009). The use of RCTs to measure the effect of intervention studies is considered the most reliable of all designs (Moule, Aveyard & Goodman 2016; Polit & Beck 2017). Accordingly, an RCT was selected as the method of preference for this current study due to the recognition that nursing practice should be underpinned by the highest forms of evidence (Littleton-Kearney 2018; Polit & Beck 2017; Ratner et al. 2013; Thorpe et al. 2009). The literature has also pointed out that a practical system of care should endeavour to normalise education interventions so that they can be delivered and reinforced by the entire health care professional team as part of routine care (Lewin & Piper 2007; Yeh, Wu & Tung 2018). For example, at the time of a patient's education in a cardiac rehabilitation program and at hospital discharge, they are required to take instructions from the health care professional team about knowledge and lifestyle modifications to increase their awareness (Lambert-Kerzner et al. 2012; Lu et al. 2015). The field of patient education needs more disruptive innovation strategies to influence individual behaviour to change inactivity in patient responsiveness (Caligtan et al. 2012; Or, Tao & Wang 2017; Tsai & Chou 2012).

For this review, the interventions have focused on cognitive behaviour and improved response actions of patients with ACS (Bell et al. 2009; Buckley et al. 2007; DeVon et al. 2010; Gallagher et al. 2013; Goff et al. 2004; McKinley et al. 2009; Meischke et al. 2004; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007), with knowledge, attitudes and beliefs being the intermediate steps to implementing appropriate response actions. Based on the findings of this review, knowledge, attitudes, beliefs and the associated patient-related factors were improved by augmenting education for ACS patients (Herlitz et al. 2010; Tawalbeh & Ahmad 2014). In addition, the literature reveals that appropriate response actions to ACS symptoms are dependent on sufficient knowledge, but also on attitudes and beliefs (Farquharson, Johnston & Bugge 2012; Shand & Menown 2010). However, ACS symptoms can be difficult to interpret because a definitive diagnosis is not straightforward (Farshidi et al. 2013; Gouveia, Victor & Lima 2011; Khan 2011; Perkins-Porras et al. 2008). Inadequate knowledge of symptoms, misattribution and inappropriate response actions can lead to delays in seeking medical care and the use of ambulance services (Bray et al. 2015; Ma et al. 2017; Mooney et al. 2016; Neubeck & Maiorana 2015; Thuresson et al. 2015). ACS symptoms are noticeable in a variety of ways and the health care professional should be aware of the range and variability of ACS symptoms and the actions to be taken in their presence (Andersson et al. 2017; Bray et al. 2016; Mol et al. 2016; Tummala & Farshid 2015). This point should be of concern to health care providers and the general public (Albarqouni et al. 2016; Bruno 2013; O'Brien et al. 2013).

The literature has revealed that education is most beneficial when it is tailored to the individual (Bell et al. 2009; Gallagher et al. 2013; McKinley et al. 2009; O'Brien et al. 2014; Singh et al. 2016; Tullmann et al. 2007). A variety of learning strategies for individuals should be considered, such as using interactive technologies and sound and visual effects that can encourage them to take more interest in the critical information and health messages being delivered (Carr et al. 2013; Geuens et al. 2016; Heapy et al. 2015; Isern & Moreno 2016; Kooij, Groen & van Harten 2017). The role of effective teaching strategies in optimising the education of cardiovascular patients has been acknowledged in the literature (Commodore-Mensah & Himmelfarb 2012; Gallagher et al. 2013) and will be presented next.

2.2.8 Conclusion

This review explored the evidence on interventions for improving knowledge, attitudes and beliefs in ACS management. The result of this review informed the conceptual framework and design of the intervention, as well as the intervention's outcome assessments. Chapter 3 will provide a detailed description of the intervention. Based on this review, beyond formal

ACS management, ongoing support is essential for the maintenance of knowledge among people with ACS. Given the variation in interventions across the selected studies and the lack of integrated innovative technology in ACS patients' education, it is timely to explore technology-based interventions, particularly how they can be incorporated into current models of care delivery to improve clinical effectiveness. Studies of interventions for improving knowledge, attitudes, beliefs and appropriate response to ACS symptoms are warranted.

2.3 Section 2: Avatar-Based Technologies in Patient Education: An Integrative Review

2.3.1 Introduction

Self-care behaviour is the process of maintaining health through health-promoting practices in states of both health and illness (Mohammadpour et al. 2015). Individuals are able to limit worsening symptoms when they understand and can manage the disease and learn to self-manage simple interventions (Barnason, Zimmerman & Young 2012). The ability of a patient to control their health and illness through an effective care plan is significantly influenced by cognitive behavioural, social or situational factors (Glanz, Rimer & Viswanath 2008). A major problem of unhealthy behaviour is the resistance of patients to lifestyle advice, such as eating a healthy diet, doing more exercise and quitting smoking (Fjeldsoe et al. 2011; Pearson 2012; Webb et al. 2010) and numerous studies have shown that a large percentage of patients do not adhere to healthy lifestyle changes, self-care behaviour or disease management (Ahmed et al. 2017; Nielsen et al. 2010). The process of behaviour change is complicated and requires more than simply the acquisition of health knowledge (Bartholomew & Mullen 2011; Ciechanowski et al. 2014; Gruman et al. 2010). To improve the effectiveness and efficacy of care, patient education plays a significant role in the decision-making processes of patients, seeking of medical care and behaviour change to improve health-related quality of life (HRQoL) (Bunge, Mühlhauser & Steckelberg 2010; Jamshidi et al. 2013; Kav et al. 2015).

Patient education is an important component of many disease management and health promotion programs (Commodore-Mensah & Himmelfarb 2012; Stenberg et al. 2016; Warsi et al. 2004). Health care providers are under increasing pressure to provide health information and resources to patients to encourage them to follow disease management programs and make informed decisions about their health behaviour (Glanz, Rimer & Viswanath 2008; Neville, Greene & Lewis 2006). Patient education has often been delivered

face-to-face and supported by paper-based flyers, brochures and sometimes videos or DVDs (Veneri & Zdanis 2018). However, as information technology has rapidly advanced, computer-based information and resources for supporting patient teaching, decision-making and information retrieval have become increasingly available (Caligtan et al. 2012; Heapy et al. 2015; Isern & Moreno 2016; Or & Karsh 2009). Several authors have claimed that these new types of systems have many advantages compared to the more traditional means used for patient education (Bernhardt et al. 2013; Kooij, Groen & van Harten 2017; Suhling et al. 2014; Yousuf et al. 2016). The main advantage is that health information can be delivered in a more interactive and engaging way and has the ability to provide individually tailored information at a lower cost (Andrade et al. 2015; Provoost et al. 2017; Webb et al. 2010; Xinyu & Pin 2008).

An avatar is a computer-generated character that is representative of people and has interactive behaviours (Provoost et al. 2017) designed to carry out simulated 'human-like character' conversations with a player or user, including appropriately mimicking human behaviours interaction such as talking and hand gestures (Schulman & Bickmore 2009). Moreover, avatars are designed with human-like behaviours to build and maintain long-term, social−emotional relationships with their users (Anam, Andrade & Ruiz 2016). They are particularly effective as relational agents, as many of the strategies used to build and support interpersonal relationships involve non-verbal communication (Neville, Greene & Lewis 2006). The use of avatar-based technologies in patient education is growing, creating new avatar characters and simulations for patients during bedside education sessions and discharge plans from the comfort of their own home. As health education changes to meet the needs of patients or caregivers, options such as avatar-based technologies need to be considered (Bickmore, Pfeifer & Paasche-Orlow 2009; Kothgassner et al. 2016). However, there is only limited research on the effectiveness and applicability of avatar-based technology interventions for patient education. This paper used an integrative review approach that allowed the inclusion of RCT studies to provide readers with a better understanding of the topic. It allows readers greater capacity to explore the relevance and applicability of avatar-based technologies as interventions for improving outcomes for patient education in clinical practice.

2.3.2 Aims

To date, the literature has demonstrated that the integration of avatar-based technology interventions to deliver health information has improved the health behaviour change process in a range of different health conditions. The aim of this review is to explore the

effectiveness of avatar-based technology interventions in patient education. There are two objectives. The first is to report and summarise the evidence on avatar-based technology interventions in patient education. The second objective is to report on how avatar-based technology interventions have improved knowledge, changed behaviours and enhanced self-efficacy and HRQoL, as well as reporting on the participating patients' acceptability of and satisfaction with the application. The intent here is to synthesise the evidence so that it can be applied to the current study.

2.3.3 Methods

This integrative review used a systematic approach, including a methodological quality assessment outlined by Whittemore and Knafl (2005) and checklist for writing an integrative review recommended by Torraco (2005). A systematic approach has been used to identify the included studies, extract, analyse and appraise the quality of their data and present the findings in a usable format (Whittemore & Knafl 2005). The synthesis of the data was conducted through a narrative analysis (Popay et al. 2006). Finally, the PRISMA flowchart was used to present the process and result of this review (Moher et al. 2010).

2.3.4 Criteria for Selecting Studies

2.3.4.1 Types of Studies

This review considered studies that evaluated the effectiveness of avatar-based technologies in patient education. The avatar-based technology interventions could be either used alone or in combination with 'usual care'.

2.3.4.2 Types of Participants

Participants with any medical condition that required patient education were selected, regardless of age, ethnicity, gender or geographical location (i.e., metropolitan or rural and remote).

2.3.4.3 Types of Interventions

The selected studies used avatar-based technologies that were delivered by a nurse, physician or allied health educator via a computer, tablet-based device or mobile phone in a hospital (i.e., inpatient or outpatient) or in the community.

2.3.4.4 Types of Outcomes

Studies with knowledge as the primary outcome that was measured by valid and reliable instruments were selected. Studies that measured secondary outcomes were also included,

including self-care or behaviour change, self-efficacy, HRQoL and acceptability of or satisfaction with avatar-based technology interventions.

2.3.5 Search Strategies

A systematic search of the literature was conducted for peer-reviewed articles written in English and published between 2004 and 2018 inclusive. Informed by the review steps of Whittemore and Knafl (2005), the literature was searched for published articles on avatar-based education interventions in clinical practice. A search of the CINAHL, MEDLINE, EMBASE, PubMed, PsycINFO, Web of Knowledge, Cochrane Library, ProQuest (health sub-set), Scopus and Web of Science databases was conducted using the following keywords: ‘avatar-based’, ‘avatar-based education’, ‘agent-based’, ‘conversation agent’, ‘intelligent agent’, ‘computer agent’, ‘conversational agent’, ‘interactive computer agent’, ‘embodies conversational agent’, ‘patient education’, ‘health education’, ‘health knowledge’, ‘self-care’, ‘health related quality of life’, ‘self-efficacy’ and ‘consumer health information’.

2.3.6 Methodological Quality Assessment

Two independent reviewers extracted data from and critically appraised the six selected studies. The data items extracted included the country in which the study was conducted, participant characteristics, objectives, intervention and control conditions and the length of follow-up. The extracted data from the reviewed studies were displayed and compared in tables based on the outcome measures (see Table 2.2). Two independent reviewers assessed all the included full-text papers through the standardised critical appraisal instrument from CASP (CASP 2018). The CASP Randomised Controlled Trials Checklist (see Appendix 1) was used to check the methodological validity of the included studies. The quality appraisal scores for the studies were 81.8-100 per cent (see Appendix 3). Any disagreements that arose between the reviewers were resolved with consensus through a third reviewer.

Table 2.2: Summary of the Included Studies (Section 2 of Literature Review)

Study	Participants	Objectives	Intervention/control condition	Length of follow-up
Bickmore, Pfeifer and Paasche-Orlow (2009) USA	Inpatients n = 29 adults Age: 28−91 years 19 females 10 males	Explaining consent form document	Three-armed RCT IG: Document explanation by avatar IG: Self-study C: Usual care (human explanation)	Until signed
An et al. (2013) USA	Previous 30 days smokers n = 1,698 Age: 18−30 years 1,230 females 468 males	Health behaviour change: eating breakfast, exercise, alcohol consumption and cigarette smoking	Three-armed RCT IG: Online video-based with peer avatar coaching IG: Personally tailored plus online video-based peer avatar coaching C: Usual care (personally tailored)	30 days and 12 weeks
Bickmore, Schulman & Sidner (2013) USA	Sedentary older adults n = 263 Mean age: 71.3±5.4 years 161 females 102 males	Daily walking, step count Walking, goal setting	Two-armed RCT IG: Avatar exercise coach with take-home tablet computer and pedometer record C: Usual care with pedometer record	30 days and 12 weeks
Andrade et al. (2015) USA	Women with at least three months of OAB symptoms n = 41 Age: 55−75 years	OAB self-management behaviours	Two-armed RCT IG: Avatar-based C: Voice-only online program	One, six and 12 weeks
Bickmore et al. (2013) USA	Walk unaided n = 122 Age: 18 or older 48 males 74 females	Health behaviour change: physical activity, step walk with pedometer record, fruit and vegetable consumption	Four-armed RCT IG: Online physical activity with avatar IG: Online fruit and vegetable consumption with avatar IG: Online physical activity plus fruit and vegetable consumption with avatar C: Usual care	Two months
Pinto et al. (2013) USA	Young adults with two weeks of depressive symptoms n = 60 Age: 18−25 years 40 females 20 males	Reduce depressive symptoms among young adults	Two-armed RCT IG: Avatar-based C: Usual care	12 weeks

Note: IG = intervention group, C = control group; OAB = overactive bladder; RCT = randomised controlled trial

2.3.7 Results

2.3.7.1 Search Outcomes

The initial search identified a total of 2,165 articles, while a manual search of other sources (i.e., Google search and the grey literature) identified a further 58 articles. In total, 2,223 articles were identified through all methods of searching. After the removal of duplicates, 1,946 articles remained for screening and another 1,925 articles were excluded. Full-text manuscripts were obtained for the remaining 21 articles. Based on a full-text review, a further 15 articles were excluded. Six RCT studies were identified. After assessment of the studies against the inclusion criteria, these six articles were included in the review (see Table 2.2). The PRISMA flow diagram presents the overall process in Figure 2.2.

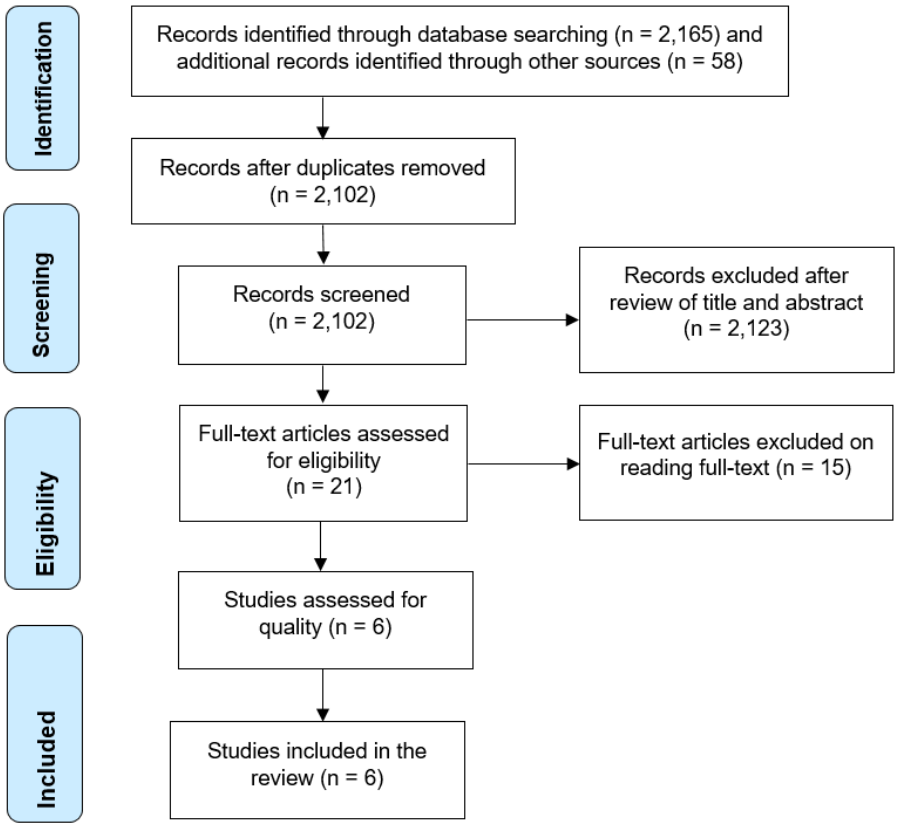


Figure 2.2: PRISMA Flowchart Showing the Identification of Studies (Section 2 of the Literature Review)

2.3.7.2 Study Characteristics

The articles in this integrative review were published between 2005 and 2017 inclusive. All the studies were RCTs that were conducted in the USA, with each being designed to evaluate the effectiveness of avatar-based technologies for the delivery of health information for patient education in the clinical practice area. Two studies were implemented in a hospital

setting, while the other four were implemented in a community setting. The characteristics of the included studies are presented in Table 2.2.

2.3.7.3 Participant Characteristics

This review included 2,204 participants in total from the six selected studies. All the participants were adults ranging from 18 to 91 years of age. Five studies included both genders while one consisted of only females (Andrade et al. 2015). In total there were 1,565 females and 648 males. The six studies in this review presented research on health education relating to general lifestyle health behaviours (An et al. 2013); self-management, including fruit and vegetable consumption and physical activity (Bickmore et al. 2013) and breakfast eating habits, alcohol consumption and smoking (An et al. 2013); overactive bladder (OAB) education (Andrade et al. 2015); depressive symptoms (Pinto et al. 2013); and explaining medical documents to patients (Bickmore, Pfeifer & Paasche-Orlow 2009). The outcome measures of all the included studies were defined differently through a range of measurement methods and timeframes. The outcomes were divided into primary and secondary outcomes (see Table 2.3). The primary outcome in the six studies was that of the acquisition of knowledge. The secondary outcomes included improved self-care or behaviour change, increased HRQoL scores, improved self-efficacy and satisfaction with and acceptability of the intervention.

Table 2.3: Summary of Primary and Secondary Outcomes

Study	Outcomes	Intervention	Control/Usual care	Follow-up	*p*-value*
Primary outcome					
Knowledge					
Bickmore, Pfeifer and Paasche-Orlow (2009)	Medical document knowledge scores	42.20 (20.33)	25.91 (11.36)	1 day	.006*
Andrade et al. (2015)	OAB symptoms knowledge scores (mean average)	5.77	2.61	12 weeks	<.001*
Secondary outcomes					
Behaviour change					
Bickmore, Schulman and Sidner (2013)	Daily step count	4,041 steps/day	3,499 steps/day	2 months	.01*
	(Adjusted mean)	3,383 steps/day	3,861 steps/day	12 months	.09
An et al. (2013)	Smoking abstinence rate	31%	11%	12 weeks	<.0001*
	Number of days of change in drinking (mean change)	−1.87	−1.00	12 weeks	<.0001*
	Number of days of eating breakfast (mean change)	7.58	2.20	12 weeks	<.0001*
	Number of days of exercise (mean change)	5.08	1.74	12 weeks	.0058*
Bickmore et al. (2013)	Daily step count	7,398 steps/day	8,003 steps/day	2 months	.367
	Fruit and vegetable consumption (mean change)	3.4	0.6	2 months	.0005*
HRQoL					
Andrade et al. (2015)	OAB HRQoL scores (mean average)	90.9	79.52	12 weeks	.002*
Self-efficacy					
Andrade et al. (2015)	Self-efficacy for urinary incontinence scores (mean average)	8.27	7.41	12 weeks	.005*
Satisfaction/acceptability					
Bickmore, Schulman and Sidner (2013)	Satisfaction (score range 1−7, mean average)	6.56	N/A	N/A	
Pinto et al. (2013)	Acceptability (score range 1−5, mean average)	4.45	N/A	N/A	

Note: *Statistical significance when $p \leq .05$; F/U = follow-up, N/A = not applicable; OAB = overactive bladder; HRQoL = health-related quality of life.

2.3.7.4 Primary Outcomes

2.3.7.4.1 Knowledge

The acquisition of knowledge was explicitly referred to in two of the six selected studies (Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009). Both studies reported that avatar-based technology interventions were effective in delivering information and that the participants were generally able to use them without difficulty (Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009). Each of the two studies indicated an improvement in health knowledge scores when the information was communicated through an avatar compared to face-to-face communication and self-study instruction. Bickmore, Pfeifer and Paasche-Orlow (2009) found that participants who received information through a conversational avatar to explain health documents and a consent form were just as likely to improve their knowledge scores as those who received explanations from health care providers or through self-study. In addition, the study reported that avatar-based delivery was useful in identifying those patients who needed additional assistance on health information (Bickmore, Pfeifer & Paasche-Orlow 2009). Andrade et al. (2015) demonstrated that at 12-weeks follow-up, the intervention resulted in an increase in OAB symptom knowledge scores when compared to usual care ($p < .001$).

2.3.7.5 Secondary Outcomes

2.3.7.5.1 Behaviour Change

Three of the six studies reported on the effectiveness of an avatar-based technology intervention for changing behaviour (An et al. 2013; Bickmore, Schulman & Sidner 2013). One study demonstrated the effectiveness of an avatar-based technology intervention for the daily step count of older adults (Bickmore et al. 2013), while another study detailed an intervention for daily step count and fruit and vegetable consumption (Bickmore, Schulman & Sidner 2013). One study reported on multiple behaviour changes in young adult smokers, consisting of number of days of exercise, smoking, alcohol consumption and breakfast consumption (An et al. 2013). Two studies measured daily step count (Bickmore, Schulman & Sidner 2013; Bickmore et al. 2013), but only one study (Bickmore et al. 2013) demonstrated a significant difference in the daily step count of older adults with an avatar coach (two-month follow-up, $p = .01$). In this study, the authors compared the efficacy of an avatar-based exercise coach interacting on a daily basis to an IG in usual care using a pedometer record to increase walking among sedentary older adults. These studies demonstrated that those coached with an avatar walked significantly more steps on a daily basis than control group participants at two months follow-up ($p = .01$). The qualitative data

from the interviews with the same participants also indicated high levels of satisfaction with the intervention in 90 per cent of the participants. An et al. (2013) conducted a three-group RCT measuring the delivery of health behaviour information to young adult smokers. The participants were assigned to the following groups: 1) receiving online health messages, 2) online health messages plus avatar peer support and 3) usual care. The results showed that the second group had increased abstinence rates from smoking ($p < .001$), increased number of days of breakfast consumption ($p < .001$) and days of exercise ($p < .0058$) and reduced number of days of alcohol consumption ($p < .001$) at 12 weeks follow-up.

2.3.7.5.2 Health-Related Quality of Life

Only one study assessed the effectiveness of an avatar-based technology intervention on HRQoL compared to a 'voice only' online program (Andrade et al. 2015). In this study, it was found that avatar-based technologies used with women with OABs resulted in increased HRQoL scores compared to a control group at 12 weeks follow-up ($p = .002$) (Andrade et al. 2015).

2.3.7.5.3 Self-Efficacy

One of the six studies examined the effectiveness of an avatar-based technology intervention on self-efficacy (Andrade et al. 2015). The results showed that the avatar-based intervention was statistically significant as measured by self-efficacy for urinary incontinence in OAB patients (Andrade et al. 2015).

2.3.7.5.4 Acceptability and Satisfaction

Two studies reported on participants' satisfaction (Bickmore, Schulman & Sidner 2013) with and acceptability (Pinto et al. 2013) of an avatar-based technology. One study reported a higher mean average for acceptability in the IG in younger people with depressive symptoms (mean average = 4.45 out of 5) (Pinto et al. 2013). Bickmore, Schulman and Sidner (2013) showed that an avatar-based exercise coach contributed to high levels of satisfaction for 90 per cent of older sedentary adult participants (mean average = 6.56 out of 7).

2.3.8 Discussion

2.3.8.1 Primary Outcomes

This integrative review has aimed to synthesise existing evidence on the effectiveness of avatar-based technology interventions for patient education. It has demonstrated that these types of interventions can improve knowledge acquisition in patient education in clinical practice (Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009). Avatar-based

technology interventions have also been shown to be effective for behaviour change (An et al. 2013; Bickmore, Schulman & Sidner 2013). However, there was insufficient evidence to recommend these interventions for improving HRQoL, self-efficacy (Andrade et al. 2015) and acceptability of or satisfaction with the intervention.

2.3.8.1.1 Knowledge

The available research on the use of avatar-based technology interventions demonstrates that positive changes in knowledge may be beneficial for managing disease and changing behaviours. Two studies revealed that their interventions yielded significant results in terms of improving knowledge (Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009). These studies reported that interactive avatar-based technology interventions could be potential tools to educate patients about medical documents, the consent process (Bickmore, Pfeifer & Paasche-Orlow 2009) and OAB conditions (Andrade et al. 2015). This approach could increase knowledge in patients with specific health conditions because avatar-based technology interventions are able to improve health literacy in individuals using visual and auditory signals. Thus, avatar-based technology interventions may promote health knowledge and have a positive effect on patient outcomes.

Two systematic reviews reported that interactive media information technologies could be a potential tool for educating patients on their health conditions (Annaim et al. 2015; Charlier et al. 2015). Interactive media technologies (Annaim et al. 2015) and serious game interactive design (Charlier et al. 2015) are able to account for health literacy through the use of visual and auditory signals that provide messages about various diseases. Thus, these technologies may have a positive effect on health outcomes. A number of authors have evaluated the effectiveness of interactive avatar-based interventions on health knowledge (Bedra et al. 2013; Clark et al. 2015; Joubert et al. 2016). Three other studies, including two pilot studies and one pre-test post-test design evaluated avatar-based technology interventions for improving heart failure knowledge (Clark et al. 2015), insulin treatment knowledge (Joubert et al. 2016) and ileostomy care knowledge (Bedra et al. 2013). Clark et al. (2015) developed an avatar-based educational resource that was delivered by tablet computers and designed as an adjunct to traditional heart failure education. The educational resource was provided to five Aboriginal participants, resulting in a 20.8 per cent increase in heart failure knowledge (Clark et al. 2015). Another pilot study demonstrated improved insulin treatment knowledge via an online interactive video game education tool on type 1 diabetes mellitus patients at six months follow-up (Joubert et al. 2016). One pre-test post-test study (Bedra et al. 2013) explored the use of an interactive

avatar-based intervention to educate new stoma patients about ileostomy care. After using the intervention, the knowledge scores of participants showed significant improvement when compared with their baseline knowledge scores (Bedra et al. 2013). In addition, interactive health teaching tools have been shown to be able to adapt content based on personal interests and specific diseases. One study reported, in accordance with one systematic review and meta-analysis, improved cancer care knowledge through the use of interactive technologies and videotapes for cancer patients (Gysels & Higginson 2007).

The above evidence endorses the findings of other studies that patients often forget the information that health care providers and professionals tell them during education sessions, bedside teaching or consultations and some patients have difficulty understanding health information in booklets and brochures (Livne, Peterfreund & Sheps 2017). Interactive media technology interventions have been shown to have a variable effect in enhancing patient involvement in decision-making processes on self-care, self-management and disease management (Azevedo et al. 2015; Chiou & Chung 2012). Avatar-based technologies can provide a flexible learning environment in which patients can learn about their health condition in a personalised health setting through decision-making tools that provide tailored health information (Blok et al. 2017; Lisetti 2012). Additionally, a systematic review by Friedman et al. (2011) reported that the use of multiple teaching techniques with specific information for patients should be provided, rather than general health information.

Overall, this systematic review has revealed that positive and effective teaching strategies and delivery methods for patient education would include integrating technologies via visual messages to enhance learning and understanding in patients with low health literacy to increase their knowledge (Friedman et al. 2011). This review of RCTs supports the findings of previous research into the potential effectiveness of avatar-based technology interventions for patient education.

2.3.8.2 Behaviour Change and Self-Care Behaviour

Avatar-based technology interventions for patient education have also been shown to improve health behaviour change or self-care behaviour in patients with multiple health risks (Anam, Andrade & Ruiz 2016; Napolitano et al. 2013). These interventions enhance activities that change behaviours such as daily step counting (Bickmore, Schulman & Sidner 2013) and activities that lower alcohol and tobacco consumption (An et al. 2013). As the results of this review show, technological methods for maintaining self-care behaviour need to be included in patient education (Napolitano et al. 2013). A study by Lo et al. (2011)

demonstrated that their chosen multimedia education program improved self-care behaviour in post-operative stoma patients. Another study reported that the use of interactive technology interventions via serious games improved the self-care behaviour of insulin administration in patients with type 1 diabetes mellitus (Joubert et al. 2016). The reason for these findings could well be that the most effective way to change behaviour is through the delivery of health information by empathic avatar characters via multimedia or interactive technologies to increase user engagement, persuasion and motivation—similar to coaching by nurses or health care professional educators (Lisetti et al. 2013). Health coaching is a behaviour change intervention that helps individuals to achieve individual health goals to change lifestyle behaviours, with the goal of decreasing the risk of health conditions and improving self-management and HRQoL (Butterworth, Linden & McClay 2007; Olsen & Nesbitt 2010). In addition, interactive technologies have the capacity to facilitate involvement and learning in an active way because the information can be matched to the patients' preferences, needs, diseases and health risk behaviours (Boren et al. 2008; List 2013).

In relation to self-care behaviour, one pre-test post-test study (Clark et al. 2015) demonstrated an avatar-based nursing intervention via a tablet-based educational resource about heart failure. The results showed an increase in self-care behaviour in three domains: a 95 per cent increase in self-care confidence, a 26.1 per cent increase in self-maintenance and a 1.9 per cent increase in self-management (Clark et al. 2015). Another single group study demonstrated improved diabetes self-care behaviour via a virtual world with an avatar on a website about diabetes self-care education (Rosal et al. 2014). The results showed improved diabetes self-care behaviour at six months follow-up (Rosal et al. 2014). These findings could be due to the participants having long-term chronic conditions or health risks that may have contributed to their lack of knowledge and understanding of the importance of health risk factors and the negative effects of not changing their behaviours (Plow & Golding 2017). This review has revealed that avatar-based technology interventions have been used to track daily health behaviours and make positive lifestyle changes such as quitting smoking, increasing exercise and decreasing alcohol consumption.

2.3.8.2.1 Self-Efficacy

One study in this review showed that the use of avatar-based technology interventions in patient education significantly improved patients' self-efficacy (Andrade et al. 2015). Other studies about integrating interactive technologies for patient education revealed significant improvements in self-efficacy (Johnson et al. 2014; Joubert et al. 2016; Kato et al. 2008). One pilot study reported that using serious game design in type 1 diabetes mellitus patients

significantly improved insulin therapy self-efficacy scores at six months follow-up (Joubert et al. 2016). A pre-test post-test intervention by Johnson et al. (2014) demonstrated the effectiveness of virtual technologies in various diabetes management situations—including selecting from the menu in restaurants and making decisions in pharmacies, fitness centres, bookshops and convenience stores—significantly improved self-efficacy in adults with type 2 diabetes mellitus. Another RCT demonstrated improved self-efficacy in a group of young adults (aged 13−29 years old) with cancer via a three-dimensional interactive video game at three months follow-up (Kato et al. 2008). The reason for these positive findings could be that avatar-based technology interventions provide significant opportunities in health care settings through providing decision-making support rather than substituting for health care professionals (Andrade et al. 2015).

2.3.8.2.2 Satisfaction and Acceptability

Two studies reported on participants' satisfaction (Bickmore, Schulman & Sidner 2013) with and acceptability (Pinto et al. 2013) of an avatar-based technology. One study reported a higher mean average of satisfaction for the avatar-based technology IG (Bickmore, Schulman & Sidner 2013), while another study reported higher levels of acceptability for avatar-based technology interventions in the IG (Pinto et al. 2013). One pre-test post-test study showed an 83 per cent level of satisfaction when using a heart failure avatar peer mentor through a tablet- and computer-based educational resource (Clark et al. 2015). Another study about technology interventions showed high levels of satisfaction when using an online video game about insulin therapy in younger patients with type 1 diabetes mellitus (Joubert et al. 2016). In relation to the acceptability of these technologies, one pilot study demonstrated that 76 per cent of participants accepted using an avatar mentor via a virtual world for diabetes education (Ruggiero et al. 2014). Therefore, interactive technologies for patient education are well obtained and patients are satisfied with the health information presented to assist their decision-making processes (Välimäki et al. 2012). Through the use of interactive technologies, health care providers are able to tailor health information to patients' needs, and patients can control the flow of information and select what they want to view and when to log out of the system (Edwards et al. 2013).

2.3.9 Conclusion

This review is the first step in investigating the effectiveness of using avatar-based technologies. The results of this review suggest that avatar-based technologies can extend the communication of personal health information by nurses or health care professionals. Avatar-based technology interventions have been shown to increase knowledge in adults,

elderly individuals and women with OABs and have determined high levels of acceptability and satisfaction. The available research on the use of avatar-based technologies shows that it can help patients and other individuals to achieve a greater understanding and recognition of disease management, healthy lifestyles and decision-making processes for changing behaviours to increase HRQoL. To capitalise on the advantages of these new approaches to patient educational learning technologies, health care professionals need to broaden their understandings of how people most appropriately learn through avatar-based technologies to determine the effect of this knowledge on outcomes in a health care context over time. The findings of this review may have implications for both nursing practice and patient education in relation to the delivery of health information interventions. This can only be accomplished through further research.

2.3.10 Relevance to Clinical Practice

Avatar-based technology interventions have been shown to be an effective method of delivery for health information and an alternative tool for improving health knowledge, changes in behaviour and patient outcomes. Health care providers should actively select and adapt avatar-based technology methods to extend the reach of health behaviour and self-management principles to the clinical environment, community and home to provide individualised care and just-in-time information (An et al. 2013; Andrade et al. 2015; Bickmore, Schulman & Sidner 2013). In this review, avatar-based educational technologies have been shown to be effective among people with different conditions, with most outcomes being superior to the use of traditional methods. It remains a challenge to find the most suitable avatar-based technology design for particular patient groups. Although all avatar-based technologies were found to be effective, their design and content varied due to the intrinsic differences among different conditions and characteristics of the patient population. This may need to be considered when implementing or testing an avatar-based intervention in a specific population (An et al. 2013; Andrade et al. 2015; Bedra et al. 2013).

The increased use of avatar-based technology interventions indicates that people living with health risks are interested in using methods to improve their knowledge, self-care, decision-making processes and clinical outcomes, in addition to changing their behaviours (Andrade et al. 2015; Annaim et al. 2015). Although it has been found that avatar-based technologies in patient education are an effective and powerful way to provide information and teach skills to patients, it is not clear whether the technologies maintain their effectives when health information needs to be regularly updated or when the skills gained require ongoing rectification (Bickmore, Schulman & Sidner 2013). Finally, if knowledge acquisition

depreciates over time, the overall usefulness of avatar-based technologies for patient education would be greatly reduced. This adds support to the need for customised health information that is adaptable enough to be modified to the dynamic nature of patients' ongoing health requirements to improve their personal health and social circumstances (Andrade et al. 2015; Bickmore, Schulman & Sidner 2013).

2.4 Section 3: Conceptual Framework

2.4.1 Introduction

Early seeking of medical attention for ACS is associated with reduced morbidity and mortality, particularly because of the obtainability of thrombolytic treatment (Zorca & Mizuguchi 2017). Individuals (patients) seek to understand their illness or disease threat by developing an understanding about its meaning and cause and whether it can be cured or controlled (Bandura 2005). Health education research needs to integrate existing education and technology learning through the use of information technologies for delivering health information in the area of CVD. This section will adopt a combination of observational learning, self-efficacy and self-regulation from Bandura's (1977) social cognitive theory (SCT) to provide a framework for this thesis.

2.4.2 Social Cognitive Theory

SCT demonstrates how humans actively seek and interpret information (Bandura 2011) rather than simply responding to influences within the environment (Bandura 1991). SCT posits that observational learning is affected by environmental factors (Bandura 1991) (see Figure 2.3). Observational learning provides a framework for understanding the use of modelling as a teaching strategy to improve targeted behaviours (Anderson et al. 2010) and how patients learn through observing others (Bandura 2002). SCT assumes that patients learn through observational behaviour by watching models and through imitation, in which they must pay attention to the model, remember and reproduce it and want to demonstrate what was learned (Bandura 2005). SCT presents patients as imitating the health educator (Ng & Lucianetti 2016). For Bandura (1985), behavioural capability, social competencies and cognitive ability are acquired through observational learning.

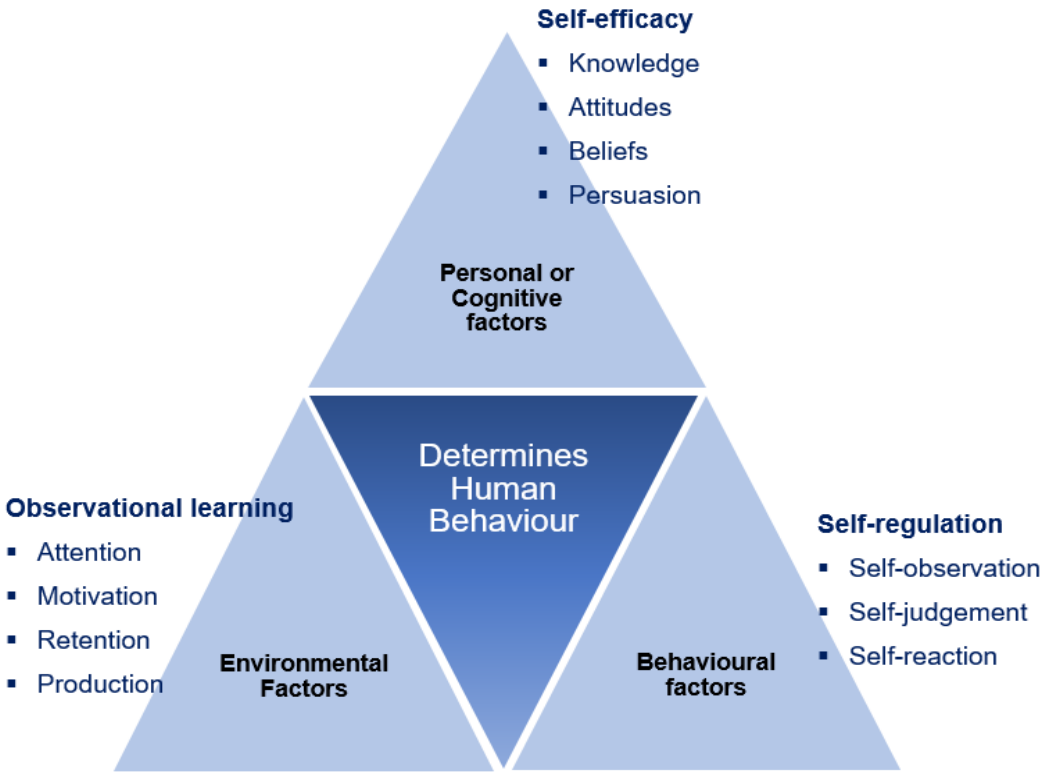


Figure 2.3: Key Concepts and Dimensions of Social Cognitive Theory

Self-efficacy theory was developed as part of SCT by Bandura (1991). This theory has been suggested as being suitable for explaining behaviour change (Bandura 2005). Self-efficacy plays an influential role in the adoption and maintenance of individual behaviour (Vancouver 2018). The most important behaviour change aspects of the model are congruent with the concept of self-efficacy and consist of an individual's attitudes, beliefs through knowledge, persuasion and respect for social norms (Bandura 2011). Even so, self-efficacy refers to the decision-making capacity of individuals in relation to behaviour change (Ghazi et al. 2018). Decision-making or adherence to appropriate response behaviours is more than just behaviour change, as it also maintains their behaviour (Bandura 2011).

Self-efficacy plays a crucial role in self-regulation (Anderson et al. 2010), which refers to a person's belief in their own competency to successfully control actions, situation or events in their lives (Bandura 1991). Self-regulation theory was also developed as part of SCT by Bandura (1991). Self-regulation is important in individual learning and performance and refers to self-produced thoughts, emotion and actions of planned and repeated cycles that are adapted to the achievement of personal goals (Bandura 2005; McClelland et al. 2018). These beliefs are based on an individual feeling that they possess the requisite cognitive abilities, motivation and other resources to complete a task (Ghazi et al. 2018). Bandura (1986) noted that self-regulation takes into account three component processes: self-observation or behavioural monitoring, self-judgement or self-evaluation of progress and

self-reaction, including both substantial self-initiated and affective consequences (Anderson et al. 2010; Bandura 2005; Zimmerman 2002). Self-observation (or self-monitoring) is deliberate attention to aspects of an individuals' behaviour and is necessary but insufficient for sustained self-regulation (Bandura 2011).

Self-judgement is the comparison of the presentation of behaviour with an individuals' goals (Bandura 1991). Such comparisons inform an individual of progress on their goals and can exert motivational effects on future behaviour (Anderson et al. 2010; McClelland et al. 2018; Zimmerman 2002).

According to Bandura's SCT, observational learning occurs through observing a well-trained role model. In an educational setting, observational learning refers to an individual's confidence to participate in definite actions that will help them to achieve prominent goals (Bandura 2002, Polit 2017; Weibell 2011). Observational learning includes four sets of processes: attention, motivation, retention and production (Bandura 2002). The components of observational learning are shown in Figure 2.4.

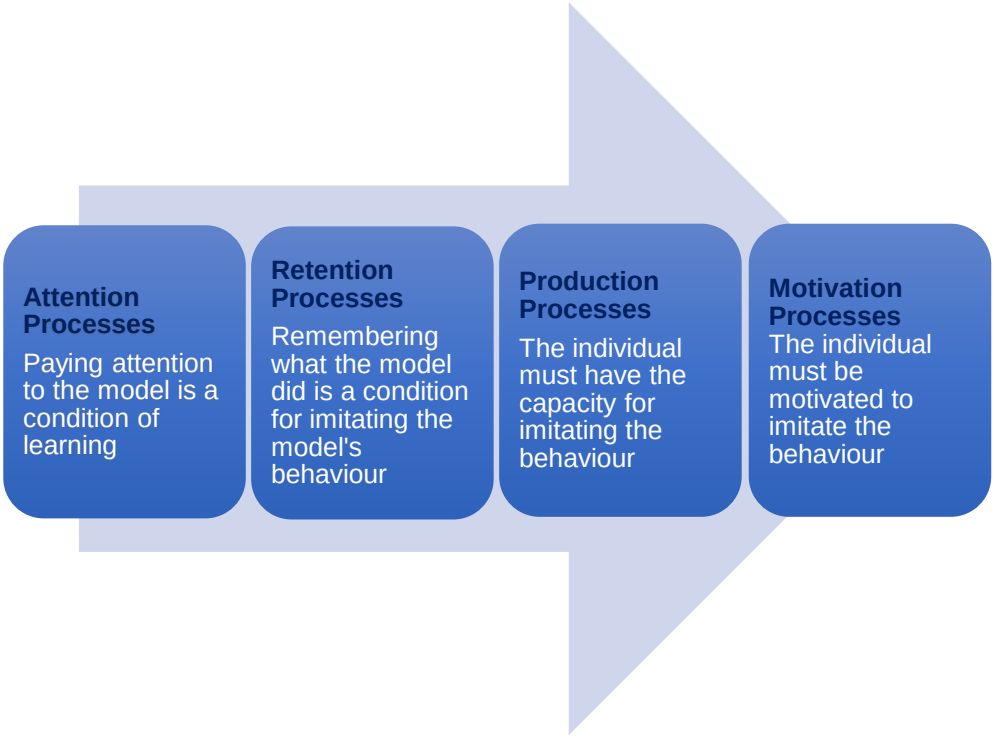


Figure 2.4: The Components of Observational Learning

Previous research has used observational learning to develop educational interventions in health care settings. One RCT compared the effectiveness of an SCT-based, structured hip fracture prevention website for older adults to the conventional websites (Nahm et al. 2010). The study showed significant improvements in knowledge (i.e., hip fracture and osteoporosis

knowledge), outcome expectations, self-efficacy, calcium intake and exercise in the IG (Nahm et al. 2010). Another experimental study explored the effects of chemotherapy video-based modelling to educate patients (Kinnane et al. 2008). The results showed that video-based modelling in pre-chemotherapy education had the potential to be incorporated into clinical practice to encourage knowledge retention and improve self-care and self-management (Kinnane et al. 2008). A further experimental study compared print- and video-based instructional materials and found significantly higher practical skills among users of video-based instructional materials on distance learning content (Donkor 2010). A study by Nanthakasikorn (2008) used SCT to evaluate the effects of computer-based breastfeeding instruction on adolescent mothers. The study found positive effects on knowledge and breastfeeding behaviour in the group of mothers who had received the breastfeeding knowledge and behaviour through computer-based instruction compared to those who had received routine nursing care (Nanthakasikorn 2008).

Another quasi-experimental study based on Bandura's SCT evaluated the effectiveness of a handwashing teaching program with videos that demonstrated handwashing techniques (Chen & Chiang 2007). The results showed a significant effect on handwashing compliance and accuracy at post-intervention among groups of families who visited the paediatric intensive care units (Chen & Chiang 2007). Another single group pre-test post-test design evaluated the effectiveness of a video-based breastfeeding teaching program (Devi 2014). The results revealed that 56.6 per cent of the mothers in the study engaged in exclusive breastfeeding and that the video-based teaching program was effective in enhancing knowledge and practice among postnatal mothers (Devi 2014).

The theoretical underpinning of the SAVE app intervention is social cognitive theory, particularly the concept of observation learning and self-efficacy (Bandura 2008). People learn by observing others and through positive and negative reinforcement (Bandura 2008). The use of plain language and a 'face-to-face' interactive approach ensures that the health information that is delivered is easy to understand. The quizzes in the education application reinforce the information through immediate feedback and verbal encouragement. Therefore, the SAVE app helps individuals to build confidence in recognising and responding to heart attack symptoms (i.e., self-efficacy) (Bandura 1977). The details of the conceptual framework are described in the next section.

2.4.3 Conceptual Framework for this Study

As anticipated, treatment-seeking behaviour is closely related to the mortality and long-term morbidity of people with ACS (see Chapters 1 and 2). The avatar-based technology intervention to be used in this study will allow for regular observational learning with a nurse avatar without the need to visit a health care professional. The development and evaluation of the avatar-based heart attack education application intervention is based on the concept of observational learning (Bandura 2008; Devi et al. 2017) and self-efficacy (Bandura 1998; Zulkosky 2009) as presented in Bandura's SCT (Bandura 1977). The avatar-based ACS education application targets factors that influence individuals' treatment-seeking behaviour and considers self-regulation theory, which is also part of SCT. Self-regulation includes self-observation, self-judgement and self-reaction (Bandura 2011). The application aims to improve knowledge of heart attack symptoms, the attitudes and beliefs about such symptoms through participation in observational learning and the response to ACS symptoms among patients with ACS. Figure 2.5 presents the theoretical framework for this study.

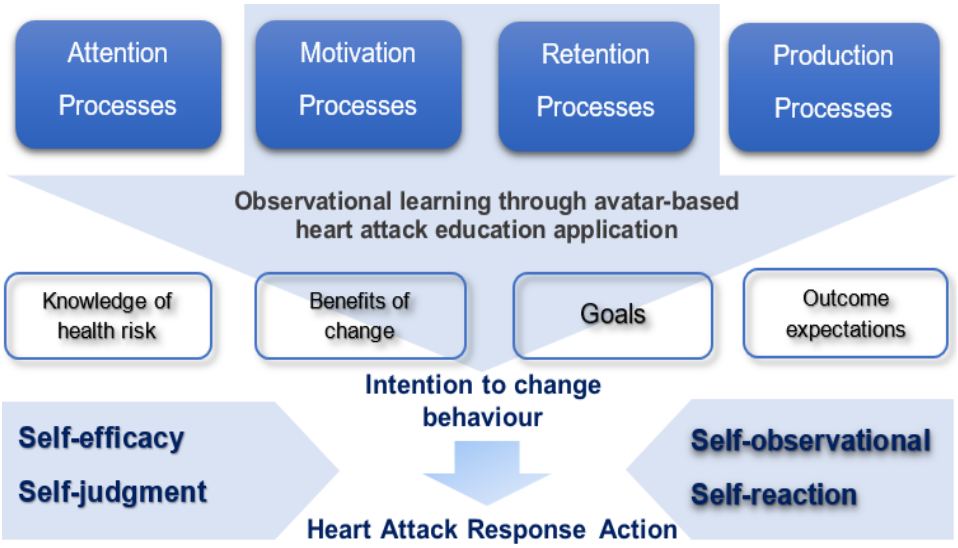


Figure 2.5: The Conceptual Framework for This Study

The avatar-based ACS education application engaged a virtual agent—an avatar nurse to deliver the education or health message content, including knowledge on ACS symptoms and what to do when symptoms occur. Through repeated use, individuals continue to gain ACS knowledge, build confidence in recognising ACS symptoms and take appropriate action when symptoms appear. The avatar-based education application used SCT to target individuals' behaviours that can be influenced by environmental, personal and behavioural factors.

2.4.3.1 Environmental Factors

An avatar-based heart attack education application was developed based on observational learning to teach heart attack symptoms and responses to users. The application comprises an animated avatar represented by a nurse. Through interactivities with the avatar nurse, the participants focus on and learn the symptoms of a heart attack (i.e., attention processes) (Bandura, 2002). The participants retain the knowledge and appropriate behaviours about ACS through repeated viewing of the education application and through participating in the quizzes section (i.e., retention processes) (Bandura, 2002).This interactive approach between the avatar nurse and users ensure the health information that is delivered is easy to understand. The pre-post quizzes in the application reinforce the information through immediate feedback and encouragement and help to build in individuals the confidence to recognise and respond to heart attack symptoms (i.e., production processes) (Bandura, 2002). Through verbal encouragement and positive body language (i.e., motivation processes) (Bandura, 2002), the avatar nurse reinforces and motivates the individual so that they may have the ability to perform response action behaviours to their ACS symptoms.

2.4.3.2 Personal Factors

The personal factors incorporated in this study include the baseline characteristics of the participants (i.e., ACS patients) and the data collected about their knowledge, attitudes and beliefs through their interaction with the avatar-based heart attack education application. The avatar nurses in the application represent health care professionals who are able to persuade the participants to learn important health messages. The use of plain language and a 'face-to-face' interactive approach ensures that the health information to be delivered is uncomplicated to understand. The before and after quizzes in the heart attack education application reinforce the health information through immediate feedback and verbal encouragement, further helping the individual to build confidence in recognising and responding to heart attack symptoms. This enhances the participants' self-efficacy, after which they are able to perform response action behaviours to their ACS symptoms.

2.4.3.3 Behavioural Factors

Based on the components of self-regulation theory, participants' knowledge, attitudes, beliefs and self-efficacy translate into changes in their behaviour. With respect to cognitive or personal factors, the participants gain knowledge, change their attitudes and beliefs and improve their self-efficacy though the avatar-based heart attack education application. These are referred to as self-regulating behaviours, in that participants' thoughts, feelings

and actions are adapted into self-observation techniques for self-monitoring the signs and symptoms of ACS.

If a heart attack occurs again, the participants will be better able to evaluate whether the symptoms are related to ACS and then move to a point of self-reaction if they recognise that the symptoms are those of a cardiac event. These judgements and reactions are based on the knowledge received from the avatar-based heart attack education application. The conceptual framework for the current study is presented in Figure 2.5.

2.4.4 Conclusion

The theoretical framework for this study is based on the concept that people learn by watching, engaging with the interactivity and the avatar-based heart attack education application in the context of social interactions, experiences and effects of other outside media. In this current study, individuals with ACS were encouraged to observe and impersonate the behaviours of the avatar-based heart attack education application. Thus, the individuals increase their own capabilities and confidence in implementing knowledge in relation to ACS symptom recognition and response.

2.5 Chapter Summary

The aim of this study is to develop and evaluate the effectiveness of an avatar-based education application intervention on knowledge, attitudes and beliefs about ACS, as well as heart attack action responses and health care use. Given that this is a complex intervention designed to change behaviour, a theoretical framework was a prerequisite. SCT was the chosen theoretical framework and was based on its successful use in prior research. The research design and methodology will be detailed in Chapter 3.

2.6 References

Ahmed, MM, El Degwy, HM, Ali, MI & Hegazy, NH 2017, 'The effect of educational intervention on knowledge, attitude and glycemic control in patients with type 2 diabetes mellitus', *International Journal of Community Medicine and Public Health*, vol. 2, no. 3, pp. 302−7.

Albarqouni, L, Smenes, K, Meinertz, T, Schunkert, H, Fang, X, Ronel, J & Ladwig, K-H 2016, 'Patients' knowledge about symptoms and adequate behaviour during acute myocardial infarction and its impact on delay time: Findings from the multicentre MEDEA study', *Patient Education and Counseling*, vol. 99, no. 11, pp. 1845−51.

An, LC, Demers, MR, Kirch, MA, Considine-Dunn, S, Nair, V, Dasgupta, K, Narisetty, N, Resnicow, K & Ahluwalia, J 2013, 'A randomized trial of an avatar-hosted multiple behavior change intervention for young adult smokers', *Journal of the National Cancer Institute. Monographs*, vol. 2013, no. 47, p. 209−15.

Anam, R, Andrade, AD & Ruiz, JG 2016, 'Promoting lifestyle change through medical avatars', in MM Cruz-Cuhna, IM Miranda, R Martinho & R Rijo (eds.), *Encyclopedia of e-health and telemedicine*, IGI Global, Hershey, USA, pp. 316−30.

Anderson, ES, Winett, RA, Wojcik, JR & Williams, DM 2010, 'Social cognitive mediators of change in a group randomized nutrition and physical activity intervention: Social support, self-efficacy, outcome expectations and self-regulation in the guide-to-health trial', *Journal of Health Psychology*, vol. 15, no. 1, pp. 21−32.

Andersson, H, Ullgren, A, Holmberg, M, Karlsson, T, Herlitz, J & Sundström, BW 2017, 'Acute coronary syndrome in relation to the occurrence of associated symptoms: A quantitative study in prehospital emergency care', *International Emergency Nursing*, vol. 33, pp. 43−7.

Andrade, AD, Anam, R, Karanam, C, Downey, P & Ruiz, JG 2015, 'An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy', *Urology*, vol. 85, no. 3, pp. 561−7.

Annaim, A, Lassiter, M, Viera, AJ & Ferris, M 2015, 'Interactive media for parental education on managing children chronic condition: A systematic review of the literature', *BMC Pediatrics*, vol. 15, no. 1, pp. 201−14.

Azevedo, R, Bernardes, M, Fonseca, J & Lima, A 2015, 'Smartphone application for rheumatoid arthritis self-management: Cross-sectional study revealed the usefulness, willingness to use and patients' needs', *Rheumatology International*, vol. 35, no. 10, pp. 1675−85.

Bandura, A 1977, *Social learning theory*, Prentice Hall, Englewood Cliff, USA.

Bandura, A 1985, 'Model of causality in social learning theory', in MJ Mahoney & A Freeman (eds.), *Cognition and psychotherapy*, Springer, Boston, USA, pp. 81−99.

Bandura, A 1986, *Social foundations of thought and action: A social cognitive theory*, Prentice Hall, Englewood Cliffs, USA.

Bandura, A 1991, 'Social cognitive theory of self-regulation', *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 248−87.

Bandura, A 1998, 'Health promotion from the perspective of social cognitive theory', *Psychology and Health*, vol. 13, no. 4, pp. 623−49.

Bandura, A 2002, 'Social cognitive theory in cultural context', *Applied Psychology*, vol. 51, no. 2, pp. 269−90.

Bandura, A 2005, 'The primacy of self-regulation in health promotion', *Applied Psychology*, vol. 54, no. 2, pp. 245−54.

Bandura, A 2008, *Observational learning*, <https://onlinelibrary.wiley.com/doi/book/10.1002/9781405186407>.

Bandura, A 2011, 'Social cognitive theory', in PAM Van Lange, AW Kruglanski & ET Higgins (eds.), *Handbook of theories of social psychology*, Sage Publications, London, pp. 349−73.

Barnason, S, Zimmerman, L & Young, L 2012, 'An integrative review of interventions promoting self-care of patients with heart failure', *Journal of Clinical Nursing*, vol. 21, no. 3−4, pp. 448−75.

Bartholomew, LK & Mullen, PD 2011, 'Five roles for using theory and evidence in the design and testing of behavior change interventions', *Journal of Public Health Dentistry*, vol. 71, no. s1, pp. S20−33.

Bedra, M, Wick, E, Brotman, D & Finkelstein, J 2013b, 'Avatar-based interactive ileostomy education in hospitalized patients', *Informatics, Management and Technology in Healthcare*, vol. 190, p. 83.

Bell, M, Lommel, T, Fischer, JG, Lee, JS, Reddy, S & Johnson, MA 2009, 'Improved recognition of heart attack and stroke symptoms after a community-based intervention for older adults, Georgia, 2006−2007', *Preventing Chronic Disease*, vol. 6, no. 2, pp. A41−52.

Bernhardt, JM, Chaney, JD, Chaney, BH & Hall, AK 2013, 'New media for health education: A revolution in progress', *Health Education & Behavior*, vol. 40, no. 2, pp. 129−32.

Bickmore, TW, Pfeifer, LM & Paasche-Orlow, MK 2009, 'Using computer agents to explain medical documents to patients with low health literacy', *Patient Education and Counseling*, vol. 75, no. 3, pp. 315−20.

Bickmore, TW, Schulman, D & Sidner, C 2013, 'Automated interventions for multiple health behaviors using conversational agents', *Patient Education & Counseling*, vol. 92, no. 2, pp. 142−8.

Bickmore, TW, Silliman, RA, Nelson, K, Cheng, DM, Winter, M, Henault, L & Paasche-Orlow, MK 2013, 'A randomized controlled trial of an automated exercise coach for older adults', *Journal of the American Geriatrics Society*, vol. 61, no. 10, pp. 1676−83.

Blok, AC, May, CN, Sadasivam, RS & Houston, TK 2017, 'Virtual patient technology: Engaging primary care in quality improvement innovations', *JMIR Medical Education*, vol. 3, no. 1, p. e3.

Boren, SA, Gunlock, TL, Peeples, MM & Krishna, S 2008, 'Computerized learning technologies for diabetes: A systematic review', *Journal of Diabetes Science and Technology*, vol. 2, no. 1, pp. 139−46.

Bray, JE, Straney, L, Barger, B & Finn, J 2015, 'Effect of public awareness campaigns on calls to ambulance across Australia', *Stroke*, vol. 46, no. 5, pp. 1377−80.

Bray, JE, Straney, L, Patsamanis, H, Stavreski, B & Finn, J 2016, 'Australian's awareness of heart attack symptoms and action improves with a mass media warning signs campaign', *Journal of the American Heart Association*, vol. 4, no. 7, pp. 1−10.

Bruno, CM 2013, ‘Understanding symptom experiences of older individuals with acute coronary syndrome’, PhD thesis, The University of Arizona Tuscon, USA.

Buckley, T, McKinley, S, Gallagher, R, Dracup, K, Moser, D & Aitken, L 2007, ‘The effect of education and counselling on knowledge, attitudes and beliefs about responses to acute myocardial infarction symptoms’, *European Journal of Cardiovascular Nursing*, vol. 6, no. 2, pp. 105−11.

Bunge, M, Mühlhauser, I & Steckelberg, A 2010, ‘What constitutes evidence-based patient information? Overview of discussed criteria’, *Patient Education and Counseling*, vol. 78, no. 3, pp. 316−28.

Butterworth, SW, Linden, A & McClay, W 2007, ‘Health coaching as an intervention in health management programs’, *Disease Management & Health Outcomes*, vol. 15, no. 5, pp. 299−307.

Caligtan, CA, Carroll, DL, Hurley, AC, Gersh-Zaremski, R & Dykes, PC 2012, ‘Bedside information technology to support patient-centered care’, *International Journal of Medical Informatics*, vol. 81, no. 7, pp. 442−51.

Carr, HJ, McDermott, A, Tadbiri, H, Uebbing, A-M & Londrigan, M 2013, ‘The effectiveness of computer-based learning in hospitalized adults with heart failure on knowledge, re-admission, self-care, quality of life, and patient satisfaction: A systematic review protocol’, *JBI Database of Systematic Reviews and Implementation Reports*, vol. 11, no. 8, pp. 129−45.

Critical Appraisal Skills Programme 2018, *CASP 2018 Randomised controlled trial checklist*, Critical Appraisal Skills Programme, Oxford, viewed 15 January 2018, https://casp-uk.net/wp-content/uploads/2018/01/CASP-Randomised-Controlled-Trial-Checklist.pdf

Charlier, N, Zupancic, N, Fieuws, S, Denhaerynck, K, Zaman, B & Moons, P 2015, ‘Serious games for improving knowledge and self-management in young people with chronic conditions: A systematic review and meta-analysis’, *Journal of the American Medical Informatics Association*, vol. 23, no. 1, pp. 230−9.

Chen, YC & Chiang, LC 2007, ‘Effectiveness of hand-washing teaching programs for families of children in paediatric intensive care units’, *Journal of Clinical Nursing*, vol. 16, no. 6, pp. 1173−9.

Chiou, CP & Chung, YC 2012, 'Effectiveness of multimedia interactive patient education on knowledge, uncertainty and decision-making in patients with end-stage renal disease', *Journal of Clinical Nursing*, vol. 21, no. 9−10, pp. 1223−31.

Ciechanowski, PS, Katon, WJ, Russo, JE & Walker, EA 2014, 'The patient-provider relationship: Attachment theory and adherence to treatment in diabetes', *American Journal of Psychiatry*, vol. 158, no. 1, pp. 29−35.

Clark, RA, Fredericks, B, Buitendyk, N, Adams, M, Howie-Esquivel, J, Dracup, K, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3231.

Claydon, LS 2015, 'Rigour in quantitative research', *Nursing Standard (2014+)*, vol. 29, no. 47, p. 43−8.

Commodore-Mensah, Y & Himmelfarb, CRD 2012, 'Patient education strategies for hospitalized cardiovascular patients: A systematic review', *Journal of Cardiovascular Nursing*, vol. 27, no. 2, pp. 154−74.

Devi, B 2014, 'Effectiveness of video-based teaching program on breastfeeding in terms of knowledge and practice among postnatal mothers in a selected rural community of West Bengal, India', *Journal of Nursing Science & Practice*, vol. 4, no. 1, pp. 1−8.

Devi, B, Das, M, Das, M & Khandelwal, B 2017, 'Application of Bandura's social cognitive theory in the technology enhanced, blended learning environment', *International Journal of Applied Research*, vol. 3, no. 1, pp. 721−4.

DeVon, HA, Rankin, SH, Paul, SM & Ochs, AL 2010, 'The Know & Go! program improves knowledge for patients with coronary heart disease in pilot testing', *Heart & Lung: The Journal of Acute and Critical Care*, vol. 39, no. 6, pp. S23−33.

Donkor, F 2010, 'The comparative instructional effectiveness of print-based and video-based instructional materials for teaching practical skills at a distance', *The International Review of Research in Open and Distributed Learning*, vol. 11, no. 1, pp. 96−116.

Edwards, RA, Bickmore, T, Jenkins, L, Foley, M & Manjourides, J 2013, 'Use of an interactive computer agent to support breastfeeding', *Maternal and Child Health Journal*, vol. 17, no. 10, pp. 1961−8.

Farquharson, B, Johnston, M & Bugge, C 2012, ‘Appraisal and illness delay with symptoms of ACS: A questionnaire study of illness representations’, *British Journal of Cardiac Nursing*, vol. 7, no. 10, pp. 493−9.

Farshidi, H, Rahimi, S, Abdi, A, Salehi, S & Madani, A 2013, ‘Factors associated with pre-hospital delay in patients with acute myocardial infarction’, *Iranian Red Crescent Medical Journal*, vol. 15, no. 4, pp. 312−6.

Fjeldsoe, B, Neuhaus, M, Winkler, E & Eakin, E 2011, ‘Systematic review of maintenance of behavior change following physical activity and dietary interventions’, *Health Psychology*, vol. 30, no. 1, p. 99−109.

Flanders, SA 2018, ‘Effective patient education: Evidence and common sense’, *Medsurg Nursing*, vol. 27, no. 1, pp. 55−8.

Friedman, AJ, Cosby, R, Boyko, S, Hatton-Bauer, J & Turnbull, G 2011, ‘Effective teaching strategies and methods of delivery for patient education: A systematic review and practice guideline recommendations’, *Journal of Cancer Education*, vol. 26, no. 1, pp. 12−21.

Gallagher, R, Roach, K, Belshaw, J, Kirkness, A, Sadler, L & Warrington, D 2013, ‘A pre-test post-test study of a brief educational intervention demonstrates improved knowledge of potential acute myocardial infarction symptoms and appropriate responses in cardiac rehabilitation patients’, *Australian Critical Care*, vol. 26, no. 2, pp. 49−54.

Geuens, J, Swinnen, TW, Westhovens, R, de Vlam, K, Geurts, L & Vanden Abeele, V 2016, ‘A review of persuasive principles in mobile apps for chronic arthritis patients: Opportunities for improvement’, *JMIR mHealth and uHealth*, vol. 4, no. 4, p. e118.

Ghazi, C, Nyland, J, Whaley, R, Rogers, T, Wera, J & Henzman, C 2018, ‘Social cognitive or learning theory use to improve self-efficacy in musculoskeletal rehabilitation: A systematic review and meta-analysis’, *Physiotherapy Theory and Practice*, vol. 37, no. 7, pp. 495−504.

Glanz, K, Rimer, BK & Viswanath, K 2008, *Health behavior and health education: Theory, research, and practice*, John Wiley & Sons, San Francisco, USA.

Glattacker, M, Heyduck, K & Meffert, C 2012, ‘Illness beliefs, treatment beliefs and information needs as starting points for patient information—evaluation of an intervention for patients with chronic back pain’, *Patient Education and Counseling*, vol. 86, no. 3, pp. 378−89.

Goff, DC, Mitchell, P, Finnegan, J, Pandey, D, Bittner, V, Feldman, H, Meischke, H, Goldberg, RJ, Luepker, RV & Raczynski, JM 2004, 'Knowledge of heart attack symptoms in 20 US communities. Results from the Rapid Early Action for Coronary Treatment Community Trial', *Preventive Medicine*, vol. 38, no. 1, pp. 85−93.

Gouveia, VDA, Victor, EG & Lima, SGD 2011, 'Pre-hospital attitudes adopted by patients faced with the symptoms of acute myocardial infarction', *Revista Latino-Americana de Enfermagem*, vol. 19, no. 5, pp. 1080−7.

Gruman, J, Rovner, MH, French, ME, Jeffress, D, Sofaer, S, Shaller, D & Prager, DJ 2010, 'From patient education to patient engagement: Implications for the field of patient education', *Patient Education and Counseling*, vol. 78, no. 3, pp. 350−6.

Gysels, M & Higginson, IJ 2007, 'Interactive technologies and videotapes for patient education in cancer care: Systematic review and meta-analysis of randomised trials', *Supportive Care in Cancer*, vol. 15, no. 1, pp. 7−20.

Heapy, AA, Higgins, DM, Cervone, D, Wandner, L, Fenton, BT & Kerns, RD 2015, 'A systematic review of technology-assisted self-management interventions for chronic pain', *The Clinical Journal of Pain*, vol. 31, no. 6, pp. 470−92.

Herlitz, J, Thuresson, M, Svensson, L, Lindqvist, J, Lindahl, B, Zedigh, C & Jarlöv, M 2010, 'Factors of importance for patients' decision time in acute coronary syndrome', *International Journal of Cardiology*, vol. 141, no. 3, pp. 236−42.

Isern, D & Moreno, A 2016, 'A systematic literature review of agents applied in healthcare', *Journal of Medical Systems*, vol. 40, no. 2, p. 43.

Jamshidi, N, Abbaszadeh, A, Kalyani, MN & Sharif, F 2013, 'Effectiveness of video information on coronary angiography patients' outcomes', *Collegian*, vol. 20, no. 3, pp. 153−9.

Joanna Briggs Institute 2017, *Critical appraisal tools for use in JBI systematic reviews, checklist for quasi-experimental studies (non-randomized experimental studies)*, <http://joannabriggs.org/assets/docs/critical-appraisal-tools/JBI_Quasi-Experimental_Appraisal_Tool2017.pdf>.

Johnson, C, Feinglos, M, Pereira, K, Hassell, N, Blascovich, J, Nicollerat, J, Beresford, HF, Levy, J & Vorderstrasse, A 2014, 'Feasibility and preliminary effects of a virtual environment for adults with type 2 diabetes: Pilot study', *JMIR Research Protocols*, vol. 3, no. 2, p. e23.

Joubert, M, Armand, C, Morera, J, Tokayeva, L, Guillaume, A & Reznik, Y 2016, 'Impact of a serious videogame designed for flexible insulin therapy on the knowledge and behaviors of children with type 1 diabetes: The LUDIDIAB pilot study', *Diabetes Technology & Therapeutics*, vol. 18, no. 2, pp. 52−8.

Kato, PM, Cole, SW, Bradlyn, AS & Pollock, BH 2008, 'A video game improves behavioral outcomes in adolescents and young adults with cancer: A randomized trial', *Pediatrics*, vol. 122, no. 2, pp. e305−17.

Kav, S, Yilmaz, AA, Bulut, Y & Dogan, N 2015, 'Self-efficacy, depression and self-care activities of people with type 2 diabetes in Turkey', *Collegian*, vol. 24, no. 1, pp. 27−35.

Khan, JA 2011, 'Factors causing delayed presentation of patients with acute myocardial infarction to the hospital', *Pakistan Armed Forces Medical Journal*, vol. 61, no. 4, p. 20−4.

Kinnane, N, Stuart, E, Thompson, L, Evans, K & Schneider-Kolsky, M 2008, 'Evaluation of the addition of video-based education for patients receiving standard pre-chemotherapy education', *European Journal of Cancer Care*, vol. 17, no. 4, pp. 328−39.

Kooij, L, Groen, WG & van Harten, WH 2017, 'The effectiveness of information technology-supported shared care for patients with chronic disease: A systematic review', *Journal of Medical Internet Research*, vol. 19, no. 6, p. e221.

Kothgassner, OD, Hlavacs, H, Beutl, L, Glenk, LM, Palme, R & Felnhofer, A 2016, 'Two experimental virtual paradigms for stress research: Developing avatar-based approaches for interpersonal and evaluative stressors', in G Wallner, S Kriglstein, H Hlavacs, R Malaka, A Lugmayr & H-S Yang, *Proceedings of the 15th International Conference on Entertainment Computing*, Wien, Austria, pp. 51−62.

Lambert-Kerzner, A, Del Giacco, EJ, Fahdi, IE, Bryson, CL, Melnyk, SD, Bosworth, HB, Davis, R, Mun, H, Weaver, J, Barnett, C, Radcliff, T, Hubbard, A, Bosket, KD, Carey, E, Virchow, A, Mihalko-Corbitt, R, Kaufman, A, Marchant-Miros, K & Ho, PM 2012, 'Patient-centered adherence intervention after acute coronary syndrome hospitalization', *Circulation: Cardiovascular Quality and Outcomes*, vol. 5, no. 4, pp. 571−6.

Lewin, D & Piper, S 2007, ‘Patient empowerment within a coronary care unit: Insights for health professionals drawn from a patient satisfaction survey’, *Intensive and Critical Care Nursing*, vol. 23, no. 2, pp. 81−90.

Lisetti, C, Amini, R, Yasavur, U & Rishe, N 2013, ‘I can help you change! An empathic virtual agent delivers behavior change health interventions’, *ACM Transactions on Management Information Systems*, vol. 4, no. 4, p. 19.

Lisetti, CL 2012, ‘10 advantages of using avatars in patient-centered computer-based interventions for behavior change’, *SIGHIT Record*, vol. 2, no. 1, p. 28.

List TP 2013, *How technology is shaping patient education*, Surrey, UK, <http://www.pmlive.com/pmhub/medical_communications/fti_consulting/white_papers_and_resourcer/how_technology_is_shaping_patient_education>.

Littleton-Kearney, M 2018, ‘Pragmatic clinical trials at the National Institute of Nursing Research’, *Nursing Outlook*, (online PubMed).

Livne, Y, Peterfreund, I & Sheps, J 2017, ‘Barriers to patient education and their relationship to nurses’ perceptions of patient education climate’, *Clinical Nursing Studies*, vol. 5, no. 4, p. 65.

Lo, SF, Wang, YT, Wu, LY, Hsu, MY, Chang, SC & Hayter, M 2011, ‘Multimedia education programme for patients with a stoma: Effectiveness evaluation’, *Journal of Advanced Nursing*, vol. 67, no. 1, pp. 68−76.

Lu, M, Tang, J, Wu, J, Yang, J & Yu, J 2015, ‘Discharge planning for acute coronary syndrome patients in a tertiary hospital: A best practice implementation project’, *JBI Database of Systematic Reviews and Implementation Reports*, vol. 13, no. 7, pp. 318−34.

Ma, J, Wang, J, Zheng, W, Zheng, J, Wang, H, Wang, G, Zhang, H, Xu, F & Chen, Y 2017, ‘Usage of ambulance transport and influencing factors in acute coronary syndrome: A cross-sectional study at a tertiary centre in China’, *BMJ Open*, vol. 7, no. 8, pp. 1−8.

McClelland, M, Geldhof, J, Morrison, F, Gestsdóttir, S, Cameron, C, Bowers, E, Duckworth, A, Little, T & Grammer, J 2018, ‘Self-regulation’, in N Halfon, CB Forrest, RM Lerner & EM Faustman (eds.), *Handbook of life course health development*, Springer, New York, USA, pp. 275−98.

McKinley, S, Dracup, K, Moser, DK, Riegel, B, Doering, LV, Meischke, H, Aitken, LM, Buckley, T, Marshall, A & Pelter, M 2009, 'The effect of a short one-on-one nursing intervention on knowledge, attitudes and beliefs related to response to acute coronary syndrome in people with coronary heart disease: A randomized controlled trial', *International Journal of Nursing Studies*, vol. 46, no. 8, p. 1037−46.

Meischke, H, Diehr, P, Rowe, S, Cagle, A & Eisenberg, M 2004, 'Evaluation of a public education program delivered by firefighters on early recognition of a heart attack', *Evaluation & the Health Professions*, vol. 27, no. 1, pp. 3−21.

Mohammadpour, A, Rahmati Sharghi, N, Khosravan, S, Alami, A & Akhond, M 2015, 'The effect of a supportive educational intervention developed based on the Orem's self-care theory on the self-care ability of patients with myocardial infarction: A randomised controlled trial', *Journal of Clinical Nursing*, vol. 24, no. 11−12, pp. 1686−92.

Moher, D, Liberati, A, Tetzlaff, J & Altman, DG 2010, 'Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement', *International Journal of Surgery*, vol. 8, no. 5, pp. 336−41.

Mol, K, Rahel, B, Meeder, J, van Casteren, B, Doevendans, P & Cramer, M 2016, 'Delays in the treatment of patients with acute coronary syndrome: Focus on pre-hospital delays and non–ST-elevated myocardial infarction', *International Journal of Cardiology*, vol. 221, pp. 1061−6.

Mooney, M, O'Brien, F, McKee, G, O'Donnell, S & Moser, D 2016, 'Ambulance use in acute coronary syndrome in Ireland: A cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 15, no. 5, pp. 345−54.

Mosca, L, Hammond, G, Mochari-Greenberger, H, Towfighi, A & Albert, MA 2013, 'Fifteen-year trends in awareness of heart disease in women: Results of a 2012 American Heart Association national survey', *Circulation*, vol. 127, no. 11, pp. 1254−63.

Moule, P, Aveyard, H & Goodman, M 2016, *Nursing research: An introduction*, Sage Publications, Los Angeles, USA.

Nahm, E-S, Barker, B, Resnick, B, Covington, B, Magaziner, J & Brennan, PF 2010, 'Effects of a social cognitive theory based hip fracture prevention website for older adults', *Computers, Informatics, Nursing: CIN*, vol. 28, no. 6, p. 371−9.

Nanthakasikorn W 2008 ‘Effectiveness of computer based instruction about breast-feeding during the early stages of labour on knowledge and breast-feeding behaviours primiparous adolescent mothers’, PhD thesis, Mahidol University, Bangkok, Thailand.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, ‘Using avatars to model weight loss behaviors: Participant attitudes and technology development’, *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057−65.

Neubeck, L & Maiorana, A 2015, ‘Time to get help? Acute myocardial infarction and delay in calling an ambulance’, *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 1−3.

Neville, RG, Greene, AC & Lewis, S 2006, ‘Patient and health care professional views and experiences of computer agent-supported health care’, *Informatics in Primary Care*, vol. 14, no. 1, pp. 11−5.

Ng, TW & Lucianetti, L 2016, ‘Within-individual increases in innovative behavior and creative, persuasion, and change self-efficacy over time: A social–cognitive theory perspective’, *Journal of Applied Psychology*, vol. 101, no. 1, p. 14−34.

Nielsen, D, Ryg, J, Nielsen, W, Knold, B, Nissen, N & Brixen, K 2010, ‘Patient education in groups increases knowledge of osteoporosis and adherence to treatment: A two-year randomized controlled trial’, *Patient Education and Counseling*, vol. 81, no. 2, pp. 155−60.

O’Brien, F, McKee, G, Mooney, M, O’Donnell, S & Moser, D 2014, ‘Improving knowledge, attitudes and beliefs about acute coronary syndrome through an individualized educational intervention: A randomized controlled trial’, *Patient Education and Counseling*, vol. 96, no. 2, pp. 179−87.

O’Brien, F, O’Donnell, S, McKee, G, Mooney, M & Moser, D 2013, ‘Knowledge, attitudes, and beliefs about acute coronary syndrome in patients diagnosed with ACS: An Irish cross-sectional study’, *European Journal of Cardiovascular Nursing*, vol. 12, no. 2, pp. 201−8.

Olsen, JM & Nesbitt, BJ 2010, ‘Health coaching to improve healthy lifestyle behaviors: An integrative review’, *American Journal of Health Promotion*, vol. 25, no. 1, pp. e1−12.

Or, CK & Karsh, B-T 2009, ‘A systematic review of patient acceptance of consumer health information technology’, *Journal of the American Medical Informatics Association*, vol. 16, no. 4, pp. 550−60.

Or, CK, Tao, D & Wang, H 2017, 'The effectiveness of the use of consumer health information technology in patients with heart failure: A meta-analysis and narrative review of randomized controlled trials', *Journal of Telemedicine and Telecare*, vol. 23, no. 1, pp. 155−66.

Pearson, ES 2012, 'Goal setting as a health behavior change strategy in overweight and obese adults: A systematic literature review examining intervention components', *Patient Education and Counseling*, vol. 87, no. 1, pp. 32−42.

Perkins-Porras, L, Whitehead, DL, Strike, PC & Steptoe, A 2008, 'Causal beliefs, cardiac denial and pre-hospital delays following the onset of acute coronary syndromes', *Journal of Behavioral Medicine*, vol. 31, no. 6, pp. 498−505.

Pinto, MD, Hickman Jr, RL, Clochesy, J & Buchner, M 2013, 'Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults', *Applied Nursing Research*, vol. 26, no. 1, pp. 45−8.

Plow, M & Golding, M 2017, 'Using mHealth technology in a self-management intervention to promote physical activity among adults with chronic disabling conditions: Randomized controlled trial', *JMIR mHealth and uHealth*, vol. 5, no. 12, p. e185.

Polit, D & Beck, C 2017, *Nursing research: Generating and assessing evidence for nursing practice; 2008,* 10th edn, Lippincott Williams & Willkins Co, Philadelphia, USA.

Polit, DF 2017, 'Clinical significance in nursing research: A discussion and descriptive analysis', *International Journal of Nursing Studies*, vol. 73, pp. 17−23.

Popay, J, Roberts, H, Sowden, A, Petticrew, M, Arai, L, Rodgers, M, Britten, N, Roen, K & Duffy, S 2006, *Guidance on the conduct of narrative synthesis in systematic reviews: A product from the ESRC methods programme version*, Penn State University, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.178.3100&rep=rep1&type=pdf >.

Provoost, S, Lau, HM, Ruwaard, J & Riper, H 2017, 'Embodied conversational agents in clinical psychology: A scoping review', *Journal of Medical Internet Research*, vol. 19, no. 5, p. e151.

Ratner, J, Mullins, D, Buesching, DP & Cantrell, RA 2013, 'Pragmatic clinical trials: US payers' views on their value', *The American Journal of Managed Care*, vol. 19, no. 5, pp. e158−65.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584−94.

Rosal, MC, Heyden, R, Mejilla, R, Capelson, R, Chalmers, KA, DePaoli, MR, Veerappa, C & Wiecha, JM 2014, 'A virtual world versus face-to-face intervention format to promote diabetes self-management among African American women: A pilot randomized clinical trial', *JMIR Research Protocols*, vol. 3, no. 4, p. e54.

Ruggiero, L, Moadsiri, A, Quinn, LT, Riley, BB, Danielson, KK, Monahan, C, Bangs, VA & Gerber, BS 2014, 'Diabetes island: Preliminary impact of a virtual world self-care educational intervention for African Americans with type 2 diabetes', *JMIR Serious Games*, vol. 2, no. 2, p. e10.

Schulman, D & Bickmore, T 2009, 'Persuading users through counseling dialogue with a conversational agent', *Proceedings of the 4th International Conference on Persuasive Technology*, Claremont, p. 25.

Shand, JA & Menown, IB 2010, 'A timely diagnosis of myocardial infarction', *Biomarkers in Medicine*, vol. 4, no. 3, pp. 385−93.

Singh, D, Sukhbeer, K, Ahmad, A, Rahmat, N & Hmwe, NTT 2016, 'Nurse-led intervention on knowledge, attitude and beliefs towards acute coronary syndrome', *Nursing in Critical Care*, (online Wiley Online Library).

Stenberg, U, Haaland-Øverby, M, Fredriksen, K, Westermann, KF & Kvisvik, T 2016, 'A scoping review of the literature on benefits and challenges of participating in patient education programs aimed at promoting self-management for people living with chronic illness', *Patient Education and Counseling*, vol. 99, no. 11, pp. 1759−71.

Suhling, H, Rademacher, J, Zinowsky, I, Fuge, J, Greer, M, Warnecke, G, Smits, JM, Bertram, A, Haverich, A & Welte, T 2014, 'Conventional vs. tablet computer-based patient education following lung transplantation—a randomized controlled trial', *PloS One*, vol. 9, no. 3, p. e90828.

Tawalbeh, LI & Ahmad, MM 2014, 'The effect of cardiac education on knowledge and adherence to healthy lifestyle', *Clinical Nursing Research*, vol. 23, no. 3, pp. 245−58.

Thorpe, KE, Zwarenstein, M, Oxman, AD, Treweek, S, Furberg, CD, Altman, DG, Tunis, S, Bergel, E, Harvey, I & Magid, DJ 2009, 'A pragmatic–explanatory continuum indicator summary (PRECIS): A tool to help trial designers', *Journal of Clinical Epidemiology*, vol. 62, no. 5, pp. 464−75.

Thuresson, M, Haglund, P, Ryttberg, B, Herlitz, J & Nilsson, U 2015, 'Impact of an information campaign on delays and ambulance use in acute coronary syndrome', *The American Journal of Emergency Medicine*, vol. 33, no. 2, pp. 297−8.

Ting, HH & Bradley, EH 2009, 'Patient education to reduce prehospital delay time in acute coronary syndrome', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, pp. 522−3.

Torraco, RJ 2005, 'Writing integrative literature reviews: Guidelines and examples', *Human Resource Development Review*, vol. 4, no. 3, pp. 356−67.

Tsai, S-T & Chou, F-H 2012, 'The effectiveness of multimedia nursing education on reducing illness-related anxiety and uncertainty in myocardial infarction patients after percutaneous coronary intervention', *Hu Li Za Zhi*, vol. 59, no. 4, pp. 43−53.

Tullmann, DF, Haugh, KH, Dracup, KA & Bourguignon, C 2007, 'A randomized controlled trial to reduce delay in older adults seeking help for symptoms of acute myocardial infarction', *Research in Nursing & Health*, vol. 30, no. 5, pp. 485−97.

Tummala, SR & Farshid, A 2015, 'Patients' understanding of their heart attack and the impact of exposure to a media campaign on pre-hospital time', *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 4−10.

Välimäki, M, Hatonen, H, Lahti, M, Kuosmanen, L & Adams, CE 2012, 'Information and communication technology in patient education and support for people with schizophrenia', *Cochrane Database of Systematic Reviews*, vol. 10, (online Cochrane Library).

Vancouver, JB 2018, 'Self-efficacy's role in unifying self-regulation theories', *Advances in Motivation Science*, vol. 5, pp. 203−30.

Veneri, DA & Zdanis, K 2018, ‘Are technology-informed methods better than traditional approaches in educating patients? A meta-analysis’, *Health Education Journal*, <http://journals.sagepub.com/>.

Warsi, A, Wang, PS, LaValley, MP, Avorn, J & Solomon, DH 2004, ‘Self-management education programs in chronic disease: A systematic review and methodological critique of the literature’, *Archives of Internal Medicine*, vol. 164, no. 15, pp. 1641−9.

Webb, T, Joseph, J, Yardley, L & Michie, S 2010, ‘Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy’, *Journal of Medical Internet Research*, vol. 12, no. 1, p. e4.

Weibell, C 2011, *Principles of learning: 7 principles to guide personalized, student-centered learning in the technology enhanced, blended learning environment*, viewed July, <https://principlesoflearning.wordpress.com/>.

Whittemore, R & Knafl, K 2005, ‘The integrative review: Updated methodology’, *Journal of Advanced Nursing*, vol. 52, no. 5, pp. 546−53.

Wynn Jr, RE 2013, ‘The effects of an educational program on recognition of atypical signs and symptoms of acute coronary syndrome in women in the emergency room’, DNP thesis, West Virginia University, West Virginia, USA.

Xinyu, D & Pin, J 2008, ‘Development and application of virtual avatar interactive technology’, *ICACTE’08 Proceedings of the 2008 International Conference on Advanced Computer Theory and Engineering*, Phuket, Thailand, pp. 286−9.

Yeh, M-Y, Wu, S-C & Tung, T-H 2018, ‘The relation between patient education, patient empowerment and patient satisfaction: A cross-sectional-comparison study’, *Applied Nursing Research*, vol. 39, pp. 11−7.

Yousuf, G, Kianoush, S, Kelli, HM, Misra, S, Urrea, B, Blaha, MJ, Graham, G, Marvel, FA & Martin, SS 2016, ‘The role of mHealth for improving medication adherence in patients with cardiovascular disease: A systematic review’, *European Heart Journal. Quality of Care and Clinical Outcomes*, vol. 2, no. 4, pp. 237−44.

Zimmerman, BJ 2002, ‘Becoming a self-regulated learner: An overview’, *Theory into Practice*, vol. 41, no. 2, pp. 64−70.

Zorca, SM & Mizuguchi, KA 2017, ‘Coronary artery disease’, in LS Aglio & RD Urman (eds.), *Anesthesiology*, Springer, Boston, USA. pp. 3−11.

Zulkosky, K 2009, ‘Self-efficacy: A concept analysis’, *Nursing Forum*, vol. 44, no. 2, pp. 93−102.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapters have described the background and rationale for the current study, as well as the findings from the literature review. The study's conceptual framework and the dynamic process of behaviour change have also been discussed. To further evaluate the effectiveness of the avatar-based heart attack education application for improving knowledge, attitudes and beliefs in people living with acute coronary syndrome (ACS), a randomised controlled trial (RCT) was needed. This consisted of two studies being undertaken with two different designs. The aims, objectives and hypotheses of the overall research project are described in the first section of this chapter, followed by an explanation of the general methodology and research design. The next two sections specifically describe each study, including the aims, objectives, hypotheses, research questions, methods, study design, participants, setting, instruments used, procedure, analysis and expected outcomes. The final section details the ethics approval process.

3.2 Aims

This research project aimed to develop and evaluate an avatar-based education application intervention for improving knowledge, attitudes, beliefs, heart attack response actions and health care utilisation among patients with ACSs.

3.3 Objectives

This study had two objectives:

1. To develop a **S**imple **A**vatar-based application for impro**V**ing ACS **E**ducation (SAVE app) for teaching ACS symptoms recognition and appropriate response.
2. To evaluate the effectiveness of an avatar-based education application intervention among patients at risk of heart attack.

3.4 Research Design

To achieve the research aims, two studies were designed to address the two research objectives using a mixed-methods research design. The SAVE app was developed through

a cyclic participatory action research (PAR) approach, including feasibility testing and subsequent evaluation of its effectiveness using a pragmatic RCT (pRCT).

3.4.1 Mixed-Methods Research Design

A mixed-methods research design focuses on collecting, analysing and interpreting the results in a single study or series of studies (Creswell & Clark 2007). The characteristics of a mixed-methods design are to collect and analyse both quantitative and qualitative data, and then to combine both forms of the data by giving priority to one form of data or equal priority to both (Bressan et al. 2017).

A mixed-methods design provides a platform for bridging the divide between qualitative and quantitative approaches (Creswell & Clark, 2007; Dunning et al. 2008). Consequently, this attribute has encouraged an increasing number of researchers to use mixed-methods designs to undertake their studies (Shaw et al. 2017; Östlund et al. 2011; Sahin & Naylor, 2017). This approach is often used over time to support the development, adaptation and evaluation of a specific program or intervention. Creswell and Creswell (2017) identified exploratory design as a major variant of mixed-methods research design. The purpose of this design is to answer different questions that require different types of data (Creswell & Clark 2007). The two differing types of data answer different research questions (Andrew & Halcomb 2009). An example of an exploratory mixed-methods design is to develop an instrument for an intervention trial, and then attempt to understand the effect of the intervention on the participants before testing the long-term effects of the intervention after the trial (Creswell & Creswell 2017). Considering the potential advantages of a mixed-methods research design, this current study adopted a within-method methodology incorporating two distinct methods (Andrew & Halcomb 2009). The present study was undertaken as a set of sub-studies (see Figure 3.1), using a combination of qualitative and quantitative data to guide the direction and collection of the information (Creswell & Creswell 2017). The methodology of the current study involved:

- **Study 1:** To develop an avatar-based education application intervention to educate heart attack patients through collaboration with engaged consumers (ACS patients), health care professionals and information technology (IT) gaming experts using a PAR approach.
- **Study 2:** To evaluate the SAVE app using a pRCT among a group of patients with ACSs.

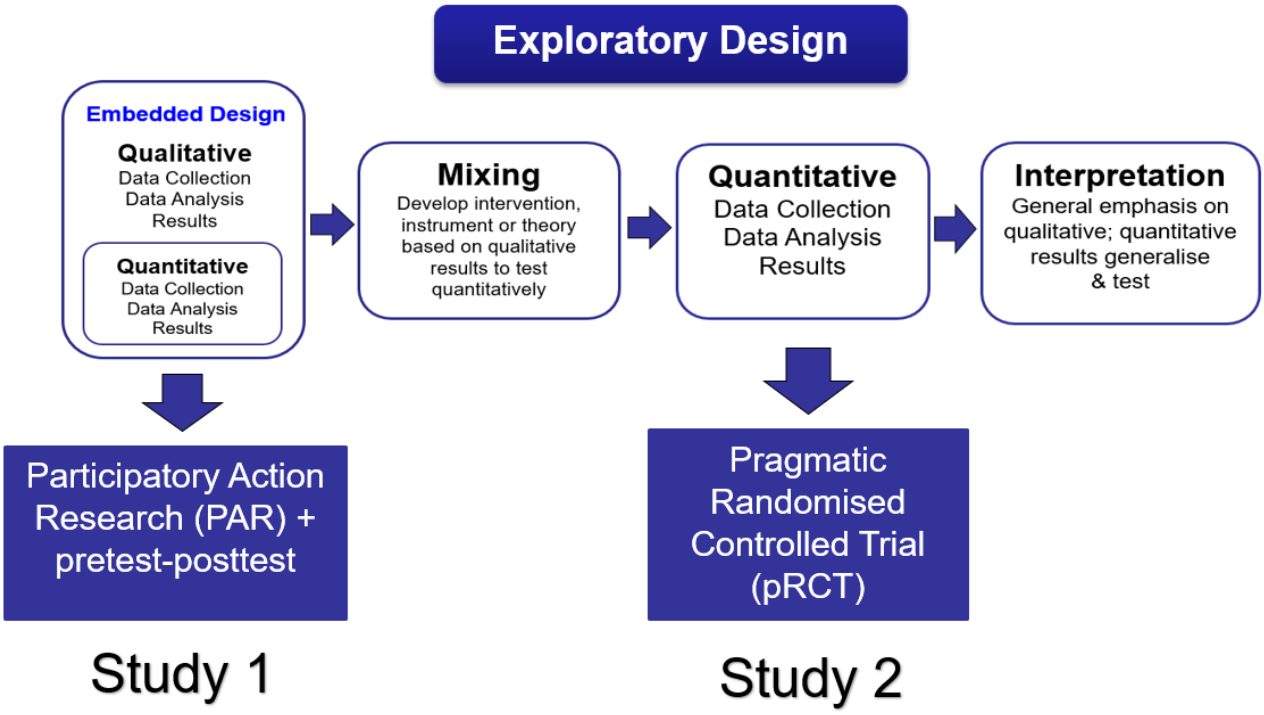


Figure 3.1: Mixed-Methods Research Design of this Study

3.5 Study 1: Development and Feasibility Testing of an Avatar-Based Heart Attack Education Application

3.5.1 Introduction

Study 1 aimed to develop an avatar-based education application for teaching chest pain recognition and management. To address the research objectives, the researcher used a PAR approach that provided a method for engagement and collaboration between a group of consumers (i.e., individuals with ACS), cardiovascular professionals and a group of IT gaming experts. This section provides an overview of the process of developing and testing the feasibility of the avatar-based heart attack education application using a PAR approach.

3.5.2 Aim

The aim of Study 1 was to develop an interactive heart attack education application to provide appropriate and engaging education for improving patients' knowledge of and response to heart attack symptoms.

3.5.3 Objectives

The objectives of Study 1 were:

1. to engage consumers (i.e., individuals with ACS) and a group of cardiovascular professionals in the development of an avatar-based education application for heart attack education
2. to undertake feasibility testing of the avatar-based education application, including an evaluation of participants' satisfaction with using the application and its limited efficacy on patients' knowledge of and response to heart attack symptoms.

3.5.4 Participatory Action Research

PAR has been used extensively in several settings, including in education (Hagevik, Aydeniz & Rowell 2012), health care (Marsh et al. 2017), nursing (Cusack et al. 2018; Fredericks et al. 2013), mental health (Katsikitis et al. 2017) primary health care (Cordeiro & Soares 2018) and in the community (Kangovi et al. 2014). The PAR approach was adopted for this study. The PAR process involved a repeated cycle of developing the heart attack educational tool with experts and potential users, negotiating what the educational tool could achieve and feasibility testing with individual group members (i.e., ACS patients).

A PAR process allows researchers to target individuals to unite in action and reflection in the pursuit of practical solutions to pressing issues (Bradbury 2015). It focuses on critical reflection through collaboration among individual group members (Kemmis, McTaggart & Nixon 2013). These collaborations follow a self-reflective cycle, including planning, acting, observing and reflecting (Herr & Anderson 2014). PAR has an orientation to create knowledge from practice and requires researchers to work with groups of consumers, practitioners or stakeholders (Bradbury 2015; Stapleton 2018).

Participatory Action research is the concurrent focus on action and research. The action component involves participants in a process of intervention planning, developing and revising through which definite strategies, activities or processes are developed within a research context (Fredericks et al. 2013; Greenwood 2018; Ivankova 2017). Interventions that arise through action research come from responding to perceived problems or questions (Friesen-Storms et al. 2015). Action research processes have been streamlined over the decades (Kemmis, McTaggart & Nixon 2014). Kemmis, McTaggart and Nixon (2014) developed a model of the cyclical nature of the action research process (see Figure 3.2). Each cycle has four steps: plan, action, observation and reflection (Kemmis, McTaggart & Nixon 2013; McTaggart, Nixon & Kemmis 2017).

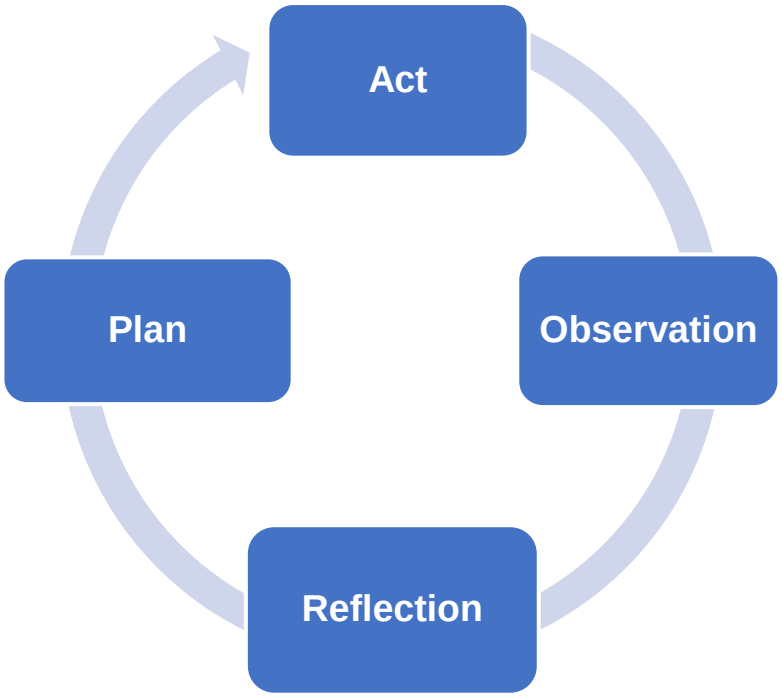


Figure 3.2: The Four Steps of the Action Research Cycle

The evidence suggests that IT can assist patients with their self-management (Licskai, Sands & Ferrone 2013; Voncken-Brewster et al. 2014). Additionally, IT interventions have shown improvements in quality of life (Strömberg, Dahlström & Fridlund 2006), reduced costs (Roberts et al. 2017), demonstrated high levels of patient acceptability (Veneri & Zdanis 2018) and shown improvements in knowledge and self-care (Clark et al. 2015; Huang, Chen & Yeh 2009; Veneri & Zdanis 2018). In this study, the role of PAR was to construct a multidisciplinary research team, including cardiovascular experts, cardiac nurses and IT experts to work collaboratively with consumers (i.e., individual patients with ACS) to design and conduct feasibility testing through a self-reflective cyclical process.

3.5.5 Avatar-Based Education Application Development

3.5.5.1 Study Design

This study was conducted in two phases:

1. **Phase I**—PAR methods were used to develop the avatar-based education application.
2. **Phase II**—the avatar-based education application was tested in a group of ACS patients using a pre-test post-test design to evaluate its feasibility.

3.5.5.1.1 Phase I: Developing the Avatar-Based Education Application

PAR methods were used to develop the technology education tool in accordance with evidence-based guidelines from the National Heart Foundation of Australia (NHF) (2015). The action research process involved two cycles of development and review by 10 consumers who were experienced ACS patients and 12 cardiovascular experts, consisting of a cardiologist, cardiac nurse practitioner, cardiac rehabilitation nurses and cardiac research academic. In addition, two IT gaming experts provided advice on the technical process of developing the application. Two action research cycles followed the planning, acting, observing and reflecting model (see Figure 3.2).

3.5.5.1.2 Phase II: Testing the Feasibility of the Avatar-Based Education Application

The avatar-based heart attack education application for ACS patients was evaluated to assess its feasibility. Using Bowen et al.'s (2009) model for feasibility studies, a focus group with a target population (i.e., individuals with ACS) was used to understand how the avatar-based heart attack education application would fit with ACS knowledge and management (Phase I). This was implemented through a small-scale pre-test post-test design to test whether the education application could be deployed in a target clinical or community setting. To conduct the evaluation, knowledge, attitudes, beliefs, symptom recognition, help-seeking, expectations and actions on ACS were measured using the ACS Response Index (Riegel et al. 2007). A previously validated satisfaction questionnaire (Fredericks et al. 2013; Gwadry-Sridhar et al. 2003) measured user satisfaction about the content, design, usability and engagement, while open-ended questions asked for any negative feedback and improvements to the application.

3.5.5.2 Phase 1: Application Development—Participatory Action Research

3.5.5.2.1 Objective

To engage consumers (i.e., individuals with ACS) and cardiovascular experts in the development of an avatar-based education application for heart attack education.

PAR methods were used to create, design and develop the educational resource. A group of consumers, cardiovascular research experts and IT gaming experts developed the application through two action research cycles of review and revision (see Figure 3.3).

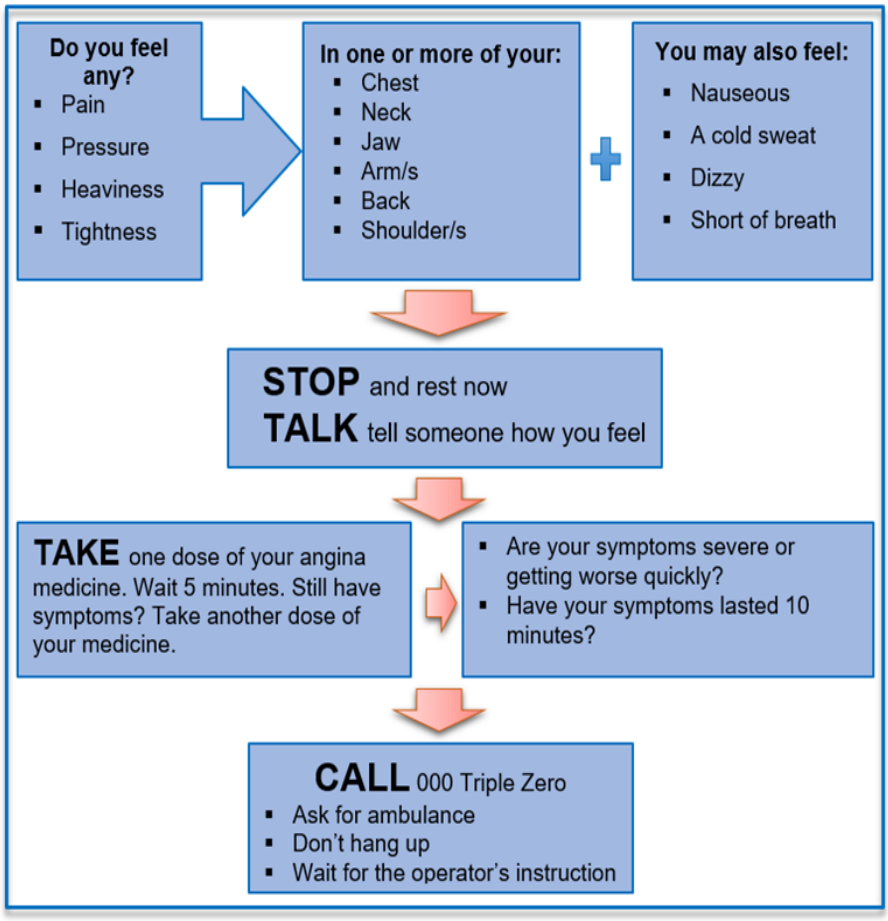


Figure 3.3: Heart Attack Action Plan

Note: Adapted from NHF (2015)

3.5.5.2.2 Cycle 1

The first action research cycle consisted of four steps: 1) content development, 2) content review by cardiac experts, 3) content review by consumers and 4) avatar creation and application development.

Step 1—content preparation: The cardiac researchers developed a content storyboard based on evidence-based guidelines from the 'Heart Attack Action Plan: Will you recognise your heart attack?' document (NHF 2015) (see Figure 3.3). The content storyboard was prepared on a Microsoft PowerPoint template that presented the proposed content of the application on a screen-by-screen basis.

Steps 2 and 3—content review: The cardiac researchers presented the content storyboard to a cardiovascular experts group and consumer group. At this early stage of development, 10 consumers were consulted on what they felt was important to them in terms of an education application. In using PAR, it is essential to consider what is best for the users of the application if it is to be useful, rather than what the researchers believe is important. The

focus group discussion was used to gather feedback from both groups. The relevance of the nurse avatar's characteristics and the content, structure, dialogue, language, images and interactivity of the application were reviewed. The session was audio recorded and field notes were used for data collection. After the focus group discussion, the researchers revised the avatar-based application storyboard based on critical feedback from both the cardiovascular experts and consumers.

Step 4—avatar-based education application development: The researchers presented the revised storyboard to the IT developers, after which the storyboard was converted into multiple slide screens that used an interactive interface with a transition between each section. The nurse avatar would respond reactively but in a variety of ways through speech, facial expressions and body gestures to the user's touch-based interaction with the application. All speech segments were pre-recorded by a voice actor and dynamically recomposed into the behaviour of the nurse avatar.

3.5.5.2.3 Cycle 2

The second action research cycle also consisted of four steps: 5) cardiovascular expert review of the first version of the application, 6) consumer review, 7) revision of application and 8) follow-up cardiovascular expert review (see Figure 3.4). After this, the application was feasibility tested with another group of 10 consumers in Phase II.

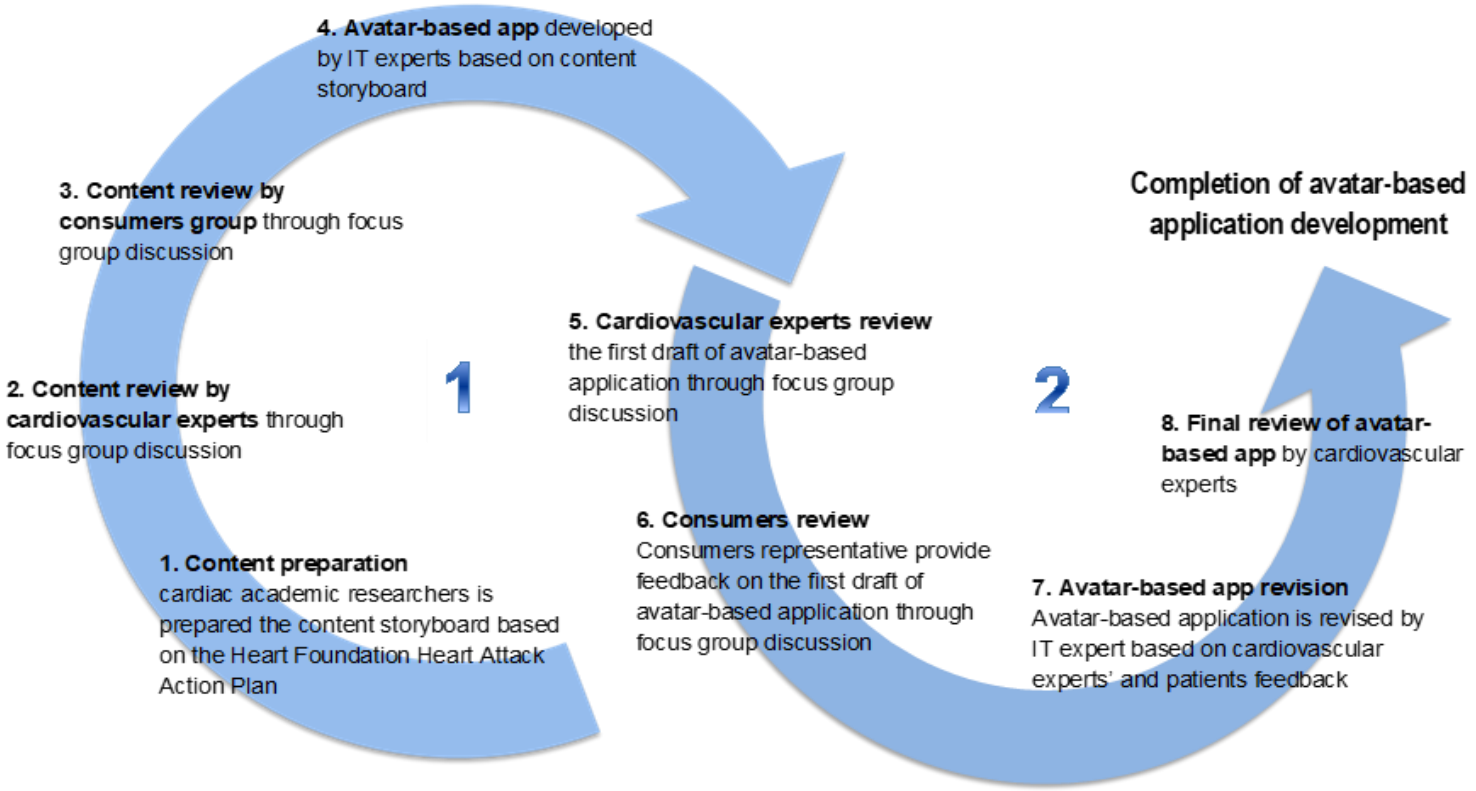


Figure 3.4: The Action Research Cycles to Develop the Avatar-Based Heart Attack Education Application

Step 5—cardiovascular expert panel review: The first version of the application was installed on Android tablets. The cardiac experts reviewed the interactive application and provided critical feedback for revision. The relevance of the level of interactivity, nurse avatar's characteristics, content structure, language, images, timing, colour theme and visual and audio quality were reviewed through focus group discussions. The focus groups were audio recorded and field notes were used for the data collection.

Step 6—consumer review: The first version of the avatar-based education application was presented for comments to 10 consumers, who were English-speaking patients who had cardiovascular disease (CVD) and who were recruited from the cardiac rehabilitation program of a metropolitan public hospital. The time taken by each patient to view the application was recorded. The relevance of the nurse avatar's characteristics, content, structure, language, images, font size and visual and audio quality were reviewed through a focus group discussion. The discussion was audio recorded and field notes were used for the data collection. After the six steps were completed, the application was revised by IT experts (Step 7) and then reviewed by the cardiovascular expert panel again (Step 8) before feasibility testing in Phase II. The cardiovascular expert panel meeting consisted of presentations from the researchers to report on the feedback from the consumer group and to formulate recommendations for revisions. Both the feedback and technological aspects of the application were modified in Steps 7 and 8 (see Figure 3.4).

3.5.5.2.4 Data Collection

The avatar-based education application was developed and refined through each PAR cycle. Within each action research cycle, three participating groups provided their feedback through a focus group method.

Designing focus group question: Focus group questions were used to gather the information to develop the avatar-based education application using the PAR approach from study 1. These questions were based on the literature around relationship building and were specifically designed towards a baseline of phenomenological reflection. In all the focus groups, the questions were open-ended and semi-structured to encourage open discussion and flexibility. The questions also allowed for adaptations to the phenomenological context of the participants. This refers to their subjective experiences of the educational content of heart attacks and the process of avatar-based education application development. The questions were constructed around topic themes, such as experiences and perceptions of ACS and aspects that participants might change like the application development process.

The use of closed or directed questions were avoided. The application was reviewed during each cycle by three participating panels.

Recruiting and preparing for participants: Ten patients with ACS were recruited from the cardiac rehabilitation program and coronary care unit (CCU) at a public hospital.

Focus group confirmation: Once the group of viable recruits had been established, each participant was called and emailed to confirm their interest and availability (Stewart and Shamdasani 2014). The participants were provided with the times and locations of the focus groups and verbal confirmation of their attendance was secured. The researchers emailed a written confirmation letter to the recruits and called to remind them two days before the scheduled group discussion (Hennink 2013).

Time management: The focus group discussion was 1.5–2 hours long. Participants were asked to attend 15 minutes prior to the focus group's actual start time to allow for the completion of necessary paperwork as well as having a bite to eat and settling in to the group (Braun & Clarke 2013).

Place: A comfortable room in a convenient location was arranged, depending on the participating group and the meeting room. The room had a door for privacy and a table and chairs to seat a circle of up to 10 people, including observers and the moderator (Sanders & Kirby 2012).

Offer an incentive: A gift voucher was encouraged for participating after the focus group discussion had finished.

Recording procedure and consent: It was the intention that the medical and cardiovascular experts, IT developer and consumers group discussions would take place in the same location. High-quality audio of the participating group interviews was recorded, including of all the participants and researcher as they occurred. The process of consenting to the recording was verified verbally by the researcher so it could be recorded as part of the session and confirmed against the participants' original written informed consent forms (see Appendix 6, 7 and Appendix 8) that were signed and returned to the researcher prior to each focus group session. These audio recordings were then transcribed by the researcher. The researcher who was also present was able to rewind and check that these responses were recorded correctly (see Table 3.1).

Table 3.1: Topics to Assess the Cycles of the Avatar-Based Education Application Development

Cardiovascular expert review	Completeness of the heart attack warning signs content according to evidence-based guidelines
	Appropriate to psychometric education instruments
	Appropriate use of pictures and language
	Appropriate use of interactive communication
Gaming (IT) development and review	Effectiveness of working
	Product reliability
Consumer review	Appropriate design
	Appropriate use of pictures
	Appropriate content
	Appropriate use of language
	Appropriate level of user-friendliness and satisfaction

3.5.5.3 Phase 2: Feasibility Testing—Pre-Test Post-Test Design

3.5.5.3.1 Objective

To undertake feasibility testing of the avatar-based education application.

3.5.5.3.2 Method

A single group pre-test post-test design was used for Phase II.

3.5.5.3.3 Sample and Setting

The feasibility testing was conducted in the CCU of a metropolitan public hospital. Ten consumers were recruited from the CCU to review the avatar-based heart attack education application.

3.5.5.3.4 Inclusion Criteria

The patients were considered eligible to participate if they:

- had been admitted for any cardiac diagnosis in which chest pain or other heart attack symptoms had been experienced
- had not received advice from a cardiac nurse on heart attack symptoms and responses prior to reviewing the application
- were clinically stable
- had normal cognitive function

- had sufficient English language ability to communicate and follow the study procedures
- were able to give informed consent.

3.5.5.3.5 Exclusion Criteria

Patients were excluded from the study if they had major and uncorrected hearing loss, were clinically unstable, had significant cognitive impairment or could not give informed consent.

3.5.5.3.6 Intervention

Prior to reviewing the avatar-based education application, the 10 participants completed the ACS Response Index (i.e., pre-test) (Riegel et al. 2007). The researchers provided explanation and instruction to the participants on how to use the application. After reviewing the application, the participants were then asked to complete the ACS Response Index (i.e., post-test), a satisfaction questionnaire and provide feedback.

3.5.5.3.7 Instruments

Two validated questionnaires were used in the feasibility testing: the ACS Response Index (Riegel et al. 2007) and the avatar-based education application satisfaction questionnaire (see Appendix 9).

The ACS Response Index is a validated instrument used to assess patients' knowledge, attitudes and beliefs about heart attack symptoms and response management (Riegel et al. 2007) (see Appendix 15). Knowledge scores were measured on a dichotomous scale. This was followed by a list of 21 pre-defined ACS symptoms (e.g., jaw pain) from which the participants were asked to correctly identify the symptoms they would associate with a heart attack using a 'yes' or 'no' answer. Attitude scores comprised of five items that measured ACS patients' attitudes towards symptom recognition and confidence in their ability to appropriately seek help (i.e., help-seeking behaviour) when ACS was suspected in themselves or others. Belief scores had nine items that recorded ACS patients' beliefs about appropriate responses to ACS symptoms. The scores indicated the accuracy of beliefs with respect to the appropriate responses to take in the event of the appearance of ACS symptoms. Attitudes and belief scores were measured using four- and five-point Likert-type scales, respectively.

The avatar-based education application satisfaction questionnaire consisted of 15 items on a Likert scale (see Appendix 15). This survey was adapted from validated education material acceptability surveys (Clark et al. 2007; Fredericks et al. 2013; Gwadry-Sridhar et al. 2003).

Participants were asked to rate each statement out of 1 = strongly agree, 2 = disagree, 3 = do not agree or disagree, 4 = agree and 5 = strongly agree. The satisfaction percentage is the percentage of participants who had a score of three or above on the five-point Likert scale. The aim of conducting this questionnaire was to assess the participants' perceptions of and satisfaction with the avatar-based education application in terms of its audiovisual quality, content, usefulness and user-friendliness.

3.5.5.4 Data Analysis

For the current study, the data were analysed after the data collection phase by identifying common themes in the experiences of the participating groups and preparing their demographic information, including their age, gender, diagnosis (of the consumer group), qualification and specialty and length of cardiovascular professional experience (for the cardiovascular professionals group). After this, a short half-page form that was designed to require no more than two or three minutes to complete was administered before the start of the focus group discussion. Content analysis—a procedure for the categorisation of verbal or behavioural data for the purposes of classification, summation and tabulation (Neuendorf 2016; Vaismoradi et al. 2016)—was used to analyse the collected data from the focus group. The content can be analysed on a basic or manifest level (i.e., this is what was said by the focus group, but no comments as to how or why) (Halkier 2010). The higher or latent level of analysis included a more interpretive approach concerned with the response and what may have been inferred or implied (Moretti et al. 2011). Each focus group discussion was transcribed verbatim. It was important to ensure that the full dialogue and main points were recorded to avoid the loss of valuable information offered by the participants (Plummer-D'Amato 2008). As for the feasibility testing, Microsoft Excel 2016 was used to collate and analyse the data. The participant characteristics are presented as means (SDs) or frequencies and percentages. The mean percentage of correct answers was calculated and reported for the three domains of the ACS Response Index (Riegel et al. 2007) (see Appendix 15). For each of the satisfaction questionnaire items, the mean rating and percentage of participants who had a rating of three or higher were calculated (see Appendix 15).

3.6 Study 2: Evaluation of the Effectiveness of an Avatar-Based Heart Attack Education Application: A Pragmatic Randomised Controlled Trial

3.6.1 Introduction

The objective of Study 2 was to evaluate the effectiveness of an avatar-based education application for teaching heart attack symptoms recognition and management. To address the research objectives, pRCTs were evaluated. This section provides the rationale for the study design and aims. It presents a detailed explanation of the elements of the study, consisting of the sample size, setting, participants, inclusion and exclusion criteria, recruitment and randomisation. Details of the control and intervention conditions are described, primary and secondary outcome measures are defined and a description of the study instruments and their scoring are presented. Finally, the statistical methods undertaken are provided. The Standard Protocol Recommendations for Intervention Trial (SPIRIT) statement (Chan et al. 2013) and the Template for Intervention Description and Replication (TIDier) (Hoffmann et al. 2014) were used to describe the trial protocol and intervention, respectively.

3.6.2 Rationale for the Pragmatic Randomised Controlled Trials

The gold standard for determining the effect of interventions in health care research is the RCT (Claydon 2015; Patten & Newhart 2017; Polit & Beck 2010; Sullivan 2011). The strength of the RCT includes the rigorous control of variables that enables the researcher to isolate and quantify the effects of an intervention. The RCT has also made the clinical trial the strongest method of supporting a hypothesised correlation between variables (Moule, Aveyard & Goodman 2016; Spieth et al. 2016). Methodologically, the RCT has high credibility and can provide empirical support for the implementation of changes in health care (Claydon 2015; Halcomb & Newton 2017; Polit & Beck 2017). As this study was health-care based and has potential clinical and health policy implications, it was important that it conformed to the highest research standards. This is important in nursing, where it is recognised that nursing practice should be underpinned by the highest form of evidence (Corry et al. 2013). Accordingly, a pRCT was selected as the design for this study, as it provides the strongest level of all research evidence (LoBiondo-Wood & Haber 2010, Grove et al. 2013).

The number of interventions using pRCTs is increasing, and many challenges remain for evaluating the effectiveness of these interventions in routine care (Chalkidou et al. 2012;

Joshi, Alexander & Kehlet 2018; Littleton-Kearney 2018; Patsopoulos 2011; Pickham et al. 2018).

Clinicians and health care providers have recognised a pressing need to understand the effect of widely practiced treatments on outcomes for common illnesses, such as heart attacks, stroke and cancer (Ford & Norrie 2016; MacPherson 2004). The pRCT is a methodology designed to evaluate how effective an intervention or treatment actually is in routine clinical practice or usual care (Ratner et al. 2013; Relton et al. 2010; Zuidgeest et al. 2017). It is useful in ordinary practice, especially for decision-making in clinical practice (Ratner et al. 2013) and is designed to improve practice and policy (Glasgow et al. 2005). A pRCT is a practical method designed to test whether an intervention will work in routine care with a focus on the successful implementation of the intervention (Littleton-Kearney 2018).

The main goals of a pRCT are to improve practice and inform clinical and policy decisions (Loudon et al. 2015). The pRCT design tests two or more real-world interventions using a flexible protocol and local customisation (Ratner et al. 2013; Zuidgeest et al. 2017). It is inclusive of disparate populations receiving care in practical or real-world settings using generally inclusive criteria for study participants (Ford & Norrie 2016).

Results from a pRCT are relevant for informing the decision-making of administrators, providers, patients and policy-makers (Tunis et al. 2003). A study protocol can be useful for minimising intrusion in daily work and can provide evidence to improve patient care and clinical decision-making (Patsopoulos 2011). The core characteristics of a pRCT are presented in Figure 3.5 (Ford & Norrie 2016; Glasgow et al. 2005; Thorpe et al. 2009; Tunis et al. 2003). Such an approach is important in nursing in which it is recognised that nursing practice should be underpinned by the highest form of evidence (Corry et al. 2013). It is also important for conforming to the highest research standards. As it provides the strongest level of research evidence, the pRCT was selected as the design for this current study. The pRCT's protocol is presented in the next section.

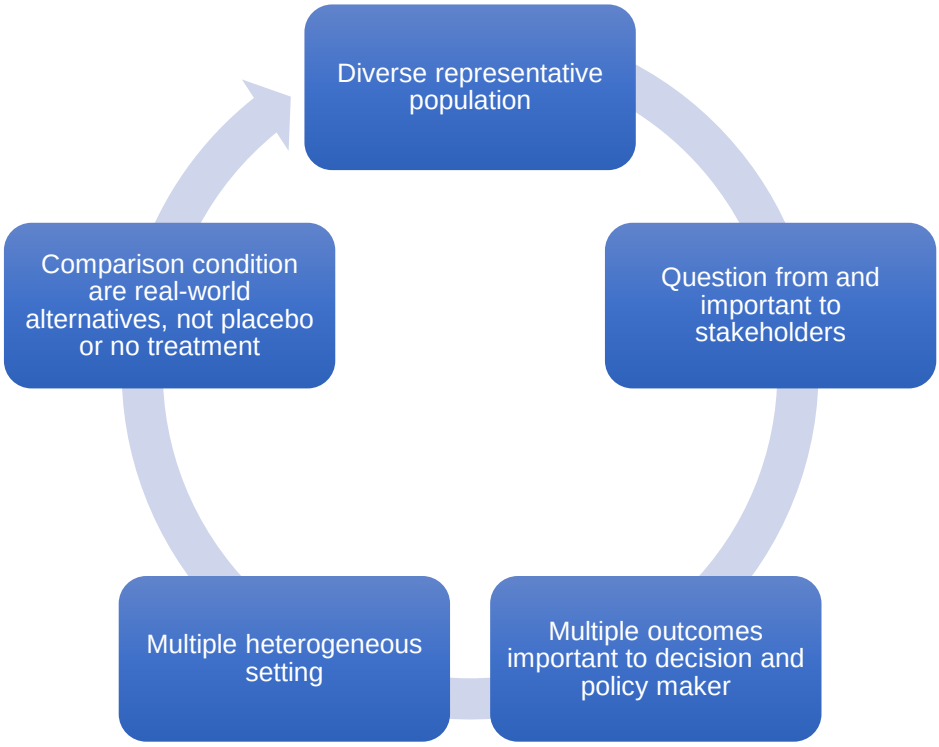


Figure 3.5: Core Characteristics of Pragmatic Randomised Controlled Trials

Sources: Ford & Norrie 2016; Glasgow et al. 2005; Thorpe et al. 2009; Tunis et al. 2003

3.6.3 Protocol of Pragmatic Randomised Controlled Trial

3.6.3.1 Preamble

Knowledge on the symptoms and response to a heart attack has been shown to have a marked effect on both hospitalisation and mortality. ACS patients with low health literacy have higher all-cause mortality. Those with lower functional health literacy have also been shown to have greater rates of hospitalisation. However, reading and understanding medical information can be time-consuming, daunting and difficult. The research team developed a health teaching tool that provides information on chest pain and other heart attack symptoms through the use of an innovative avatar-based heart attack teaching application. The application was appropriately designed and tested using consumer involvement. The proposed implementation of the education application for ACS patients will improve patient outcomes and reduce health care resource utilisation. The planned research will result in a highly significant advancement in nursing knowledge in the field of patient education.

The following is a pRCT protocol that was produced as a manuscript and accepted to be published in the *Journal of Advanced Nursing*.

Tongpeth J, Du, H & Clark, R 2018, 'An avatar-based education application to improve patients' knowledge of and response to heart attack symptoms: A pragmatic randomised controlled trial protocol', *Journal of Advanced Nursing*, (online Wiley Online Library). [Impact Factor 2.267]

Authorship and Guarantor

Study protocol: An avatar-based education application to improve patients' knowledge of and response to heart attack symptoms: A pragmatic randomised controlled trial protocol

Jintana Tongpeth RN, BScN, MNS	Contribution (70%) Concept and design Drafting the article and critical revision for important concepts Final approval of version to be submitted
Huiyun Du RN, PhD	Contribution (15%) Revision of content Final approval of version to be submitted
Robyn A Clark RN, PhD, FAHA	Contribution (15%) Revision of important content Final approval of version to be submitted

Candidature: Jintana Tongpeth

Signed July 20 2018

Guarantor

I certified the fidelity of the authorship and act as guarantor for all data.

Signed July 20 2018

Professor Robyn A Clark
Professor of Nursing (Acute Care and Cardiovascular Research)
College of Nursing and Health Sciences, Flinders University

An Avatar-Based Education Application to Improve Patients' Knowledge of and Response to Heart Attack Symptoms: A Pragmatic Randomized Controlled Trial Protocol

Authors

Jintana TONGPETH MSN, RN

PhD Candidate

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 5135

Email: tong0076@flinders.edu.au

Huiyun DU PhD, RN

Lecturer

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 2997

Email: huiyun.du@flinders.edu.au

Robyn CLARK PhD, RN

Professor of Acute Care and Cardiovascular Nursing

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 3266

Email: robyn.clark@flinders.edu.au

Contact Details for the Corresponding Author

Jintana TONGPETH

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

GPO Box 2100 N316 Sturt North Wing Sturt Road, Bedford Park, Adelaide, 5001

Phone: +61 8 8201 5135, FAX: +618 8276 1602

Email: tong0076@flinders.edu.au

Conflict of Interest

No conflict of interest has been declared by the authors

Funding Statement

Prof Robyn Clark is supported by a Heart Foundation Future Leader Fellowship 2016–2019 (APP 100847).

Dr Huiyun Du is supported by an establishment grant (2015) from Faculty of Medicine, Nursing and Health Science, Flinders University and a Heart Foundation Tom Simpson Trust Fund grant (2017)

Jintana Tongpeth is supported by a Royal Thai Government scholarship, Prachomklao College of Nursing, Praboromarajchanok Institute for Health Workforce Development, Ministry of Public Health, Thailand.

An Avatar-Based Education Application to Improve Patients' Knowledge of and Response to Heart Attack Symptoms: A Pragmatic Randomized Controlled Trial Protocol

3.6.3.1 Abstract

Aim: To evaluate the effectiveness of an interactive, avatar-based education application to improve the knowledge of and response to heart attack symptoms in people who are at risk of a heart attack.

Background: Poor knowledge of heart attack symptoms is recognised as a significant barrier to timely medical treatment. Numerous studies have demonstrated that technology can assist in patient education to improve their knowledge and self-care.

Design: A single-centre, non-blinded, two parallel groups, pRCT.

Methods: Seventy patients will be recruited from the CCU of a public hospital. Eligible participants will be randomised to either the usual care or the intervention group (IG) (usual care plus avatar-based heart attack education application). The primary outcome of this study is knowledge. Secondary outcomes include responses to heart attack symptoms, health service use and satisfaction. Study participants will be followed up for six months.

Discussion: This study will evaluate the avatar-based education application as a method to deliver vital information to patients. Participants' knowledge of and response to heart attack symptoms, health service use and satisfaction. Study participants will be followed up for 6 months.

Keywords: acute coronary syndrome, avatar-based education application, heart attack, heart attack symptoms, nursing intervention, nursing practice, patient education

Trial Registration

Australian New Zealand Clinical Trials Registry (ANZCTR) Trial ID: ACTRN12616000803493

Summary Statement

Why is this research needed?

- Low health literacy and the lack of knowledge of symptoms are two important factors related to poor outcomes after a heart attack.
- Interactive IT can overcome the barrier of low literacy in patient education. Avatar-based interventions in patient education are innovative but their effectiveness is unclear.
- Avatar-based patient education has the potential to improve the delivery of patient education and improve clinical outcomes.

3.6.3.2 Introduction

It is estimated that 17.7 million people worldwide died from CVD in 2015 (World Health Organization [WHO] 2017) and that 75% of such deaths are due to heart attack or stroke (WHO 2011). A significant proportion of the burden on the health care system can be attributed to hospitalisations associated with heart attacks (Benjamin et al. 2017; Members et al. 2014). Lack of knowledge of heart attack symptoms often leads to delay in seeking medical treatment, which is associated with poor clinical outcomes (Coventry et al. 2017; Nielsen et al. 2016) that are critically time-dependent following a heart attack (Chew et al. 2016; Mol et al. 2016). Improving people's knowledge of heart attack symptoms is a continuing challenge for clinicians and researchers. This paper presents a research protocol to evaluate the effectiveness of an innovative, interactive, avatar-based application for teaching heart attack symptoms and appropriate responses.

3.6.3.2.1 Background

When a heart attack is suspected, timely medical treatment is critical for survival (Chew et al. 2016; Fihn et al. 2014; Rodriguez and Mahaffey 2016). A lack of knowledge of heart attack symptoms has been identified as a major delaying factor in seeking medical treatment and is associated with potentially preventable death and complications (Albarqouni et al. 2016). Recognising and responding appropriately to heart attack symptoms can be challenging (Stenberg et al. 2016). Factors such as literacy, health literacy, numeracy, cognitive capacity, language and cultural and health-seeking behaviours can influence an individual's learning and their capacity to assimilate information (Dennison et al. 2011; Gutierrez et al. 2014). However, various education strategies can be used to improve knowledge and self-care, leading to better clinical outcomes (Stenberg et al. 2016).

In the health care system, the rapid advances in IT over the last 10 years have enhanced access to information and communication with patients (Caligtan et al. 2012; Finkelstein et al. 2012; Or and Karsh 2009). The use of technology to support more active service user involvement and more engaging learning experiences helps to deliver critical health-related information more effectively to patients (Swallow et al. 2016; Ventola 2014). Given the versatility of this technology, each educational intervention can be tailored to the target population or individual to provide the most relevant, personalised teaching and better outcomes (Clark et al. 2015; Dennison et al. 2011; Gutierrez et al. 2014).

Avatar-based educational interventions have been shown to achieve better patient outcomes for chronic conditions, such as cancer, diabetes and depression (Beale et al. 2007; Klaassen et al. 2018; Pinto et al. 2013), by promoting more active engagement and enhancing knowledge and behaviour (Napolitano et al. 2013; Andrade et al. 2015). An avatar is an icon or figure representing a particular person in a computer game or Internet forum (Lee and Berge 2011; Xinyu and Pin 2008). Using modern computerised tools such as animation and video, an avatar can enhance learning by helping to explain complicated medical information while mimicking real human interaction, which facilitates communication and understanding (Chattaraman, Kwon & Gilbert 2012; Wiederhold 2013). Because it minimises the need to read printed materials, this approach is likely to be especially beneficial for people with low levels of literacy or health literacy.

In our preliminary study, we developed the SAVE app to teach heart attack symptoms and responses. The animated avatar was represented by a nurse. The theoretical underpinning of the SAVE app is social cognitive theory, particularly the concept of observation learning and self-efficacy (Bandura 2008). People learn by observing others and through positive and negative reinforcement (Bandura 2008). The use of plain language and a ‘face-to-face’ interactive approach ensures that the health information that is delivered is easy to understand. The quizzes in the education application reinforce the information through immediate feedback and verbal encouragement. Therefore, the SAVE app helps individuals to build confidence in recognising and responding to heart attack symptoms (i.e., self-efficacy) (Bandura 1977).

In a group of 10 individuals who have had a heart attack previously (90% male; mean age 62 years), the results of the preliminary study indicated a high level of intervention satisfaction (87%) when using the SAVE app (Tongpeth, Du & Clark 2018). The proposed

pRCT will evaluate the effectiveness of the education application in improving patient knowledge and responses in relation to heart attack symptoms.

3.6.3.3 The Study

3.6.3.3.1 Aim

The aim of the proposed study is to evaluate the effectiveness of the SAVE app as an innovative method of patient education.

3.6.3.3.2 Objectives

The objectives of the study are to:

1. evaluate the effectiveness of the SAVE app on participants' knowledge of heart attack symptoms
2. evaluate the effectiveness of the SAVE app on participants' responses to heart attack symptoms
3. evaluate the effectiveness of the SAVE app in relation to participants' use of health services
4. compare outcomes for participants with low and adequate health literacy levels.

3.6.3.4 Methodology

3.6.3.4.1 Design

The proposed study will be a single-centre, non-blinded, parallel (two-group), pRCT.

3.6.3.4.2 Setting and Eligibility Criteria

Participants will be recruited prior to discharge from the CCU of a large metropolitan tertiary public hospital in South Australia. To be eligible for the study, participants must (a) be 18 years of age and older, (b) be admitted with a cardiac diagnosis involving a previous experience of chest pain or other heart attack symptoms, (c) be clinically stable, 4) exhibit normal cognitive function and (e) have sufficient English language ability to communicate and follow the research procedure. Those who are clinically unstable or cognitively impaired, are unable to communicate in English or refuse to give informed consent will be excluded from the study. Detailed inclusion and exclusion criteria are set out in Table 3.2.

Table 3.2: Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Admitted with any cardiac diagnosis in which chest pain or other heart attack symptoms have been experienced previously	Clinically unstable
Clinically stable*	Cognitive impairment
Normal cognitive function	Failure to give
Sufficient English language ability to communicate and follow the study procedure	informed consent

* Clinically stable is defined as the achievement of five normal vital signs (i.e. heart rate, systolic blood pressure, respiratory rate, oxygen saturation and temperature) plus normal mental status and the ability to eat for at least 24 hours prior to enrolment in the study. (Aliberti et al. 2013, Doyle, Noonan & O'Connell 2013)

3.6.3.4.3 Usual Care Group

The participants who are randomly assigned to the control group will receive usual care in the CCU that includes bedside education by cardiac rehabilitation nurses to reinforce understanding of the diagnosis, procedures and risk factor management. The bedside nurses will provide information about the emergency Heart Attack Action Plan and how to use angina medicine. In addition, Heart Foundation educational booklets (NHF 2015a; 2015b; 2015c) will be provided to these participants. Under this study protocol, the usual care group (UG) will receive two follow-up telephone calls at one month and six months after discharge.

3.6.3.4.4 Intervention Group (Usual Care Plus the SAVE App)

In addition to usual care, participants in the IG will receive the SAVE app on a handheld computer tablet. The content of the education application is divided into four sections: (a) heart attack warning sign quiz, (b) heart attack signs and symptoms, (c) what to do when having a heart attack and (d) heart attack action test (see Appendix 16). The education application was developed in collaboration with consumers who had previous experience of a heart attack. No complex medical terminology is used in the SAVE app (see Figure 3.6). On starting the application, the user will be prompted to complete a quiz comprising five true-or-false questions to generate interest and promote engagement. Participants will also be asked to complete a similar quiz at the end as a means of reinforcing learning.

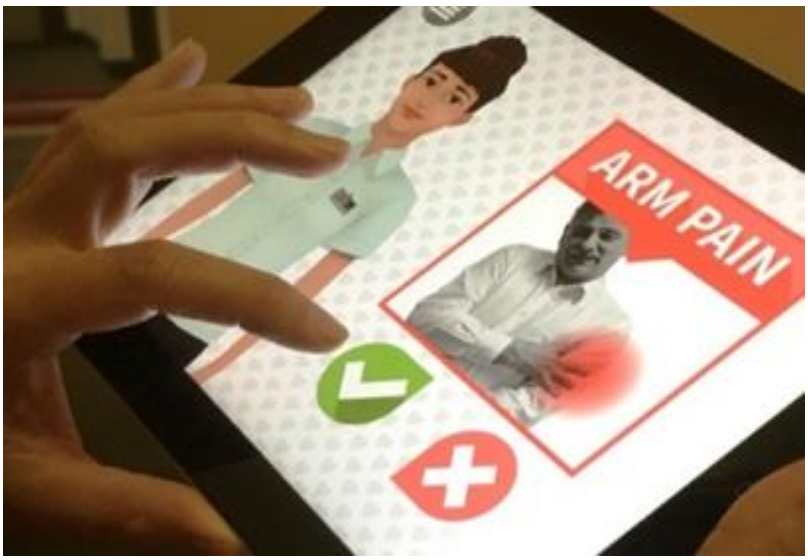


Figure 3.6: A Screen Picture of the SAVE App

Participants in the IG will be asked to use the SAVE app before being discharged from the hospital. The research nurse will provide instructions on how to use the SAVE app (see Appendix 14) that will take approximately 10 minutes to complete. To assess their knowledge of heart attack symptoms and appropriate responses, participants will be asked to complete the study questionnaire before and after using the application (see Appendix 15). A tablet computer will be provided to every IG participant for home use during the six-month study period. As in the case of the UG, IG participants will receive two follow-up telephone calls at one month and six months. At six months, the IG will also be asked to complete a satisfaction survey (see Appendix 15) to provide feedback on the SAVE app.

3.6.3.4.5 Outcome Measures

The timeline of measurements is presented in Table 3.3. In relation to primary outcome knowledge, the ACS Response Index will be used to measure changes in heart attack knowledge over time. This tool will also be used to measure secondary outcomes that consist of attitudes and beliefs in relation to heart attack symptoms (Dracup et al. 2009; O'Brien et al. 2014; Riegel et al. 2007).

Table 3.3: Timeline of Study Measurements (see Appendix 15)

Measures	**Baseline**	One m**onth**	Six m**onths**
MMSE-SF	×		
Clinical and demographic	×		
REALM-SF	×		
Charlson Comorbidity Index	×		
GRACE Risk Score	×		
ACS Response Index	×	×	×
Heart Attack Action Plan	×	×	×
Health care use		×	×
Satisfaction questionnaire (Intervention group)			×

Note: MMSE-SF = Mini-Mental State Examination—Short Form; REALM-SF = Rapid Estimate of Adult Literacy in Medicine—Short Form; GRACE Risk Score = The Global Registry of Acute Coronary Events Risk Score

ACS Response Index: The ACS Response Index is a validated instrument comprising 33 items that measure knowledge (21), attitudes (6) and beliefs (7) in relation to heart attack symptoms and responses. This questionnaire has been widely used and its reliability has been confirmed in the literature (Dracup et al. 2009; O'Brien et al. 2014; Riegel et al. 2007).

Heart Attack Response Action Questionnaire: The Heart Attack Action Plan Questionnaire is an investigator-developed instrument for assessing the affected individuals' responses and management. The questionnaire was adapted from the Heart Foundation's Heart Attack Action Plan ('Will you recognise a heart attack?'), including participants' experiences and their behavioural responses to symptoms (i.e., STOP, TALK, TAKE and CALL) (NHF 2015a). This information will be collected at three time points: baseline, one month and six months.

Health Care Utilisation Questionnaire: The Health Care Utilisation Questionnaire is an investigator-developed instrument for assessing ACS-related presentations to emergency services or outpatient clinics. Health care use is measured by the number of hospitalisations, length of stay, attendance at outpatient clinics or general practitioners and number of unscheduled emergency department visits. This information will be collected at one and six months.

Satisfaction Questionnaire: The SAVE app's Satisfaction Questionnaire comprises 15 items, each measured on a Likert-type scale. The instrument is adapted from validated surveys of education material acceptability (Fredericks et al. 2013; Gwadry-Sridhar et al.

2003) and assesses participants' perceptions of the SAVE app in terms of audiovisuals, content, usefulness and user-friendliness.

3.6.3.4.6 Sample Size

The primary study outcome is knowledge change, as measured on the relevant sub-scale of the ACS Response Index (Riegel et al. 2007). In a previously published study (O'Brien et al. 2014), change in the knowledge sub-scale was used to calculate the required sample size. Using a standard deviation of 2.9 and an effect size of 0.42 for ACS Response Index (Riegel et al. 2007), the required sample size was calculated as 31 per group (alpha = .05, power = .95). This calculation was performed using the independent samples *t*-test and PASS software (Julious and Campbell 2012; Suresh and Chandrashekara 2012). Based on a 10 per cent attrition rate, 70 participants will be required for the proposed study (35 per group).

3.6.3.4.7 Recruitment

To assist the research nurse in identifying potential participants, CCU nursing staff at the study site will be provided with the inclusion and exclusion criteria. If the patient gives their permission, a research nurse will approach the patient to explain the study's purpose and protocol. If the patient agrees to participant in the study, a signed consent form will be obtained and the patient will then be screened for eligibility.

3.6.3.4.8 Assignment of Intervention

Sequence generation: Using a computerised system, the randomisation sequence will be generated to two block sizes by an independent randomisation centre.

Allocation concealment: The use of two block sizes to generate the randomisation sequence will ensure that the random allocation sequence is concealed at all times during the study.

Implementation: To ensure that the baseline assessment will not be affected by group allocation, randomisation will follow consent and completion of the baseline assessment (see Figure 3.7). Participants will be randomly assigned through an independent randomisation centre using an interactive voice response system (see Appendix 14). that the researcher will contact by telephone after completion of the baseline assessment Participants will be randomly assigned to the intervention and control groups in a 1:1 ratio.

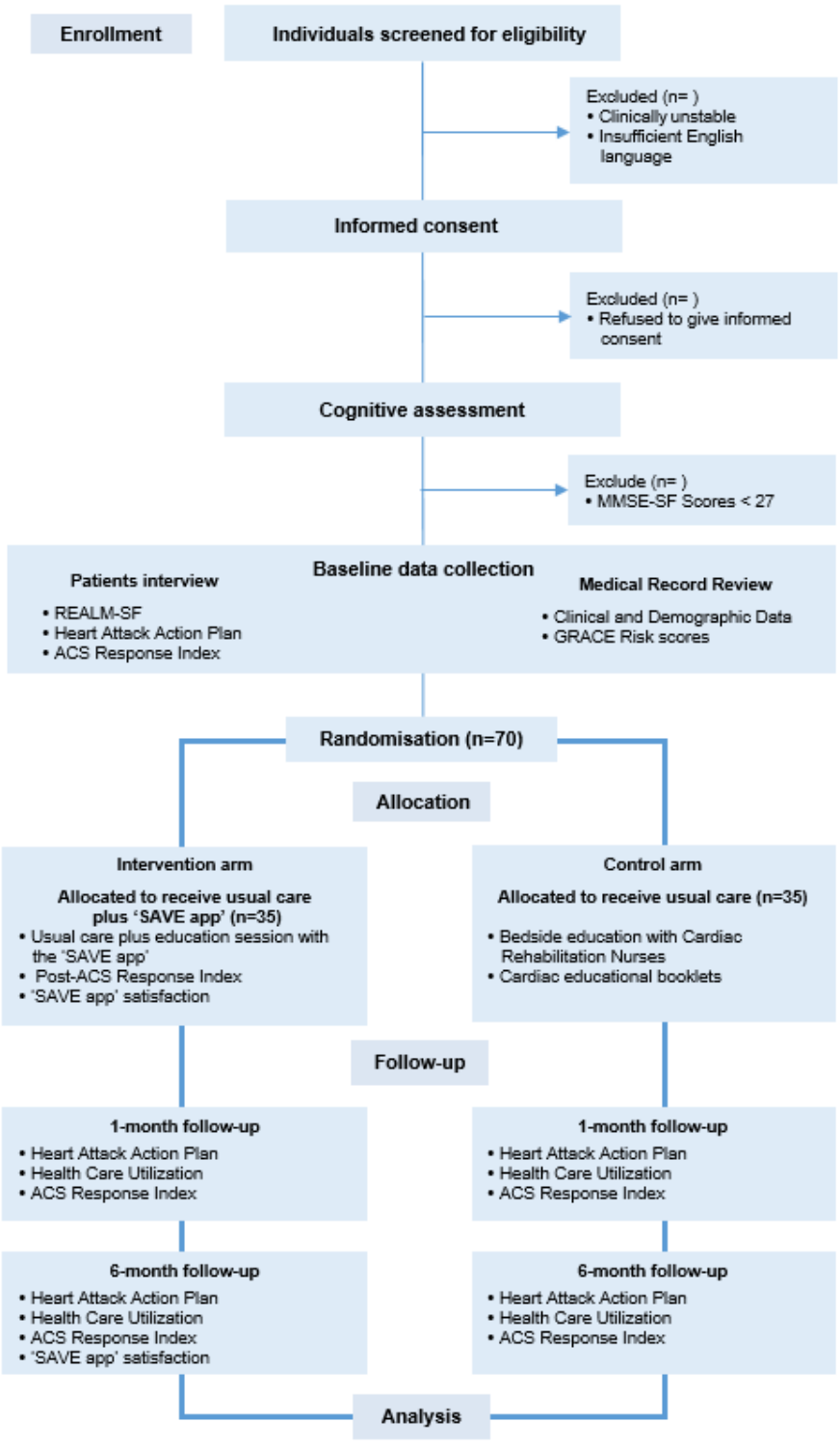


Figure 3.7: CONSORT Flow Diagram of the Study Procedure

Blinding: The nature of the educational intervention means that blinding of participants or the researcher will not be possible.

3.6.3.4.9 Data Collection and Management

For each group, data will be collected at three time points: baseline, one month and six months after discharge. Data will be entered into an Excel spreadsheet that will be password

protected and saved on the university network computer. Range checks for data value and auditing will be conducted by the research team at each weekly meeting. Study data will be accessible only to members of the research team.

The Consolidated Standards of Reporting Trials (CONSORT) diagram of the study procedure is shown in Figure 3.7. The following information will be collected from participants in both the intervention and control groups.

3.6.3.4.10Background Information

Regardless of group allocation, all participants consenting to participate in the study will be subject to a baseline assessment that will include (a) (from the participant's medical record): (i) demographic data, (ii) clinical information and history and (iii) Global Registry of Acute Coronary Events (GRACE) Risk Score (Goodacre et al. 2012), and (b) (from individual interviews): (i) Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF) (Ibrahim et al. 2008), (ii) Heart Attack Action Plan Questionnaire, (iii) Health Care Utilisation Questionnaire and (iv) ACS Response Index (Riegel et al. 2007). The timeline of study measurements is detailed in Table 3.3.

Clinical and demographic data: These data include the participants' age, gender, education, domiciliary and employment status, medical history, clinical status, past procedures, family history, smoking status Charlson Comorbidity Index (Roffman, Buchanan & Allison 2016) and cardiac biochemistry, including GRACE Risk Score (Goodacre et al. 2012). These will be collected at baseline.

GRACE Risk Score: The GRACE Risk Score was designed to predict in-hospital mortality. The components of the GRACE Risk Score are age, history of heart failure, history of acute myocardial infarction, heart rate at admission, systolic blood pressure at admission, ST-segment deviation, serum creatinine at admission and elevated troponin and cardiac arrest at admission. For the purposes of the proposed study, the GRACE Risk Score will be used to provide information on participants' clinical status at baseline (Goodacre et al. 2012).

REALM-SF: The REALM-SF is widely used as a brief, validated instrument for assessing literacy in diverse health care settings. In the proposed study, the REALM-SF will be used to assess the health literacy levels of study participants at baseline (Ibrahim et al. 2008).

3.6.3.4.11Statistical Methods

The collected data will be analysed according to the intention-to-treat principle to provide an unbiased assessment of intervention effectiveness. Data will be computed and analysed

using SPSS v23.0 (SPSS Inc, Chicago, IL, USA). Data analysis will be supervised by a statistician who has not been involved in the screening, recruitment or follow-up of study participants. Descriptive statistics will be used to summarise participants' baseline demographic and clinical characteristics. Continuous data will be summarised using mean, median, standard deviation and standard error of the mean. Categorical data will be summarised as percentages. The demographic data of those participating in the intervention and UGs will be compared using the independent samples *t*-test or Pearson's chi-square test to measure between-group differences. Normally distributed continuous data will be analysed using the independent *t*-test, and the Mann-Whitney *U* test will be used for non-normally distributed data. The association between categorical data will be analysed using the chi-square test. ANOVA will be used to compare the change in ACS Response Index sub-scale scores over time and between groups. The Mann-Whitney *U* test will be used for data that does not meet ANOVA assumptions. The statistical significance level will be $p < .05$ unless otherwise specified. All reported test results will be two-tailed.

3.6.3.4.12Monitoring

A data monitoring committee will be established, comprising the principal investigators and research nurse. The committee will meet on a weekly basis to review recruitment, site status and data entry. Any adverse event occurring during that week will be reported by the research nurse, reviewed by the committee and reported to the ethics committee and health authorities according to local regulations. Any reasons to suspend or terminate the study will be discussed and decided by the principal investigators at the weekly meeting.

3.6.3.4.13Ethical Considerations

The study protocol has been approved by Southern Adelaide Clinical Human Research Ethic Committee (SAC HREC) (reference number OFR#290.15-HREC/15/SAC/247).

Written informed consent (See Appendix 12) will be sought from all participants, who will be provided with a copy of their signed consent. Participants will be reminded that they are free to withdraw from the study at any time without explanation and that this will not affect the usual care they receive.

3.6.3.4.14Data Protection, Security and Confidentiality

All participants will be identified by a unique code. All identifiable personal information will be accessible only to the research team. All data will be stored electronically with a password-protected file on the university network computer. The researchers intend to have

the results of this study published in a peer-reviewed journal and presented at conferences and research seminars. Only de-identified, aggregated data will be presented.

3.6.3.4.15Validity and Reliability

The researchers will be trained to adhere strictly to the study protocol. The research data safety and monitoring committee will meet weekly to review recruitment and study progress and to review any issues raised by the research nurse. This meeting will ensure that the study is being carried out according to the stated protocol and adheres rigorously to the CONSORT statement (Schulz, Altman & Moher 2010; Zwarenstein et al. 2008). The SPIRIT statement (Chan et al. 2013) and TIDieR templates (Hoffmann et al. 2014) have been used to describe both the trial protocol and intervention.

3.6.3.5 Discussion

The relevant literature provides evidence for a lack of knowledge of heart attack symptoms, and pre-hospital delay is a significant factor in preventable deaths and complications (Coventry et al. 2017; Nielsen et al. 2016). Effective educational interventions are needed to improve patients' knowledge and behaviour, but printed materials have little effect. Working with people who have had a heart attack previously as well as IT gaming experts and cardiovascular experts, the research team designed and developed the SAVE app. This education application has gained a high satisfaction rating in our preliminary study as a result of this patient-centred approach. By addressing the barriers of literacy and engagement, the avatar-based education application has the potential to significantly enhance teaching and learning and clinical outcomes in people who experience a heart attack.

3.6.3.6 Limitations

Despite the many strengths of a pRCT, this study has several limitations. By its nature, an education intervention does not permit blinding of participants. However, an independent statistician (who is not involved in any other aspect of this study) will conduct the data analysis. A second limitation is that conducting the study at a single site may limit generalisability of the findings. These limitations and their effect will be reported and discussed along with the study results.

3.6.3.7 Conclusion

Avatar-based education has the potential to overcome the challenge of delivering vital but complicated medical information to patients. In addition, it seems likely that it can readily be used for other conditions and for people from diverse cultural and linguistic backgrounds.

Author contributions

All authors have agreed on the final version and meet at least one of the following criteria (recommended by the International Committee of Medical Journal Editors [http://www.icmje.org/ethical/]):

1. substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data
2. drafting the article or revising it critically for important intellectual content.

3.6.3.8 References

Albarqouni, L, Smenes, K, Meinertz, T, Schunkert, H, Fang, X, Ronel, J & Ladwig, KH (2016), 'Patients' knowledge about symptoms and adequate behaviour during acute myocardial infarction and its impact on delay time: Findings from the multicentre MEDEA Study', *Patient Education and Counseling*, vol. 99, no. 11, pp. 1845–51.

Aliberti, S, Zanaboni, AM, Wiemken, T, Nahas, A, Uppatla, S, Morlacchi, LC, Peyrani, P, Blasi, F & Ramirez, J 2013, 'Criteria for clinical stability in hospitalised patients with community-acquired pneumonia', *European Respiratory Journal*, vol. 52, no. 1, pp. 1008-12.

Andrade, AD, Anam, R, Karanam, C, Downey, P & Ruiz, JG 2015, 'An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy', *Urology*, vol. 85, no. 3, pp. 561–7.

Bandura, A 1977, 'Self-efficacy: Toward a unifying theory of behavioral change', *Psychological Review*, vol. 84, no. 2, pp. 191–215.

Bandura, A 2008, 'Observational learning', in W Donsbach (ed.), *The international encyclopedia of communication*, Blackwell, Oxford, UK, pp. 3359–61.

Bandura, A 2011, 'Social cognitive theory', in PAM Van Lange, AW Kruglanski & ET Huggins (eds.), *Handbook of theories of social psychology*, Sage Publications, Thousand Oaks, USA, pp. 349-373.

Beale, IL, Kato, PM, Marin-Bowling, VM, Guthrie, N & Cole, SW 2007, 'Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer', *Journal of Adolescent Health*, vol. 41, no. 3, pp. 263–70.

Benjamin, EJ, Blaha, MJ, Chiuve, SE, Cushman, M, Das, SR, Deo, R, de Ferranti, SD, Floyd, J, Fornage, M, Gillespie, C, Isasi, CR, Jiménez, MC, Jordan, LC, Judd, SE, Lackland, D, Lichtman, JH, Lisabeth, L, Liu, S, Longenecker, CT, Mackey, RH, Matsushita, K, Mozaffarian, D, Mussolino, ME, Nasir, K, Neumar, RW, Palaniappan, L, Pandey, DK, Thiagarajan, RR, Reeves, MJ, Ritchey, M, Rodriguez, CJ, Roth, GA, Rosamond, WD, Sasson, C, Towfighi, A, Tsao, CW, Turner, MB, Virani, SS, Voeks, JH, Willey, JZ, Wilkins, JT, Wu, JHY, Alger, HM, Wong, SS, Muntner, P & American Heart Association Statistics Committee and Stroke Statistics Subcommittee 2017, 'Heart disease and stroke statistics—

2017 update: A report from the American Heart Association', *Circulation*, vol. 135, no. 10, pp. e146–603.

Caligtan, CA, Carroll, DL, Hurley, AC, Gersh-Zaremski, R & Dykes, PC 2012, 'Bedside information technology to support patient-centered care', *International Journal of Medical Informatics*, vol. 81, no. 7, pp. 442–51.

Chan, AW, Tetzlaff, JM, Altman, DG, Laupacis, A, Gøtzsche, PC, Krleža-Jerić, K, Hróbjartsson, A, Mann, H, Dickersin, K, Berlin, JA, Dore, CJ, Parulekar, WR, Summerskill, WS, Groves, T, Schulz, KF, Sox, HC, Rockhold, FW, Rennie, D & Moher, D 2013, 'SPIRIT 2013 statement: Defining standard protocol items for clinical trials', *Annals of Internal Medicine,* vol. 158, no. 3, pp. 200–7.

Chattaraman, V, Kwon, WS & Gilbert, JE 2012, 'Virtual agents in retail web sites: Benefits of simulated social interaction for older users', *Computers in Human Behavior*, vol. 28, no. 6, pp. 2055–66.

Chew, DP, Scott, IA, Cullen, L, French, JK, Briffa, TG, Tideman, PA, Woodruffe, S, Keer, A, Branagan, M & Aylward, PE 2016, 'National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Australian clinical guidelines for the management of acute coronary syndromes 2016', *Medical Journal of Australia*, vol. 205, no. 3, pp. 128–33.

Clark, RA, Fredericks, B, Buitendyk, NJ, Adams, MJ, Howie-Esquivel, J, Dracup, KA, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3, pp. 231-43.

Coventry, LL, van Schalkwyk, JW, Thompson, PL, Hawkins, SA & Hegney, DG 2017, 'Myocardial infarction, patient decision delay and help-seeking behaviour: A thematic analysis', *Journal of Clinical Nursing,* vol. 26, no. 13–14, pp. 1993–2005.

Dennison, CR, McEntee, ML, Samuel, L, Johnson, BJ, Rotman, S, Kielty, A & Russell, SD 2011, 'Adequate health literacy is associated with higher heart failure knowledge and self-care confidence in hospitalized patients', *The Journal of Cardiovascular Nursing*, vol. 26, no. 5, pp. 359–67.

Dracup, K, McKinley, S, Riegel, B, Moser, DK, Meischke, H, Doering, LV, Davidson, P, Paul, SM, Baker, H & Pelter, M 2009, 'A randomized clinical trial to reduce patient prehospital

delay to treatment in acute coronary syndrome', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 6, pp. 524–32.

Doyle, M, Noonan, B, O'Connell, E. 2013. Care study: a cardiovascular physical assessment. *British Journal of Cardiac Nursing*, vol. 8, no. 3, pp.122-126.

Fihn, SD, Blankenship, JC, Alexander, KP, Bittl, JA, Byrne, JG, Fletcher, BJ, Fonarow, GC, Lange, RA, Levine, GN & Maddox, TM 2014, '2014 ACC/AHA/AATS/PCNA/SCAI/STS focused update of the guideline for the diagnosis and management of patients with stable ischemic heart disease: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, and the American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons', *Journal of the American College of Cardiology*, vol. 64, no. 18, pp. 1929–49.

Finkelstein, J, Knight, A, Marinopoulos, S, Gibbons, MC, Berger, Z, Aboumatar, H, Wilson, RF, Lau, BD, Sharma, R & Bass, EB 2012, 'Enabling patient-centered care through health information technology', *Evidence Report/Technology Assessment*, vol. 206, pp. 1–1531.

Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure self-care amongst indigenous Australians: A pilot study', *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, pp. 40–60.

Goodacre, SW, Bradburn, M, Mohamed, A & Gray, A 2012, 'Evaluation of Global Registry of Acute Cardiac Events and Thrombolysis in Myocardial Infarction scores in patients with suspected acute coronary syndrome', *The American Journal of Emergency Medicine*, vol. 30, no. 1, pp. 37–44.

Gutierrez, N, Kindratt, TB, Pagels, P, Foster, B & Gimpel, NE 2014, 'Health literacy, health information seeking behaviors and internet use among patients attending a private and public clinic in the same geographic area', *Journal of Community Health*, vol. 39, no. 1, pp. 83–9.

Gwadry-Sridhar, F, Guyatt, GH, Arnold, JMO, Massel, D, Brown, J, Nadeau, L & Lawrence, S 2003, 'Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure', *European Journal of Heart Failure*, vol. 5, no. 6, pp. 783–91.

Hoffmann, TC, Glasziou, PP, Boutron, I, Milne, R, Perera, R, Moher, D, Altman, DG, Barbour, V, Macdonald, H, Johnston, M, Lamb, SE, Dixon-Woods, M, McCulloch, P, Wyatt, JC, Chan, AW & Michie, S 2016, 'Better reporting of interventions: Template for Intervention Description and Replication (TIDieR) checklist and guide', *British Medical Journal*, vol. 348, p. g1687.

Ibrahim, SY, Reid, F, Shaw, A, Rowlands, G, Gomez, GB, Chesnokov, M & Ussher, M 2008, 'Validation of a health literacy screening tool (REALM) in a UK population with coronary heart disease', *Journal of Public Health*, vol. 30, no. 4, pp. 449–55.

Julious, SA & Campbell, MJ 2012, 'Tutorial in biostatistics: Sample sizes for parallel group clinical trials with binary data', *Statistics in Medicine*, vol. 31, no. 24, pp. 2904–36.

Lee, A & Berge, ZL 2011, 'Second life in healthcare education: Virtual environment's potential to improve patient safety', *Knowledge Management & E-Learning: An International Journal*, vol. 3, no. 1, pp. 17–23.

Members, WG, Go, AS, Mozaffarian, D, Roger, VL, Benjamin, EJ, Berry, JD, Blaha, MJ, Dai, S, Ford, ES, Fox, CS, Franco, S, Fullerton, HJ, Gillespie, C, Hailpern, SM, Heit, JA, Howard, VJ, Huffman, MD, Judd, SE, Kissela, BM, Kittner, SJ, Lackland, DT, Lichtman, JH, Lisabeth, LD, Mackey, RH, Magid, DJ, Marcus, GM, Marelli, A, Matchar, DB, McGuire, DK, Mohler, ER 3rd, Moy, CS, Mussolino, ME, Neumar, RW, Nichol, G, Pandey, DK, Paynter, NP, Reeves, MJ, Sorlie, PD, Stein, J, Towfighi, A, Turan, TN, Virani, SS, Wong, ND, Woo, D, Turner MB & American Heart Association Statistics Committee and Stroke Statistics Subcommittee 2014, 'Heart disease and stroke statistics—2014 update: A report from the American Heart Association', *Circulation*, vol. 129, no. 3, p. e28–292.

Mol, KA, Rahel, BM, Meeder, JG, van Casteren, BCAM, Doevendans, PA & Cramer, MJM 2016, 'Delays in the treatment of patients with acute coronary syndrome: Focus on pre-hospital delays and non–ST-elevated myocardial infarction', *International Journal of Cardiology*, vol. 221, pp. 1061–6.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, 'Using avatars to model weight loss behaviors: Participant attitudes and technology development', *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057–65.

National Heart Foundation of Australia 2015a, *Heart attack action plan: Will you recognise your heart attack?*, viewed December 2017,

<https://www.heartfoundation.org.au/images/uploads/main/Your_heart/Heart_attack_actio a_plan.pdf>.

National Heart Foundation of Australia 2015b, *My heart, my life*, 2nd edn, National Heart Foundation of Australia, Sydney, Australia.

National Heart Foundation of Australia 2015c, *Living well with chronic heart failure*, National Heart Foundation of Australia, Sydney, Australia.

Nielsen, CG, Laut, KG, Jensen, LO, Ravkilde, J, Terkelsen, CJ & Kristensen, SD 2016, 'Patient delay in patients with ST-elevation myocardial infarction: Time patterns and predictors for a prolonged delay', *European Heart Journal: Acute Cardiovascular Care*, vol. 6, no. 7, pp. 583–91.

O'Brien, F, McKee, G, Mooney, M, O'Donnell, S & Moser, D 2014, 'Improving knowledge, attitudes and beliefs about acute coronary syndrome through an individualized educational intervention: A randomized controlled trial', *Patient Education and Counseling*, vol. 96, no. 2, pp. 179–87.

Or, CK & Karsh, BT 2009, 'A systematic review of patient acceptance of consumer health information technology', *Journal of the American Medical Informatics Association*, vol. 16, no. 4, pp. 550–60.

Pinto, MD, Hickman Jr, RL, Clochesy, J & Buchner, M 2013, 'Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults', *Applied Nursing Research*, vol. 26, no. 1, pp. 45–8.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584–94.

Rodriguez, F & Mahaffey, KW 2016, 'Management of patients with NSTE-ACS: A comparison of the recent AHA/ACC and ESC guidelines', *Journal of the American College of Cardiology*, vol. 68, no. 3, pp. 313–21.

Roffman, CE, Buchanan, J & Allison, GT 2016, 'Charlson comorbidities index', *Journal of Physiotherapy*, vol. 62, no. 3, p. 171.

Schulz, KF, Altman, DG & Moher, D 2010, 'CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials', *BMC Medicine*, vol. 8, no. 1, p. 18.

Stenberg, U, Haaland-Øverby, M, Fredriksen, K, Westermann, KF & Kvisvik, T 2016, 'A scoping review of the literature on benefits and challenges of participating in patient education programs aimed at promoting self-management for people living with chronic illness', *Patient Education and Counseling,* vol. 99, no. 11, pp. 1759–71.

Suresh, KP & Chandrashekara, S 2012, 'Sample size estimation and power analysis for clinical research studies', *Journal of Human Reproductive Sciences*, vol. 5, no. 1, pp. 7–13.

Swallow, V, Carolan, I, Smith, T, Webb, NJ, Knafl, K, Santacroce, S, Campbell, M, Harper-Jones, M, Hanif, N & Hall, A 2016, 'A novel Interactive Health Communication Application (IHCA) for parents of children with long-term conditions: Development, implementation and feasibility assessment', *Informatics for Health and Social Care*, vol. 41, no. 1, pp. 20–46.

Tongpeth, J, Du, HY & Clark, RA 2018, 'Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome', *Journal of Clinical Nursing*, (online Wiley Online Library).

Ventola, CL 2014, 'Mobile devices and apps for health care professionals: Uses and benefits', *Pharmacy and Therapeutics*, vol. 39, no. 5, pp. 356–64.

Wiederhold, BK 2013, 'Avatars: Changing behavior for better or for worse?', *Cyberpsychology, Behavior, and Social Networking*, vol. 16, no. 5, pp. 319–20.

World Health Organization 2011, *Global atlas on cardiovascular disease prevention and control*, World Health Organization Geneva, Switzerland.

World Health Organization 2017, *Cardiovascular diseases (CVDs) fact sheet*, <http://www.who.int/mediacentre/factsheets/fs317/en/>.

Xinyu, D & Pin, J 2008, 'Development and application of virtual avatar interactive technology', *ICACTE'08 Proceedings of the 2008 International Conference on Advanced Computer Theory and Engineering*, Phuket, Thailand, pp. 286−9.

Zwarenstein, M, Treweek, S, Gagnier, JJ, Altman, DG, Tunis, S, Haynes, B, Oxman, AD & Moher, D 2008, 'Improving the reporting of pragmatic trials: An extension of the CONSORT statement', *British Medical Journal*, vol. 337, p. a2390.

3.7 Ethics Approval

All human research needs to consider the ethical issues that may have an effect on individuals who participate in research. In Australia, the National Statement on Ethical Conduct in Human Research is the primary guideline for the ethical consideration of all human research. This is known as the Australian Code for the Responsible Conduct of Research (National Health and Medical Research Council 2007). The essential aspects of ethics, which are the values and principles of ethical conduct, consist of respect, merit, integrity, justice and beneficence.

The ethical principles upon which this study has been conducted are based on the Australian Code for the Responsible Conduct of Research (National Health and Medical Research Council 2007). Ethics approval for this study was obtained from Flinders University and from the SAC HREC, which is a joint committee of the Southern Adelaide Local Health Network. Overall project coordination was undertaken with the Flinders University College of Nursing and Health Sciences.

3.7.1 Ethical Considerations

The ethical principles on which this study will be conducted are based on the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007). Ethical approval for this study will be obtained from the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC), which is a joint committee of the Southern Adelaide Local Health Network and Flinders University. The overall project coordination was occur from College of Nursing and Health Sciences.

3.7.3.1 Protection of privacy

Data protection at the College of Nursing and Health Sciences meets all standards and follows all steps to protect other people's personal information under the Information Privacy Principles. The system and processes with respect to privacy and data protection comply with Health Records and Information Privacy Act (NSW) 2002, and Privacy Act (1988) and the Information Privacy Principles. Data access is limited to the authorised researchers listed at the beginning of this document.

3.7.3.2 Confidentiality

Confidentiality was ensured by replacing participants' names with numerical codes on all study documents. Data linking each participant's identifying information and participant code were kept separately and were removed prior to analysis. Any information or comments provided by participants will be collected in a de-identified form. Data collected through this study were stored in a locked filing cabinet in the researcher's office within the College of Nursing and Health Sciences, Flinders University. Electronic data were kept on the Flinders University network computer in the College of Nursing and Health Sciencesy, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document. Paper based data will be stored for seven years and then shredded; electronic data will be deleted permanently from the Flinders University network computer.

3.7.3.3 Restriction of use of data.

Data ownership and publication: Ownership of the data collected during the PAR and pRCT is retained by the College of Nursing and Health Sciences under Flinders University. Persons contributing to the design, analysis or the writing process were listed as authors on publications associated with this study. Data collected through this project were only be used for the purpose of this project.

3.7.3.4 Consent Process

The key ethical issue in this study population concerns the vulnerability of the participants who have heart conditions. To minimise coercion, the nursing shift coordinator was first approach patients in cardiac care unit, Flinders Medical Centre. The research nurse was then introduced to individuals who have indicated their willingness to participate. The research nurse was explain the study procedure and provide the Participant Information and Consent form (PICF). The research nurse was read out aloud the PICF and explain the study in detail to any potential participants that have a low level of literacy so that they can provide informed consent.Participants were reminded that they can withdraw at any time during the study and that withdrawal from the study will not affect their current or future treatment.

Each patient was asked to read the Patient Information sheet and consent form (PICF), and the research nurses were answer any questions that the patient may have. The patient does not have to provide consent immediately. He or she will be encouraged to think about the

project and discuss it with others if they wish to. The contact details of the researchers will be provided to the patient. Once the patient agrees to participate in this study, they were asked to sign the written consent form, in the presence of a witness. A copy of the signed consent form is to be filed in the participant's medical record. The research team were introduced the research project through the Director of Cardiology Department, and CCU manager, Flinders Medical Centre and through in-service sessions on the ward.

The ethics approval applications for both studies were submitted separately to SAC HREC (Online LNR application and General Research Application [see Appendix 13]). The Site Specific Assessment forms were also submitted along with the ethics approval applications. Insurance and indemnity were arranged by Flinders University and accepted by SA Health.

Having been granted ethics approval (see Appendix 4 and Appendix 10) and site-specific assessment approval (see Appendix 5 and Appendix 11), a letter of approval was submitted to Flinders University before commencing data collection at the research site. A flowchart of the ethics approval process and the associated applications is presented in Figure 3.7.

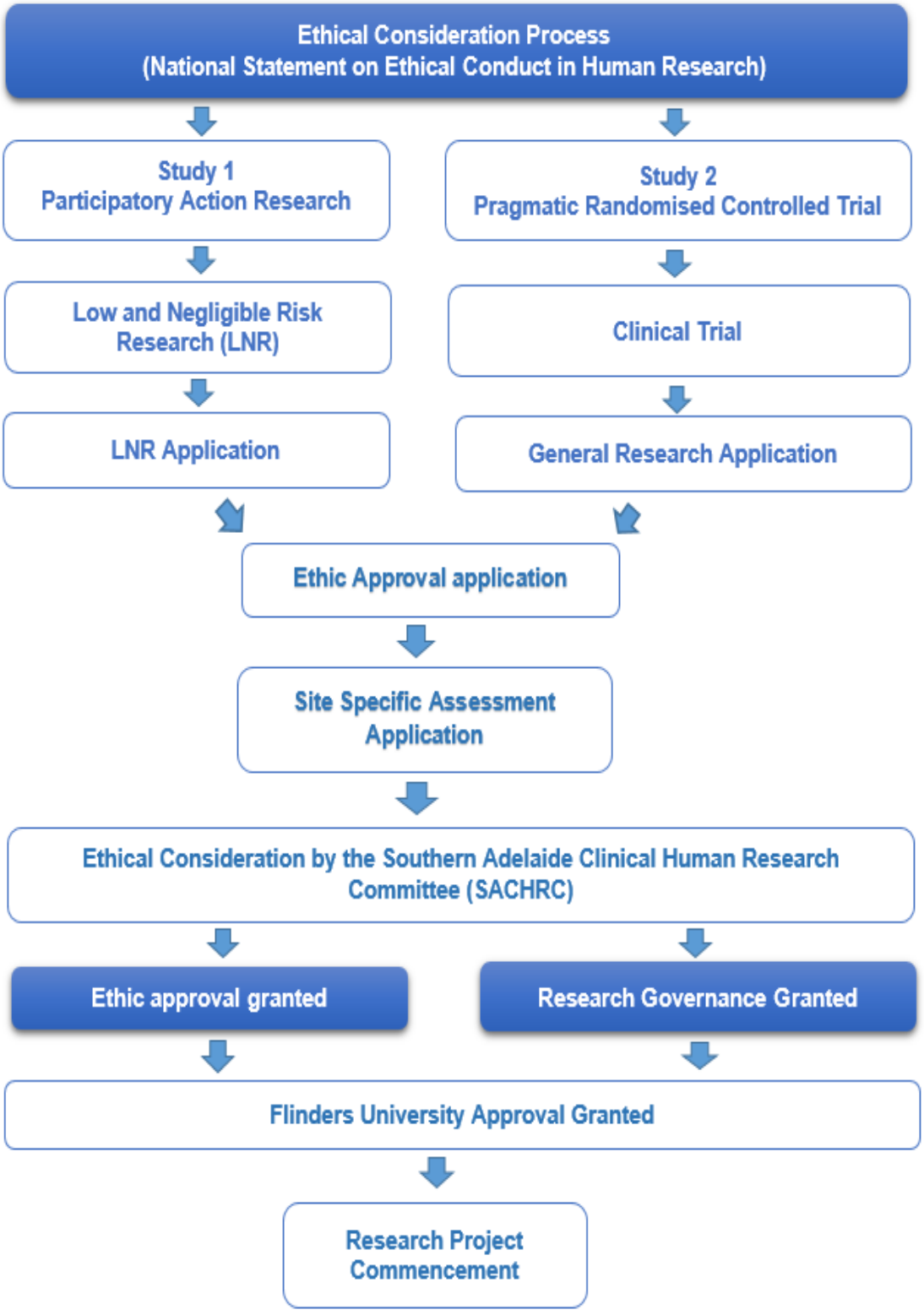


Figure 3.7: Flowchart of Ethics Considerations and Approvals

3.8 Chapter Summary

This chapter has provided a detailed overview of the methodology of the two studies that make up this project. This research project intended to develop an innovative interactive

educational tool for individuals with ACS. The methodology consisted of two methodologies to gain evidence about which avatar-based technologies are suitable for individuals with ACS and to explore appropriate delivery methods by health educators or health care professionals. If successful, this study has the potential to provide a way of overcoming the challenge of delivering complicated but vital medical information to patients, particularly those with low health literacy who most need the education and those from diverse cultural and linguistic backgrounds. The results of the two studies will be presented in the next chapter.

3.9 References

Andrew, S & Halcomb, EJ 2009, *Mixed methods research for nursing and the health sciences*, John Wiley & Sons, West Sussex, UK.

Bowen, DJ, Kreuter, M, Spring, B, Cofta-Woerpel, L, Linnan, L, Weiner, D, Bakken, S, Kaplan, CP, Squiers, L & Fabrizio, C 2009, 'How we design feasibility studies', *American Journal of Preventive Medicine*, vol. 36, no. 5, pp. 452−7.

Bradbury, H 2015, *The Sage handbook of action research*, Sage Publications, London, UK.

Braun, V & Clarke, V 2013. *Successful qualitative research: A practical guide for beginners*, Sage Publications, London, UK.

Bressan, V, Bagnasco, A, Aleo, G, Timmins, F, Barisone, M, Bianchi, M, Pellegrini, R & Sasso, L 2017, 'Mixed-methods research in nursing—a critical review', *Journal of Clinical Nursing*, vol. 26, no. 19−20, pp. 2878−90.

Chalkidou, K, Tunis, S, Whicher, D, Fowler, R & Zwarenstein, M 2012, 'The role for pragmatic randomized controlled trials (pRCTs) in comparative effectiveness research', *Clinical Trials*, vol. 9, no. 4, pp. 436−46.

Chan, A-W, Tetzlaff, JM, Altman, DG, Laupacis, A, Gøtzsche, PC, Krleža-Jerić, K, Hróbjartsson, A, Mann, H, Dickersin, K & Berlin, JA 2013, 'SPIRIT 2013 statement: Defining standard protocol items for clinical trials', *Annals of Internal Medicine*, vol. 158, no. 3, pp. 200−7.

Clark, RA, Yallop, JJ, Piterman, L, Croucher, J, Tonkin, A, Stewart, S, Krum, H & CHAT Study Team 2007, 'Adherence, adaptation and acceptance of elderly chronic heart failure patients to receiving healthcare via telephone-monitoring', *European Journal of Heart Failure*, vol. 9, no. 11, pp.1104−11.

Clark, R, Fredericks, B, Buitendyk, N, Adams, M, Howie-Esquivel, J, Dracup, K, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3231.

Claydon, LS 2015, 'Rigour in quantitative research', *Nursing Standard (2014+)*, vol. 29, no. 47, p. 43−8.

Cordeiro, L & Soares, CB 2018, ‘Participation in action research in the context of primary health care’, *EC Psychology and Psychiatry*, vol. 7, pp. 153−9.

Corry, M, Clarke, M, While, AE & Lalor, J 2013, ‘Developing complex interventions for nursing: A critical review of key guidelines’, *Journal of Clinical Nursing*, vol. 22, no. 17−18, pp. 2366−86.

Creswell, JW & Clark, VLP 2007, *Designing and conducting mixed methods research*, Sage Publications, California, USA.

Creswell, JW & Creswell, JD 2017, *Research design: Qualitative, quantitative, and mixed methods approaches*, Sage Publications, Thousand Oaks, USA.

Cusack, C, Cohen, B, Mignone, J, Chartier, MJ & Lutfiyya, Z 2018, ‘Participatory action as a research method with public health nurses’, *Journal of Advanced Nursing*, vol. 74, no. 7, pp. 1544−53.

Dunning, H, Williams, A, Abonyi, S & Crooks, V 2008, ‘A mixed method approach to quality of life research: A case study approach’, *Social Indicators Research*, vol. 85, no. 1, pp. 145−58.

Ford, I & Norrie, J 2016, ‘Pragmatic trials’, *New England Journal of Medicine*, vol. 375, no. 5, pp. 454−63.

Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, ‘Using participatory action research to assist heart failure self-care amongst indigenous Australians: A pilot study’, *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, p. 40−60.

Friesen-Storms, JH, Moser, A, Loo, S, Beurskens, AJ & Bours, GJ 2015, ‘Systematic implementation of evidence-based practice in a clinical nursing setting: A participatory action research project’, *Journal of Clinical Nursing*, vol. 24, no. 1−2, pp. 57−68.

Glasgow, RE, Magid, DJ, Beck, A, Ritzwoller, D & Estabrooks, PA 2005, ‘Practical clinical trials for translating research to practice: Design and measurement recommendations’, *Medical Care*, vol. 43, no. 6, pp. 551−7.

Greenwood, DJ 2018, ‘Action research’, in M Ciesielska & D Jemielniak (eds.), *Qualitative methodologies in organization studies*, Springer, Cham, Switzerland, pp. 75−98.

Gwadry-Sridhar, F, Guyatt, GH, Arnold, JMO, Massel, D, Brown, J, Nadeau, L & Lawrence, S 2003, 'Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure', *European Journal of Heart Failure*, vol. 5, no. 6, pp. 783−91.

Hagevik, R, Aydeniz, M & Rowell, CG 2012, 'Using action research in middle level teacher education to evaluate and deepen reflective practice', *Teaching and Teacher Education*, vol. 28, no. 5, pp. 675−84.

Halcomb, E & Newton, P 2017, 'Research in nursing', in J Daly, S Speedy & D Jackson (eds.), *Contexts of nursing: An introduction*, Elsevier, Sydney, Australia. pp. 129−42.

Halkier, B, 2010, 'Focus groups as social enactments: Integrating interaction and content in the analysis of focus group data', *Qualitative Research*, vol. 10, no. 1, pp. 71−89.

Herr, K & Anderson, GL 2014, *The action research dissertation: A guide for students and faculty*, Sage Publications, Thousand Oaks, USA.

Hennink, MM 2013, *Focus group discussions*, Oxford University Press, Oxford, UK.

Hoffmann, TC, Glasziou, PP, Boutron, I, Milne, R, Perera, R, Moher, D, Altman, DG, Barbour, V, Macdonald, H & Johnston, M 2014, 'Better reporting of interventions: Template for intervention description and replication (TIDieR) checklist and guide', *British Medical Journal*, vol. 348, p. g1687.

Huang, JP, Chen, HH & Yeh, ML 2009, 'A comparison of diabetes learning with and without interactive multimedia to improve knowledge, control, and self-care among people with diabetes in Taiwan', *Public Health Nursing*, vol. 26, no. 4, pp. 317−28.

Ivankova, NV 2017, 'Applying mixed methods in community-based participatory action research: A framework for engaging stakeholders with research as a means for promoting patient-centredness', *Journal of Research in Nursing*, vol. 22, no. 4, pp. 282−94.

Joshi, G, Alexander, J & Kehlet, H 2018, 'Large pragmatic randomised controlled trials in peri-operative decision making: Are they really the gold standard?', *Anaesthesia*, (online Wiley Online Library).

Kangovi, S, Grande, D, Carter, T, Barg, FK, Rogers, M, Glanz, K, Shannon, R & Long, JA 2014, 'The use of participatory action research to design a patient-centered community health worker care transitions intervention', *Healthcare*, vol. 2, no. 2, pp. 136−44.

Katsikitis, M, Lane, BR, Ozols, I & Statham, D 2017, ‘Consumer and carer perspectives in the development of a mental health research, treatment, and teaching facility: A thematic analysis’, *Journal of Psychiatric and Mental Health Nursing*, vol. 24, no. 7, pp. 534−44.

Kemmis, S, McTaggart, R & Nixon, R 2013, *The action research planner: Doing critical participatory action research*, Springer Science & Business Media, Singapore.

Kemmis, S, McTaggart, R & Nixon, R 2014, ‘Introducing critical participatory action research’, in S Kemmis, R McTaggart & R Nixon (eds.), *The action research planner: Doing critical participatory research*, Springer Science & Business Media, Singapore, pp. 1−31.

Klaassen, R., Bul, K., van der Burg, G.J., Kato, P.M. and Di Bitonto, P., 2018. Design and Evaluation of a Pervasive Coaching and Gamification Platform for Young Diabetes Patients. *Sensors*, vol. 18, no. 2, p.402-29.

Licskai, CJMD, Sands, TWP & Ferrone, MRRT 2013, ‘Development and pilot testing of a mobile health solution for asthma self-management: Asthma action plan smartphone application pilot study/L’élaboration et le projet pilote d’une solution mobile pour l’autogestion de l’asthme : projet pilote d’une application pour téléphone intelligent d’un plan d’action de l’asthme’, *Canadian Respiratory Journal*, vol. 20, no. 4, pp. 301−6.

Littleton-Kearney, M 2018, ‘Pragmatic clinical trials at the National Institute of Nursing Research’, *Nursing Outlook*, In Press.

Loudon, K, Treweek, S, Sullivan, F, Donnan, P, Thorpe, KE & Zwarenstein, M 2015, 'The PRECIS-2 tool: designing trials that are fit for purpose', *The British Medical Journal*, vol. 350, p. h2147.

MacPherson, H 2004, ‘Pragmatic clinical trials’, *Complementary Therapies in Medicine*, vol. 12, no. 2−3, pp. 136−40.

Marsh, P, Gartrell, G, Egg, G, Nolan, A & Cross, M 2017, ‘End-of-life care in a community garden: Findings from a participatory action research project in regional Australia’, *Health & Place*, vol. 45, pp. 110−6.

McTaggart, R, Nixon, R & Kemmis, S 2017, ‘Critical participatory action research’, in L Rowell, C Bruce, JM Shosh & M Riel (eds.), *The Palgrave international handbook of action research*, Springer, New York, pp. 21−35.

Moretti, F, van Vliet, L, Bensing, J, Deledda, G, Mazzi, M, Rimondini, M, Zimmermann, C & Fletcher, I 2011, 'A standardized approach to qualitative content analysis of focus group discussions from different countries', *Patient Education and Counseling*, vol. 82, no. 3, pp.420−8.

Moule, P, Aveyard, H & Goodman, M 2016, *Nursing research: An introduction*, Sage Publications, Los Angeles, USA.

National Health and Medical Research Council 2007, *The Australian code for the responsible conduct of research*, National Health and Medical Research Council, Canberra.

National Heart Foundation of Australia 2015, *Heart attack action plan: Will you recognise your heart attack?*, viewed 16 June 2015, <https://www.heartfoundation.org.au/images/uploads/publications/WS_Patient_Fact_Sheet_English.pdf>.

Neuendorf, KA 2016, *The content analysis guidebook*, Sage Publications, Los Angeles, USA.

Östlund, U, Kidd, L, Wengström, Y & Rowa-Dewar, N 2011, 'Combining qualitative and quantitative research within mixed method research designs: A methodological review', *International Journal of Nursing Studies*, vol. 48, no. 3, pp. 369−83.

Patsopoulos, NA 2011, 'A pragmatic view on pragmatic trials', *Dialogues in Clinical Neuroscience*, vol. 13, no. 2, p. 217−24.

Patten, ML & Newhart, M 2017, *Understanding research methods: An overview of the essentials*, Taylor & Francis, London, UK.

Pickham, D, Berte, N, Pihulic, M, Valdez, A, Mayer, B & Desai, M 2018, 'Effect of a wearable patient sensor on care delivery for preventing pressure injuries in acutely ill adults: A pragmatic randomized clinical trial (LS-HAPI study)', *International Journal of Nursing Studies*, vol. 80, pp. 12−9.

Plummer-D'Amato, P 2008, 'Focus group methodology part 2: Considerations for analysis', *International Journal of Therapy and Rehabilitation*, vol. 15, no. 3, pp. 123−9.

Polit, D & Beck, C 2017, *Nursing research: Generating and assessing evidence for nursing practice*, 10th edn, Lippincott Williams & Wilkins Co, Philadelphia, USA.

Polit, DF & Beck, CT 2010, *Essentials of nursing research: Appraising evidence for nursing practice*, Lippincott Williams & Wilkins Co, Philadelphia, USA.

Ratner, J, Mullins, D, Buesching, DP & Cantrell, RA 2013, 'Pragmatic clinical trials: US payers' views on their value', *The American Journal of Managed Care*, vol. 19, no. 5, pp. e158−65.

Relton, C, Torgerson, D, O'Cathain, A & Nicholl, J 2010, 'Rethinking pragmatic randomised controlled trials: Introducing the "cohort multiple randomised controlled trial" design', *British Medical Journal*, vol. 340, p. c1066.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584−94.

Roberts, S, Chaboyer, W, Gonzalez, R & Marshall, A 2017, 'Using technology to engage hospitalised patients in their care: A realist review', *BMC Health Services Research*, vol. 17, p. 388.

Sahin, C & Naylor, P-J 2017, 'Mixed-methods research in diabetes management via mobile health technologies: A scoping review', *Journal of Medical Internet Research: Diabetes*, vol. 2, no. 1, p. e3.

Sanders, MR & Kirby, JN 2012, 'Consumer engagement and the development, evaluation, and dissemination of evidence-based parenting programs', *Behavior Therapy*, vol. 43, no. 2, pp. 236−50.

Shaw, T, Yates, P, Moore, B, Ash, K, Nolte, L, Krishnasamy, M, Nicholson, J, Rynderman, M, Avery, J & Jefford, M 2017, 'Development and evaluation of an online educational resource about cancer survivorship for cancer nurses: A mixed-methods sequential study', *European Journal of Cancer Care*, vol. 26, no. 4.

Spieth, PM, Kubasch, AS, Penzlin, AI, Illigens, BM-W, Barlinn, K & Siepmann, T 2016, 'Randomized controlled trials—a matter of design', *Neuropsychiatric Disease and Treatment*, vol. 12, p. 1341−49.

Stapleton, SR 2018, 'Teacher participatory action research (TPAR): A methodological framework for political teacher research', *Action Research*, <http://journals.sagepub.com/>.

Stewart, DW & Shamdasani, PN 2014, *Focus groups: Theory and practice*, vol. 20, Sage publications, Thousand Oaks, USA.

Strömberg, A, Dahlström, U & Fridlund, B 2006, 'Computer-based education for patients with chronic heart failure: A randomised, controlled, multicentre trial of the effects on knowledge, compliance and quality of life', *Patient Education and Counseling*, vol. 64, no. 1, pp. 128−35.

Sullivan, GM 2011, 'Getting off the "gold standard": Randomized controlled trials and education research', *Journal of Graduate Medical Education*, vol. 3, no. 3, pp. 285−9.

Thorpe, KE, Zwarenstein, M, Oxman, AD, Treweek, S, Furberg, CD, Altman, DG, Tunis, S, Bergel, E, Harvey, I & Magid, DJ 2009, 'A pragmatic–explanatory continuum indicator summary (PRECIS): A tool to help trial designers', *Journal of Clinical Epidemio*logy, vol. 62, no. 5, pp. 464−75.

Tunis, SR, Stryer, DB & Clancy, CM 2003, 'Practical clinical trials: Increasing the value of clinical research for decision making in clinical and health policy', *The Journal of the American Medical Association*, vol. 290, no. 12, pp. 1624−32.

Vaismoradi, M, Jones, J, Turunen, H & Snelgrove, S 2016, 'Theme development in qualitative content analysis and thematic analysis', *Journal of Nursing Education and Practice*, vol. 6, no. 5, p. 100−10.

Veneri, DA & Zdanis, K 2018, 'Are technology-informed methods better than traditional approaches in educating patients? A meta-analysis', *Health Education Journal*, <http://journals.sagepub.com/>.

Voncken-Brewster, V, Tange, H, Moser, A, Nagykaldi, Z, de Vries, H & van der Weijden, T 2014, 'Integrating a tailored e-health self-management application for chronic obstructive pulmonary disease patients into primary care: A pilot study', *BMC Family Practice*, vol. 15, no. 4, p. 1−10.

Zuidgeest, MG, Welsing, PM, van Thiel, GJ, Ciaglia, A, Alfonso-Cristancho, R, Eckert, L, Eijkemans, MJ & Egger, M 2017, 'Series: Pragmatic trials and real world evidence: Paper 5. Usual care and real life comparators', *Journal of Clinical Epidemiology*, vol. 90, pp. 92−8.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter will present the outcomes of the PhD research project, including the results from the two studies. The two studies have been produced as separate manuscripts and submitted to international journals. The status of each publication is presented in Table 4.1. The details of each study are presented in this chapter as published in or submitted to the particular journals.

Table 4.1: Status of the Manuscripts

Study and title	Publication status*
Study 1: Development and feasibility testing of an avatar-based heart attack education application for patients with acute coronary syndrome	Published
Study 2: Evaluation of an avatar-based education intervention for improving knowledge, response and outcomes for patients with acute coronary syndromes	Under review

Note: * Status as per on 20 July 2018

4.2 Results of Study 1

4.2.1 Preamble

The use of avatar-based technologies in health care and clinical settings is growing, but few have been rigorously evaluated over time (An et al. 2013; Bickmore et al. 2013; Pinto et al. 2013). While the positive outcomes of avatar-based interactive education in different conditions have been demonstrated in the literature, no published studies have focused on the development and evaluation of an interactive education intervention for people living with acute coronary syndrome (ACS) and at risk of heart attack. Given the evident knowledge deficiency and pre-hospital decision delay in patients with ACS, this study aimed to develop and evaluate an interactive patient education application to improve their symptom recognition and responses. The development and feasibility testing of an avatar-based education application for patients with ACS was produced as a manuscript and has been accepted to be published in the *Journal of Clinical Nursing*.

Tongpeth J, Du, H & Clark, R 2018, 'Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome', *Journal of Clinical Nursing*, (online Wiley Online Library). [Impact Factor 1.635]

Authorship and Guarantor

Study 1: Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome

Jintana Tongpeth RN, BScN, MNS	Contribution (70%) Concept and design Analysis and interpretation of data Drafting the article and critical revision for important concepts Final approval of version to be submitted
Huiyun Du RN, PhD	Contribution (15%) Analysis and interpretation of data Revision of content Final approval of version to be submitted
Robyn A Clark RN, PhD, FAHA	Contribution (15%) Revision of important content Final approval of version to be submitted

Candidature Jintana Tongpeth

Signed July 20 2018

Guarantor

I certified the fidelity of the authorship and act as guarantor for all data.

Signed July 202018

Professor Robyn A Clark
Professor of Nursing (Acute Care and Cardiovascular Research)
College of Nursing and Health Sciences, Flinders University

4.2.2 Development and Feasibility Testing of an Avatar-Based Education Application for Patients with Acute Coronary Syndrome

Authors

Jintana Tongpeth PhD RN PhD Candidate

School of Nursing & Midwifery, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 5135, FAX: +618 8276 1602
Email: tong0076@flinders.edu.au

Hui Yun Du PhD RN Lecturer

College of Nursing and Health Sciences, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 2997, FAX: +618 8276 1602

Email: huiyun.du@flinders.edu.au

Robyn A Clark PhD RN

Professor of Acute Care and Cardiovascular Research

College of Nursing and Health Sciences, Flinders University, Adelaide, SA, Australia Phone: +61 8 8201 3266, FAX: +618 8276 1602

Email: robyn.clark@flinders.edu.au

Corresponding Author

Jintana Tongpeth

College of Nursing and Health Sciences, Flinders University, Adelaide, SA, Australia

GPO Box 2100 N316A Sturt North Wing Sturt Road, Bedford Park, Adelaide, 5001 Phone: +61 8 8201 5135, FAX: +618 8276 1602

Email: tong0076@flinders.edu.au

Acknowledgement

The authors would like to thank the participants for their generous contribution to this study.

Conflict of Interest

The author(s) declare that they have no conflict of interests.

Contributions

Study design: JT, HD, RC; data collection: JT, HD, RC; data analysis: JT, HD, RC; manuscript preparation: JT, HD, RC; final approval: JT, HD, RC

Funding Statement

Prof Robyn Clark is supported by a Heart Foundation Future Leader Fellowship 2016–2019 (APP 100847).

Dr Du is supported by an establishment grant (2015) from the Faculty of Medicine, Nursing and Health Science, Flinders University.

Jintana Tongpeth is supported by a Royal Thai Government scholarship, Prachomklao College of Nursing, Praboromarajchanok Institute for Health Workforce Development, Ministry of Public Health, Thailand to pursue PhD.

4.2.2 Development and Feasibility Testing of an Avatar-Based Education Application for Patients with Acute Coronary Syndrome

4.2.2.1 Abstract

Aims: To develop and evaluate an interactive, avatar-based education application for improving patients' knowledge of and response to ACS symptoms.

Background: A patient's ability to recognise and respond to the symptoms of ACS is imperative for seeking timely medical intervention. Innovative patient education interventions are needed to support patient education and self-care.

Methods: Participatory action research (PAR) methods were used to engage consumers and cardiac and information technology (IT) experts to develop an avatar-based education application. The avatar-based education application was developed according to evidence-based guidelines. The effect on ACS knowledge was evaluated in a group of 10 patients with ACS.

Results: In total, 10 consumers with ACS and 12 cardiovascular clinical and IT experts participated in the design and development of the education application. An additional 10 consumers (mean age 52.2±10.4 years) were recruited for testing the feasibility of the application on improving ACS knowledge. A high level (87.3%) of satisfaction was reported with an increase in the sub-scale scores of the ACS Response Index of 15.7 per cent for knowledge, 25.7 per cent for belief and 24.2 per cent for symptom recognition.

Conclusion: An avatar-based application for heart attack education is feasible and has the potential to support patient education by enhancing engagement and improving health literacy. These outcomes will provide preliminary data for an effectiveness trial.

Relevance to clinical practice: Nurses frequently experience obstacles in providing patient education such as health literacy and language barriers. Using avatar-based technology could potentially support the delivery of patient education. Involving consumers in the development these innovative educational tools is essential. Consumer participation in the design of the application has improved consumer engagement, satisfaction and outcomes.

Keywords: acute coronary syndrome, avatar, consumer participation, patient education

What does this paper contribute to the wider global clinical community?

1. Nurses frequently experience obstacles in providing patient education such as health literacy and language barriers.
2. Using avatar-based technology could potentially support the delivery of patient education. Involving consumers in the development these innovative educational tools is essential.
3. Consumer participation in designing the education tool has improved the engagement, satisfaction and outcomes of the **S**imple **A**vatar-based application for impro**V**ing ACS **E**ducation (SAVE app).

4.2.2.2 Introduction

Cardiovascular disease (CVD) remains the primary cause of death and disability worldwide (Amsterdam et al. 2014; Anderson & Morrow 2017). Each year, more than 48,000 heart attack cases are reported in Australia, half of which are fatal (Chew et al. 2016). Much of the morbidity and potential preventable complications associated with heart attack are linked with pre-hospital delays in seeking medical treatment (Farquharson et al. 2017; Farshidi et al. 2013). The time taken by patients to decide to seek medical help accounts for the largest portion of pre-hospital delay, and this is where the greatest improvement is needed to optimise patient outcomes (Cullen et al. 2016; Makam et al. 2016). A lack of knowledge of heart attack symptoms and the appropriate response to them are believed to be the primary reasons for patients delaying seeking medical attention (Albarqouni et al. 2016).

4.2.2.3 Background

The signs and symptoms of a heart attack can vary from person to person, and they may not always be easily recognisable. A good understanding of heart attack signs and symptoms, as well as the appropriate response to these symptoms, is essential for receiving timely medical attention and an optimal outcome. Previous research has identified a lack of knowledge regarding heart attack symptoms as a factor in patients' delay in seeking medical attention (Dracup 2009; McKinley et al. 2009; Nielsen et al. 2016; Tummala & Farshid 2015). Despite efforts to improve awareness of heart attack symptoms over the past decade, it remains a key challenge in reducing pre-hospital delays (Dracup 2009; McKinley et al. 2009). A recent cross-sectional study reported that only 14.2 per cent of the 486 patients studied correctly identified all heart attack symptoms, and approximately 65 per cent of the participants failed to recognise jaw pain as a symptom of heart attack (Albarqouni et al. 2016). The literature suggests that people with a history of heart attack need continued

reinforcement of the nature of the symptoms and benefits of early medical treatment (Albarqouni et al. 2016; Dracup 2009; Poomsrikaew, Ryan & Zerwic 2010).

Around 59 per cent of Australians aged 15–47 have been identified as having below adequate health literacy (Australian Institute of Health and Welfare 2016). People with low health literacy are more likely to have poorer health knowledge, lower self-efficacy and less engagement in self-care (Macabasco-O'Connell et al. 2011; van Schaik et al. 2017). Innovative interventions for patient education have been reported to provide more engaging education and to improve self-care knowledge and behaviour, particularly for people with low health literacy levels (Bickmore, Pfeifer & Paasche-Orlow 2009; Clark et al. 2015). However, not all technology-based educational interventions are equally developed and useful to patients. Any educational intervention needs to be carefully designed and tested with the characteristics and preferences of the end user in mind (Clark et al. 2015).

Avatar-based technology is emerging as a strategy to promote user engagement. An avatar is a simulated human character in a digital system that provides users with a natural interface through which avatars interact with the user through natural and innate human communication modalities such as facial expressions, body language, speech and natural language understanding (An et al. 2013; Anam et al. 2016). An avatar can deliver engaging, motivating and persuasive health dialogue via computers, tablets or smartphones. The use of avatars is a novel and effective 'face-to-face' patient-centred teaching style (Bickmore, Schulman & Sidner 2013). Avatar-based education interventions have been reported to improve patients' knowledge and behaviour in relation to heart failure (Clark et al. 2015), diabetic mellitus (Fuchslocher, Niesenhaus & Krämer 2011), mental health (Burton et al. 2016; Pinto et al. 2013) and obesity (Napolitano et al. 2013). The use of avatar-based technologies in patient education is growing. However, few have been designed with the involvement of consumers or have been rigorously evaluated (Clark et al. 2015; Fredericks et al. 2013). This study involved the engagement of consumers in the development and feasibility testing of an avatar-based application for delivering education on heart attack symptoms and responses.

4.2.2.4 Aim

To involve consumers in the development of an interactive application to provide appropriate and engaging education that improves users' knowledge of and response to heart attack symptoms.

4.2.2.5 Objectives

The objectives of this study were to:

1. engage consumers, cardiovascular experts and IT gaming experts in the development of an avatar-based education application for heart attack symptom education
2. test the feasibility of the application, its ability to improve consumers' knowledge of heart attack symptoms and consumers' satisfaction with the education application.

4.2.2.6 Methods

4.2.2.6.1 Study Design

This study was conducted in two phases. In Phase I, PAR methods were used to develop the avatar and the application. In Phase II, the application was tested in a group of consumers using a pre-test post-test design.

PAR is an approach that emphasises empowerment and participation. It is concerned with developing practice knowing through critically reflecting on and examining the actions of individual group members (Altrichter et al. 2002; Kemmis, McTaggart & Nixon 2013; Reason & Bradbury 2005). In this study, the PAR process involved a repeated cycle of developing the heart attack educational application with consumers and clinical experts, with negotiations and feedback on what the functionality of the educational application. As a process, it allowed researchers, in cooperation with consumers, to seek to unite action and reflection in the pursuit of practical solutions to an issue that is of pressing concern to the target individuals (Bradbury 2015). PAR was used to focus on critical reflection through collaboration with consumers (Altrichter et al. 2002; Kemmis et al. 2013). These collaborations included planning, acting, observing and reflecting as the avatar and application was developed (Herr & Anderson 2014).

4.2.2.6.2 Phase I

The PAR process (Phase I) involved two cycles, each containing four steps (see Figure 4.1). The participants were divided into three groups: (a) consumers with previous experience of ACS who were English-speaking and who were recruited from the cardiac rehabilitation program of the local hospital, (b) cardiovascular experts, consisting of a cardiologist, cardiac nurse practitioner, cardiac rehabilitation nurses and cardiac research academics and (c) IT gaming experts.

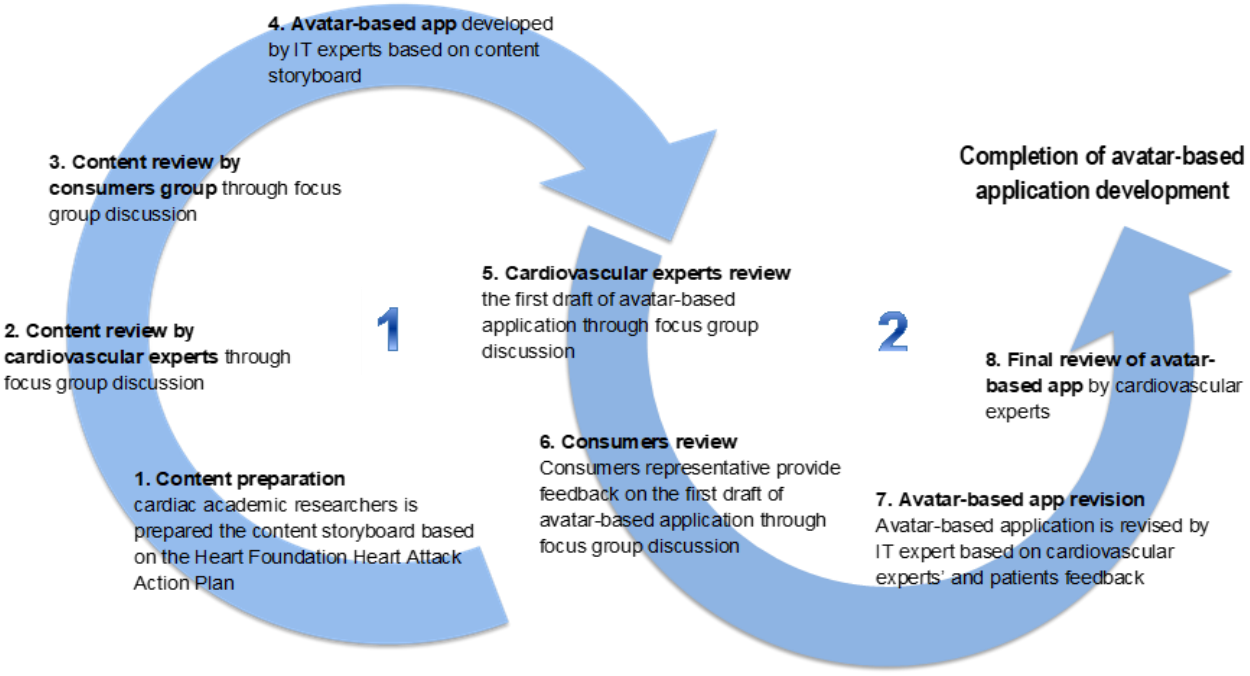


Figure 4.1: Participatory Action Research Cycles of the Development of the Avatar-Based Education Application

4.2.2.6.3 Cycle 1

The first action research cycle consisted of the following four steps: (a) content development, (b) content review by cardiac experts, (c) content review by consumers and (d) avatar creation and application development.

Step 1—content preparation: The researchers developed a content storyboard according to evidence-based guidelines (National Heart Foundation of Australia [NHF] 2015). The storyboard was prepared in a Microsoft PowerPoint template.

Steps 2 and 3—content review by cardiac experts and consumers: The cardiac researchers presented the content storyboard to a panel of cardiovascular experts and to consumers. At this early stage of development, 10 consumers were consulted about what was important to them in terms of an education application. This consultation is essential in a PAR approach. Consumers reviewed the relevance of the characteristics of the nurse avatar as well as the content, structure, dialogue, language, images and interactivity of the application. Through group discussions, consumers' feedback on the content and their ideas of an ideal education application and avatar were collected, reviewed and incorporated into the next stage of application development. Audio recordings and field notes were used for data collection during the group discussions.

Step 4—avatar and application development: The researchers presented the revised storyboard to the IT developers, after which the storyboard was converted into multiple slide screens that used an interactive interface with a transition between each section. The nurse avatar would respond reactively but in varied ways through speech, facial expressions and body gestures to the user's touch-based interaction with the interface. All speech segments were pre-recorded by a voice actor and dynamically recomposed into the behaviour of the nurse avatar.

4.2.2.6.4 Cycle 2

The second action research cycle consisted of steps five through eight (see Figure 4.1).

Step 5—cardiovascular expert panel review: The first draft of the application was installed onto Android tablets. The cardiac experts reviewed the interactive application and provided critical feedback for revision. The relevance of the interactivity, nurse avatar characteristics, content, structure, language, images, timing, colour theme and visual and audio quality were reviewed through group discussions.

Step 6—consumer review: The first draft of the avatar application was presented to the consumer group. The time taken by each person to complete a session on the application was recorded. The relevance of the nurse avatar characteristics, content, structure, language, images, font size and visual and audio quality were reviewed through group discussions. Audio recordings and field notes were used for data collection during the meeting.

Steps 7 and 8—application revision and review: After receiving feedback from the sessions, the application was revised again by the IT experts (Step 7), with a final review by the cardiovascular expert panel (Step 8).

4.2.2.6.5 Phase II

In this phase, the application was evaluated to assess its feasibility, including whether it improved consumers' knowledge and whether consumers were satisfied with the application.

4.2.2.6.6 Sample and Setting

The feasibility testing was conducted in the coronary care unit (CCU) of a local public hospital. Ten consumers (ACS patients) were recruited from the CCU to review the avatar-based heart attack education application.

4.2.2.6.7 Inclusion Criteria

The patients were considered eligible to participate if they have been admitted for any cardiac diagnosis in which chest pain or other heart attack symptoms had been experienced, had not received education prior to reviewing the application, were clinically stable, had normal cognitive function, had sufficient English language ability to communicate and follow the study procedures and were able to give informed consent.

4.2.2.6.8 Study Procedure

Prior to reviewing the avatar application, the consumers completed the ACS Response Index (i.e., pre-test) (Riegel et al. 2007). The researcher provided explanation and instruction to the participants about how to use the application. After reviewing the application, the participants were then asked to complete the ACS Response Index again (post-test) and to fill out the satisfaction questionnaire.

4.2.2.6.9 ACS Response Index

The ACS Response Index (Riegel et al. 2007) is a validated instrument used to assess patients' knowledge, attitudes and beliefs about heart attack symptoms and responses. This questionnaire was originally adapted from the REACT trial (Luepker et al. 2000) and it has been widely used in many other studies (Gallagher et al. 2013; McKinley et al. 2009; O'Brien et al. 2014). Validity and reliability of this instrument have been reported, with internal consistency coefficient alphas of .85, .65 and .63 for knowledge, attitudes and beliefs sub-scales, respectively (O' Brien et al. 2014).

The knowledge domain included 21 dichotomous items. Consumers were asked to identify heart attack symptoms from a list of 15 correct and six incorrect symptoms. The attitudes domain included five questions using a four-point Likert scale. Consumers were asked to provide a rating on five attitude questions such as 'How sure are you that you could recognise the signs and symptoms of a heart attack?' This domain measured consumers' attitudes towards symptom recognition and confidence in their ability to appropriately seek help (i.e., help-seeking behaviour) when ACS was suspected in themselves or others. The beliefs domain included nine items. This domain assessed consumers' beliefs about appropriate responses to ACS symptoms, with the scores indicating the accuracy of the beliefs with respect to appropriate responses in the event of a suspected heart attack.

4.2.2.6.10 Avatar-Based Education Application Satisfaction Questionnaire

The satisfaction questionnaire consisted of 15 items using a Likert scale and was adapted from a validated telephone monitoring satisfaction and acceptability questionnaire on heart

failure (Cronbach α=0.89) and an education material acceptability questionnaire for people with heart failure (Cronbach's α = .79) (Clark et al. 2007; Gwadry-Sridhar et al. 2003). The aim of this questionnaire was to assess participants' satisfaction with the avatar-based education application in terms of its audiovisual quality, content, usefulness and user-friendliness. The participants were asked to indicate their level of agreement with each statement in which one indicated strongly disagree and five indicated strongly agree. For example, 'The size of the print on screen was large enough for easy reading' (visual), 'The app has taught me how to recognise and respond to symptoms of a heart attack' (usefulness) and 'The content was hard to understand' (content). The questionnaire also included an open-ended question to elicit free-flow feedback.

4.2.2.7 Data Analysis

Microsoft Excel 2016 was used to collate and analyse the data. Participant characteristics are presented as means (SD) or frequencies and percentages. The mean percentage of correct answers was calculated and reported for the three domains of the ACS Response Index. The mean rating for each of the satisfaction questionnaire items was calculated, as well as the percentage of participants who had a rating of three or higher.

4.2.2.8 Ethics Approval

This study has been approved by the local human research ethics committee (reference number 168.15-HREC/15/SAC/138). All participants provided written informed consent.

4.2.2.9 Results

4.2.2.9.1 Phase I

A total of 12 clinical and research experts participated in the application's development. The average age of the experts in this group was 39.5 years and their experience in cardiovascular health ranged from 10–25 years (see Table 4.2). Experts provided feedback on the storyboard and first draft of the avatar-based education application. Five main themes emerged from the expert panel feedback: a focus on the target consumers, content design, engagement and the functionality and aesthetics of the application.

Table 4. 2: Characteristics of Consumers (Phase I)

Cardiovascular experts (n = 12)	n (%)	ACS patient reviewers (n = 10)	n (%)
Age (years), mean (SD)	39.5 (8.2)	Age (years), mean SD	52.2 (10.4)
21–30	2 (16.7)	25–39	1 (10)
31–40	5 (41.7)	40–59	2 (20)
41–50	4 (33.3)	60–79	5 (50)
51–60	1 (8.3)	80–99	2 (20)
Gender		Gender	
Male	1 (8.3)	Male	9 (90)
Female	11(91.7)	Female	1 (10)
Specialty		Education level	
Cardiologist	1 (8.3)	Elementary school	6 (60)
Cardiac nurse	6 (50.0)	Junior high	2 (20)
Cardiac researcher/academic	5 (41.7)	College/university	2 (20)
Type of practice		Marital status	
Public hospital	4 (33.3)	Single	1 (10)
Academic	5 (41.7)	Married	6 (60)
Cardiovascular network	3 (25.0)	Widowed, divorced or separated	3 (30)
Experiences (years), mean	17.5	Diagnosis	
10–15	7 (58.3)	ACS	8 (80)
16–25	5 (41.7)	CAD (post-CABG)	2 (20)

Note: SD = standard deviation; CAD = coronary artery disease; CABG = coronary artery bypass graft

Target consumers: The expert reviewers suggested that the application should be tailored to the characteristics and needs of elderly consumers.

Content design: A script was created to present warning signs and explain what to do when having a heart attack. The content was based on the Heart Foundation's Heart Attack Action Plan (see Figure 4.2). The expert panel stated that the content should be presented in plain English and should avoid the use of technical or medical terms. Based the expert panel's discussion, the content of the application was divided into the following four sections: (a) a heart attack warning sign quiz, (b) heart attack signs and symptoms, (c) what to do when having a heart attack and (d) a heart attack action quiz. Examples of screenshots from the application are presented in Figure 4.3.

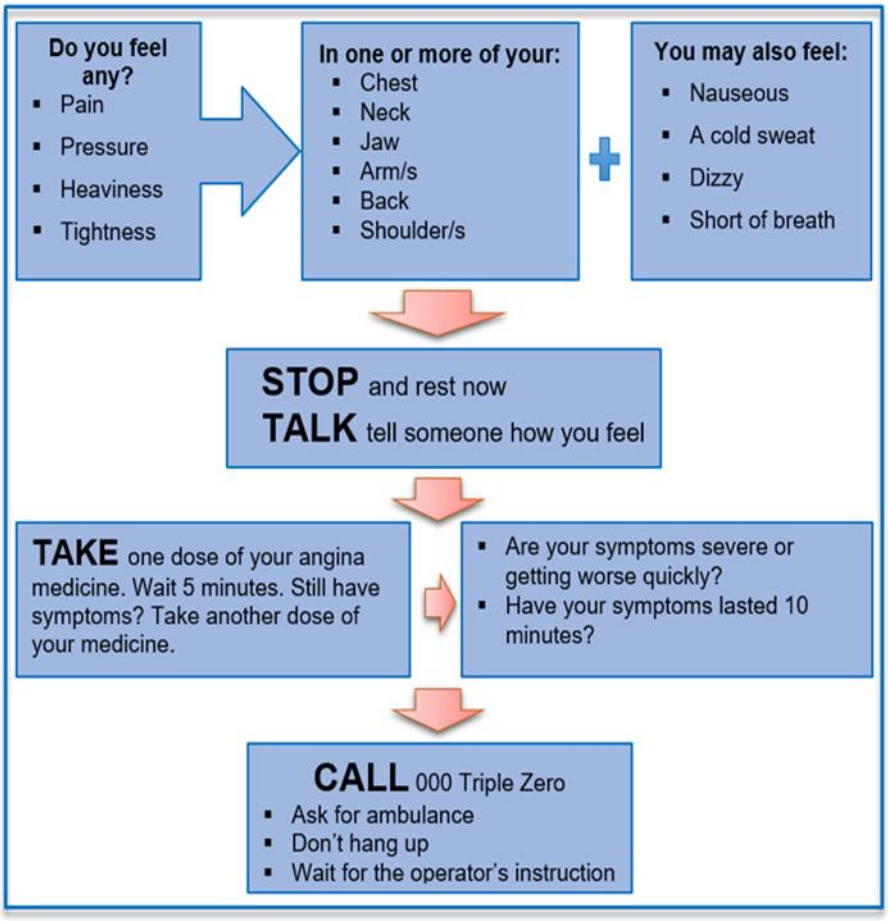


Figure 4.2: Heart Attack Action Plan

Note: Adapted from Heart Attack Action Plan, NHF 2015
(https://www.heartfoundation.org.au/images/uploads/publications/ws_Action_Plan_patient_English.pdf)

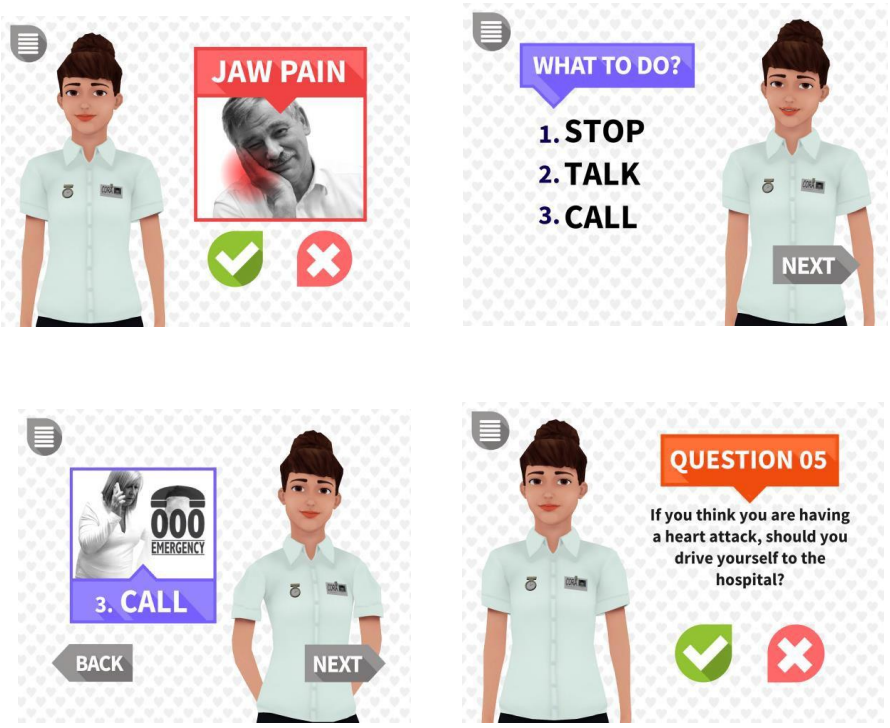


Figure 4.3: Examples of Screens Shots from the SAVE App

Engagement: The avatar was a computer-animated female who is multiracial and wears a modern nurse's uniform. The expert panel stated that the female avatar character should represent a real health professional or nurse to maintain users' interest and attention (see Figure 4.4). All experts expressed that non-verbal communication, including facial expression and body gestures, is an important characteristic of an engaging avatar.



Figure 4.4: Evolution of Avatar (Cora Nurse)

Functionality and aesthetics: The expert panel considered the touch interface of the SAVE app to be appropriate for elderly patients. All experts agreed that the touch interface should be intuitive, natural and easy to use, especially for older people. Backlighting, large text, bold colours, an attractive colour scheme and large buttons were rated as high-priority features (see Figure 4.3).

4.2.2.9.2 Consumer Feedback

Ten consumers from the cardiac rehabilitation unit participated in the development of the education application. The participants' characteristics are presented in Table 4.2. All consumers expressed enjoyment in their experience and indicated that the warning sign quiz and heart attack action quiz were very useful. All participants indicated that the touchscreen and navigation were easy to use. They also liked the overall look and feel of the application. The consumers provided their opinions on the illustrations, colour scheme and language of the SAVE app, as well as the body language of the nurse avatar, such as the avatar's eye contact and gestures, and the interaction between the user and avatar.

4.2.2.9.3 Gaming Information Technology Development and Review

The SAVE app was developed based on the content storyboard. The IT team created rough sketches of ideas on template tiles. The content of the education application was developed based on the user interface design and style guide from cardiac experts and consumers. The main design characteristics of the SAVE app consisted of its content and layout design, graphic design, navigation, cognitive design, text design and health literacy design. The IT team also completed a basic assessment of technical feasibility. The cardiovascular expert panel and the IT team reported that the SAVE app should be available on both iOS and Android platforms, as well as being in a suitable format for tablets and smartphones. The IT team reviewed the application to assess its usability and reliability. In total, 41 screens were designed. These included screens for the main menu, six screens for the warning signs quiz, 28 screens for the 'Signs and Symptoms' and 'What to Do?' sections and seven for the heart attack action quiz.

4.2.2.9.4 Phase II

The 10 patients involved in the feasibility testing consisted of nine males and one female. The mean age of the group was 52.2 (±10.37) years. The participants' characteristics are presented in Table 4.3.

Table 4.3: Characteristics of Consumers (Phase II)

Characteristics (n = 10)	n (%)
Gender	
Male	9 (90)
Female	1 (10)
Age, years, mean (SD)	52.2 (10.37)
25–39	1 (10)
40–59	2 (20)
60–79	5 (50)
80–99	2 (20)
Education level	
None	1 (10)
Elementary school	5 (50)
Junior high	2 (20)
College/university	2 (20)
Marital status	
Single	1 (10)
Married	6 (60)
Widowed/divorced/separated	3 (30)
Diagnosis	
ACS	8 (80)
CAD	2 (20)
Previous history	
None	1 (10)
Hypertension	4 (40)
Diabetes	5 (50)
Stroke	1 (10)

Note: SD = standard deviation; ACS = acute coronary syndrome; CAD = coronary artery disease

ACS Response Index scores: The ACS Response Index scores are presented in Table 4.4. The mean percentages of correct answers for each of the three domains are presented, as well as the percentage change before and after using the SAVE app. A 15.7 per cent increase in knowledge scores was found (from 62.4±13.4 to 78.1±9.3). Attitude scores increased from 77.0±5.4 to 96.5±6.3, representing a 19.5 per cent increase and a 24.2 per cent increase in symptom recognition was also observed (from 72.5±5.6 to 96.7±8.0).

Table 4.4: Changes in ACS Response Index Scores

Domains	Pre-intervention	Post-intervention	
	Per cent correct Mean (SD) n = 10	Per cent correct Mean (SD) n = 10	Per cent change (%)
Knowledge	62.4 (13.4)	78.1 (9.3)	↑ 15.7
Attitude	77.0 (5.4)	96.5 (6.3)	↑ 19.5
Belief	73.2 (6.1)	98.9 (1.7)	↑ 25.7
Sub-domains			
Symptom recognition	72.5 (5.6)	96.7 (8.0)	↑ 24.2
Help-seeking	83.8 (11.9)	97.6 (7.9)	↑ 13.8
Expectation	79.4 (5.2)	100	↑ 20.6
Action	65.0 (10.9)	97.5 (4.0)	↑ 32.5

Note: ACS = acute coronary syndrome; SD = standard deviation

Avatar-based education application satisfaction: Consumers' satisfaction with the SAVE app is described in Table 4.5. Participants reported a high level of satisfaction with the application (87.3%). All 10 participants rated the SAVE app highly for its format and design. The participants were also satisfied that the application delivered information in terms that they could understand and felt more confident to recognise and respond to heart attack symptoms in the future. The participants agreed that the application was easy to use (agree = 80%; strongly agree = 20%) and maintained their interest and attention (agree = 80%; strongly agree = 20%). Participants reported that they were likely to recommend the SAVE app to others who are at risk of experiencing a heart attack. The participants also commented on the simplicity of the application. Although most aspects of the application were satisfactory, there were some suggestions for improvement, including that the avatar should have more natural gestures and that there should be an option to repeat the dialogue, instructions about how to navigate at the beginning, more feedback within the quizzes and a bigger font size to emphasise important points. A summary of the feedback is presented in Box 4.1.

Table 4.5: Consumer Satisfaction

	Satisfaction questionnaire items	Mean (SD) (n=10)	Satisfied* (%)
1	I liked the avatar (Nurse Cora)	4.7 (0.84)	94
2	The audio of the app was clear and easy enough for me to understand	4 (0)	80
3	The size of the print on screen was large enough for easy reading	4.1 (0.32)	82
4	It was easy to press the buttons on the screen	4.9 (0.32)	98
5	The app has helped me to better understand symptoms of a heart attack	4.8 (0.42)	96
6	The app has taught me how to recognise and respond to symptoms of a heart attack	4.8 (0.42)	96
7	The content was easy to understand	4.2 (0.42)	84
8	It did not take too long to use the app	4.4 (0.52)	88
9	The information was clear and concise	4.5 (0.53)	90
10	The app explained things in terms I could understand	4.1 (4.10)	82
11	I learnt something that I was not taught about before	4.5 (0.53)	90
12	I now have an action plan if I experience symptoms of a heart attack in the future	4 (0)	80
13	The app has helped me to be more confident in recognising and managing heart attack symptoms in the future	4.5 (0.53)	90
14	The app maintained my interest and attention	4 (0)	80
15	My overall impression is that the app was excellent	4 (0)	80
	Overall satisfaction score		

Note: * % satisfied = the percentage of participants who had a score of 3 or above on the five-point Likert scale

Box 4.1: Feedback from Consumers

Positive feedback:

- The avatar's personality was kind and friendly
- The texts, images and audio were clear and easy to understand
- The navigation was easy to follow
- Length of time to complete a session on the application was suitable
- The application maintained interest and attention
- The size of the tablet screen was large enough for easy viewing
- The avatar–user interaction was fun
- Quizzes within the application were helpful for understanding the Heart Attack Action Plan

Areas for improvement:

- Ability to repeat dialogue
- Instruction on how to navigate the application at the beginning
- More feedback within the quizzes would be encouraging
- More natural gestures from the avatar
- Larger font size should be used to emphasise important messages while the avatar is talking such as the action plan, 'STOP', 'TALK' and 'CALL'

4.2.2.10 Discussion

We involved consumers in the design, development and feasibility testing of an interactive avatar education application for teaching patients how to recognise and respond to heart attack symptoms. The SAVE app has demonstrated that this technology is feasible on a handheld tablet computer and has the potential to improve patients' knowledge of and response to heart attack symptoms. The participants were satisfied with the content and functionality of the application. A high level of participant engagement and improved knowledge among the study participants was also observed. Engagement of the consumers in the development process was an essential aspect that ensured this application was tailored to the characteristics and needs of its end user. This study suggested the importance of consumer participation, especially in the development of health interventions that can bring health benefits both in a clinical setting and the community (Fredericks et al. 2013).

Each PAR cycle with the consumers produced new knowledge that was used to design and develop the SAVE app to better meet its consumers' needs.

Health technology in the health care sector is rapidly growing (Heffernan et al. 2016; Sax 2017). Formal and informal e-health coaching models have been demonstrated to be beneficial in promoting behaviour change, self-care behaviour and self-management activities (Cho, Park & Lee 2014; Sax 2017). The results of this development and feasibility study indicated that creating an effective and engaging avatar-based education application required a multidisciplinary team and consumers' input throughout the development process. Our findings show that avatar-based education can improve consumers' knowledge, attitudes and beliefs in relation to heart attack symptoms recognition and response. This positive outcome is no doubt attributed to the involvement of the consumers. This finding is similar to results of previous studies that have adapted a PAR approach (Fredericks et al. 2013; Clark et al. 2015).

While technology is showing promising benefits in enhancing health education and supporting patient self-care, it is important to consider that each intervention is unique to its end user. The characteristics and needs of the target population must be carefully considered and the involvement of consumers throughout development and preliminary testing is essential for ensuring the intervention's feasibility (Bickmore et al. 2009; Clark et al. 2015; Fredericks et al. 2013).

4.2.2.10.1Limitations

This study has some limitations that must be considered in the interpretation of the results. First, although the PAR method was the most suitable approach for our study because it empowers participants and enables an in-depth understanding of their needs and preferences for an education application (Reason 1994), it has been criticised for lacking methodological rigour and technical validity (Paredes-Chi & Castillo-Berguete 2018). Second, there were only 10 consumers involved in the PAR cycles. This might not be representative of the broader population of ACS patients, particularly females with ACS, as nine of the 10 consumers in this study were male. Third, the researcher met with the consumers and cardiac experts separately in different groups. As the PAR approach depends greatly on the researcher's perception of the participants and the issue under investigation, there might be undesirable subjectivity in the findings. Having the cardiac experts and consumers in the same group for discussion would have been beneficial to foster agreement on issues related to the SAVE app's design and development. Fourth,

PAR encourages power sharing between academic researchers and consumers. However, the researcher, who is more powerful in terms of knowledge and experience, can subconsciously affect the mindsets of the participants. Therefore, the results might not accurately reflect the reality. For the limitations in the second phase, as a development and a feasibility study, limited data analysis was performed due to a small sample size and lack of statistical power. Therefore, generalisability of the study results cannot be assumed. While there is some evidence on the technology readiness of people across different age groups, computer readiness among people with cardiac conditions is uncertain (Gallagher et al. 2017; Liu et al. 2016; Makkonen, Frank & Koivisto 2017). Refinement of the education application and its subsequent testing in a larger study is warranted.

4.2.2.11 Conclusion

This study involved developing a tablet-style avatar application to support education about heart attack symptoms recognition and responses for patients with ACS. The outcome of this study suggests that PAR is appropriate and useful for the development of a patient-centred education intervention. Involving patients in the development process ensured feasibility of the SAVE app and its potential to support patient education by enhancing engagement and improving health literacy.

4.2.2.12 Relevance to Clinical Practice

Nurses frequently experience obstacles in providing patient education such as health literacy and language barriers. Using avatar-based technology could potentially support the delivery of patient education. Consumer participation in designing an education tool is essential for engagement, satisfaction and improving clinical outcomes. If this approach is successful, an avatar-based education application can be easily translated into different languages to benefit patients from culturally and linguistically diverse backgrounds.

4.2.2.13 References

Albarqouni, L, Smenes, K, Meinertz, T, Schunkert, H, Fang, X, Ronel, J & Ladwig, KH 2016, 'Patients' knowledge about symptoms and adequate behaviour during acute myocardial infarction and its impact on delay time: Findings from the multicentre MEDEA Study', *Patient Education and Counselling*, vol. 99, no. 11, pp. 1845–51.

Altrichter, H, Kemmis, S, McTaggart, R & Zuber-Skerritt, O 2002, 'The concept of action research', *The Learning Organization*, vol. 9, no. 3, pp. 125–31.

Amsterdam, EA, Wenger, NK, Brindis, RG, Casey, DE, Ganiats, TG, Holmes, DR, Jaffe, AS, Jneid, H, Kelly, RF & Kontos, MC 2014, '2014 AHA/ACC guideline for the management of patients with non–ST-elevation acute coronary syndromes', *Circulation*, vol. 130, pp. e344–426.

An, LC, Demers, MR, Kirch, MA, Considine-Dunn, S, Nair, V, Dasgupta, K, Narisetty, N, Resnicow, K & Ahluwalia, J 2013, 'A randomized trial of an avatar-hosted multiple behaviour change intervention for young adult smokers', *Journal of the National Cancer Institute. Monographs*, vol. 2013, no. 47, pp. 209–15.

Anam, R, Andrade, AD & Ruiz, JG 2016, 'Promoting lifestyle change through medical avatars', in R Anam (ed.), *Encyclopedia of e-health and telemedicine*, IGI Global, Hershey, USA, pp. 316–30.

Anderson, JL & Morrow, DA 2017, 'Acute myocardial infarction', *New England Journal of Medicine*, vol. 376, no. 21, pp. 2053–64.

Australian Institute of Health and Welfare 2016, *Australia's health 2016*. Australia's health series no. 15, cat. no. AUS 199.

Bickmore, TW, Pfeifer, LM & Paasche-Orlow, MK 2009, 'Using computer agents to explain medical documents to patients with low health literacy', *Patient Education and Counseling*, vol. 75, no. 3, pp. 315–20.

Bickmore, TW, Schulman, D & Sidner, C 2013, 'Automated interventions for multiple health behaviors using conversational agents', *Patient Education and Counseling*, vol. 92, no. 2, pp. 142–8.

Bradbury, H (ed.) 2015, *The Sage handbook of action research*, Sage Publications, Thousand Oaks, USA.

Burton, C, Szentagotai Tatar, A, McKinstry, B, Matheson, C, Matu, S, Moldovan, R, Macnab, M, Farrow, E, David, D & Pagliari, C 2016, 'Pilot randomised controlled trial of Help4Mood, an embodied virtual agent-based system to support treatment of depression', *Journal of Telemedicine and Telecare*, vol. 22, no. 6, pp. 348–55.

Chew, DP, Scott, IA, Cullen, L, French, JK, Briffa, TG, Tideman, PA, Woodruffe, S, Kerr, A, Branagan, M & Aylward, PE 2016, 'National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Australian clinical guidelines for the management of acute coronary syndromes 2016', *The Medical Journal of Australia*, vol. 205, no. 3, pp. 128–33.

Cho, J, Park, D & Lee, HE 2014, 'Cognitive factors of using health apps: Systematic analysis of relationships among health consciousness, health information orientation, eHealth literacy, and health app use efficacy', *Journal of Medical Internet Research*, vol. 16, no. 5, e125.

Clark, RA, Fredericks, B, Buitendyk, NJ, Adams, MJ, Howie-Esquivel, J, Dracup, KA, Berry, NM, Atherton, J & Johnson, S 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3231.

Clark, RA, Yallop, JJ, Piterman, L, Croucher, J, Tonkin, A, Stewart, S, Krum, H & CHAT Study Team 2007, 'Adherence, adaptation and acceptance of elderly chronic heart failure patients to receiving healthcare via telephone-monitoring', *European Journal of Heart Failure*, vol. 9, no. 11, pp. 1104–11.

Cullen, L, Greenslade, JH, Menzies, L, Leong, A, Than, M, Pemberton, C, Aldous, S, Pickering, J, Dalton, E & Crosling, B 2016, 'Time to presentation and 12-month health outcomes in patients presenting to the emergency department with symptoms of possible acute coronary syndrome', *Emergency Medicine Journal*, vol. 33, no. 6, pp. 390–5.

Dracup, K 2009, 'The challenge of reducing prehospital delay in patients with acute coronary syndrome', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 3, pp. 144–5.

Farquharson, B, Johnston, M, Smith, K, Williams, B, Treweek, S, Dombrowski, SU, Dougall, N, Abhyankar, P & Grindle, M 2017, 'Reducing patient delay in acute coronary syndrome (RAPiD): Research protocol for a web-based randomized controlled trial examining the effect of a behaviour change intervention', *Journal of Advanced Nursing*, vol. 73, no. 5, pp. 1220–34.

Farshidi, H, Rahimi, S, Abdi, A, Salehi, S & Madani, A 2013, 'Factors associated with pre-hospital delay in patients with acute myocardial infarction', *Iranian Red Crescent Medical Journal*, vol. 15, no. 4, pp. 312–6.

Fredericks, B, Clark, R., Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure self-care amongst indigenous Australians: A pilot study', *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, pp. 40–60.

Fuchslocher, A, Niesenhaus, J & Krämer, N 2011, 'Serious games for health: An empirical study of the game "Balance" for teenagers with diabetes mellitus', *Entertainment Computing*, vol. 2, no. 2, pp. 97–101.

Gallagher, R, Roach, K, Belshaw, J, Kirkness, A, Sadler, L & Warrington, D 2013, 'A pre-test post-test study of a brief educational intervention demonstrates improved knowledge of potential acute myocardial infarction symptoms and appropriate responses in cardiac rehabilitation patients', *Australian Critical Care*, vol. 26, no. 2, pp. 49–54.

Gallagher, R, Roach, K, Sadler, L, Glinatsis, H, Belshaw, J, Kirkness, A, Zhang, L, Gallagher, P, Paull, G, Gao, Y, Partridge, SR, Parker, H & Neubeck, L 2017, 'Mobile technology use across age groups in patients eligible for cardiac rehabilitation: Survey study', *Journal of Medical Internet Research: mHealth and uHealth*, vol. 5, no. 10, p. e161.

Gwadry-Sridhar, F, Guyatt, GH, Arnold, JMO, Massel, D, Brown, J, Nadeau, L & Lawrence, S 2003, 'Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure', *European Journal of Heart Failure*, vol. 5, no. 6, pp. 783–91.

Heffernan, KJ, Chang, S, Maclean, ST, Callegari, ET, Garland, SM, Reavley, NJ, Varigos, GA, & Wark, JD 2016, 'Guidelines and recommendations for developing interactive eHealth apps for complex messaging in health promotion', *Journal of Medical Internet Research: mHealth and uHealth*, vol. 4, no. 1, p. e14.

Herr, K & Anderson, GL 2014, *The action research dissertation: A guide for students and faculty*, Sage Publications, Thousand Oaks, USA.

Kemmis, S, Mctaggart, R & Nixon, R 2013, *The action research planner: Doing critical participatory action research,* Springer Science & Business Media, Berlin, Germany.

Liu, L, Stroulia, E, Nikolaidis, I, Miguel-Cruz, A, Rincon, AR 2016, 'Smart homes and home health monitoring technologies for older adults: A systematic review', *International Journal of Medical Informatics,* vol. 91, pp. 44–59.

Luepker, RV, Raczynski, JM, Osganian, S, Goldberg, RJ, Finnegan Jr, JR, Hedges, JR, Goff Jr, DC, Eisenberg, MS, Zapka, JG & Feldman, HA 2000, 'Effect of a community intervention on patient delay and emergency medical service use in acute coronary heart disease: The Rapid Early Action for Coronary Treatment (REACT) Trial', *The Journal of the American Medical Association*, vol. 284, no. 1, pp. 60–7.

Macabasco-O'Connell, A, DeWalt, DA, Broucksou, KA, Hawk, V, Baker, DW, Schillinger, D, Ruo, B, Bibbins-Domingo, K, Holmes, GM & Erman, B 2011, 'Relationship between literacy, knowledge, self-care behaviors, and heart failure-related quality of life among patients with heart failure', *Journal of General Internal Medicine*, vol. 26, no. 9, pp. 979–86.

Makam, RP, Erskine, N, Yarzebski, J, Lessard, D, Lau, J, Allison, J, Gore, JM, Gurwitz, J, McManus, DD & Goldberg, RJ 2016, 'Decade long trends (2001–2011) in duration of pre-hospital delay among elderly patients hospitalized for an acute myocardial infarction', *Journal of the American Heart Association*, vol. 5, no. 4, p. e002664.

Makkonen, M, Frank, L & Koivisto, K 2017, 'Age differences in technology readiness and its effects on information system acceptance and use: The case of online electricity services in Finland', *Bled 2017: Proceedings of the 30th Bled eConference. Digital transformation: From connecting things to transforming our lives*, Bled, Slovenia, pp. 403–20.

McKinley, S, Dracup, K, Moser, DK, Riegel, B, Doering, LV, Meischke, H, Aitken, LM, Buckley, T, Marshall, A & Pelter, M 2009, 'The effect of a short one-on-one nursing intervention on knowledge, attitudes and beliefs related to response to acute coronary syndrome in people with coronary heart disease: A randomized controlled trial', *International Journal of Nursing Studies*, vol. 46, no. 8, pp. 1037–46.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, 'Using avatars to model weight loss behaviors: Participant attitudes and technology development', *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057–65.

National Heart Foundation of Australia 2015, *Heart attack action plan: Will you recognise your heart attack?*, viewed 5 January 2016, <https://www.heartfoundation.org.au/images/uploads/publications/ws_Action_Plan_patient_English.pdf>.

Nielsen, CG, Laut, KG, Jensen, LO, Ravkilde, J, Terkelsen, CJ & Kristensen, SD 2016, 'Patient delay in patients with ST-elevation myocardial infarction: Time patterns and predictors for a prolonged delay', *European Heart Journal: Acute Cardiovascular Care*, vol. 6, no. 7, pp. 538–91.

O'Brien, F, McKee, G, Mooney, M, O'Donnell, S & Moser, D 2014, 'Improving knowledge, attitudes and beliefs about acute coronary syndrome through an individualized educational intervention: A randomized controlled trial', *Patient Education and Counseling*, vol. 96, no. 2, pp. 179–87.

Paredes-Chi, AA & Castillo-Burguete, MT 2018, 'Is participatory action research an innovative pedagogical alternative for training teachers as researchers? The training plan and evaluation for normal schools', *Evaluation and Program Planning*, vol. 68, pp. 176–84.

Pinto, MD, Hickman, RL, Clochesy, J & Buchner, M 2013, 'Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults', *Applied Nursing Research*, vol. 26, no. 1, pp. 45–8.

Poomsrikaew, O, Ryan, CJ & Zerwic, JJ 2010, 'Knowledge of heart attack symptoms and risk factors among native Thais: A street-intercept survey method', *International Journal of Nursing Practice,* vol. 16, no. 5, pp. 492–8.

Reason, PE 1994, *Participation in human inquiry*, Sage Publications, Thousand Oaks, USA.

Reason, P & Bradbury, H (eds.) 2005, *The Sage handbook of action research: Participatory inquiry and practice*, 2nd edn, Sage Publications, Thousand Oaks, USA.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584–94.

Sax, HC 2017, ‘Healthcare transformation: What are the challenges?’, in HC Sax (ed.), *Measurement and analysis in transforming healthcare delivery*, Springer, Cham, Switzerland, pp. 1–6.

van Schaik, TM, Jørstad, HT, Twickler, TB, Peters, RJG, Tijssen, JPG, Essink-Bot, ML & Fransen, MP 2017, ‘Cardiovascular disease risk and secondary prevention of cardiovascular disease among patients with low health literacy’, *Netherlands Heart Journal*, vol. 25, no. 7–8, pp. 446–54.

Tummala, SR & Farshid, A 2015, ‘Patients’ understanding of their heart attack and the impact of exposure to a media campaign on pre-hospital time’, *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 4–10.

4.3 Results of Study 2

4.3.1 Preamble

Knowledge of and response to symptoms of ACS are known to have a marked effect on both hospitalisation and mortality. In this high-risk population, a lack of understanding of symptoms of ACS continues to present challenges for clinicians and researchers. The benefits of information and communication technology to promote engagement in learning are documented in the relevant literature. This study demonstrated that an avatar-based education application is an effective method for delivering critical medical information, regardless of individual literacy levels. This intervention can be readily incorporated into nurses' clinical practice and community settings to increase individuals' knowledge of ACS and improve clinical outcomes. The results of Study 2 were produced as a manuscript and submitted to the *Journal of Advanced Nursing*. This manuscript is currently under review.

Tongpeth J, Du, H & Clark, R 2018, 'Evaluation of the effectiveness of an avatar-based education application intervention for improving knowledge and response management in patients with acute coronary syndrome (ACS): A pragmatic randomised controlled trial', *Journal of Advanced Nursing*, submitted. [Impact Factor 2.267]

Authorship and Guarantor

Study 2: Evaluation of the effectiveness of an avatar-based education application intervention for improving knowledge and response management in patients with acute coronary syndrome (ACS): A pragmatic randomised controlled trial

Jintana Tongpeth RN, BScN, MNS	Contribution (70%) Concept and design Analysis and interpretation of data Drafting the article and critical revision of important concepts Final approval of version to be submitted
Huiyun Du RN, PhD	Contribution (15%) Revision of content
Tracey Barry RN, BN	Final approval of version to be submitted Contribution (5%) Data collection and data entry Final approval of version to be submitted
Robyn A Clark RN, PhD, FAHA	Contribution (10%) Revision of important content Final approval of version to be submitted

Candidature Jintana Tongpeth

Signed July 20 2018

Guarantor

I certified the fidelity of the authorship and act as guarantor for all data.

Signed July 20 2018

Professor Robyn A Clark

Professor of Nursing (Acute Care and Cardiovascular Research)

College of Nursing and Health Science, Flinders University

4.3.2 Evaluation of an Avatar-Based Education Application for Improving Knowledge of and Response to Symptoms of People with Acute Coronary Syndrome: A Pragmatic Randomised Controlled Trial

Authors

Jintana TONGPETH RN MNS

PhD Candidate

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

Phone: +61 8 8201 5135, FAX: +618 8276 1602

Email: tong0076@flinders.edu.au

Hui Yun DU RN PhD

Lecturer

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

Phone: +61 8 8201 2997, FAX: +618 8276 1602

Email: huiyun.du@flinders.edu.au

Tracey BARRY BN DipAppliSc RN

Research Assistant

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

Phone: +61 8 8201 3266, FAX: +618 8276 1602

Email: tracey.barry@flinders.edu.au

Robyn CLARK RN PhD

Professor of Acute Care and Cardiovascular Nursing

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

Phone: +61 8 8201 3266, FAX: +618 8276 1602

Email: robyn.clark@flinders.edu.au

Corresponding Author

Jintana TONGPETH

College of Nursing & Health Sciences, Flinders University, Adelaide, SA, Australia

GPO Box 2100 N316 Sturt North Wing Sturt Road, Bedford Park, Adelaide, 5001

Phone: +61 8 8201 5135, FAX: +618 8276 1602

Email: tong0076@flinders.edu.au

Acknowledgements

We would like to acknowledge the support from Prof Derek Chew, Network Director of Cardiology, Southern Adelaide Local Health Network; Debra Moen, Nursing Director Critical Care and Medical Services, Flinders Medical Centre; Christine Hincks and Matthew Horsfall, Cardiology Research Department, Flinders Medical Centre; Sharon Burns, Head of Cardiac Care Unit, Flinders Medical Centre; Sanchia Shute and Rhonda Naffin, Cardiac Rehabilitation Department, Flinders Medical Centre; and Bronwyn Maynard, administration staff at Cardiac Care Unit, Flinders Medical Centre. We would like to thank all participants of this trial as well as nursing staff at Cardiac Care Unit, Flinders Medical Centre, for their support and collaboration.

Conflict of Interest

No conflict of interest has been declared by the author(s)

Funding Statement

Prof Robyn Clark is supported by a Heart Foundation Future Leader Fellowship 2016–2019 (APP 100847).

Dr Huiyun Du is supported by an establishment grant (2015) from the Faculty of Medicine, Nursing and Health Science, Flinders University, and the Heart Foundation Tom Simpson Trust Fund (2017).

Jintana Tongpeth is supported by a Royal Thai Government scholarship, Prachomklao College of Nursing, Praboromarajchanok, Institute for Health Workforce Development, Ministry of Public Health, Thailand to pursue PhD (2014–2018).

4.3.2 Evaluation of an Avatar-Based Education Application for Improving Knowledge of and Response to Symptoms of People with Acute Coronary Syndrome: A Pragmatic Randomised Controlled Trial

4.3.2.1 Abstract

Aims. To evaluate the effectiveness of an avatar-based education application for people with ACS.

Background. For people who experience ACS, lack of understanding of symptoms and appropriate responses contribute to delay in seeking medical treatment, which can lead to complications and preventable death. An avatar-based education application can enhance learning for people with ACS.

Design. A single-centre, non-blinded, pragmatic randomised controlled trial (pRCT).

Methods. Data were collected between September 2016 and September 2017. Seventy patients with previous experience of ACS were randomly assigned to an intervention group (IG) (n = 35) or a usual care group (UG) (n = 35). The UG received routine discharge education while the IG received routine discharge education plus an avatar-based education application. A tablet computer with the installed application was provided to every IG participant for home use during the study. Participants were followed up at one month and six months. The primary outcome was knowledge of ACS symptoms. Secondary outcomes included attitudes and beliefs of ACS symptoms and health care use.

Results. Participants in the IG showed significant improvements in knowledge of ACS symptoms ($p < .001$), attitudes ($p < .009$) and beliefs ($p < .001$). The majority (94.23%) of participants were satisfied with the education application.

Conclusion. The education application was effective in improving individuals' knowledge, attitudes and beliefs of symptoms of ACS. Studies involving a longer follow-up period would be necessary to evaluate the intervention's effectiveness in terms of clinical outcomes.

Trial Registration: This study has been registered with Australian New Zealand Clinical Trials Registry (ANZCTR). The trial registration number is ACTRN12616000803493.

Keywords: acute coronary syndrome, avatar-based education application, heart attack response, heart attack symptoms, nurse, nursing intervention, patient education, pragmatic randomised controlled trial

Summary Statement

Why is this research needed?

- The ability to recognise symptoms of ACS and take appropriate action is essential to avoid preventable deaths and complications.
- The literature indicates a lack of understanding of the symptoms of ACS and appropriate responses among the high-risk population.
- Avatar-based technology can promote engagement and enhance learning, but its use in delivering education to people at high risk of ACS has not previously been studied.

What are the key findings?

- The avatar-based educational application was effective in improving participants' knowledge, attitudes and beliefs in relation to ACS symptoms.
- This approach was acceptable to this group of individuals, who were at risk of ACS. The majority (94.23%) of participants were satisfied with the SAVE app.

How should the findings be used to influence policy, practice, research and education?

- Nurses should consider the use of technology to assist in the delivery of medical information to facilitate patient learning. The SAVE app can be used in both clinical and community settings to deliver education in relation to ACS.
- Larger studies with longer follow-up periods are needed to assess long-term knowledge retention, behaviour change and clinical outcomes.
- The content of the SAVE app can be translated into different languages and evaluated for patients from different cultural and linguistic backgrounds.

4.3.2.2 Introduction

The majority of deaths related to ACS occur within the first few hours of symptom onset (Youssef et al. 2017). Minimising pre-hospital delay can reduce the death rate by half (Amsterdam et al. 2014; Ting & Bradley 2009). The time patients take to recognise the symptoms of ACS and decide to seek medical help accounts for the largest portion of pre-hospital delay. This decision delay has been linked to individuals' lack of understanding of

the symptoms of ACS and the appropriate response (Darawad et al. 2016; DeVon et al. 2010; Nielsen et al. 2016).This paper reports the results of a pRCT to evaluate the effectiveness of the SAVE app.

4.3.2.3 Background

ACS refers to a spectrum of conditions caused by sudden reduced blood flow to the heart, including acute myocardial ischemia and infarction (Amsterdam et al. 2014). People with previous experience of ACS are at high risk of recurrence and the need to provide these individuals with relevant information is well recognised (DeVon et al. 2010; Dracup, McKinley & Moser 1997; Luepker et al. 2000; Makam et al. 2016; Mooney et al. 2014; O'Brien et al. 2013). However, signs and symptoms of ACS vary from person to person and individuals may experience different symptoms when ACS recurs, making it challenging to recognise the symptoms and respond in a timely manner.

Studies worldwide consistently reveal a lack of knowledge of ACS symptoms in the high-risk population, including an inability to correctly identify all ACS symptoms (Albarqouni et al. 2016) and confusion between stroke and ACS symptoms (Poomsrikaew et al. 2010). To avoid complications and preventable death, it is crucial that individuals can confidently identify symptoms of ACS and seek medical attention without delay (Dracup, McKinley & Moser 1997; Finnegan et al. 2000; Goldberg et al. 2009).

Patient education is a significant component of many health promotion and disease management programs (Glanz, Rimer & Viswanath 2008). Booklets or pamphlets are the most commonly used method for delivering medical information to patients (Anam, Andrade & Ruiz 2016; Blok et al. 2017). However, understanding printed materials is challenging for people with low literacy levels, who comprise about 59 per cent of Australians aged 15–47 (Australian Institute of Health and Welfare 2016) and 35 per cent of European respondents (World Health Organization 2016).

With rapid developments in information and communication technology and its successful application in many aspects of health care, clinicians and researchers are beginning to realise the potential benefits of information and communication technology in overcoming literacy barriers and improving the outcomes of patient education programs (Bernhardt et al. 2013; Sax 2017; Win et al. 2016). Patient–educator interaction has also been identified as an important factor in facilitating behaviour changes and maintaining motivation (Suhling et al. 2014; Treskes et al. 2018). Combining the key elements of literacy and interaction,

avatar-based technology can deliver effective patient education by mimicking the natural face-to-face human communication between patients and health care professionals using an animated virtual agent or avatar (An et al. 2013; Anam et al. 2016; Bell, Gachuhi & Assefi 2018; Wu et al. 2018).

An avatar is a simulated digital character that interacts with the user by means of natural communication modalities such as facial expression, body language and speech (An et al. 2013; Anam et al. 2016). The use of avatar-based technologies in patient education is rapidly growing and evolving and has previously been used for people with heart failure (Clark et al. 2015), diabetes mellitus (Fuchslocher et al. 2011), mental health issues (Burton et al. 2016; Pinto et al. 2013) and obesity (Napolitano et al. 2013), all of which had a focus on health literacy. Before implementation in clinical practice, any such initiative must be rigorously evaluated over time (Clark et al. 2015; Fredericks et al. 2013).

4.3.2.4 The Study

4.3.2.4.1 Aim

The aim of this study was to evaluate the effectiveness of the SAVE app in improving individuals' knowledge of and response to ACS symptoms.

4.3.2.4.2 Objectives

The objectives of this study were to:

1. evaluate the effectiveness of the SAVE app on participants' knowledge of ACS symptoms
2. evaluate the effectiveness of the SAVE app on participants' intention to implement the Heart Attack Action Plan
3. evaluate the effectiveness of the SAVE app on participants' health care use
4. compare outcomes between patients with low health literacy levels and patients with adequate health literacy levels.

4.3.2.5 Design

This study was a single-centre, non-blinded, two parallel groups, pRCT. The study protocol has been described in detail elsewhere (Tongpeth, Du & Clark 2018a). This study was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR): ACTRN12616000803493.

4.3.2.5.1 Participants and Setting

Patients were recruited from the cardiac care unit of a metropolitan public hospital in Adelaide. This hospital is the largest in the southern area of Adelaide, Australia, servicing the southern Adelaide population and major regional rural centres. Participants were recruited based on the following inclusion criteria: 1) 18 years of age and older, 2) admitted with any cardiac diagnosis in which chest pain or other heart attack symptoms have been experienced previously, 3) clinically unstable, 4) normal cognitive function and 5) sufficient English language ability to communicate and follow the study procedure. Individuals were excluded if they were clinically unstable, cognitively impaired or unable to communicate in the English language.

4.3.2.5.2 Randomisation and Sample Size

A sample size of 31 participants was needed for each group based on an effect size of .42, a standard deviation of 2.9, a 95 per cent power and a significance level of .05 (two-sided). Allowing for a 10 per cent attrition rate, 70 participants (35 in each group) were recruited (Julious & Campbell 2012; Suresh & Chandrashekara 2012). Participants were randomly assigned to the IG or UG on a 1:1 basis.

For allocation concealment, two random block sizes were used, along with an interactive voice response system provided by an independent clinical trial randomisation centre. Due to the intervention's educational nature, study participants and the researcher who delivered the intervention were not blinded. However, the statistician who performed the data analysis was blinded to group allocation.

4.3.2.5.3 Interventions

UG participants received standard care at the study site, including bedside education on diagnosis, procedures and risk factors and a Heart Attack Action Plan. Educational booklets published by the Heart Foundation (NHF 2015) were provided to all participants.

IG participants received usual care plus the SAVE app on a Samsung tablet computer. The SAVE app includes four sections: 1) heart attack warning sign quiz, 2) heart attack signs and symptoms, 3) what to do when having a heart attack and 4) heart attack warning signs test. To encourage engagement and reinforce learning, there was a quiz at the beginning and end of the SAVE app.

Participants were asked to use the application before they were discharged from the hospital. To assess their knowledge of ACS symptoms and appropriate responses,

participants completed the study questionnaire before and after using the SAVE app. A Samsung tablet computer was provided to every IG participant for home use during the six-month study period.

Both IG and UG participants received a follow-up telephone call at one month and six months. At six months, IG participants were also asked to complete a satisfaction survey to provide feedback on the SAVE app.

4.3.2.5.4 Outcome Measures

The primary outcome of this study was knowledge of ACS symptoms that was assessed on the knowledge sub-scale of the ACS Response Index (Riegel et al. 2007). This instrument contains three sub-scales: 1) knowledge (21 items), 2) attitude (five items) and 3) belief (seven items). The knowledge sub-scale lists 21 pre-defined ACS symptoms (e.g., jaw pain), from which participants were asked to correctly identify symptoms they would associate with a heart attack using a 'yes' or 'no' answer. Scores for the knowledge domain ranged from 0 to 21 (the best possible score).

The study had four secondary outcomes: 1) attitudes and beliefs in relation to ACS symptoms, 2) intention to implement recommended Heart Attack Action Plan, 3) health care use and 4) intervention satisfaction. The ACS Response Index questionnaire sub-scales were used to assess participants' attitudes and beliefs in relation to ACS symptoms (Riegel et al. 2007). The attitude sub-scale comprised five items measuring the individual's attitude to symptom recognition and their confidence in their ability to seek appropriate medical attention when they suspected ACS in themselves or others. The belief sub-scale comprised seven items concerning individual beliefs about appropriate responses to ACS symptoms.

Participants' intentions to implement the recommended action plan were evaluated by an investigator-developed questionnaire based on the Heart Attack Action Plan by the NHF (see Figure 4.5). Using a 'yes' or 'no' option, participants were asked to indicate whether they would take the specified action on experiencing ACS symptoms.

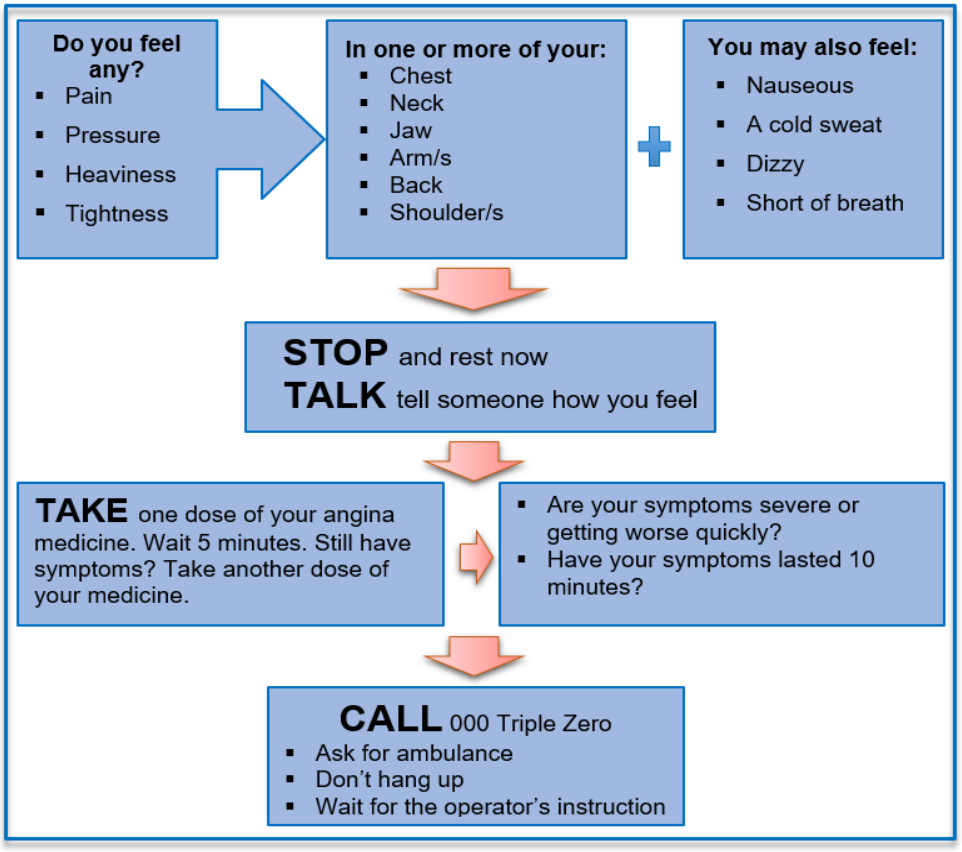


Figure 4.5: Heart Attack Action Plan

Note: Adapted from NHF 2015

Healthcare use was assessed as the number of presentations to an emergency department (ED), outpatient clinic or general practitioner, as well as ambulance use and hospitalisations.

Participants' satisfaction with the SAVE app was assessed by means of a survey adapted from two questionnaires on education material acceptability (Fredericks et al. 2013; Gwadry-Sridhar et al. 2003).

4.3.2.5.5 Data Collection

Data were collected between September 2016 and September 2017. Using paper-based questionnaires, data were collected at baseline before participants were discharged from hospital. The data collected included demographic characteristics and health literacy that were assessed using the Rapid Estimate of Adult Literacy in Medicine—Short Form, ACS Response Index and response to ACS symptoms. At the one-month and six-month follow-ups, data were collected by means of pre-scheduled telephone calls. Information provided by participants regarding their ED visits and hospitalisations were verified by the research assistant by reviewing participants' medical records.

4.3.2.5.6 Validity and Reliability

The study adhered strictly to the designated protocol (Tongpeth, Du & Clark 2018a). All participants were randomised after giving their informed consent and completing the baseline questionnaires. To ensure intervention fidelity, the same research assistant provided training to all IG participants on how to use the SAVE app. The research assistant was an experienced cardiac nurse and had received training in relation to the purpose and design of the trial, data collection procedures and ethical requirements. Reporting of the study results conformed to the Consolidated Standards of Reporting Trials (CONSORT) statement (Schulz, Altman & Moher 2010). The study questionnaires were based mainly on validated instruments (Gallagher et al. 2013; McKinley et al. 2009; O'Brien et al. 2014).

4.3.2.5.7 Ethical Considerations

The study was approved by the Southern Adelaide Clinical Human Research Ethics Committee (reference number: OFR#290.15-HREC/15/SAC/247). Participants were thoroughly briefed on the research purpose and process before obtaining their consent. All participants were informed that their participation was voluntary and there would be no consequences should they choose to withdraw their participation at any point in the study. All participants were identified by a unique code. Data obtained through this study were stored on a secure university server and only accessible to study personnel.

4.3.2.6 Data Analysis

Data were analysed according to the intention-to-treat principles, using SPSS v25.0 (IBM Corp, Armonk, NY, USA). Because the number of missing values was very small, the carry forward method was used to impute the missing values (Bell et al. 2014; Lachin 2016). Descriptive statistics for the approximately normally distributed numerical variables are presented as mean (SD) and n (%) for categorical variables. An independent sample *t*-test was performed to compare the differences between the continuous variables of the two groups when normality and homogeneity assumptions were satisfied. The Mann-Whitney *U* test was used when these assumptions were not met. Chi-square or Fisher's Exact test were used to compare the categorical variables. The primary outcome of 'ACS symptoms knowledge' as well as the secondary outcomes of 'Patients' beliefs about appropriate responses to ACS symptoms' and their 'Attitudes towards ASC symptom recognition' were found to produce a considerable 'ceiling effect' in the control group. Following a recommendation by Wang et al. (2008), these outcomes were analysed using the Tobit growth curve model and implementing Stata's (StataCorp 2018) metobit procedure using Bonferroni-corrected pairwise comparisons of the predictive margins. Chi-square and the

Mann-Whitney *U* test were used to compare the two groups' intentions to implement the Heart Attack Action Plan and health care use. Binary logistic regression was used to identify the factors associated with improvements in ACS knowledge. All conducted tests were two-tailed and *p* values of <.05 were considered statistically significant.

4.3.2.7 Results

4.3.2.7.1 Participant Enrolment and Withdrawal

In total, 130 individuals from the CCU were screened for their eligibility to participate. Of these, 70 participants were enrolled and randomised while the remaining 60 were excluded. Forty per cent of those excluded were clinically unstable (n = 24). Other reasons for exclusion included refusal to use technology (n = 22), inability to communicate in English (n = 3) and inability to return for follow-up (n = 7) (see Figure 4.6). One participant died from an acute myocardial infarction one week after enrolment in the study. One IG participant and two UG participants were lost to follow-up (i.e., could not be contacted by telephone).

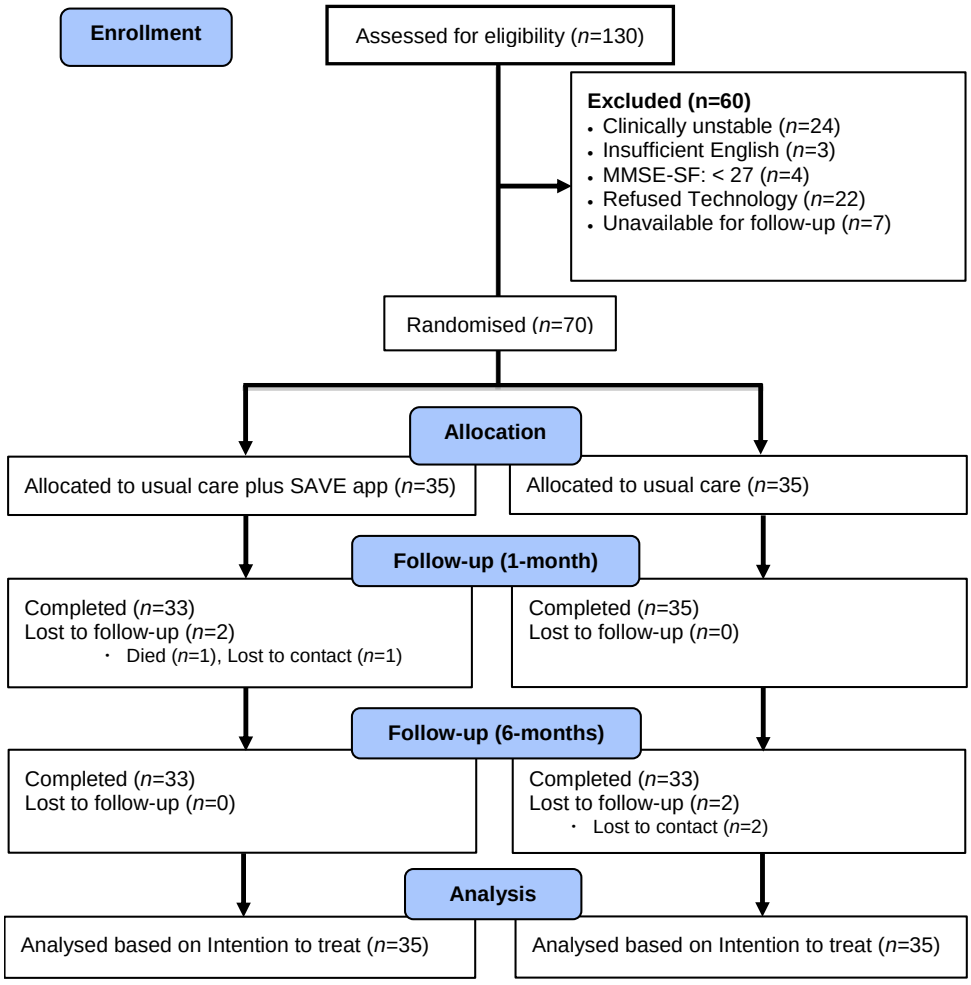


Figure 4.6: CONSORT Flow Diagram of the Study

4.3.2.7.2 Baseline Characteristics

Demographic and clinical data for all participants are presented in Table 4.6. In total, 35 participants were assigned to each group (i.e., IG and UG). There were no statistically significant differences between IG and UG participants in terms of their demographic and clinical characteristics (see Table 4.6). The mean age of the participants was 64.7 years (SD: 11.7) and 44 (62.9%) were male. In terms of educational attainment, 29 (41.4 %) of the participants had reached a trade, certificate or diploma level and 11 (15.7%) had a university or higher-level degree. There was no significant difference between the groups in terms of CVD risk factors, ACS Response Index scores or response to ACS symptoms based on the Heart Attack Action Plan by the NHF.

Table 4.6: Baseline Characteristics of Participants

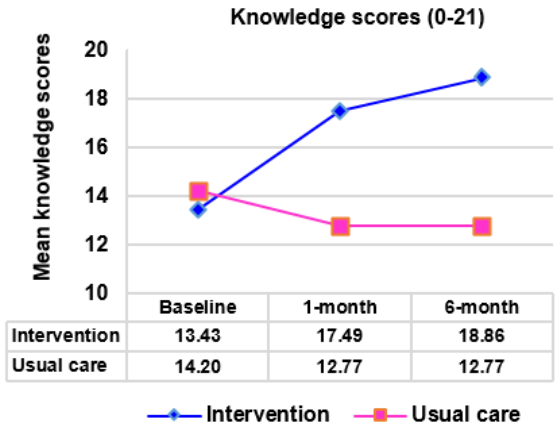
Characteristics	Total (n = 70) n (%)	IG (n = 35) n (%)	UG (n = 35) n (%)	*p*
Age, years, mean (SD)	64.7 (11.7)	65 (12.5)	64 (10.9)	.678
Sex, male	44 (62.9)	24 (68.6)	20 (57.1)	.458
Country of birth				.924
Born in Australia	47 (67.1)	24 (68.6)	23 (65.7)	
Primary language spoken				.478
English	63 (90.0)	33 (94.3)	30 (85.7)	
Marital status				.062
Single or separated				
Divorced or widowed	12 (17.1)	7 (20.0)	5 (14.3)	
Highest education level				.971
<Year 10	2 (5.7)	1 (2.9)	1 (2.9)	
≥Year 10	28 (40.0)	13 (37.1)	15 (42.8)	
Trade/certificate/diploma	29 (41.4)	14 (40.0)	15 (42.8)	
University or higher	11 (15.7)	7 (20.0)	4 (11.4)	
Literacy assessment (REALM—SF)				1.000
Reading grade level ≥9th	65 (92.9)	32 (91.4)	33 (94.3)	
Reading grade level <9th	5 (7.1)	3 (8.6)	2 (5.7)	
Living status				
Living alone	17 (24.3)	5 (14.3)	12 (34.3)	.068
Employment status				.458
Paid employment	26 (37.1)	11 (31.4)	15 (49.2)	
Retired/pensioner	44 (62.9)	24 (68.6)	20 (51.7)	
Diagnosis				.190
STEMI	33 (47.1)	15 (42.9)	18 (51.4)	
NSTEMI	35 (50.0)	18 (51.4)	17 (48.6)	
Unstable angina	2 (2.9)	2 (5.7)	0	
First-episode ACS	35 (50.0)	19 (54.3)	16 (45.7)	.633
CVD risk factors				
Diabetes	16 (22.9)	9 (25.7)	7 (20.0)	.693
Hypertension	47 (67.1)	24 (68.6)	23 (65.7)	.799
High cholesterol	42 (60.0)	23 (65.7)	19 (54.3)	.368
History of smoking	44 (62.9)	21 (60.0)	23 (65.7)	.161
Body Mass Index, mean (SD)	28.4 (5.5)	27.7 (5.25)	29.1 (5.8)	.325
Family history, n (%)	44 (62.9)	24 (68.6)	20 (57.1)	.400
Charlson Index, mean (SD)	3.6 (1.8)	2 (0.0)	3 (2.0)	.288
GRACE Risk Scores, mean (SD)	99.6 (24.7)	99 (24.0)	100 (26.0)	.943
Response to ACS symptoms				
STOP	55 (78.6)	27 (77.1)	28 (80.0)	1.000
TALK	59 (84.3)	27 (77.1)	32 (91.4)	.189
TAKE	12 (17.1)	8 (22.9)	4 (11.4)	.341
CALL	20 (28.6)	9 (25.7)	11 (31.4)	.791

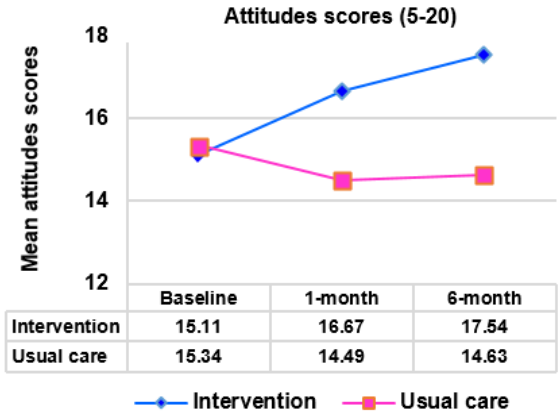
Note: CVD = cardiovascular disease; STEMI = ST-elevation myocardial infarction; NSTEMI = non–ST-elevation myocardial infarction; GRACE = Global Registry of Acute Coronary Events; REALM—SF = Rapid Estimate of Adult Literacy in Medicine—Short Form. Indicates significant at $p < .05$

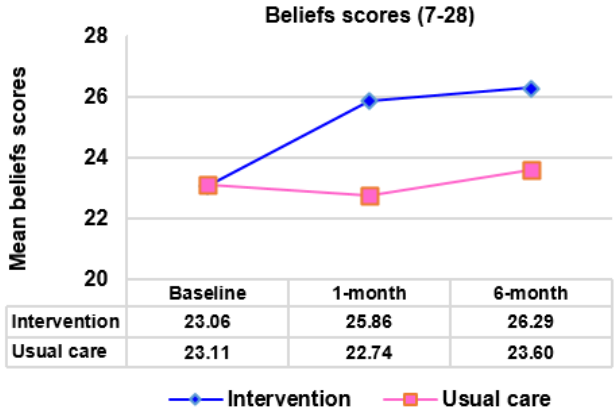
4.3.2.7.3 Primary Outcome: ACS Symptom Knowledge

Figure 4.7 presents the raw scores for the ACS Response Index. The mean ACS knowledge score of the IG participants increased from 13.43 at baseline to 17.49 at one month and to 18.86 at six months. This improvement represented a 25.2 per cent (95% CI: 18.59, 31.79) increase over the six-month period (26.02%, 95% CI: 18.49, 33.55, $p < .001$) (see Figure

4.7). Among the UG participants, there was no significant improvement in knowledge of ACS symptoms over the six-month study period ($p = .152$). Between-group differences were statistically significant at the one-month ($p < .001$) and six-month ($p < .001$) follow-ups.







	Mean of percentages (95%CI)						Within group , percentages difference (95%CI)						Overall *p*-value
	Baseline	*p*	1-month	*p*	6-month	*p*	1-month vs. Baseline	*p*	6-month vs. 1-month	*p*	6-month vs. Baseline	*p*	
ACS knowledge (%)													
Usual care group	61.48 (53.67 to 66.51)		58.38 (55.73 to 63.19)		58.37 (55.78 to 62.98)		-3.11 (-9.57 to 3.38)	0.152	-0.01 (-7.18 to 7.16)	0.890	-3.11 (-10.39 to4.18)	0.152	0.133
Intervention group	58.35 (55.07 to 62.47)		82.72 (79.01 to 88.14)		83.55 (78.48 to 88.62)		25.20 (18.59 to 31.79)	<0.001	0.83 (-6.53 to 8.19)	0.990	26.02 (18.49 to 33.55)	<0.001	<0.001
IG vs. UG (% Dif)	-3.13 (-11.44 to-3.54)	0.045	24.34 (16.14 to 32.54)	<0.001	25.18 (14.13 to36.23)	<0.001							
ACS attitudes (%)													
Usual care group	75.98 (72.35 to 79.88)		70.94 68.34 to 74.12)		72.72 (69.59 to 75.86)		-5.04 (-11.32 to 1.24)	0.041	1.78 (-4.68 to 8.23)	0.052	-3.26 (-9.63 to 3.11	0.068	0.140
Intervention group	74.84 (71.39 to 78.92)		78.38 (74.10 to 81.75)		83.40 (79.97 to 86.83)		3.54 (-2.77 to 9.84)	0.027	5.02 (-0.44 to 11.49)	0.030	8.56 (2.14 to 14.98)	0.017	0.009
IG vs. UG (%Dif)	-1.14 (-7.96 to 5.67)	0.722	7.44 (0.30 to 14.56)	0.002	10.68 (2.94 to 18.42)	<0.001							
ACS beliefs (%)													
Usual care group	82.53 (79.74 to 85.36)		81.65 (78.56 to 84.99)		85.72 (80.92 to 90.50)		-0.88 (-5.92 to 4.15)	0.648	4.07 (-2.37 to 10.52)	0.028	3.19 (-3.61 to 9.98)	0.228	0.092
Intervention group	82.33 (79.53 to 85.16)		94.33 (91.07 to 97.92)		99.45 (94.36 to 99.81)		12.00 (6.74 to17.27)	<0.001	5.12 (-2.41 to 2.65)	0.012	17.12 (9.27 to 24.98)	<0.001	<0.001
IG vs. UG (%Dif)	-0.20 (-6.41 to 6.00)	0.452	12.68 (5.88 to 19.49)	<0.001	13.73 (3.23 to 24.23)	<0.001							

IG: Intervention group; UG: Usual care group; CI: confidence interval, Indicates significant at $p < 0.05$ level

Figure 4.7: Comparison of ACS Response Index Scores and the Percentage Changes at Baseline, One Month and Six Months Between Groups and Within Groups, Tobit Growth Curve Model

4.3.2.7.4 Secondary Outcomes

ACS attitudes: In the IG, the mean percentage of correct answers on the ACS attitude sub-scale increased significantly over the six-month study period (p = .009) from 74.84 per cent (95% CI: 71.39, 78.92) at baseline to 78.38 per cent (95% CI: 74.10, 81.75) at one month and 83.40 per cent (95% CI: 79.97, 86.83) at six months. The change over time among UG participants was not statistically significant over the six-month period (p = .140). As in the ACS attitudes sub-scale, between-group differences on the attitude sub-scale were statistically significant at both the one-month (p = .002) and six-month (p < .001) follow-ups (see Figure 4.7).

ACS beliefs: In the IG, the percentage of correct answers on the ACS belief sub-scale increased significantly from 82.33 per cent (95% CI: 79.53, 85.16) at baseline to 94.33 per cent (95% CI: 91.07, 97.92) at one month and 99.45 per cent (95% CI: 94.36, 99.81) at six months, representing a 17.12 per cent increase (95% CI: 9.27, 24.98, p < .001*)*. For UG participants, the change over the six-month period was not statistically significant (3.19%, 95% CI: −3.61, 9.98, p = .092). Between-group differences at one month (p < .001) and six months (p < .001) were statistically significant (see Figure 4.7).

4.3.2.7.5 Heart Attack Action Plan

A total of 16 participants had further episodes of ACS during the study period. Due to the small number of participants, we were unable to perform statistical analyses to evaluate the between-group differences in the implementation of the action plan. The responses of those 16 participants during their most recent ACS episodes at the six-month follow-up are presented in Table 4.7.

Table 4.7: Case Review of the 16 Participants Who Had Further Episodes of ACS During the Six-Month Study Period

Case	Group	STOP	TALK	TAKE	CALL	Note
1	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
2	IG	Yes	Yes	Yes	Yes	Pain went away after taking angina medicine x2
3	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
4	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
5	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x1
6	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x1
7	IG	Yes	Yes	No	No	Did not bring angina medicine, but pain went away after resting Went to GP for check-up next day
8	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
9	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
10	IG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2
11	IG	Yes	Yes	Yes	No	Pain went away after angina medicine x2 Went to GP then GP called EMS
Total		11	11	11	1	
1	UG	Yes	Yes	No	No	Pain went away after resting
2	UG	Yes	No	No	No	Pain went away after two minutes of resting
3	UG	Yes	Yes	No	Yes	Expired angina medicine
4	UG	Yes	No	No	No	Pain went away after two minutes of resting
5	UG	Yes	Yes	Yes	No	Pain went away after taking angina medicine x2 Went to GP then GP called EMS
Total		5	3	2	1	

Note: IG = intervention group; UG = usual care group; GP = general practitioner; EMS = emergency medical services

The scores for the Heart Attack Action Plan at the one-month (n = 62) and six-month (n = 54) follow-ups represent participants' intentions to implement the Heart Attack Action Plan (NHF 2015). These participants did not experience another episode of ACS during the six-month study period. At the one-month follow-up, 13 of the 31 IG participants answered 'yes' to all four steps of the action plan compared to one of the 31 participants in the UG (p = .001). This difference was sustained at the six-month follow-up (IG 13/26 v. UG 5/28, p = .027) (see Table 4.8).

Table 4.8: Intention to Implement the Heart Attack Action Plan

Variables	One-month follow-up			Six-month follow-up	
		n (%)	*p*	n (%)	*p*
STOP	IG	29 (93.55)	.084	25 (96.15)	.038
	UG	23 (74.19)		20 (71.43)	
TALK	IG	28 (90.32)	<.001	24 (92.31)	.059
	UG	13 (41.94)		19 (67.86)	
TAKE	IG	24 (77.42)	1.000	23 (88.46)	.543
	UG	25 (80.65)		22 (78.57)	
CALL	IG	18 (58.06)	.021	15 (57.69)	.059
	UG	8 (25.81)		8 (28.57)	
All correct	IG	13 (41.94)	.001	13 (50.00)	.027
	UG	1 (3.23)		5 (17.86)	

Note: one-month: IG n = 31, UG n = 31; six-month: IG n = 26, UG n=28. Indicates significant at $p < .05$; *p*-value indicates the significance of the between-group differences observed at the one-month and six-month follow-ups, Chi-square

4.3.2.7.6 Healthcare Use

The health care use questionnaire collected information regarding participants' general practitioner (GP) visits, ED visits and hospitalisations during the study period. No statistically significant between-group difference was observed in relation to the number of regular and urgent GP visits, cardiac and non-cardiac ED visits or cardiac and non-cardiac 30-day re-hospitalisations or the length of stay for cardiac and non–cardiac-related conditions (see Table 4.9). Interestingly, during the six-month follow-up period, 11 (33.33%) IG participants attended the ED via ambulance compared to six (18.18%) UG participants. This difference was statistically significant ($p = .008$). However, there was no significant between-group difference in terms of cardiac-related ED visits by ambulance ($p = .154$).

Table 4.9: Secondary Outcome—Healthcare Use

Variables	Total (n = 66) n (%)	IG (n = 33) n (%)	UG (n = 33) n (%)	*p*
Regular GP visit, times, mean (SD)	3.17 (0.77)	2.94 (1.07)	3.03 (1.07)	.737
Urgent GP visit (non-cardiac)	11 (16.67)	5 (15.15)	6 (18.18)	.788
Urgent GP visit (cardiac)	8 (12.12)	5 (15.15)	3 (9.09)	.463
ED visit (non-cardiac), n (%)	13 (19.70)	3 (9.09)	10 (30.30)	.071
ED visit (cardiac), n (%)	16 (24.24)	9 (27.27)	7 (21.21)	.154
Went to ED by ambulance, total, n (%)	17 (25.76)	11 (33.33)	6 (18.18)	.008
Went to ED (cardiac) by ambulance, n (%)	11 (16.67)	8 (88.89)	3 (42.86)	.049
Hospitalised (non-cardiac) <30 days	11 (16.67)	4 (12.12)	7 (21.21)	.165
Hospitalised (cardiac) <30 days	14 (21.21)	9 (27.27)	5 (15.15)	.325
LOS (non-cardiac), days, mean (SD)	1.37 (7.13)	2.09 (9.96)	0.65 (1.78)	.406
LOS (cardiac), days, mean (SD)	0.69 (1.70)	0.71 (2.04)	0.66 (1.33)	.890

Note: GP = general practitioner; ED = emergency department; LOS = length of hospital stay; IG = intervention group; UG = usual care group. Indicates significant at $p < .05$

Factors associated with improvement in ACS knowledge: Data collected from IG participants were analysed to explore factors associated with improvement in knowledge. The results suggest that literacy levels (as assessed by the REALM—SF) were not associated with the likelihood of improved knowledge of ACS symptoms using the SAVE app. Interestingly, being male and over 65 years was associated with a significant improvement in ACS symptom knowledge after using the SAVE app (OR = .17, 95% CI: 0.03, 0.89, $p = .036$), as were participants with a university or other higher degree (OR = 2.50, 95% CI: 0.17, 1.31, $p = .028$).

4.3.2.7.7 Intervention Satisfaction

Over the six-month study period, 33 IG participants (94.23%) used the SAVE app. The mean number of times they reviewed the application was 5.84 (SD 4.67), ranging from two to 20 times. In addition, 32 participants (91.43%) showed the SAVE app to their family members (60%) or friends (31.41%). With regard to satisfaction, the majority (n = 33) of participants were satisfied with the SAVE app (with a mean score of 3 or above). Of those participants, 84.65 per cent revealed that the application helped them to feel more confident in recognising and responding to ACS symptoms in the future. Participants also commented that the SAVE app was very helpful and simple (n = 14), 2), informative and helped them to

understand appropriate response actions (n = 13), easy to use (n = 8) and used plain language best (n = 6).

4.3.2.8 Discussion

The present study examined the effectiveness of the SAVE app among a group of people with previous experience of ACS. The application yielded a significant improvement in IG participants' knowledge of ACS symptoms over the six-month study period compared to participants in the UG. The percentages improved in the IG over time were higher than many of the scores reported in the ACS literature (Buckley et al. 2007; Mooney et al. 2014; O'Brien et al. 2014). This result confirms the effectiveness of the present avatar-based intervention. The simple interactivity and encouragement from the avatar nurse in the SAVE app addressed an important component of Bandura's social cognitive theory (SCT)—how self-regulation and self-efficacy influence people's behaviour during observational learning (Bandura 2011). Individuals develop self-regulation and self-efficacy through their previous successes, others' successes, positive appraisal and somatic and emotional feedback when judging their own ability (Bandura 2011; Vancouver 2018).

The significant between-group difference in participants' intentions to implement the Heart Attack Action Plan suggests that while the one-page printed Heart Attack Action Plan may appear easy to read and understand, there is still a need for explanation, reinforcement and encouragement to help build people's understanding and confidence in making critical decisions and implementing recommended actions. Based on Bandura's (1977) observational learning theory, effective learning or teaching must consider such factors as attention, motivation, retention, production and self-efficacy. The SAVE app was developed through a PAR approach, involving people with previous experience of ACS (Tongpeth, Du & Clark 2018b). The nurse avatar in the SAVE app was designed to mimic real human interaction and to promote engagement, reinforce learning and improve participants' self-efficacy in recognising and responding to ACS symptoms. In particular, the SAVE app avoided the use of complicated medical terminology and the user interface was designed with input from end users. The results support findings from previous studies that carefully designed education interventions tailored to the characteristics of a target population are likely to be more effective than standardised or generic education interventions (Lambert-Kerzner et al. 2012; Lauver et al. 2002; Suhonen, Välimäki & Leino-Kilpi 2008) in lowering health risk and promoting behaviour change (Alm-Roijer et al. 2006, Jensen et al. 2009; Strecher et al. 2002).

There is evidence that an individual's decision time is shortened if they attribute their symptoms to a cardiac origin, and they are more likely to seek urgent medical attention (American College of Cardiology 2018; Bray et al. 2015; Khan, 2011; Patel et al. 2017; Tummala & Farshid 2015; Youssef et al. 2017). Based on previous studies, improved knowledge can result in higher confidence in decision-making in seeking medical attention, ultimately leading to reduced pre-hospital delay (Buckley et al. 2007; McKinley et al. 2009; Mooney et al. 2014). Pre-hospital delay time was not evaluated in this study. However, this study found that IG participants not only had a significant improvement in knowledge of ACS symptoms, but were more likely to (i.e., intention) implement the recommended action plan (p = .008). There was no statistically significant between-group difference in the number of cardiac-related ED visits by ambulance. This was possibly due to a type II error as a result of the small sample size. In the future, actual pre-hospital delay time and ambulance use should be considered outcomes in a larger study with a longer follow-up.

A recent integrative literature review suggested the benefits of using an avatar in patient education interventions are to improve disease-related knowledge (Andrade et al. 2015; Bickmore, Pfeifer & Paasche-Orlow 2009), self-efficacy (Andrade et al. 2015), health-related quality of life (Andrade et al. 2015) and behaviour change (An et al. 2013) in people with several health conditions. At the same time, this review identified a need for well-conducted RCTs in this area. The present study is a powered clinical trial and the SAVE app serves as an exemplar for avatar-based patient education interventions. It can be readily adapted to other conditions and may have particular advantages, as earlier evidence suggests that for some conditions, participants are more comfortable when interacting with an avatar than in a face-to-face encounter (Andrade et al. 2015; Bickmore et al. 2013; Clark et al. 2015; Gabarron et al. 2012; Hswen et al. 2013; Lyles et al. 2017; Pinto et al. 2013).

Nurses often encounter language barriers when communicating with people from diverse backgrounds. To overcome this difficulty, the content of an education application like the SAVE app can readily be translated into different languages. In addition to its use in clinical practice, an intervention of this kind can be applied to the general population in community settings that are the focus of most health promotion programs.

4.3.2.8.1 Limitations and Recommendations for Future Research

This study had some limitations that must be considered when interpreting the results. First, as participation was voluntary, it is possible that people who lack confidence in using a tablet computer or technology in general may have refused to participate. Just as literacy is a

barrier to understanding booklets, the level of technology readiness might also prevent some people from benefiting from this type of education intervention. While there is some evidence of computer readiness among the elderly, the level of information and communication technology acceptance among people with cardiac conditions is unknown (Gallagher et al. 2017; Liu et al. 2016; Makkonen, Frank & Koivisto 2017). Second, while this study demonstrated a significant improvement in knowledge and behaviour among IG participants, levels of knowledge retention and longer-term behaviour change and clinical outcomes were beyond the scope of this study. Third, we were unable to evaluate the effect of the intervention on participants' actual response to ACS symptoms due a small sample size and short follow-up period. Instead, we evaluated participants' intentions to implement the recommended Heart Attack Action Plan. We recommend that participants' actual responses should be evaluated in a future study with a larger sample size and longer follow-up period. Moreover, detailed case reviews of every cardiac-related ED visit would also be beneficial to better understand participants' actual behaviour. Fourth, the nature of an education intervention means that study participants cannot be blinded. Although the intervention was designed to study participants immediately before discharge from hospital, the control group might be contaminated, as patients were recruited from the same ward and could communicate with each other about the study intervention. Fifth, we used the REALM—SF to assess health literacy levels. As shown in Table 4.6, only five participants had a REALM—SF literacy level of less than grade 9, meaning that comparison of different literacy groups must be interpreted with caution. While the REALM—SF was short and easy to implement, future research studies should perhaps incorporate an additional tool (Kirk et al. 2012). Finally, the study was conducted at a single site, which may limit its generalisability. In addition, since the completion of this study, the NHF has released a new Heart Attack Action Plan in 2018. In addition to the previous STOP, TALK, TAKE and CALL, individuals are advised to call 000 and chew 300 mg of Aspirin (unless individuals have been told not to by doctors previously, or they are allergic to it). This change will be reflected in the future versions of the SAVE app.

4.3.2.9 Conclusion

This pRCT confirms that the SAVE app was effective in improving individuals' knowledge of and response to ACS symptoms. In light of language and literacy barriers, this approach has the potential to assist nurses in delivering patient education in both clinical and

community settings. The intervention should be evaluated in a larger study with long-term follow-up to evaluate knowledge retention and its effect on clinical outcomes.

Author contributions

All authors have agreed on the final version and meet at least one of the following criteria recommended by the International Committee of Medical Journal Editors (http://www.icmje.org/ethical_1author.html):

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data
- drafting the article or revising it critically for important intellectual content.

4.3.2.10 References

Albarqouni, L, Smenes, K, Meinertz, T, Schunkert, H, Fang, X, Ronel, J & Ladwig, K-H 2016), 'Patients' knowledge about symptoms and adequate behaviour during acute myocardial infarction and its impact on delay time: Findings from the multicentre MEDEA Study', *Patient Education and Counseling,* vol. 99, no. 11, pp. 1845–51.

Alm-Roijer, C, Fridlund, B, Stagmo, M & Erhardt, L 2006, 'Knowing your risk factors for coronary heart disease improves adherence to advice on lifestyle changes and medication', *Journal of Cardiovascular Nursing,* vol. 21, no. 5, pp. E24–31.

American College of Cardiology 2018, 'TCT-356: Reperfusion delay in patients with ST-elevation myocardial infarction presenting to hospitals without angioplasty capability: Should 'door-to-ambulance' time be the new quality parameter?', *Journal of the American College of Cardiology*, vol. 58, vol. 20, Suppl., p. B97.

Amsterdam, EA, Wenger, NK, Brindis, RG, Casey, DE, Ganiats, TG, Holmes, DR, Jaffe, AS, Jneid, H, Kelly, RF & Kontos, MC 2014, '2014 AHA/ACC guideline for the management of patients with non–ST-elevation acute coronary syndromes: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines', *Journal of the American College of Cardiology*, vol. 64, no. 24, pp. e139–228.

An, LC, Demers, MR, Kirch, MA, Considine-Dunn, S, Nair, V, Dasgupta, K, Narisetty, N, Resnicow, K & Ahluwalia, J 2013, 'A randomized trial of an avatar-hosted multiple behavior change intervention for young adult smokers', *Journal of the National Cancer Institute. Monographs*, vol. 2013, no. 47, pp. 209–15.

Anam, R, Andrade, AD & Ruiz, JG 2016, 'Promoting lifestyle change through medical avatars', in R Anam (ed.), *Encyclopedia of e-health and* telemedicine, IGI Global, Hershey, USA, pp. 316–30.

Andrade, AD, Anam, R, Karanam, C, Downey, P & Ruiz, JG 2015, 'An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy', *Urology*, vol. 85, no. 3, pp. 561–7.

Australian Institute of Health and Welfare 2016, *Australia's health 2016*, Australia's health series no.15, cat. no. AUS 199.

Bandura, A 2011, ‘Social cognitive theory’, in PAM Van Lange, AW Kruglanski & ET Huggins (eds.), *Handbook of theories of social psychology,* Sage Publications, Thousand Oaks, USA, pp. 349–73.

Bell, D, Gachuhi, N & Assefi, N 2018, ‘Dynamic clinical algorithms: Digital technology can transform health care decision-making’, *The American Journal of Tropical Medicine and Hygiene*, vol. 98, no. 1, pp. 9–14.

Bell, ML, Fiero, M, Horton, NJ & Hsu, C-H 2014, ‘Handling missing data in RCTs: A review of the top medical journals’, *BMC Medical Research Methodology*, vol. 14, no. 1, p. 118.

Bernhardt, JM, Chaney, JD, Chaney, BH & Hall, AK 2013, ‘New media for health education: A revolution in progress’, *Health Education & Behavior*, vol. 40, no. 2, pp. 129–32.

Bickmore, TW, Schulman, D & Sidner, C 2013, ‘Automated interventions for multiple health behaviors using conversational agents’, *Patient Education and Counseling*, vol. 92, no. 2, pp. 142–8.

Bickmore, TW, Pfeifer, LM & Paasche-Orlow, MK 2009, ‘Using computer agents to explain medical documents to patients with low health literacy’, *Patient Education and Counseling*, vol. 75, no. 3, pp. 315−20.

Blok, AC, May, CN, Sadasivam, RS & Houston, TK 2017, ‘Virtual patient technology: Engaging primary care in quality improvement innovations’, *Journal of Medical Internet Research: Medical Education*, vol. 3, no. 1, p. e3.

Bray, JE, Stub, D, Ngu, P, Cartledge, S, Straney, L, Stewart, M, Keech, W, Patsamanis, H, Shaw, J & Finn, J 2015, ‘Mass media campaigns’ influence on prehospital behavior for acute coronary syndromes: An evaluation of the Australian Heart Foundation’s warning signs campaign’, *Journal of the American Heart Association*, vol. 4, no. 7, p. e001927.

Buckley, T, McKinley, S, Gallagher, R, Dracup, K, Moser, D & Aitken, L 2007, ‘The effect of education and counselling on knowledge, attitudes and beliefs about responses to acute myocardial infarction symptoms’, *European Journal of Cardiovascular Nursing*, vol. 6, no. 2, pp. 105−11.

Burton, C, Szentagotai Tatar A, McKinstry, B Matheson, C., Matu, S, Moldovan, R, Macnab, M, Farrow, E, David, D & Pagliari, C 2016, ‘Pilot randomised controlled trial of Help4Mood,

an embodied virtual agent-based system to support treatment of depression', *Journal of Telemedicine and Telecare*, vol. 22, no. 6, pp. 348−55.

Clark, R, Fredericks, B, Buitendyk, N, Adams, M, Howie-Esquivel, J, Dracup, K, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3231.

Darawad, MW, Alfasfos, N, Saleh, Z, Saleh, AM & Hamdan-Mansour, A 2016, 'Predictors of delay in seeking treatment by Jordanian patients with acute coronary syndrome', *International Emergency Nursing*, vol. 26, pp. 20−5.

DeVon, HA, Hogan, N, Ochs, AL & Shapiro, M 2010, 'Time to treatment for acute coronary syndromes: The cost of indecision', *The Journal of Cardiovascular Nursing*, vol. 25, no. 2, pp. 106−14.

Dracup, K, McKinley, SM & Moser, DK 1997, 'Australian patients' delay in response to heart attack symptoms', *The Medical Journal of Australia*, vol. 166, no. 5, pp. 233−6.

Finnegan, JR, Meischke, H, Zapka, JG, Leviton, L, Meshack, A, Benjamin-Garner, R, Estabrook, B, Hall, NJ, Schaeffer, S & Smith, C 2000), 'Patient delay in seeking care for heart attack symptoms: Findings from focus groups conducted in five US regions', *Preventive Medicine*, vol. 31, no. 3, pp. 205−13.

Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure self-care amongst indigenous Australians: a pilot study', *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, pp. 40−60.

Fuchslocher, A, Niesenhaus, J & Krämer, N 2011, 'Serious games for health: An empirical study of the game "Balance" for teenagers with diabetes mellitus', *Entertainment Computing*, vol. 2, no. 2, pp. 97−101.

Gabarron, E, Serrano, JA, Wynn, R & Armayones, M 2012, 'Avatars using computer/smartphone mediated communication and social networking in prevention of sexually transmitted diseases among North-Norwegian youngsters', *BMC Medical Informatics and Decision Making*, vol. 12, no. 1, p. 120.

Gallagher, R, Roach, K, Belshaw, J, Kirkness, A, Sadler, . & Warrington, D 2013, 'A pre-test post-test study of a brief educational intervention demonstrates improved knowledge of potential acute myocardial infarction symptoms and appropriate responses in cardiac rehabilitation patients', *Australian Critical Care*, vol. 26, no. 2, pp. 49−54.

Gallagher, R, Roach, K, Sadler, L, Glinatsis, H, Belshaw, J, Kirkness, A, Zhang, L, Gallagher, P, Paull, G, Gao, Y, Partridge, SR, Parker, H & Neubeck, L 2017, 'Mobile technology use across age groups in patients eligible for cardiac rehabilitation: Survey study', *Journal of Medical Internet Research*: *mHealth and uHealth*, vol. 5, no. 10, p. e161.

Glanz, K, Rimer, BK & Viswanath, K 2008, *Health behavior and health education: Theory, research, and practice*, John Wiley & Sons San Francisco, USA.

Goldberg, RJ, Spencer, FA, Fox, KA, Brieger, D, Steg, PG, Gurfinkel, E, Dedrick, R & Gore, JM 2009, 'Prehospital delay in patients with acute coronary syndromes (from the Global Registry of Acute Coronary Events [GRACE])', *American Journal of Cardiology*, vol. 103, no. 5, pp. 598−603.

Gwadry-Sridhar, F, Guyatt, GH, Arnold, JMO, Massel, D, Brown, J, Nadeau, L & Lawrence, S 2003, 'Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure', *European Journal of Heart Failure*, vol. 5, no. 6, pp. 783−91.

Hswen, Y, Murti, V, Vormawor, AA, Bhattacharjee, R & Naslund, JA 2013, 'Virtual avatars, gaming, and social media: Designing a mobile health app to help children choose healthier food options', *Journal of Mobile Technology in Medicine*, vol. 2, no. 2, pp. 8−14.

IBM Corp 2016, *IBM SPSS Statistics for Windows*, version 25.0, IBM Corp, Armonk, USA.

Jensen, L, Leeman-Castillo, B, Coronel, SM, Perry, D, Belz, C, Kapral, C & Krantz, MJ 2009, 'Impact of a nurse telephone intervention among high-cardiovascular-risk, health fair participants', *Journal of Cardiovascular Nursing*, vol. 24, no. 6, pp. 447−53.

Julious, SA & Campbell, MJ 2012, 'Tutorial in biostatistics: Sample sizes for parallel group clinical trials with binary data', *Statistics in Medicine*, vol. 31, no. 24, pp. 2904−36.

Khan, JA 2011, 'Factors causing delayed presentation of patients with acute myocardial infarction to the hospital', *Pakistan Armed Forces Medical Journal,* vol. 61, no. 4, pp. 20−4.

Kirk, JK, Grzywacz, JG, Arcury, TA, Ip, EH, Nguyen, HT, Bell, RA Saldana, S. & Quandt, SA 2012, 'Performance of health literacy tests among older adults with diabetes', *Journal of General Internal Medicine*, vol. 27, no. 5, pp. 534−40.

Lachin, JM 2016, 'Fallacies of last observation carried forward analyses', *Clinical Trials*, vol. 13, no. 2, pp. 161−8.

Lambert-Kerzner, A, Del Giacco, EJ, Fahdi, IE, Bryson, CL, Melnyk, SD, Bosworth, HB, Davis, R, Mun, H, Weaver, J, Barnett, C, Radcliff, T, Hubbard, A, Bosket, KD, Carey, E, Virchow, A, Mihalko-Corbitt, R, Kaufman, A, Marchant-Miros, K & Ho, PM 2012, 'Patient-centered adherence intervention after acute coronary syndrome hospitalization', *Circulation: Cardiovascular Quality and Outcomes*, vol. 5, no. 4, pp. 571−6.

Lauver, DR, Ward, SE, Heidrich, SM, Keller, ML, Bowers, BJ, Brennan, PF, Kirchhoff, KT & Wells, TJ 2002, 'Patient-centered interventions', *Research in Nursing & Health*, vol. 25, no. 4, pp. 246−55.

Liu, L, Stroulia, E, Nikolaidis, I, Miguel-Cruz, A & Rincon, A R 2016, 'Smart homes and home health monitoring technologies for older adults: A systematic review', *International Journal of Medical Informatics*, vol. 91, pp. 44−59.

Luepker, RV, Raczynski, JM, Osganian, S, Goldberg, RJ, Finnegan Jr, JR, Hedges, JR, Goff Jr, DC, Eisenberg, MS, Zapka, JG & Feldman, HA 2000, 'Effect of a community intervention on patient delay and emergency medical service use in acute coronary heart disease: The Rapid Early Action for Coronary Treatment (REACT) Trial', *The Journal of the American Medical Association*, vol. 284, no. 1, pp. 60−7.

Lyles, AA, Amresh, A, Huberty, J, Todd, M & Lee, RE 2017, 'A mobile, avatar-based app for improving body perceptions among adolescents: A pilot test', *Journal of Medical Internet Research: Serious Games*, vol. 5, no. 1, p. e4.

Makkonen, M, Frank, L & Koivisto, K 2017, 'Age differences in technology readiness and its effects on information system acceptance and use : The case of online electricity services in Finland', *Bled 2017: Proceedings of the 30th Bled eConference. Digital transformation: From connecting things to transforming our lives*, Bled, Slovakia, pp. 403−20.

Makam, RP, Erskine, N, Yarzebski, J, Lessard, D, Lau, J, Allison, J, Gore, JM, Gurwitz, J, McManus, DD & Goldberg, RJ 2016, 'Decade long trends (2001–2011) in duration of pre-

hospital delay among elderly patients hospitalized for an acute myocardial infarction', *Journal of the American Heart Association*, vol. 5, no. 4, p. e002664.

McKinley, S, Dracup, K, Moser, DK, Riegel, B, Doering, LV, Meischke, H, Aitken, LM, Buckley, T, Marshall, A & Pelter, M 2009, 'The effect of a short one-on-one nursing intervention on knowledge, attitudes and beliefs related to response to acute coronary syndrome in people with coronary heart disease: A randomized controlled trial', *International Journal of Nursing Study*, vol. 46, no. 8, pp. 1037−46.

Mooney, M, McKee, G, Fealy, G, O'Brien, F, O'Donnell, S & Moser, D 2014, 'A randomized controlled trial to reduce prehospital delay time in patients with acute coronary syndrome (ACS)', *The Journal of Emergency Medicine*, vol. 46, no. 4, pp. 495−506.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, 'Using avatars to model weight loss behaviors: Participant attitudes and technology development', *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057−65.

National Heart Foundation of Australia 2015, *Heart attack action plan: Will you recognise your heart attack?*, <https://www.heartfoundation.org.au/images/uploads/main/Your_heart/Heart_attack_actio a_plan.pdf>.

Nielsen, CG, Laut, KG, Jensen, LO, Ravkilde, J, Terkelsen, CJ & Kristensen, SD 2016, 'Patient delay in patients with ST-elevation myocardial infarction: Time patterns and predictors for a prolonged delay', *European Heart Journal: Acute Cardiovascular Care*, vol. 6, no. 7, pp. 538–91.

O'Brien, F, McKee, G, Mooney, M, O'Donnell, S & Moser, D 2014, 'Improving knowledge, attitudes and beliefs about acute coronary syndrome through an individualized educational intervention: A randomized controlled trial', *Patient Education and Counseling*, vol. 96, no. 2, pp. 179–87.

O'Brien, F, O'Donnell, S, McKee, G, Mooney, M & Moser, D 2013, 'Knowledge, attitudes, and beliefs about acute coronary syndrome in patients diagnosed with ACS: An Irish cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 12, no. 2, pp. 201–8.

Patel, A, Mohanan, PP, Prabhakaran, D & Huffman, MD 2017, 'Pre-hospital acute coronary syndrome care in Kerala, India: A qualitative analysis', *Indian Heart Journal*, vol. 69, no. 1, pp. 93–100.

Pinto, MD, Hickman, RL, Clochesy, J & Buchner, M 2013, 'Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults', *Applied Nursing Research*, vol. 26, no. 1, pp. 45–8.

Poomsrikaew, O, Ryan, CJ & Zerwic, JJ 2010, 'Knowledge of heart attack symptoms and risk factors among native Thais: A street-intercept survey method', *International Journal of Nursing Practice*, vol. 16, no. 5, pp. 492–8.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584–94.

Sax, HC 2017, 'Healthcare transformation: What are the challenges?', in in HC Sax (ed.), *Measurement and Analysis in Transforming Healthcare Delivery,* Springer, Cham, Switzerland, pp. 1–6.

Schulz, KF, Altman, DG & Moher, D 2010, 'CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials', *BMC Medicine,* vol. 8, no. 1, p. 18.

StataCorp 2018, *Stata Statistical Software: Release 15*, version 15.1, StatCorp LP, College Station, USA.

Strecher, V, Wang, C, Derry, H, Wildenhaus, K & Johnson, C 2002, 'Tailored interventions for multiple risk behaviors', *Health Education Research*, vol. 17, no. 5, pp. 619–26.

Suhling, H, Rademacher, J, Zinowsky, I, Fuge, J, Greer, M, Warnecke, G, Smits, JM, Bertram, A, Haverich, A & Welte, T 2014, 'Conventional vs. tablet computer-based patient education following lung transplantation–a randomized controlled trial', *PloS One,* vol. 9, no. 3, p. e90828.

Suhonen, R, Välimäki, M & Leino-Kilpi, H 2008, 'A review of outcomes of individualised nursing interventions on adult patients', *Journal of Clinical Nursing*, vol. 17, no. 7, pp. 843–60.

Suresh, K & Chandrashekara, S 2012, 'Sample size estimation and power analysis for clinical research studies', *Journal of Human Reproductive Sciences*, vol. 5, no. 1, p. 7–13.

Ting, HH & Bradley, EH 2009, 'Patient education to reduce prehospital delay time in acute coronary syndrome', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 6, pp. 522–3.

Tongpeth, J, Du, H & Clark, R 2018a, 'An avatar-based education application to improve patients' knowledge of and response to heart attack symptoms: A pragmatic randomized controlled trial protocol', *Journal of Advanced Nursing*, (online Wiley Online Library).

Tongpeth, J, Du, H & Clark, R 2018b, 'Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome', *Journal of Clinical Nursing*, (online Wiley Online Library).

Treskes, R, Van der Velde, E, Schoones, JW & Schalij, MJ 2018, 'Implementation of smart technology to improve medication adherence in patients with cardiovascular disease: Is it effective?', *Expert Review of Medical Devices,* vol. 15, no. 2, pp. 119–26.

Tummala, SR & Farshid, A 2015, 'Patients' understanding of their heart attack and the impact of exposure to a media campaign on pre-hospital time', *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 4–10.

Vancouver, JB 2018, 'Self-efficacy's role in unifying self-regulation theories', in AJ Elliot (ed.), *Advances in motivation science*, Elsevier, San Diego, USA. pp. 203-230.

Wang, L, Zhang, Z, McArdle, JJ & Salthouse, TA 2008, 'Investigating ceiling effects in longitudinal data analysis', *Multivariate Behavioral Research*, vol. 43, no. 3, pp. 476–96.

Win, KT, Hassan, NM, Oinas-Kukkonen, H & Probst, Y 2016, 'Online patient education for chronic disease management: Consumer perspectives', *Journal of Medical Systems*, vol. 40, no. 4, pp. 1–13.

World Health Organization 2016, *Health literacy: The solid facts*, World Health Organization, Geneva, <http://www.euro.who.int/__data/assets/pdf_file>.

Wu, I, Kee, J, Threapleton, D, Ma, R, Lam, V, Lee, E, Wong, S & Chung, V 2018, 'Effectiveness of smartphone technologies on glycaemic control in patients with type 2

diabetes: Systematic review with meta-analysis of 17 trials', *Obesity Reviews*, vol. 19, no. 6, pp. 825–38.

Youssef, G, Kassem, H, Ameen, O, Al Taaban, H & Rizk, H 2017, 'Pre-hospital and hospital delay in patients with non–ST-elevation acute coronary syndromes in tertiary care', *The Egyptian Heart Journal*, vol. 69, no. 3, pp. 177–81.

CHAPTER 5: CONCLUSIONS AND IMPLICATIONS FOR PRACTICE, POLICY AND RESEARCH

5.1 Introduction

This thesis has provided the rationale and conceptual model of participatory action research (PAR) to develop an avatar-based education application intervention to improve the knowledge, attitudes, beliefs and action responses to acute coronary syndrome (ACS) symptoms in people with ACS. This thesis has also presented a pragmatic randomised controlled trial to evaluate the effectiveness of a **S**imple **A**vatar-based application for impro**V**ing ACS **E**ducation (SAVE app). The SAVE app is a novel approach to support ACS health messages in individuals with ACS. The previous chapters provided the results and a discussion of the effect of the SAVE app intervention on health outcomes. This chapter summarises the context within which this research is situated and the new knowledge gained from this study. This is followed by the limitations of the research and the implications for practice, research and policy and the study's conclusions.

5.2 Context of the Study

The context within which the results of this research is situated is summarised in the following key points.

5.2.1 Acute Coronary Syndrome Facts

Every day in 2013, around 55,000 Australians suffered from and almost 9,000 Australians died of a heart attack—one heart attack occurred every 10 minutes and one person died every 60 minutes of a heart attack (Australian Bureau of Statistics 2015; Australian Institute of Health and Welfare [AIHW] 2016). The hospitalisation and mortality data from the AIHW (2016) estimated that in 2013, approximately 65,300 Australian people aged 25 and over experienced an acute coronary event in the form of a heart attack or unstable angina. That equates to around 200 events every day. However, the data from the National Heart Foundation of Australia's HeartWatch Survey (2017) showed that only 34 per cent of Australians knew someone who had a heart attack.

5.2.2 Delay in Response to Symptoms of Acute Coronary Syndrome

The literature from the past two decades shows that the median pre-hospital delay time in seeking medical attention varied from country to country and ranged from one hour and 50 minutes to six hours and 40 minutes.

The data from the HeartWatch Survey (2017) reported that around 33 per cent of Australians were ignorant about the typical signs or symptoms of a heart attack, such as whether the symptoms were critical enough to warrant calling an ambulance. These Australians tend to wait for symptoms go away and ignore the warning signs of a heart attack.

5.3 New Knowledge

The new knowledge obtained through this study is summarised below.

5.3.1 Avatar-Based Technology and Patient Education

Fifty-nine per cent of Australians aged between 15 and 47 have a low level of health literacy and for these people, understanding complex medical information is challenging (AIHW 2016). The previous literature has established a scientific basis for the use of avatar-based technologies as a health care intervention and an effective strategy for the transfer of knowledge and development of skills in patients, particularly those with limited health literacy.

First, our study suggested that the use of an avatar-based education application can effectively delivery critical information to consumers. Promoting effective self-care and self-management behaviour in patients is critical to improve outcomes for clinical practice, as well as chronic conditions such as ACS and mutual goal setting between the patient and health care professional. These behaviours can be enhanced to improve health outcomes by the delivery of an avatar-based technology intervention.

While technology may have been viewed as an easy solution for many, our experience in this present study shows that any technology-based intervention must be carefully designed and tailored to the characteristics of the target population. For example, an intervention for children or young adults requires a different design in terms of aesthetics and functionality compared to an intervention for older adults, as was the case for this study's target ACS population. The collaboration between clinical exerts, technology experts and consumers in the design and development process is essential for achieving a successful outcome. By

using a PAR approach, the researchers were able to agree on actions to develop and implement the SAVE app and carefully observe the outcomes. Further, the approach allowed researchers, in cooperation with consumers with previous experience with ACS, to unite their views, experiences and knowledge into action and reflection.

Second, while the effect of the SAVE app on knowledge and behaviour is important, users' satisfaction and experience with the education application determines the long-term sustainability of an avatar technology-based approach to patient education. The SAVE app was tested for feasibility after preliminary access by patients and health care professionals confirmed its acceptability. This evaluation focused on examining how the intended recipients reacted to the intervention, including their satisfaction with and perceived appropriateness of the application, intentions to continue its use and positive or negative effects on the health care setting in which it was implemented. The SAVE app was effective in improving individuals' knowledge, attitudes, beliefs and intentions to implement the Heart Attack Action Plan. The SAVE app is feasible and has the potential to support patient education by enhancing their engagement. More importantly, the majority (94.4%) of participants were satisfied with the SAVE app.

Third, avatar-based technologies can be used to supplement—but not substitute—health care professionals by providing patients with health education relevant to their disease. One of the reasons that avatar-based intervention is more effective in delivering information than printed material is the avatar's ability to mimic innate human interactions. This, in fact, further emphases the importance of human interaction. Therefore, it is important to understand and have a realistic expectation of the role of avatar technology in patient education.

This thesis has provided detailed information on the development and evaluation of an avatar-based education application. Nurse educators and health care providers can use the results of this thesis to guide the delivery of their own innovative health care education and resources for improving in patients their health knowledge, self-care, behaviour change and decision-making processes to improve clinical outcomes.

5.4 Limitations

This study has several limitations. First, in terms of the PAR method, it was considered the most suitable approach to develop the avatar-based ACS education application intervention, as it empowered the participants and enabled an in-depth understanding of their needs and

preferences for development into an education application (Reason 1994). However, it has been criticised for lacking methodological rigour and technical validity (Paredes-Chi & Castillo-Burguete 2018). The focus group discussions on the PAR cycles between the consumer group and the cardiovascular expert panel were organised separately due to the nature of the confirmed interest and availability. As the PAR approach depends greatly on the researcher's perception of the participants and the issue under investigation, there might be undesirable subjectivity in the findings. Organisation of the focus group discussion that brought together both the cardiovascular experts and consumers would have been beneficial to foster agreement on issues related to the SAVE app's design and development. Second, the PAR method encourages power sharing between academic researchers and consumers. However, the researcher, who is more influential in terms of knowledge and experience, can subconsciously affect the mindsets of the participants. Therefore, the results might not accurately reflect the reality. In addition, the ACS participants were representative but there were only 10 participants involved in the PAR cycles. Therefore, the consumers might not be representative of the broader population of ACS patients—particularly females with ACS—as nine of the 10 consumers in this study were male.

In terms of feasibility testing, it consisted of a small-scale experiment to examine whether the intervention showed evidence of effectiveness when implemented in a clinical setting (Bowen et al. 2009). Ten participants were recruited to the pre-test post-test design to test the preliminary knowledge, attitudes and beliefs of the participants. As this was a small sample size, the power of the data analysis was limited and generalisability of the study results cannot be assumed. Refinement of the SAVE app and its subsequent testing in a larger study is warranted.

Third, with respect to Study 2, participation was voluntary and it is possible that people who lacked confidence in using a tablet computer or technology in general may have refused to participate. Just as literacy is a barrier to understanding booklets, the level of technology readiness might also prevent some people from benefiting from this type of education intervention. While there is some evidence of computer readiness among the elderly (Kirk et al. 2012), the level of information and communication technology acceptance among people with cardiac conditions is unknown. While this study demonstrated a significant improvement in knowledge and behaviour among intervention group participants, levels of knowledge retention and longer-term behaviour change and clinical outcomes were beyond the scope of this study.

Fourth, the nature of an education intervention means that study participants cannot be blinded. Although the intervention was designed to study participants immediately before discharge from hospital, the control group may have been contaminated, as patients were recruited from the same ward and could communicate with each other about the study intervention.

Fifth, the Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF) was used to assess the health literacy level of participants. Only five participants had a REALM-SF literacy level of less than grade 9, meaning that comparison of different literacy groups must be interpreted with caution. While the REALM-SF was short and easy to implement, future research studies should perhaps incorporate an additional tool (Kirk et al. 2012). Finally, the study was conducted at a single site, which may limit its generalisability.

5.5 Implications for Practice

There are several implications that the results of this study have for practice. First, the SAVE app has shown that it provides the ability to standardise and deliver high-quality practice in an environment that is notoriously time-poor. Second, the avatar-based education application can provide bedside education in practice areas, such as in rural and remote hospitals where there is limited specialist support. Last, nurses frequently experience challenges in providing patient education, such as low health literacy in patients or patient language barriers. This project has demonstrated how technology can be used to overcome these challenges.

5.6 Implications for Policy

This project has also demonstrated several implications for policy. The SAVE app is highly effective in translating evidence into practice. It is a cost-effective strategy to provide health education to patients with low literacy and health literacy. Further, the SAVE app is an appropriate strategy to provide health education to culturally and linguistically diverse patient groups.

5.7 Implications for Research

This thesis demonstrates one of the first trials on the use of an avatar-based ACS education application for improving the knowledge, beliefs, attitudes and response actions in people with ACS. Therefore, there are many implications for future research.

Future research into avatar-based education should tailor the avatar and game component to the target audience, such as an application targeted towards younger or older patients or those with visual or audio impairment.

This study predominantly measured knowledge improvement in its participants. Future research should consist of a large effectiveness trial to measure clinical outcomes, such as pre-hospital delay time, readmission, mortality and cost-effectiveness. The involvement of consumers is essential for any research involving this technology.

5.8 Conclusion

In the clinical world, technology is rapidly evolving and infiltrating practice in all aspects of patient care. This project has demonstrated that any technology intervention for supporting patient care can and must be carefully designed and developed and based on sound theoretical underpinnings and sophisticated methodology. This research is an example of such an intervention and demonstrates that avatar-based education applications can be developed and used in future clinical practice.

We have created an avatar who embodies a perfect nurse who delivers evidence-based education precisely and consistently according to guidelines. The avatar can be easily translated into other languages and any health care system and updated as new evidence occurs. This study demonstrates how technology can be used to deliver complex medical information to patients with different literacy levels and backgrounds. However, the avatar will always only be a tool. It will never replace human interaction.

5.9 References

Australian Bureau of Statistics 2015, *Australian health survey: First results, 2014/2015*, cat. no. 4364.0, Australian Bureau of Statistics, Canberra.

Australian Institute of Health and Welfare 2016, *Australia's health 2016.* Australia's health series no.15, cat. no. AUS 199.

Bowen, DJ, Kreuter, M, Spring, B, Cofta-Woerpel, L, Linnan, L, Weiner, D, Bakken, S, Kaplan, CP, Squiers, L & Fabrizio, C 2009, 'How we design feasibility studies', *American Journal of Preventive Medicine*, vol. 36, no. 5, pp. 452−7.

Kirk, JK, Grzywacz, JG, Arcury, TA, Ip, EH, Nguyen, HT, Bell, RA, Saldana, S & Quandt, SA 2012, 'Performance of health literacy tests among older adults with diabetes', *Journal of General Internal Medicine*, vol. 27, no. 5, pp. 534−40.

National Heart Foundation of Australia 2017, *HeartWatch survey*, customised data, April 2018.

Paredes-Chi, AA & Castillo-Burguete, MT 2018, 'Is participatory action research an innovative pedagogical alternative for training teachers as researchers? The training plan and evaluation for normal schools', *Evaluation and Program Planning*, vol. 68, pp. 176−84.

Reason, PE 1994, *Participation in human inquiry*, Sage Publications, Thousand Oaks, USA.

APPENDICES

Appendix 1: Appraisal Instruments

CASP
Critical Appraisal Skills Programme

Section A: Are the results of the trial valid?

1. Did the trial address a clearly focused issue?

Yes ☐
Can't Tell ☐
No ☐

HINT: An issue can be 'focused' In terms of
- the population studied
- the intervention given
- the comparator given
- the outcomes considered

Comments:

2. Was the assignment of patients to treatments randomised?

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider
- how this was carried out
- was the allocation sequence concealed from researchers and patients

Comments:

3. Were all of the patients who entered the trial properly accounted for at its conclusion?

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider
- was the trial stopped early
- were patients analysed in the groups to which they were randomised

Comments:

Is it worth continuing?

CASP
Critical Appraisal Skills Programme

4. Were patients, health workers and study personnel 'blind' to treatment?

Yes ☐
Can't Tell ☐
No ☐

Comments:

5. Were the groups similar at the start of the trial

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider
• other factors that might affect the outcome, such as; age, sex, social class

Comments:

6. Aside from the experimental intervention, were the groups treated equally?

Yes ☐
Can't Tell ☐
No ☐

Comments:

Section B: What are the results?

CASP
Critical Appraisal Skills Programme

7. How large was the treatment effect?

HINT: Consider
- what outcomes were measured
- Is the primary outcome clearly specified
- what results were found for each outcome

Comments:

8. How precise was the estimate of the treatment effect?

HINT: Consider
- what are the confidence limits

Comments:

Section C: Will the results help locally?

9. Can the results be applied to the local population, or in your context?

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider whether
- the patients covered by the trial are similar enough to the patients to whom you will apply this
- how they differ

Comments:

10. Were all clinically important outcomes considered?

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider whether
- there is other information you would like to have seen
- if not, does this affect the decision

Comments:

CASP
Critical Appraisal Skills Programme

11. Are the benefits worth the harms and costs?

Yes ☐
Can't Tell ☐
No ☐

HINT: Consider
- even if this is not addressed by the trial, what do **you** think?

Comments:

THE JOANNA BRIGGS INSTITUTE

JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies)

Reviewer_____Date_____

Author _____Year_____Record Number_____

		Yes	No	Unclear	Not applicable
1.	Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	☐	☐	☐	☐
2.	Were the participants included in any comparisons similar?	☐	☐	☐	☐
3.	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	☐	☐	☐	☐
4.	Was there a control group?	☐	☐	☐	☐
5.	Were there multiple measurements of the outcome both pre and post the intervention/exposure?	☐	☐	☐	☐
6.	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	☐	☐	☐	☐
7.	Were the outcomes of participants included in any comparisons measured in the same way?	☐	☐	☐	☐
8.	Were outcomes measured in a reliable way?	☐	☐	☐	☐
9.	Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

_____

_____

_____

© Joanna Briggs Institute 2017

Appendix 2: Summary of Quality Appraisal (Literature Review Section 1)

Critical Appraisal Results of Included Randomised Controlled Trial Studies

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total%
1.Goff et al.2004	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	81.8
2.Meischke et al.2004	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	90.9
2.Buckley et al.2007	Y	Y	Y	C	N	Y	Y	Y	Y	Y	Y	81.8
3.Tullmann et al.2007	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	90.9
4.McKinley et al.2007	Y	Y	Y	C	N	Y	Y	Y	Y	Y	Y	81.8
5.O' Brien et al. 2014	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	90.9

Y=Yes, C= can't tell, N=No

Critical Appraisal Results of Included Non-Randomised Controlled Trial Studies

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total%
7.Bell et al.2009	Y	N/A	Y	NA	Y	Y	Y	Y	Y	77.8
8.DeVon et al. 2010	Y	Y	Y	Y	Y	Y	Y	Y	Y	100.0
9.Gallagher et al. 2013	Y	N/A	N/A	NA	Y	Y	Y	Y	Y	66.7
10.Singh et al. 2016	Y	N/A	N/A	NA	Y	Y	Y	Y	Y	66.7

Y=Yes, U=Unclear, N=No

Appendix 3: Summary of Quality Appraisal (Literature Review Section 2)

Summary of Quality Appraisal of Included Studies

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total%
1.Bickmore, Pfeifer & Paasche-Orlow 2009	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	90.9
2.An et al. 2013	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	90.9
3.Bickmore, Schulman & Sidner 2013	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	90.9
4.Andrade et al. 2014	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	81.8
5.Bickmore et al. 2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
6.Pinto et al.2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100

Y=Yes, C= Can't tell, N=No

Appendix 4: Ethics Approval Letter (Study 1)

Southern Adelaide Clinical Human Research Ethics Committee

Government of South Australia
Southern Adelaide Health Service

Ethics application approval

You are reminded that this letter constitutes ethical approval only. You must not commence this research project at a SA Health site until separate authorisation from the Chief Executive or delegate of that site has been obtained.

07 July 2015

Dear Professor Clark

This is a formal correspondence from the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC EC00188). This committee operates in accordance with the "National Statement on Ethical Conduct in Human Research (2007)." No hard copy correspondence will be issued.

Application Number: 168.15 - HREC/15/SAC/138

Title: The development and evaluation of a Simple avatar based Application for improVing chest pain Education: The SAVE study

Chief investigator: Professor Robyn Clark

Public health sites approved: Flinders Medical Centre

The Issue: The Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC) have reviewed and approved the above application. The approval extends to the following documents/changes:

- SA Health Low and Negligible Risk (LNR) application form dated 07 April 2015
- Avatar story board
- Finders University indemnity approval dated 08 April 2015

Your response to committee concerns received via email containing the following:

- Cover letter dated 18 June 2015
- Minute addressing committee concerns dated 18 June 2015
- Preliminary evaluation survey v3 dated 18 June 2015
- Participant information sheet/consent form – focus group v2 dated 15 June 2015
- Participant information sheet/consent form – survey v2 dated 15 June 2015

Approval Period: 07 July 2015 – 07 July 2018

Please read the terms and conditions of ethical approval below, as researchers have a significant responsibility to comply with reporting requirements and the other stated conditions.

For example, the implications of not providing annual reports and requesting an extension for research prior to approval expiring could lead to the suspension of the research, and has further serious consequences.

Please retain a copy of this approval for your records.

Flinders Medical Centre
The Flats G5 – Rooms 3 and 4
Flinders Drive, Bedford Park SA 5042
T: 08 8204 6453
F: 08 8204 4586
E:Research.ethics @health.sa.gov.au

TERMS AND CONDITIONS OF ETHICAL APPROVAL
Final ethical approval is granted subject to the researcher agreeing to meet the following terms and conditions.

As part of the Institution's responsibilities in monitoring research and complying with audit requirements, it is essential that researchers adhere to the conditions below.

Researchers have a significant responsibility to comply with the *National Statement 5.5.* in providing the SAC HREC with the required information and reporting as detailed below:

1. **The approval only covers the science and ethics component of the application**. A SSA will need to be submitted and authorised before this research project can commence at any of the approved sites identified in the application.
2. **It is the policy of the SAC HREC not to provide signed hardcopy or signed electronic approval letters**, as our office is moving to electronic documentation. The SAC HREC office provides an unsigned electronic PDF version of the study approval letter to the Chief Investigator/Study Manager via email. These email approvals are generated via the email address research.ethics@health.sa.gov.au which can be linked back to the SAC HREC.
3. **If University personnel are involved in this project**, the Principal Investigator should notify the University before commencing their research to ensure compliance with University requirements including any insurance and indemnification requirements.
4. **Compliance** with the *National Statement on Ethical Conduct in Human Research* (2007) & the *Australian Code for the Responsible Conduct of Research* (2007).
5. To **immediately report to SAC HREC** anything that may change the ethical or scientific integrity of the project.
6. **Report Significant Adverse events (SAE's)** as per SAE requirements available at our website.
7. **Submit an annual report on each anniversary of the date of final approval** and in the correct template from the SAC HREC website.
8. **Confidentiality** of research participants MUST be maintained at all times.
9. A copy of the **signed consent form** must be given to the participant unless the project is an audit.
10. Any **reports or publications derived from the research** should be submitted to the Committee at the completion of the project.
11. All requests for **access to medical records** at any SALHN site must be accompanied by this approval email.
12. To **regularly review the SAC HREC website** and comply with all submission requirements, as they change from time to time.
13. The researchers agree to use **electronic format** for all correspondence with this department.

Kind Regards

Petrina Kasperski
Executive Officer, SAC HREC

On behalf of
Professor David Gordon
Chair, SAC HREC

Appendix 5: Site Specific Assessment Approval Letter (Study 1)

FLINDERS MEDICAL CENTRE

Government of South Australia
Southern Adelaide Health Service

19 August 2015

Professor Robyn Clark
School of Nursing and Midwifery
Flinders University
BEDFORD PARK SA 5042

Dear Professor Clark

HREC reference number:	HREC/15/SAC/138 (168.15)
SSA reference number:	SSA/15/SAC/284
Project title:	The development and evaluation of a Simple avatar based Application for improving chest pain Education: The SAVE study
Ethics approval:	07 July 2015 – 07 July 2018
Site:	Flinders Medical Centre
Subject:	Site Specific Assessment Review

Thank you for submitting an application for authorisation of this project. I am pleased to inform you that authorisation has been granted for this study to commence.

- SAC HREC approval letter dated 07 July 2015
- Site Specific Assessment form
- CV for Professor Robyn Clark
- Finders University indemnity approval dated 08 April 2015
- Preliminary evaluation survey v3 dated 18 June 2015
- Participant information sheet/consent form – focus group v2 dated 15 June 2015
- Participant information sheet/consent form – survey v2 dated 15 June 2015

HREC reviewed documents listed on the approval letter dated 07 July 2015 from the SAC HREC are accepted as part of the site authorisation.

Should you have any queries about the consideration of your Site Specific Assessment form, please contact Timothy Jones on 8204 4507.

The SSA reference number should be quoted in any correspondence about this matter.

If University personnel are involved in this project, the Principal Investigator should notify the University before commencing their research to ensure compliance with University requirements including any insurance and indemnification requirements.

Yours sincerely

[redacted]

Timothy Jones
Acting Research Governance Officer, Southern Adelaide Local Health Network

Flinders Medical Centre
The Flats G5 – Rooms 3 and 4
Flinders Drive, Bedford Park SA 5042
T: 08 8204 6453
F: 08 8204 4586
E:Research.ethics @health.sa.gov.au

Appendix 6: Participant Information/Consent Form Focus Group (Study 1 - Consumers)

Government of South Australia
SA Health

Flinders UNIVERSITY

Participant Information Sheet/Consent Form

Non-Interventional Study - *Adult providing own consent*

Flinders Medical Centre

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for impro**V**ing chest pain **E**ducation – *phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Rehabilitation Unit FMC

Part 1 What does my participation involve?

1. Introduction

You have been invited to take part in this research study, 'The development and evaluation of a simple avatar-based application for improving chest pain education'. This research project aims to develop an interactive education tool for improving patients' knowledge of and response to chest pain and other heart attack symptoms.

This Participant Information sheet/Consent Form tells you about the research project. It explains what participation in this study involves and knowing what is involved will help you to decide whether you want to take part in this research.

Please read this information carefully and ask questions about anything that you do not understand or want to know more about. Before deciding whether to take part in this study, you are welcome to talk about it with a relative, friend or local doctor.

Participation in this research is voluntary. If you do not wish to take part, you do not have to. If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing this, you are telling us that you:

- Understand what you have read.
- Consent to take part in the research project.
- Consent to allow us the use of your personal and health information as described.

You will be given a copy of the Participant Information Sheet/Consent Form to keep for your records.

2. What is the purpose of this research?

The warning signs of a heart attack are not the same for everyone; they can be mistaken for symptoms of other non-urgent and non-cardiac conditions (e.g., heartburn), therefore delaying appropriate effective management. A good understanding of heart attack symptoms and the correct responses to these symptoms are important for receiving timely treatment. However, reading and understanding medical information in a traditional booklet can be time consuming, daunting and difficult. In this research study, our research team aims to develop an interactive education tool that provides information on chest pain and other heart attack symptoms through the use of animation, videos, and voice, and without complex medical language. We would like you to participate in this development process to provide your opinion about the content, audio-visuals, and the user friendliness of the tool.

3. What does participation in this research involve?

If you agree to participate in this study, you will be asked to sign the Consent Form. Participation in this study will not interfere with your current medical treatment or your participation in the cardiac rehabilitation program. You will be involved in two focus group meetings with other people who also have heart conditions and the research team. The focus group meetings will be held at your cardiac rehabilitation unit at a time that is most suitable for all participants. It is anticipated that each focus group meeting will run for approximately one hour.

The sessions will be run by Ms Jintana Tongpeth and there will also be another researcher from the team to take notes during the meeting. Two audio recording devices will be used during the focus group meeting to record the conversations and help the researchers recall the conversations at a later time. The audio recording device will only be used if all participants give their permission to have the conversations recorded.

During the first focus group meeting, you will be asked to review our education tool and provide your opinions of the content, audio-visuals, and any other ideas you may have. Your opinions will be used to help the research team to develop and refine the education tool. The revised education tool will be presented to you during the second focus group meeting for your comments and feedback. A free copy of the tool will be given to you when it is completed at the end of this study.

If you would like to view the focus group meeting notes, please let one of the researchers know, and we will be very happy to send you a copy.

There is no cost associated with participating in this research project. You will be reimbursed for your time through a Myer gift card to the value of $20.

4. Do I have to take part in this research project?

Participation in this research study is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the study at any stage.

Your decision to take part in this research study will not affect your routine treatment, your relationship with those treating you or your relationship with Flinders Medical Centre or the cardiac rehabilitation program.

All research in Australia involving humans is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). This study will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies.
This research project has been approved by the HREC of Southern Adelaide (approval number HREC XXXX).

12. Further information and who to contact

If you want any questions or concerns about your participation in this research project, you can contact the researcher listed below:

Contact person

Name	Jintana Tongpeth
Position	PhD candidate
Telephone	08 8201 5135/08 8201 2997
Email	tong0076@flinders.edu.au

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

Reviewing HREC approving this research and HREC Executive Officer details

Reviewing HREC name	Southern Adelaide
HREC Executive Officer	Bev Stewart-Campbell
Telephone	08 8204 4507
Email	research.ethics@health.sa.gov.au

5. What if I withdraw from this research project?

You are free to withdraw from the study anytime without consequence. Please note, since the data collected during focus group meetings will not be individually identifiable; we will not be able to identify or remove data provided by you from this study.

6. What are the possible benefits of taking part?

The aim of this project is to develop and evaluate an education tool to help people gain information on how to recognise and respond to heart attack symptoms. Your participation will help the researchers develop a simple and effective education tool. Viewing the education tool during this study may help you gain a better understanding of chest pain and other heart attack symptoms, as well as the appropriate response.

7. What are the possible risks and disadvantages of taking part?

We do not foresee any physical or emotional risks from taking part in this research.

8. How will my confidentiality be protected?

Data collected through this research project is not individually identifiable and will be stored in a locked cabinet in the researcher's office within the School of Nursing & Midwifery building, Flinders University and will only be accessible to the researchers listed at the beginning of this document.

Any identifiable information that is collected about you during this study, including the Consent Form, will remain confidential and locked in a filing cabinet in the researcher's office within the School of Nursing & Midwifery, Flinders University. Your identification will be disclosed only with your permission or as required by law.

Part 2 How is the research project being conducted?

9. What will happen to information about me?

Any information or comments provided by you will be collected in a de-identified form.

Data collected through this study will be stored in a locked filing cabinet in the researcher's office within the School of Nursing and Midwifery, Flinders University. Electronic data will be kept on the Flinders University network computer in the School of Nursing and Midwifery, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document.

After completion of the study, audio files will be deleted, and the paper-based data will be stored for five years and destroyed by means of shredding. After five years, the electronic data files will also be deleted from the Flinders University network computer.

10. Who should I contact if I have concerns about the conduct of this study?

The ethical aspects of this study have been approved by the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC). If you have any concerns or complaints please contact: the Executive Officer, on 08 8204 6453 or email research.ethics@health.sa.gov.au.quote. The study approval number is HRECXXXX.

11. Who has reviewed the research project?

Form for Withdrawal of Participation - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation -*phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Rehabilitation Unit FMC

Declaration by Participant

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine treatment, my relationship with those treating me or my relationship with Flinders Medical Centre

Name of Participant (please print) _____

Signature _____ Date _____

Declaration by Study student/Senior Researcher†

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

Name of Study student/
Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of and information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

Consent Form - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation – *phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Rehabilitation Unit FMC

Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future health care.

I understand that I will be given a signed copy of this document to keep.

☐ (Please tick if you agree) I agree to have the conversations recorded during the focus group meetings.

Name of Participant (please print) _____

Signature _____ Date _____

Name of Witness* to Participant's Signature (please print) _____

Signature _____ Date _____

* Witness is not to be the investigator, a member of the study team or their delegate. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. Witness must be 18 years or older.

Declaration by Study student /Senior Researcher†

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Study student/ Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

Appendix 7: Participant Information/Consent Form Focus Group (Study 1 - Cardiovascular Experts)

Government of South Australia
SA Health

Flinders UNIVERSITY

Participant Information Sheet/Consent Form

Non-Interventional Study - *Adult providing own consent*

Flinders Medical Centre

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for impro**V**ing chest pain **E**ducation – *phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	iCCnet Country Health SA Local Health Network Level 2B Oliphant science centre Boardroom Mark Oliphant Building Laffer Drive

Part 1 What does my participation involve?

1. Introduction

You have been invited to take part in this research study, 'The development and evaluation of a simple avatar-based application for improving chest pain education'. This research project aims to develop an interactive education tool for improving patients' knowledge of and response to chest pain and other heart attack symptoms.

This Participant Information sheet/Consent Form tells you about the research project. It explains what participation in this research project involves and understanding what is involved will help you to decide whether you want to take part in this research.

Please read this information carefully and ask questions about anything that you do not understand or want to know more about. Before deciding whether to take part in this study.

Participation in this research is voluntary. If you do not wish to take part, you do not have to. If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing this, you are telling us that you:

- Understand what you have read.
- Consent to take part in the research project.
- Consent to allow us the use of your personal information as described.

You will be given a copy of the Participant Information Sheet/Consent Form to keep for your records.

2. What is the purpose of this research?

The warning signs of a heart attack are not the same for everyone; they can be mistaken for symptoms of other non-urgent and non-cardiac conditions (e.g., heartburn), therefore delaying appropriate effective management. A good understanding of heart attack symptoms and the correct responses to these symptoms are important for receiving timely treatment. However, reading and understanding medical information in a traditional booklet can be time consuming, daunting and difficult. In this research study, our research team aims to develop an interactive education tool that provides information on chest pain and other heart attack symptoms through the use of animation, videos, and voice, and without complex medical language. We would like you to participate in this development process to provide your opinion about the content, audio-visuals, and the user friendliness of the tool.

3. What does participation in this research involve?

If you agree to participate in this study, you will be asked to sign the Consent Form. You will be involved in two expert panel discussion sessions with other cardiovascular experts and the research team. The expert panel discussion sessions will be held at iCCnet Oliphant science centre Boardroom at a time that is most suitable for all participants. It is anticipated that each expert panel discussion sessions will run for approximately one hour.

We would like to invite you to two expert panel discussion sessions will be run by Prof Robyn Clark (Moderator) and Ms Jintana Tongpeth (Assistant Moderator). Recording devices will be used during the focus group meetings to record the conversations.

During our the first discussion, you will be asked to provide ideas for improving patient education particularly for elders and patients with low functional and health literacy and we will present our work to date. In the second expert panel meeting we will present our interactive education application (based on your feedback) and seek further opinions of the content, and any other ideas you may have to help us.

If you would like to view the focus group meeting notes, please let one of the researchers know, and we will be very happy to send you a copy.

There is no cost associated with participating in this research project. You will be reimbursed for your time through a Myer gift card to the value of $20.

4. Do I have to take part in this research project?

Participation in this research study is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the study at any stage.

5. What if I withdraw from this research project?

You are free to withdraw from the study anytime without consequence. Please note, since the data collected during focus group meetings will not be individually identifiable; we will not be able to identify or remove data provided by you from this study.

12. Further information and who to contact

If you want any questions or concerns about your participation in this research project, you can contact the researcher listed below:

Contact person

Name	Jintana Tongpeth
Position	PhD candidate
Telephone	08 8201 5135/08 8201 3266
Email	tong0076@flinders.edu.au/robyn.clark@flinders.edu.au

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

Reviewing HREC approving this research and HREC Executive Officer details

Reviewing HREC name	Southern Adelaide
HREC Executive Officer	Bev Stewart-Campbell
Telephone	08 8204 4507
Email	research.ethics@health.sa.gov.au

Consent Form - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation – *phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	iCCnet Country Health SA Local Health Network Level 2B Oliphant science centre Boardroom Mark Oliphant Building Laffer Drive

Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future health care.

I understand that I will be given a signed copy of this document to keep.

☐ (Please tick if you agree) I agree to have the conversations recorded during the focus group meetings.

Name of Participant (please print) _____

Signature _____ Date _____

Name of Witness* to Participant's Signature (please print) _____

Signature _____ Date _____

* Witness is not to be the investigator, a member of the study team or their delegate. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. Witness must be 18 years or older.

Declaration by Study student /Senior Researcher†

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Study student/ Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

Form for Withdrawal of Participation - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation -*phase I (focus group)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	School of Nursing and Midwifery Flinders University

Declaration by Participant

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine treatment, my relationship with those treating me or my relationship with Flinders Medical Centre

Name of Participant (please print) _____

Signature _____ Date _____

Declaration by Study student/Senior Researcher†

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

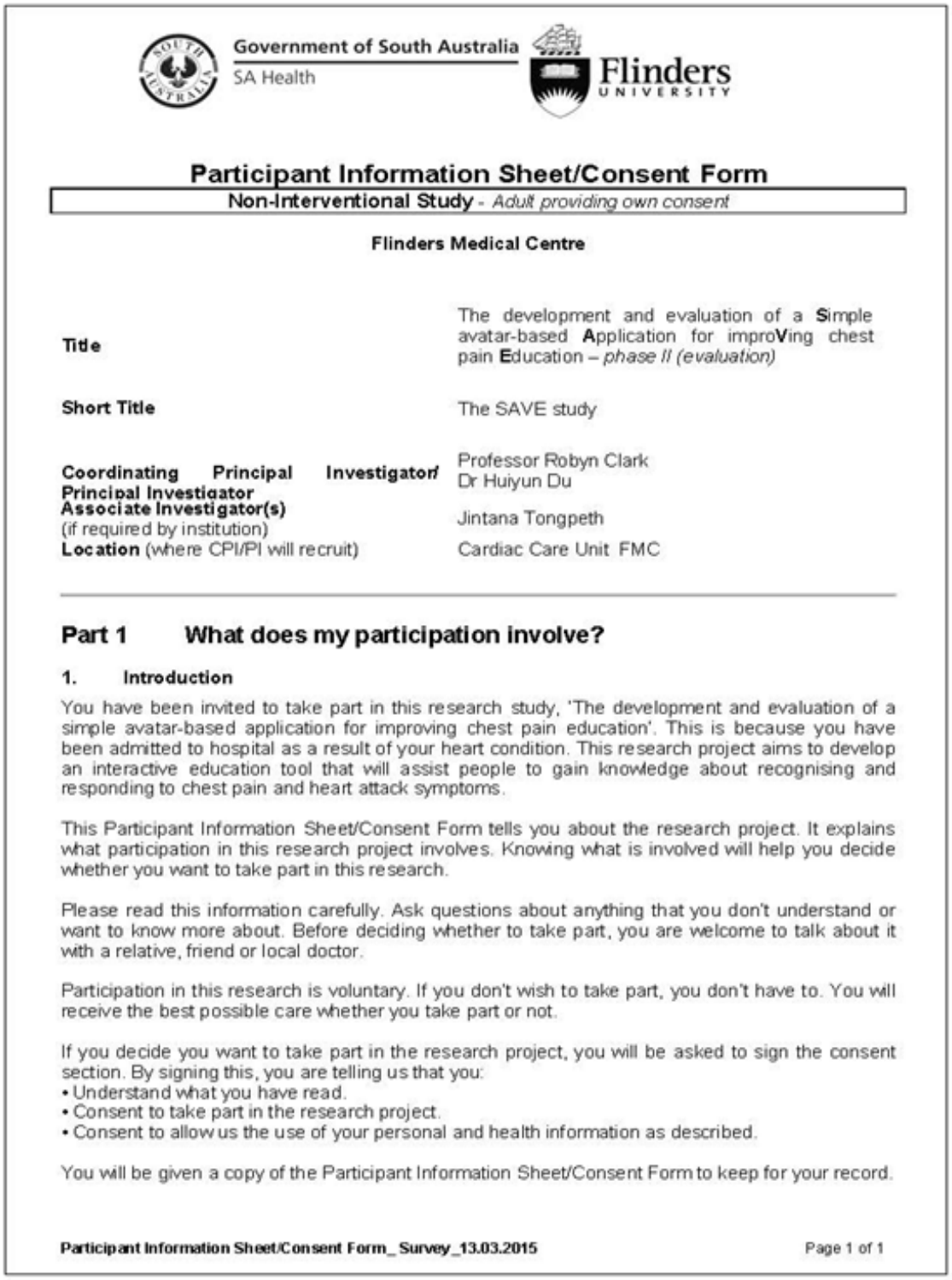
Name of Study student/
Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of and information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

Appendix 8: Participant Information/Consent Form Pre-Test Post-Test (Study 1)



Government of South Australia
SA Health

Flinders UNIVERSITY

Participant Information Sheet/Consent Form

Non-Interventional Study - *Adult providing own consent*

Flinders Medical Centre

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for impro**V**ing chest pain **E**ducation – *phase II (evaluation)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Care Unit FMC

Part 1 What does my participation involve?

1. Introduction

You have been invited to take part in this research study, 'The development and evaluation of a simple avatar-based application for improving chest pain education'. This is because you have been admitted to hospital as a result of your heart condition. This research project aims to develop an interactive education tool that will assist people to gain knowledge about recognising and responding to chest pain and heart attack symptoms.

This Participant Information Sheet/Consent Form tells you about the research project. It explains what participation in this research project involves. Knowing what is involved will help you decide whether you want to take part in this research.

Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether to take part, you are welcome to talk about it with a relative, friend or local doctor.

Participation in this research is voluntary. If you don't wish to take part, you don't have to. You will receive the best possible care whether you take part or not.

If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing this, you are telling us that you:
- Understand what you have read.
- Consent to take part in the research project.
- Consent to allow us the use of your personal and health information as described.

You will be given a copy of the Participant Information Sheet/Consent Form to keep for your record.

Participant Information Sheet/Consent Form_ Survey_13.03.2015 Page 1 of 1

2. What is the purpose of this research?

The warning signs of a heart attack are not the same for everyone; they can be mistaken for symptoms of other non-urgent and non-cardiac conditions (e.g., heartburn) and, therefore, delay appropriate effective management. A good understanding of heart attack symptoms and the correct responses to these symptoms is important for receiving timely treatment. However, reading and understanding medical information in a traditional booklet can be time consuming, daunting and, at times, difficult. In this research study, our research team has developed an interactive education tool that provides information on chest pain recognition and management through the use of animation, videos and voice and without the use of complex medical language. We would like you to review and evaluate this tool and provide your opinions of the content, audio-visuals and user friendliness through a survey.

3. What does participation in this research involve?

If you agree to participate in this study, you will be asked to sign the Consent Form. Participation in this research involves the trial use of a newly developed education tool and completion of a survey.

Participation in this study will not interfere with your current medical treatment. You will be asked to use a newly developed education tool via an iPad. It will take less than five minutes of your time to go through the tool. After using the education tool, you will be asked to complete a two-page survey, which will ask for your opinions of the audio-visuals, content and user friendliness of the tool. It will take less than five minutes to complete this survey. The researcher will be available to answer any questions you may have about the tool and/or the survey. Your opinions will be used to help the research team develop and refine this education tool.

There are no costs associated with participating in this research project. You will be reimbursed for your time through a Myer gift card to the value of $20.

4. Do I have to take part in this research project?

Participation in this research study is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the study at any stage.

Your decision to take part in this research study will not affect your routine treatment, your relationship with those treating you or your relationship with Flinders Medical Centre.

5. What if I withdraw from this research project?

You are free to withdraw from the study at any time without consequence. Please note however, since the data will be collected and stored in a de-identified form, once the survey is submitted, we will not be able to re-identify it or remove it from this study.

6. What are the possible benefits of taking part?

The aim of this project is to develop and evaluate an education tool to help people gain information on heart attack symptoms and the correct responses to those symptoms. Your participation will help the researchers develop a simple and effective education tool. Viewing the education tool during this study may help you gain a better understanding of chest pain and heart attack symptoms and what you should do.

7. What are the possible risks and disadvantages of taking part?

We do not foresee any physical or emotional risks from taking part in this research.

8. How will my confidentiality be protected?'

Data collected through this research project is not individually identifiable. Completed surveys will be stored in a locked cabinet in the researcher's office within the School of Nursing & Midwifery building, Flinders University and will only be accessible to the researchers listed at the beginning of this document.

Any identifiable information that is collected about you during this study, including the Consent Form, will remain confidential and locked in a filing cabinet in the researcher's office within the School of Nursing & Midwifery, Flinders University. Your identification will be disclosed only with your permission or as required by law.

Part 2 How is the research project being conducted?

9. What will happen to information about me?

Any information or comments provided by you will be collected in a de-identified form.

The survey will be stored in a locked filing cabinet in the researcher's office within the School of Nursing and Midwifery, Flinders University. Electronic data will be kept on the Flinders University network computer in the School of Nursing and Midwifery, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document.

After completion of the study, audio files will be deleted, and the paper data will be stored for five years and then shredded. After five years, the electronic data files will also be deleted from the Flinders University network computer.

10. Who should I contact if I have concerns about the conduct of this study?

The ethical aspects of this study have been approved by the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC). If you have any concerns or complaints please contact: the Executive Officer, on 08 8204 6453 or email research.ethics@health.sa.gov.au.quote The study approval number is HRECXXXX.

11. Who has reviewed the research project?

All research in Australia involving humans is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). This study will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies.
This research project has been approved by the HREC of Southern Adelaide (approval number HREC XXXX).

12. Further information and who to contact

If you want any questions or concerns about your participation in this research project, you can contact the researcher listed below:

Contact person

Name	Jintana Tongpeth
Position	PhD candidate
Telephone	08 8201 5135/08 8201 2997
Email	tong0076@flinders.edu.au

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

Reviewing HREC approving this research and HREC Executive Officer details

Reviewing HREC name	Southern Adelaide
HREC Executive Officer	Bev Stewart-Campbell
Telephone	0882044507
Email	research.ethics@health.sa.gov.au

Consent Form - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation - *phase II (evaluation)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Care Unit FMC

Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future health care.

I understand that I will be given a signed copy of this document to keep.

Name of Participant (please print) _____

Signature _____ Date _____

Name of Witness* to Participant's Signature (please print) _____

Signature _____ Date _____

* Witness is not to be the investigator, a member of the study team or their delegate. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. Witness must be 18 years or older.

Declaration by Study student /Senior Researcher†

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Study student/ Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

Form for Withdrawal of Participation - *Adult providing own consent*

Title	The development and evaluation of a **S**imple avatar-based **A**pplication for improVing chest pain **E**ducation -*phase II (evaluation)*
Short Title	The SAVE study
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du
Associate Investigator(s) (if required by institution)	Jintana Tongpeth
Location (where CPI/PI will recruit)	Cardiac Rehabilitation Unit FMC

Declaration by Participant

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine treatment, my relationship with those treating me or my relationship with Flinders Medical Centre

Name of Participant (please print) _____

Signature _____ Date _____

Declaration by Study student/Senior Researcher†

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

Name of Study Student/
Senior Researcher† (please print) _____

Signature _____ Date _____

† A senior member of the research team must provide the explanation of and information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

Appendix 9: Data Collection (Pre-Test Post-Test) (Study 1)



Participant ID

The development and evaluation of a Simple avatar-based education Application for improVing chest pain Education

Preliminary evaluation



Participant ID

Section 1: Acute Coronary Syndrome Response Index

Patient interview

Age: _____ years; Gender: Male Female

Knowledge Subscale

Please circle "0" if the participant thinks it *is not* a symptom of a heart attack or "1" if the participant thinks it *is* a symptom of heart attack.

		No	Yes
1.	Lower abdominal pain (Reverse coded)	0	1
2.	Arm pain or shoulder pain	0	1
3.	Arm paralysis (Reverse coded)	0	1
4.	Back pain	0	1
5.	Chest pain/pressure/tightness	0	1
6.	Chest discomfort (heaviness, burning, tenderness)	0	1
7.	Cough (Reverse coded)	0	1
8.	Dizziness, lightheadedness	0	1
9.	Headache (Reverse coded)	0	1
10.	Heartburn/indigestion/stomach problem	0	1
11.	Jaw pain	0	1
12.	Loss of consciousness/fainting	0	1
13.	Nausea/vomiting	0	1
14.	Neck pain	0	1
15.	Numbness/tingling in arm or hand (Reverse coded)	0	1
16.	Pale, ashen, loss/change of colour	0	1
17.	Palpitations/rapid heart rate	0	1
18.	Shortness of breath/difficulty breathing	0	1
19.	Slurred speech	0	1
20.	Sweating	0	1
21.	Weakness/fatigue	0	1



Participant ID

Attitudes Subscale

Please circle "1" for not at all, "2" for a little sure, "3' for pretty sure, and "4" for very sure.

22. How sure are you that you could recognize the signs and symptoms of a heart attack in someone else?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
23. How sure are you that you could recognize the signs and symptoms of a heart attack in yourself?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
24. How sure are you that you could tell the difference between the signs or symptoms of a heart attack and other medical problems?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
25. How sure are you that you could get help for someone if you though they were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
26. How sure are you that you could get help for yourself if you thought you were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure



Participant ID

Belief Subscale

Please circle "1" for not at all, "2" for a little sure, "3' for pretty sure, and "4" for very sure.

27. If I have chest pain that doesn't stop after 15 minutes, I should get to the hospital as soon as possible			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
28. I would be embarrassed to go to the hospital if I thought I was having a heart attack but I wasn't.			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
29. If I thought I was having a heart attack, I would wait until I was very sure before going to the hospital.			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
30. If I thought I was having a heart attack, I would rather have someone drive me to the hospital than have an ambulance come to my home.			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
31. Because of the cost of medical care, I would want to be absolutely sure I was having a heart attack before going to the hospital.			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
32. If I'm having chest pain and I'm not very sure if it's a heart attack, I should go to the hospital			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
33. If I thought I was having a heart attack, I would go to the hospital right away			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure

Riegel, B., et al., *Psychometric evaluation of the acute coronary syndrome (ACS) response index.* Research in nursing & health, 2007. **30**(6): p. 584-594.



Participant ID

Section 2: SAVE Satisfaction Questionnaire

Patient interview

✓ Tick Box	Strongly Disagree	Disagree	Do Not Agree Nor Disagree	Agree	Strongly Agree
1. I liked the Avatar (the character within the app)					
2. The audio of the app was clear and easy enough for me to understand					
3. The size of the print on screen was large enough for easy reading					
4. It was easy to press the buttons on the screen					
5. The app has helped me to better understand symptoms of a heart attack					
6. The app has taught me how to recognise and respond to symptoms of a heart attack					
7. The content were hard to understand					
8. It takes too long to use the app					
9. The information was clear and concise					
10. The app explained things in terms I could understand					
11. I learnt something that I was not taught about before					
12. I now have an action plan if I experience symptoms of a heart attack in the future					



Participant ID

✓ Tick Box	Strongly Disagree	Disagree	Do Not Agree Nor Disagree	Agree	Strongly Agree
13. The app has helped me to be more confident in recognising and managing heart attack symptoms in the future.					
14. The app maintained my interest and attention					
15. My overall impression is that the app was excellent					

Overall, how satisfied are you with this app?

Not at all					Indifferent					Highly
0	1	2	3	4	5	6	7	8	9	10

Do you have any further comment about this app?

Adapted from:
Gwadry-Sridhar, F., et al., Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure. European journal of heart failure, 2003. 5(6): p. 783-791.
Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure self-care amongst indigenous Australians: a pilot study', ALAR: Action Learning and Action Research Journal, vol. 19, no. 2, p. 40.

Appendix 10: Ethics Approval Letter (Study 2)

Office for Research

Flinders Medical Centre / The Flats F6/F8
Flinders Drive, Bedford Park SA 5042
Tel: (08) 8204 6453
E: Health.SALHNOfficeforResearch@sa.gov.au

Government of South Australia
SA Health
Southern Adelaide Local Health Network

Final approval for ethics application

You are reminded that this letter constitutes **ethical** approval only. **Ethics approval is one aspect of the research governance process.**
You must not commence this research project at any SA Health sites listed in the application until a Site Specific Assessment (SSA), or Access Request for data or tissue form has been authorised by the Chief Executive or delegate of each site.

28 April 2016

Professor Robyn Clark
School of Nursing and Midwifery
Flinders University
BEDFORD PARK SA 5042

Dear Professor Clark

The Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC EC00188) have reviewed and provided ethical approval for this application which appears to meet the requirements of the *National Statement on Ethical Conduct in Human Research.*

Application Number: OFR # 290.15 - HREC/15/SAC/247

Title: The effectiveness of a simple avatar-based application for improving heart attack symptom education: A pragmatic randomised controlled trial.

Chief investigator: Professor Robyn Clark

Approval Date: 26 April 2016

Approval Period: 26 April 2016 to 26 April 2020

Public health sites approved under this application: Flinders Medical Centre

The below documents have been reviewed and approved:

- Cover Letter dated 16 June 2015
- General Research Application form v3 dated 11 April 2015 (clean and tracked)
- Participant Information Sheet/Consent Form v4 dated 11 April 2016
- Baseline Data Collection and Assessment v9 dated 12 June 2015
- Post-teaching with SAVE app v9 dated 12 June 2015
- One-month telephone follow up v9 dated 12 June 2015
- Six-month telephone follow-up v9 dated 12 June 2015
- Indemnity – Flinders University dated 06 May 2015
- Indemnity – SA Health dated 06 May 2015
- Dr Huiyun Du CV dated May 2015
- Jintana Tongpeth CV dated May 2015

TERMS AND CONDITIONS OF ETHICAL APPROVAL
As part of the Institution's responsibilities in monitoring research and complying with audit requirements, it is essential that researchers adhere to the conditions below and with the *National Statement chapter 5.5.*

Final ethical approval is granted subject to the researcher agreeing to meet the following terms and conditions:

Appendix 11: Site Specific Assessment Approval Letter (Study 2)

Office for Research

Flinders Medical Centre / The Flats F6/F8
Flinders Drive, Bedford Park SA 5042
Tel: (08) 8204 6453
E: Health.SALHNOfficeforResearch@sa.gov.au

Government of South Australia
SA Health
Southern Adelaide Local Health Network

10 June 2016

Professor Robyn Clark
School of Nursing and Midwifery
Flinders University
BEDFORD PARK SA 5042

Dear Professor Robyn Clark

HREC reference number:	HREC/15/SAC/247 **290.15**
SSA reference number:	SSA/16/SAC/156
Project title:	The effectiveness of a Simple avatar based Application for improving chest pain Education: A Pragmatic randomised controlled trial.
Ethics approval:	26 April 2016 to 26 April 2020
Site:	Flinders Medical Centre
Subject:	Site Specific Assessment Review

Thank you for submitting an application for authorisation of this project.

On the basis of the information provided in your Site Specific Assessment submission, I am pleased to inform you that authorisation has been granted for this study to commence.

This authorisation is based on the following documents:

Site Specific Assessment form AU/12/087F114
SAC HREC Approval Letter dated 28 April 2018
PICF_SAVEstudy_PRCT_version4 dated 11 April 2016
SA Health Indemnity dated 07 May 2015
FUSA Indemnity dated 06 May 2015
Professor Robyn Clark, Principal Investigator CV

HREC reviewed documents listed on the approval letter are accepted as part of the site authorisation.

The SSA reference number should be quoted in any correspondence about this matter.

If Flinders University SA personnel are involved in this project, the Principal Investigator should notify the University before commencing their research to ensure compliance with University requirements including any insurance and indemnification requirements.

Should you have any queries about the consideration of your Site Specific Assessment form, please contact Dawn Jennifer on 8204 6453.

Yours sincerely

[redacted]

Paula Davies
Manager, Office for Research

Appendix 12: Participant Information Sheet/Consent Form (Study 2)



Participant Information Sheet/Consent Form

Interventional Study - *Adult providing own consent*

Flinders Medical Centre

Title	The effectiveness of a **S**imple avatar-based **A**pplication for impro**V**ing Heart Attack Symptom **E**ducation: A Pragmatic randomised controlled trial
Short Title	The SAVE study: PRCT
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du Ms Jintana Tongpeth
Associate Investigator(s) (if required by institution)	Professor Derek Chew Ms Sharon Burns
Location (where CPI/PI will recruit)	Cardiac care unit FMC

Part 1 What does my participation involve?

1. Introduction

You have been invited to take part in a research study because you have experienced chest pain or other heart attack symptoms previously. The project, entitled 'The effectiveness of a simple avatar-based application for improving heart attack symptom education' aims to evaluate a health teaching tool for improving patients' knowledge of and response to symptoms of heart attack

This Participant Information Sheet/Consent Form tells you about the research project. It explains what participation in this research project involves and knowing what is involved will help you to decide whether you want to take part in this research.

Please read this information carefully, and ask questions about anything that you do not understand or want to know more about. Before deciding whether to take part in this study, you are welcome to talk about it with a relative, friend or your doctor.

Participation in this research is voluntary. If you do not wish to take part, you do not have to. If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing this, you are telling us that you:

- Understand what you have read.
- Consent to take part in the research project.
- Consent to allow us the use of your personal and health information as described.

You will be given a copy of this Participant Information Sheet/Consent Form to keep for your records.

2. What is the purpose of this research?

The warning signs of a heart attack are not the same for everyone; they can be mistaken for symptoms of other non-urgent and non-cardiac conditions (e.g., heartburn), therefore, delaying appropriate effective management. A good understanding of heart attack symptoms and the correct responses to these symptoms are important for receiving timely treatment. However, reading and understanding medical information in a traditional booklet can be time consuming, daunting and difficult. In this research study, our research team has developed a health teaching tool that provides information on chest pain and other heart attack symptoms through the use of animation, and voice, without the use of complex medical language. Therefore, this study aims to evaluate whether this health teaching tool is effective in teaching heart attack symptoms.

3. What does participation in this research involve?

If you agree to participate in this study:

- You will be asked to sign the Consent Form. This is to tell us that you understand what you have read and consent to take part in the research project, as well as to allow us the use of your personal and health information as described.

- You will be assessed for cognitive function at baseline with a questionnaire before you are randomised to the education group or the usual care group.

- If your cognitive function score less than minimum score of 27. You will be not randomised to take part in the research project

- The research nurse will also collect information about your current medical condition and past medical history from your medical records.

- You will be randomly allocated to a study group; this may be the health teaching tool group or the usual care group. Neither the research nurse nor you can decide which group you will be put into.

- If you are assigned to the health teaching tool group, you will meet with a research nurse, who will provide an iPad style tablet and shown how to use it. The health teaching tool, which provides information about heart attack symptoms and what you should do if these symptoms do occur in the future. It will take approximately 10 minutes of your time

- After that, the research nurse will ask you some questions regarding the information provided in the health teaching tool and your thoughts about the health teaching tool. It will take you approximately 20 minutes in total. You can take home a tablet to review the heath teaching tool during six-months after you discharged from the hospital.

- After discharge, you will have another two telephone appointments with the research nurse. The first telephone appointment will be one month after you are discharged from the hospital, and the second telephone appointment will be at six months after you are discharged. During the telephone follow-up, the research nurse will ask you some questions from those same questionnaires you had in hospital to see if you remembered what you have learned. Each phone call will take you approximately 20 minutes in total.

- If you are assigned to the usual care group, the research nurse will contact you by telephone after 1 and 6-months to ask your some questions regarding your heart condition.

- Regardless of the group you are allocated to, you will be provided with the “My heart my life” and/or “Living well with chronic heart failure” booklets, and will be contacted by telephone by our research nurse at 1-month and 6-months time after you are discharged from the hospital. The usual care you receive for your medical condition will not be

affected because of your participation in this study.

Please see the study flow chart. (Figure 1)

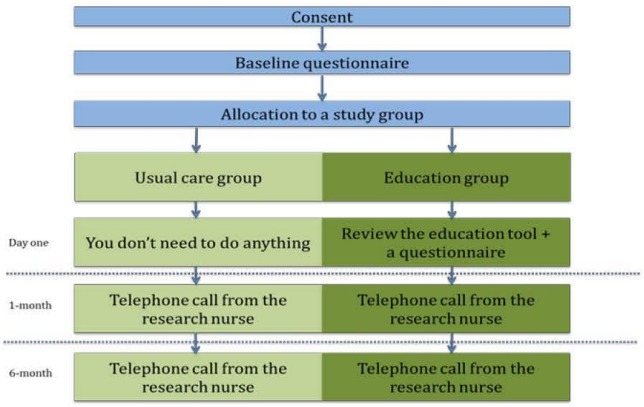


Figure 1 Study flow chart

4. Do I have to take part in this research project?

Participation in this research study is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the study at any stage.

Your decision to take part in this research study will not affect your routine treatment, your relationship with those treating you or your relationship with Flinders Medical Centre.

5. What are the possible benefits of taking part?

The aim of this project is to evaluate an education tool to help patients learn how to recognise and respond to heart attack symptoms. Your participation will help the researchers to evaluate a health teaching tool. Viewing the education tool during this study may help you to gain a better understanding of chest pain and other heart attack symptoms, as well as the appropriate response.

6. Will taking part in this study cost me anything, and will I be paid?"

Participation in this study will not cost you anything. Regardless of which group you are allocated to, you will be offered the health teaching tool to keep at the completion of this study.

7. What are the possible risks and disadvantages of taking part?

We do not foresee any physical or emotional risks from taking part in this research.

8. What if I withdraw from this research project?

You are free to withdraw from this study at any time without consequence.

9. What happens to my treatment when the study is finished?

Your current and future medical treatment and the care you receive from the hospital will not be affected by your participation in this study.

Part 2 How is the research project being conducted?

10. . What will happen to the information about me?

Any information or comments provided by you will be collected in a de-identified form.

The survey will be stored in a locked filing cabinet in the researcher's office within the School of Nursing and Midwifery, Flinders University. The electronic data will be kept on the Flinders University network computer in the School of Nursing and Midwifery, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document. The paper based data will be stored for seven years and destroyed by means of shredding, and the electronic data files will also be permanently deleted from the Flinders University network computer.

11. Who should I contact if I have concerns about the conduct of this study?

The ethical aspects of this study have been approved by the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC). If you have any concerns or complaints please contact: the Executive Officer, on 08 8204 6453 or email research.ethics@health.sa.gov.au.quote. The study approval number is HRECXXXX.

12. . Who has reviewed the research project?

All research in Australia involving humans is reviewed by an independent group of people called the Human Research Ethics Committee (HREC). This study will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies.
This research project has been approved by the Southern Adelaide Clinical Human Research Ethics Committee

13. Further information and who to contact

If you have any questions or concerns about your participation in this research project, you can contact the researcher listed below:

Contact person

Name	Jintana Tongpeth
Position	PhD candidate
Telephone	08 8201 5135/08 8201 2997
Email	tong0076@flinders.edu.au

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact:

Reviewing HREC approving this research and HREC Executive Officer details

Reviewing HREC name	Southern Adelaide Clinical
HREC Executive Officer	Damain Creaser
Telephone	088 204 6453
Email	Health.SALHNOfficeforresearch.sa.gov.au

Consent Form - *Adult providing own consent*

Title	The effectiveness of a **S**imple avatar-based **A**pplication for impro**V**ing heart attack symptom **E**ducation: A Pragmatic randomised controlled trial
Short Title	The SAVE study: PRCT
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du Ms Jintana Tongpeth
Associate Investigator(s) (if required by institution)	Professor Derek Chew Ms Sharon Burns
Location (where CPI/PI will recruit)	Cardiac care unit FMC

Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future health care.

I understand that I will be given a signed copy of this document to keep.

Name of Participant (please print) _____

Signature_____Date_____

Name of Witness* to Participant's Signature (please print) _____

Signature_____Date_____

* Witness is not to be the investigator, a member of the study team or their delegate. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. Witness must be 18 years or older.

Declaration by Study student /Senior Researcher†

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Study student / Senior Researcher† (please print) _____

Signature_____Date_____

† A senior member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

Form for Withdrawal of Participation - *Adult providing own consent*

Title	The effectiveness of a **S**imple avatar-based **A**pplication for impro**V**ing Heart Attack symptom **E**ducation: A Pragmatic randomised controlled trial
Short Title	The SAVE study: PRCT
Coordinating Principal Investigator/ Principal Investigator	Professor Robyn Clark Dr Huiyun Du Ms Jintana Tongpeth
Associate Investigator(s) (if required by institution)	Professor Derek Chew Ms Sharon Burns
Location (where CPI/PI will recruit)	Cardiac care unit FMC

Declaration by Participant

I wish to withdraw from participation in the above research project and understand that such withdrawal will not affect my routine treatment, my relationship with those treating me or my relationship with Flinders Medical Centre

Name of Participant (please print) _____

Signature_____Date_____

Declaration by Study student/Senior Researcher†

I have given a verbal explanation of the implications of withdrawal from the research project and I believe that the participant has understood that explanation.

Name of Study student / Senior Researcher† (please print) _____

Signature_____Date_____

† A senior member of the research team must provide the explanation of and information concerning withdrawal from the research project.

Note: All parties signing the consent section must date their own signature.

Appendix 13: General Research Application

Southern Adelaide Clinical Human Research Ethics Committee

Government of South Australia
SA Health

Flinders UNIVERSITY

General research application form

Project Title:	The effectiveness of a **S**imple avatar-based **A**pplication for impro**V**ing Heart Attack symptom **E**ducation: A Pragmatic randomised controlled trial
Investigator Details:	
Chief Investigators	
Name:	Robyn Clark
Qualifications:	Professor
Department/address:	School of Nursing and Midwifery Flinders University Bedford Park South Australia 5042
Contact details: phone and email	08 8201 3266
The Chief Investigator is to provide either a signature or an email to confirm they are part of the study with this application. Please do not send separately.	YES- an email is included confirming I am part of the study (See attached)
Name:	Huiyun Du
Qualifications:	PhD
Department/address:	School of Nursing and Midwifery Flinders University Bedford Park South Australia 5001
Contact details: phone and email	08 8201 2997
The Chief Investigator is to provide either a signature or an email to confirm they are part of the study with this application. Please do not send separately.	YES- an email is included confirming I am part of the study (See attached)
Name:	Jintana Tongpeth

Qualifications:	PhD candidate
Department/address:	School of Nursing and Midwifery Flinders University Bedford Park South Australia 5001
Contact details: phone and email	08 8201 5135
The Chief Investigator is to provide either a signature or an email to confirm they are part of the study with this application. Please do not send separately.	YES- an email is included confirming I am part of the study (See attached)
Co-investigators	
Name:	Derek Chew
Qualifications:	Professor
Department/address:	Cardiology
Contact telephone number:	08 8404 2001
Co-investigator agreement All co investigators are to provide either a signature or an email to confirm they are part of the study.	YES- an email is included confirming I am part of the study;
Name:	Sharon Burns
Qualifications:	Head of Cardiac care unit
Department/address:	Cardiac Care Unit
Contact telephone number:	08 8204 4315
Co-investigator agreement All co investigators are to provide either a signature or an email to confirm they are part of the study.	YES- an email is included confirming I am part of the study;
Contact Person	If other than an investigator
Name:	Jintana Tongpeth
Position:	PhD candidate
Department/address:	School of Nursing and Midwifery Flinders University Bedford Park

	South Australia 5001
Contact telephone number:	08 8201 5135
Email address:	tong0076@flinders.edu.au
Are you requesting a waiver of consent?	NO
Genetic Analysis Will there be any genetic (DNA/RNA) analyses?	NO
Financial interest Does the principal investigator have a financial interest in this study?	NO
Is this study commercially sponsored*? A commercial sponsor is the organisation or company that will be invoiced for the SAC HREC review of this application. **Details for invoicing:** Sponsor or coordinating company: ABN: Australian postal address and contact person: Sponsor protocol number for this study:	NO
Is this study funded by a grant? Is this study investigator driven? Is this study part of a cooperative trial group?	NO Yes NO

Where is this research being done in Australia?

Cardiac Care Unit, Flinders Medical Centre, South Australia

SA public health sites: Flinders Medical Centre, South Australia

Interstate public health sites: Nil

Letter of endorsement from the head of department

Please see attached letter from Prof Derek Chew the Director of Cardiology Department, Flinders Medical Centre.

Project Details

1. Background

Cardiovascular disease remains the leading cause of death and disability worldwide [1]. Each year there are more than 48,000 heart attacks in Australia, half of which are fatal. Much of the morbidity and many of the potential preventable complications associated with heart attack are linked with pre-hospital delay in seeking medical treatment [2-4]. Reducing the time from symptom onset to reperfusion therapy in people who are having a heart attack, can decrease the damage to heart muscle and reduce death rate. Reperfusion therapy within the first one to two hours can reduce death rate up to 50% [5]. Longer delay from symptom onset to treatment is associated with higher in-hospital mortality. Transportation and the time from patient's hospital arrival to treatment (in-hospital delay), is decreasing and only contributes to

a small percentage of the total delay time [6]. However the median pre-hospital delay time is 6.4 hours in Australia [7]. The time taken, by patients to decide to seek medical help, accounts for the largest portion of pre-hospital delay, and it is where the greatest improvement is needed in order to optimize patients' outcomes [8].

Evidence-based guidelines recommend that an ambulance should be called within 10 minutes of symptom onset [9]. Unfortunately, warning signs of a heart attack are inconsistent from person to person, and they can be mistaken as symptoms of another non-urgent and non-cardiac conditions (e.g. heartburn), therefore delaying appropriate response. Inadequate knowledge of symptom recognition and symptom management has been documented in the literature and it appears to be consistent with the observed patterns in patients' delay observed [10]. In one study in the United States, individuals with a history of heart disease had five to seven times the risk of having a heart attack or dying, however, 43% of those high-risk patients inappropriately rated their risk of having a heart attack as low. Moreover, 44% of the 3,522 patients (average age 67) with a history of heart attack had a low level of knowledge on heart disease [11]. A research study has shown that 78.15% of the patients (n=254) identified chest discomfort as a symptom of heart attack, 66.7% mistakenly thought the chest discomfort would be severe, sharp and stabbing pain. Almost 50% of the participants identified symptoms of a stroke (e.g. weakness on one side, severe headache, etc.) as the symptoms of a heart attack [8]. People with a history of heart disease need continuous reinforcement of both the nature of the symptoms, and the benefits of early medical treatment [8, 10].

Changes in the health care delivery system have led to shorter length of stay, and reduced the amount of time available for education. Patients are often provided with pamphlets, and booklets for reading; however, a mismatch often exists between the reading levels of health-related materials and the reading skills/health literacy level of the intended audience. Despite these being the groups with the most to gain from education interventions, the existing patient education programs have had limited reach to this population. The use of jargon and technical language has often made educational materials unnecessarily difficult for patients. A recent report showed that three quarters of Australian and New Zealand patients who have had a heart attack, were discharged to home without receiving basic follow-up advice and preventive care [12]. The large US study called the REACT study was conducted to test community based educational interventions, showed only a slight decrease in delay time in the interventions group [13]. Since this disappointing result, there have been few insights to further the development in the area of preventing pre-hospital delay using educational interventions [14]

2. Rationale

Limited health literacy is associated with high health system costs, and it is a challenge to the healthcare system globally. In 2011 the Australian Bureau of Statistics reported that 47% of the Australians are functionally illiterate. This means they cannot read the instructions on a medicine bottle, or even a map, or a recipe. Lack of knowledge regarding the symptoms of a

heart attack is recognized as a major obstacle to timely medical treatment and it is associated with potentially preventable death and complications.

Recent research in neuroscience and in cognitive functioning has increased our understanding of how people learn and how desired outcomes can be achieved through innovative interventions. Factors such as health literacy, numeracy, cognitive capacity and cultural needs influence the patient's learning experience and their capacity to adopt information for decision-making [15-17]. Specifically, cognitive capacity is an important consideration in understanding the design, feasibility and acceptability of patient education interventions [18, 19]. Interactive patient education interventions have been used to overcome barriers such as low literacy and low health literacy, among people living with a variety of conditions, including depression [20], diabetes [21, 22], breast cancer [23] and ileostomy [24]. In recent decades, the use of information technology in education has grown exponentially, such as the use of avatar [24] and simulation [25] Patients are increasingly access information from computer-based and multimedia sources. While positive outcomes of interactive education in different conditions existing in the literature [23], there is no published study on the development and evaluation of interactive education intervention for people at risk of a heart attack. Given the evident knowledge deficiency and pre-hospital decision delay, this interactive patient education approach may have a significant impact on the outcome of people experiencing a heart attack and could revolutionize the way that health information is communicated to patients.

The proposed project has the potential to replace the traditional booklets, brochures and complex medical language in patient education and is one of the first to address the issue of low literacy and low health literacy when communicating with patients who are at risk of heart attack. Our approach will improve patients' ability to recognize and manage heart attack symptoms, therefore improving patient outcome.

3. Objective

The aim of this project is to evaluate the effectiveness of an avatar-based education application for improving patients' knowledge of and responses to chest pain and other heart attack symptoms, through a pragmatic randomised controlled trial.

The specific objectives are:

1. To evaluate the effect of an avatar-based education application on knowledge of heart attack symptoms among patients who have experienced heart attack symptoms.
2. To evaluate the effect of an avatar-based education application on patients' responses to heart attack symptoms and healthcare service utilisation.
3. To compare the effect of an avatar based education application (aimed at improving patients' knowledge of and response to heart attack symptoms), between patients with low health literacy level and patients with an adequate literacy level.

Proposed Methods

1. Study design

   A pragmatic randomised controlled trial design, with two parallel groups, will be used to achieve the study's aim.

2. Study duration 1 January 2016 to 30 December 2017

3. Participants

   Potential participants will be identified by the nursing shift coordinator, during their hospital stay in the Cardiac Care Unit (CCU) of Flinders Medical Centre. Once consented, participants will undergo a screening phase to assess their eligibility. The study design will include a six-month follow-up period. It is anticipated that approximately 25 participants per week will be recruited.

4. Inclusion criteria and exclusion criteria

Inclusion Criteria	Exclusion Criteria
○ Admitted with any cardiac diagnosis where chest pain or other heart attack symptoms have been experienced previously	○ Clinically unstable
○ Clinically stable*	○ Cognitive impairment
○ Normal cognitive function	○ Failure to give informed consent
○ Sufficient English language ability to communicate and to follow the study procedure	

*Clinically stable is defined as the achievement of five normal vital signs (i.e. heart rate, systolic blood pressure, respiratory rate, oxygen saturation, and temperature) plus normal mental status and ability to eat, for at least 24 hours prior to enrolment in the study.

The nursing shift coordinator will identify potential participants based on his/her clinical judgement of patients' English language ability, cognitive capacity and clinical stability. If a potential participant agrees to be contacted by the study research nurse, the nursing shift coordinator will then introduce the research nurse to the patient at an agreed time. After obtaining consent, the research nurse will screen the potential participant based on the inclusion and exclusion criteria. Participants who are clinically unstable, whose MMSE score is less than 27 or who do not have the language skills to follow the study protocol will be excluded from this study.

5. Withdrawal criteria

   Participation in this study is voluntary. Participants are free to withdraw from the study at any time without consequence.

6. Intervention

6.1 Usual care group

"Usual care" in this study means care specific to a patient's diagnosis. Usual care at the study site will include bedside education in order to reinforce the diagnosis, procedures and risk factor management by bedside nurse. Bedside nurses will provide education about emergency chest pain and heart attack symptom action plans and about how to use the angina medicine. As part of usual care, the educational booklet (Heart Foundation's *My heart, my Life*)[26] and/or *Living well with chronic heart failure*) [27] will be provided to all patients. Moreover, the patients will be introduced to the cardiac rehabilitation co-ordinator for information regarding phase I and phase II cardiac rehabilitation programs before they are discharged from the hospital. The usual care group in this study will receive two telephone follow-ups (at one month and six months) after they are discharged from the hospital. Research nurse will contact the Cardiac Rehabilitation Nurse Team before telephone follow-up in order to avoid unknowingly contacting patient's families that the patients have passed away. The purpose of the telephone follow-up is to obtain information on implementation of the heart attack action plan and administer the Acute Coronary Syndrome (ACS) Response Index, Chest Pain Action Plan Survey and Health Services Utilisation questionnaires.

6.2 Intervention group

The education tool (i.e., the app) that will be used in this project is a simple and interactive avatar-based education application. An avatar is an icon or figure representing a particular person in a computer, tablet or smart phone. The app will enhance patient learning by minimising the need for reading, and by using modern computerized tools such as animation, voice and touch screen response; also, there will be no complex medical terminology used in the app (Figure 1).

Participants in the intervention group will receive the usual care plus the avatar-based education application (the app). Once randomisation, an iPad style tablet will be provide to all intervention group participants to view the app and to take home for the study period. The research nurse will provide explanations and instructions to participants on how to use the avatar-based education application. Participants in this group will be asked to use the app before they are discharged from hospital. It will take approximately 10 minutes to go through the app and an additional 10 minutes to complete the associated baseline surveys (i.e., ACS index and satisfaction survey).

Participant will be encouraged to use the app after hospital discharge, during the follow-up period. Two telephone follow-up calls (at one month and six months) will be scheduled with the participants before they are discharged from the hospital. The purpose of the telephone follow-up is to obtain information on implementation of the heart attack action plan and administer the Acute Coronary Syndrome (ACS) Response Index, Heart Attack Action Plan Survey and Health Services Utilisation questionnaires.

Regardless of group allocation, all patients consenting to participate in the study will undertake baseline assessment, including the following:

From the participant's medical record:

- Demographics data
- Clinical information and history
- The Global Registry of Acute Coronary Events (GRACE) Risk Score [28],

From the participant's interview:

- Rapid Estimate of Adult Literacy in Medicine-Short Form (REALM-SF) [29],
- Heart Attack Action Plan Survey,
- Health Services Utilisation, and
- Acute Coronary Syndrome Response Index (ACS Response Index) [30].

Both the intervention and usual care group will receive one-month and six-month telephone follow ups.

Details about each study measurement will be provided in a later section of this document. The Trial schema is illustrated in Figure 2.

8. Outcomes

Primary outcome

- Knowledge of heart attack symptoms as assessed by the Knowledge sub-scale of the ACS Response Index [30].

Secondary outcomes

- Attitudes and beliefs sub-scales of the ACS Response Index [30].
- Response to heart attack symptoms as assessed by the investigator-developed questions based on the Heart Foundation Heart Attack Action Plan [31]. (See Attached Heart Attack Action Plan Survey)
- Health Services Utilisation as assessed by the investigator-developed questions.(See attached Health Services Utilisation Survey)
- Participants' satisfaction as assessed by SAVE Satisfaction Questionnaire (adapted from two validated surveys) [32,33].

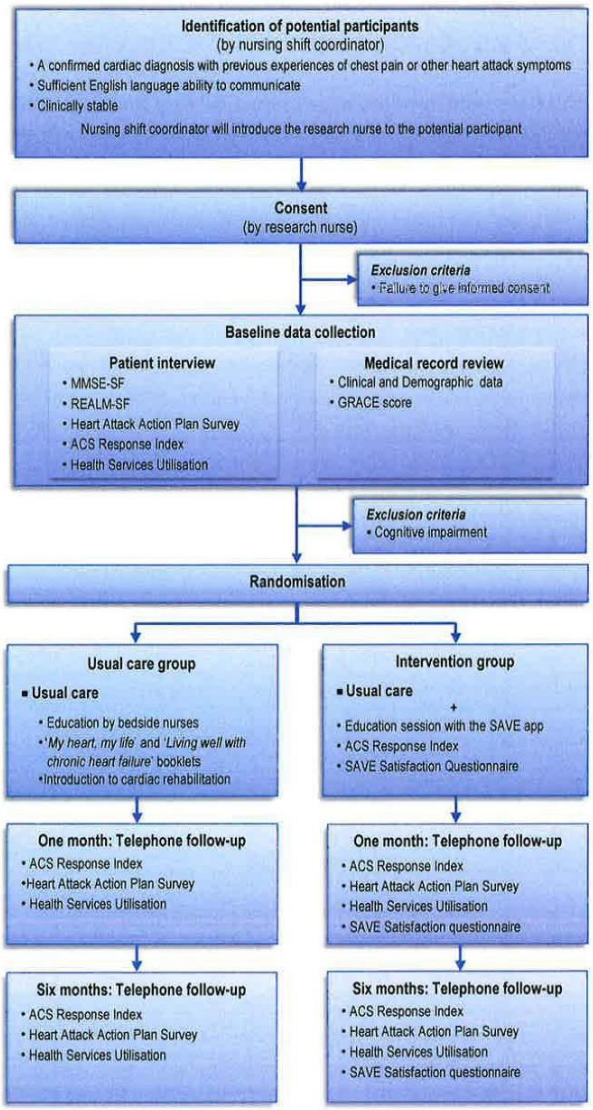


Figure 2: Trial schema

9. Study measurements

The mini mental state examination (MMSE)

The MMSE is the most commonly used instrument for screening cognitive function [34]. This examination is not suitable for making a diagnosis but can be used to indicate the presence of cognitive impairment, such as in a person with suspected dementia or following a head injury. The following cut off levels be used for classification purposes: normal cognitive function =27-30, mild cognitive function impairment = 21-26, moderate cognitive function impairment = 11-20, and severe cognitive function = 0-10 [32]. The MMSE will be used in this study to evaluate potential participants' cognitive function, as a part of assessing their eligibility.

Clinical and Demographic data

Information on the study participants' age, gender, education, domiciliary and employment status, medical history, clinical status, past procedures, other admissions, vital signs, and cardiac biochemistry, including in-hospital risk score (GRACE Risk Score) [28], will be collected at baseline.

The Global Registry of Acute Coronary Events Risk Score (GRACE Risk Score)

The GRACE Risk Score [28], designed to predict in-hospital mortality, was developed from an earlier cohort of GRACE patients. The components of the GRACE RS are age, history of heart failure, history of acute myocardial infarction, heart rate at admission, systolic blood pressure at admission, ST segment deviation, serum creatinine at admission, and elevated troponin and cardiac arrest at admission. In this proposed study, the GRACE Risk Score will be used to provide information on participants' clinical status at baseline.

Rapid Estimate of Adult Literacy in Medicine – Short Form (REALM-SF)

The REALM-SF [35] provides researchers with a brief, validated instrument for assessing patient literacy in diverse research settings in the healthcare system. It has been widely used in the healthcare settings. In the proposed study, the REALM-SF will be used to assess the health literacy level of study participants at baseline.

Acute Coronary Syndrome Response Index (ACS Response Index).

The ACS Response Index [30] is a validated instrument for assessing patients' knowledge, attitudes and beliefs about heart attack symptoms. It includes 21 knowledge subscales, six attitudes subscales and seven beliefs subscales. In the proposed study, the ACS Response Index will be used to assess the knowledge, attitudes and beliefs regarding heart attack symptoms of the study participants.

Heart Attack Action Plan Survey

The Heart Attack Action Plan Survey is an investigator-developed questionnaire for assessing participants' response to heart attack symptoms. It is adapted from the Heart Foundation's Heart Attack Action Plan, including participants' symptoms experiences and their behavioural

responses (STOP, TALK and CALL) (Figure 3) [31]. This information will be collected at baseline, one-month and six-month follow-ups. The purpose of this questionnaire is to evaluate the effect of the app on participants' response to heart attack symptoms.



Figure 3 Heart Attack Action Plan

Health Services Utilisation

Health Services Utilisation is an investigator-developed questionnaire for assessing participants' health-behaviour (including emergency services or GPs). This information will be collected at baseline, and at one-month and six-month follow-ups. The purpose of this questionnaire is to evaluate the effect of the app on participants' response to heart attack symptoms.

Simple avatar-based Application for ImproVing Heart Attack Education (SAVE)-Satisfaction Questionnaire

Intervention Satisfaction Questionnaire is a 15-item Likert scale. This survey is adapted from validated education material acceptability surveys [32, 33]. The aim of this survey is to assess the participants' perception of the avatar-based education application in terms of audio-visuals, content, usefulness and user-friendliness.

7. Statistical analysis (including justification of sample size, if relevant):

Sample size

The change in the knowledge sub-scale of the ACS Response Index [30] between the control and the intervention groups in a previously published study was used to calculate the required sample size [36]. A sample size calculation was performed using a standard deviation of 2.9 and an effect size of 0.42 for ACS Response Index, which was determined from a previously published study [36]. The require sample size per group was calculated to be 31 (alpha=0.05, power=0.95) this calculation was performed using the independent sample t-test and test by Power Analysis and Sample Size (PASS) software [37, 38]. When taking into account a 10% attrition rate, 70 participants (35 per group) must be enrolled in the study.

8. Recruitment and randomisation

Recruitment

The research nurse will not approach potential participants directly. Potential participants will be identified during their hospital stay in the CCU at Flinders Medical Centre by the nursing shift coordinator. The inclusion and exclusion criteria will be provided to the nursing shift coordinator. The nursing shift coordinator will identify potential participants and obtain their permission to be contacted by the research nurse, as well as the patient's preferred time to be contacted. With the patient's permission, a research nurse (JT or HYD) will approach the patient with the nursing shift coordinator to provide the Patient Information and Consent Form (PICF) and to further explain the purpose and the protocol of this study.

Once consent is obtained, participants will undergo a screening phase to assess their eligibility. Based on current admission statistics it is anticipated that approximately 25 participants per week will be recruited. A study log will be maintained where all individuals screened and their reasons for not participating will be documented.

Randomisation

Randomisation will occur after consent and completion of baseline assessment (See Figure 2). This is to ensure that the baseline assessment will not be affected by the participant's group allocation. The design of this type of patient education research means that the participant's group allocation will be obvious to the researcher and the participants after randomisation.

Upon completion of the baseline assessment, the research nurse will contact the telephone randomisation service to obtain group allocation.

Block randomisation sequence will be generated in blocks of 10 by the Excel computer software program. Participants' detail will be recorded with their group allocation in a secure file only accessible to the administrative assistant responsible for randomisation.

9. Allocation concealment mechanism

The Excel file containing allocation sequences will be password protected and only accessible to an administrative assistant (randomisation service) who is based externally to the study

site and who will not be involved in the process of recruitment, implementation and data analysis.

10. Blinding

As the avatar-based education application is an education intervention, blinding of the participants and the researcher who will conduct telephone follow-ups is not possible. Thus, a non-blinded pragmatic randomised control trial will be used.

11. Statistical methods

Data from this study will be analysed according to the intention-to-treat principle, in order to provide unbiased assessment of intervention effectiveness. Data will be analysed by using the statistics software - Statistic Package for Social Science (SPSS), version 22 [39].

Descriptive statistics will be used to summarise the baseline demographic, clinical status, health literacy and mental status of participants. Continuous data will be summarised using mean, median, standard deviation and standard error of the mean scores, whilst categorical data will be summarised in terms of percentages. The demographics of the participants in the intervention and usual care groups will be compared using the independent sample t-test or Pearson's Chi-square test, to measure differences including age and gender. Continuous data with normal distribution will be analysed using the independent t-test, and the Mann-Whitney U test will be used for non-normally distributed data. Association between categorical data will be analysed using the Chi-square test. When comparing the change in ACS Response Index subscale scores overtime and between groups, ANCOVA will be used. The Mann-Whitney U test will be used for data that does not meet the assumptions of ANCOVA. Statistical significance will be considered at $P<0.05$ unless otherwise specified. All test result reported will be two-tailed. Data analysis will be supervised by a statistician who is not involved in the screening, recruitment or follow-up of the study participants.

Assessment of Participants

1. Clinical Assessment (Medical record review):

Routine clinical data includes: height and weight, previous medical history, risk factors, past cardiac procedure, smoking status, past admission in previous 12 months, GRACE Risk Score, Charlson index of comorbidity, vital sign and cardiac biochemistry.

2. Pathology: Participants will not undertake additional laboratory tests for this project. Cardiac biochemistry will be recorded. Cardiac biochemistry will not be done specifically for this research.

3. Other (e.g. radiological) Assessment: Participants will not undertake other assessment.

4. Monitoring adverse effects

Serious Adverse Effect (SAE) will be defined as any untoward medical, emotional, psychological occurrence resulting in hospitalisation or prolongation of hospitalisation, SAE will be defined as any untoward occurrences in study participants, potentially related to

implementation of the study protocol. Information regarding SAE will be collected during telephone follow-ups.

5. Significant adverse effects should be reported to the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC)

   SAEs for clinical research study at Flinders Medical Centre site will be reported to the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC) via the Executive Officer within 48 hours of the event becoming known to the local investigator.

Research relating specifically to the Aboriginal community:

This study is not specificlly related to Aboriginal community.

Important information for researchers intending to undertake research in South Australian schools. N/A

Researcher indemnity

Please see attached documentation from the Insurance Officer, Flinders University

Registration of Clinical Trials N/A

Administrative Aspects

1. Name of a contact person, the company name and the ABN of the commercial sponsor MUST be included on page 1. A commercial sponsor is the organisation or company that will be invoiced for the SAC HREC review of this application

   Ms Jintana Tongpeth is the contact person for this study.

   This study is not commercially sponsored.

2. Provision of source and details of funding (Grant, investigator driven, CTG) including payment per participant.

   N/A

3. Clinical data sheets

   The following documents are attached with your application:

   1. Baseline assessment form (Demographic and Clinical information, GRACE Risk Score, MMSE,REALM-SF, ACS Response Index, Heart Attack Action Plan Survey, and Health Services Utilisation)
   2. Post intervention survey for intervention group (ACS Response Index, and SAVE Satisfaction Questionnaire)
   3. One-month follow-up form (ACS Response Index, Heart Attack Action Plan Survey, and Health Services Utilisation, SAVE Satisfaction Questionnaire)
   4. Six-month follow-up form for intervention group (ACS Response Index, Heart Attack Action Plan Survey, Health Services Utilisation, and SAVE Satisfaction Questionnaire

5. Six-month follow-up form for usual care group (ACS Response Index, Heart Attack Action Plan Survey, and Health Services Utilisation)

4. Maintenance of records

All data will be collected in a de-identified form. Data collected through this study will be stored in a locked filing cabinet in the researcher's office within the School of Nursing and Midwifery, Flinders University. Electronic data will be kept on the Flinders University network computer in the School of Nursing and Midwifery, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document. All data will be retained for seven years, and then it will be destroyed permanently.

5. Special facilities required and use of hospital facilities: No

Ethical Considerations

The ethical principles on which this study will be conducted are based on the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007). Ethical approval for this study will be obtained from the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC), which is a joint committee of the Southern Adelaide Local Health Network and Flinders University. The overall project coordination will occur from School of Nursing and Midwifery.

1. Benefits anticipated from study.

The aim of this project is to evaluate an education application to help patients, particularly those with low literacy, to gain knowledge on heart attack symptoms and the appropriate responses to those symptoms.

2. Risks of any harm - including physical disturbance, discomfort, anxiety or pain.

The research team does not foresee any physical or emotional risk from taking part in this research.

3. Research involving dependent relationships-that includes patients of the researcher, staff, and student, children, mentally ill, intellectual impaired.
N/A

4. Separation of research and clinical responsibilities

N/A

5. Treatment of control group

N/A

6. Use of placebo

N/A

7. Source of payment for normal participants.

   Participants will not be paid for their participation in this study. All participants will be offered the avatar education application to keep for their use after completion of the study.

8. Protection of privacy and preservation of confidentiality.

   Protection of privacy

   Data protection at the School of Nursing and Midwifery meets all standards and follows all steps to protect other people's personal information under the Information Privacy Principles. The system and processes with respect to privacy and data protection comply with Health Records and Information Privacy Act (NSW) 2002, and Privacy Act (1988) and the Information Privacy Principles. Data access is limited to the authorised researchers listed at the beginning of this document.

   Confidentiality

   Confidentiality will be ensured by replacing participants' names with numerical codes on all study documents. Data linking each participant's identifying information and participant code will be kept separately and will be removed prior to analysis. Any information or comments provided by participants will be collected in a de-identified form. Data collected through this study will be stored in a locked filing cabinet in the researcher's office within the School of Nursing and Midwifery, Flinders University. Electronic data will be kept on the Flinders University network computer in the School of Nursing and Midwifery, Flinders University, which is password protected. All study-related data will only be accessible to the researchers listed at the beginning of this document. Paper based data will be stored for seven years and then shredded; electronic data will be deleted permanently from the Flinders University network computer.

9. Restriction of use of data.

   Data ownership and publication: Ownership of the data collected during the Pragmatic Randomised Control Trial is retained by the School of Nursing and Midwifery under Flinders University. Persons contributing to the design, analysis or the writing process will be listed as authors on publications associated with this study. Data collected through this project will only be used for the purpose of this project.

Consent Process

The key ethical issue in this study population concerns the vulnerability of the participants who have heart conditions. To minimise coercion, the nursing shift coordinator will first approach patients in cardiac care unit, Flinders Medical Centre. The research nurse will then be introduced to individuals who have indicated their willingness to participate. The research nurse will explain the study procedure and provide the Participant Information and Consent form (PICF). The research nurse will read out aloud the PICF and explain the study in detail to any potential participants that have a low level of literacy so that they can provide informed consent.

Participants will be reminded that they can withdraw at any time during the study and that withdrawal from the study will not affect their current or future treatment.

Each patient will be asked to read the Patient Information sheet and consent form (PICF), and the research nurses (JT, HYD) will answer any questions that the patient may have. The patient does not have to provide consent immediately. He or she will be encouraged to think about the project and discuss it with others if they wish to. The contact details of the researchers will be provided to the patient. Once the patient agrees to participate in this study, they will be asked to sign the written consent form, in the presence of a witness.

A copy of the signed consent form is to be filed in the participant's medical record

The signed consent will be filed in the participant's medical record.

How will the study be promoted or advertised?

The research team will introduce the research project through the Director of Cardiology Department, and CCU manager, Flinders Medical Centre and through in-service sessions on the ward.

Statement of compliance with NH&MRC National Statement on Ethical Conduct in Human Research (2007) & the Australian Code for the Responsible Conduct of Research (2007)

By submitting this application the applicant(s) will comply with both of the above documents. All researchers are expected to be familiar with their responsibilities under each document. The application must include a statement that the project complies with the above documents.

STATEMENT: I hereby declare that " The effectiveness of a Simple avatar-based Application for improVing Heart Attack symptom Education: A Pragmatic Randomised Controlled Trial" trial complies with the above documents

Signed: [redacted]

Print name: Professor Robyn Clark

Dated: 26/09/2016

References

1. Fihn, S.D., et al., 2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS guideline for the diagnosis and management of patients with stable ischemic heart disease: executive summary: a report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines, and the American College of Physicians, American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. Circulation, 2012. 126(25): p. 3097-137.
2. Lloyd-Jones, D., et al., Heart disease and stroke statistics—2010 update A report from the American Heart Association. Circulation, 2010. **121**(7): p. e46-e215.
3. Furie, K.L., et al., *Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack a guideline for healthcare professionals from the American Heart Association/American Stroke Association.* Stroke, 2011. **42**(1): p. 227-276.
4. Mays, N., *Origins and development of the National Health Service.* Sociology as applied to medicine, 2008: p. 221-251.
5. C.-H, R., *Patient delay from onset of chest pain suggesting acute coronary syndrome to hospital admission.* Scandinavian Cardiovascular Journal, 2003. **37**(4): p. 183-186.
6. Gersh, B.J., et al., *Pharmacological facilitation of primary percutaneous coronary intervention for acute myocardial infarction: is the slope of the curve the shape of the future?* Jama, 2005. **293**(8): p. 979-986.
7. Nestler, D.M., et al., *Sustaining Improvement in Door-to-Balloon Time Over 4 Years The Mayo Clinic ST-Elevation Myocardial Infarction Protocol.* Circulation: Cardiovascular Quality and Outcomes, 2009. **2**(5): p. 508-513.
8. Dracup, K., S.M. McKinley, and D.K. Moser, *Australian patients' delay in response to heart attack symptoms.* Medical Journal of Australia, 1997. **166**(5): p. 233-236.
9. Poomsrikaew, O., C.J. Ryan, and J.J. Zerwic, *Knowledge of heart attack symptoms and risk factors among native Thais: A street intercept survey method.* International journal of nursing practice, 2010. **16**(5): p. 492-498.
10. Foundation, N.H., *Will you recognise your heart attack? .* In: Foundation NH 2010. **editor**
11. Goff Jr, D.C., et al., *Prehospital delay in patients hospitalized with heart attack symptoms in the United States: The REACT trial.* American Heart Journal, 1999. **138**(6): p. 1046-1057.
12. Dracup, K., et al., *A randomized clinical trial to reduce patient prehospital delay to treatment in acute coronary syndrome.* Circ Cardiovasc Qual Outcomes, 2009. **2**(6): p. 524-32.
13. S., S., *Majority of MI patients discharge with out follow-up advice* mEDICAL oBSERVER 2014.
14. Luepker, R.V., et al., *Effect of a community intervention on patient delay and emergency medical service use in acute coronary heart disease: The Rapid Early Action for Coronary Treatment (REACT) Trial.* Jama, 2000. **284**(1): p. 60-67.
15. Tsai, S.-T. and F.-H. Chou, *The effectiveness of multimedia nursing education on reducing illness-related anxiety and uncertainty in myocardial infarction patients after percutaneous coronary intervention [Chinese].* Journal of Nursing, 2012. **59**(4): p. 43-53.
16. Dennison, C.R., et al., *Adequate health literacy is associated with higher heart failure knowledge and self care confidence in hospitalized patients.* The Journal of cardiovascular nursing, 2011. **26**(5): p. 359.
17. McNaughton, C.D., et al., *Low numeracy is associated with increased odds of 30-day emergency department or hospital recidivism for patients with acute heart failure.* Circulation: Heart Failure, 2013. **6**(1): p. 40-46.
18. Davidson, P.M., S.C. Inglis, and P.J. Newton, *Self-care in patients with chronic heart failure.* 2013.
19. Dickson, V.V., N. Tkacs, and B. Riegel, *Cognitive influences on self-care decision making in persons with heart failure.* American heart journal, 2007. **154**[1]: p. 424-431.
20. Bennett, S.J. and M.J. Sauvé, *Cognitive deficits in patients with heart failure: a review of the literature.* Journal of Cardiovascular Nursing, 2003. **18**[1]: p. 219-242.
21. Pinto, M.D., et al., *Avatar-based depression self-management technology: promising approach to improve depressive symptoms among young adults.* Appl Nurs Res, 2013. **26**(1): p. 45-8.
22. Boren, S.A., et al., *Computerized learning technologies for diabetes: a systematic review.* Journal of diabetes science and technology, 2008. **2**(1): p. 139-146.
23. Heinrich, E., et al., *Evaluation of the web-based Diabetes Interactive Education Programme (DIEP) for patients with type 2 diabetes.* Patient education and counseling, 2012. **86**(2): p. 172-178.

24. Jibaja-Weiss, M.L., et al., *Entertainment education for breast cancer surgery decisions: a randomized trial among patients with low health literacy.* Patient education and counseling, 2011. **84**(1): p. 41-48.
25. Bedra, M., et al., *Avatar-Based Interactive Ileostomy Education in Hospitalized Patients.* Informatics, Management and Technology in Healthcare, 2013. **190**: p. 83.
26. Australia, National Heart Foundation., My heart my life. 2012.
27. Australia, National Heart Foundation., Living well with chronic heart failure. 2011
28. Goodacre, S.W., et al., *Evaluation of Global Registry of Acute Cardiac Events and Thrombolysis in Myocardial Infarction scores in patients with suspected acute coronary syndrome.* The American Journal of Emergency Medicine, 2012. **30**(1): p. 37-44
29. Arozullah, A.M., et al., *Development and validation of a short-form, rapid estimate of adult literacy in medicine.* Medical care, 2007. **45**(11): p. 1026-1033.
30. Riegel, B., et al., *Psychometric evaluation of the acute coronary syndrome (ACS) response index.* Research in nursing & health, 2007. **30**(6): p. 584-594.
31. Foundation, N.H., Will you recognise your heart attack? . In: Foundation NH 2010.
32. Gwadry-Sridhar, F., et al., *Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure.* European journal of heart failure, 2003. **5**(6): p. 783-791.
33. Fredericks, B., et al., *Using participatory action research to assist heart failure self-care amongst indigenous Australians: a pilot study.* ALAR: Action Learning and Action Research Journal, 2013. **19**(2): p. 40.
34. Folstein, M.F., S. Folstein, and P. Mc Hugh, Mini-mental state examination: MMSE-2. 2010: Psychological Assessment Resources.
35. Ibrahim, S., et al., *Validation of a health literacy screening tool (REALM) in a UK population with coronary heart disease.* Journal of public health, 2008. **30**(4): p. 449-455.
36. Tullmann, D.F., et al., *A randomized controlled trial to reduce delay in older adults seeking help for symptoms of acute myocardial infarction.* Research in Nursing & Health, 2007. **30**(5): p. 485-497.
37. Julious, S.A. and M.J. Campbell, *Tutorial in biostatistics: sample sizes for parallel group clinical trials with binary data.* Statistics in medicine, 2012. **31**(24): p. 2904-2936.
38. Suresh, K. and S. Chandrashekara, *Sample size estimation and power analysis for clinical research studies.* Journal of human reproductive sciences, 2012. **5**(1): p. 7.
39. Wagner III, W.E., *Using IBM® SPSS® statistics for research methods and social science statistics.* 2014: Sage Publications.

Appendix 14: Intervention Documents

Randomisation Worksheet

ID ☐☐☐

SAVE Trial

1. Dial 1800 039 854 or +61 (02) 8093 7200
2. Enter the trial ID: 1603#
3. Follow the voice prompts.

Section 1: Complete this section before making the randomisation call

1.1 User PIN - enter your 4 digit PIN number, followed by the hash key:
☐☐☐☐ #

1.2 Site ID - enter your site ID number, followed by the hash key:
☐#

1.3 You will hear a message stating whether this is a real or practice call. Press 1 to continue, 0 to exit.

1.4 Initials - enter the patient's initials followed by the hash key:

- 3 initials should be entered for each patient
- Each initial should be entered as a 2 digit code, as per the list below, e.g. 01 = A, etc.
- All three initials should be entered together, so a valid entry consists of 6 digits, followed by the hash key, e.g. "010203#" = "ABC"
- If the patient has no middle initial, this may be replaced with a dash, "-", code 27

Letter	Code	Letter	Code	Letter	Code
A	01	J	10	S	19
B	02	K	11	T	20
C	03	L	12	U	21
D	04	M	13	V	22
E	05	N	14	W	23
F	06	O	15	X	24
G	07	P	16	Y	25
H	08	Q	17	Z	26
I	09	R	18	- (dash)	27

Patient initials as letters: _ _ _
Patient initials coded for IVRS entry:
☐☐☐☐☐☐ #

1.5 Date of Birth – Enter the patient's date of birth in DDMMYYYY format, followed by the hash key: ☐☐.☐☐.☐☐☐☐ #
D D M M Y Y Y Y

1.6 Inclusion/exclusion criteria – Does the patient meet all of the inclusion criteria and none of the exclusion criteria? Press 1 for yes or 0 for no. ☐

1.7 Informed consent – Has written informed consent been obtained?
Press 1 for yes or 0 for no. ☐

1.8 Confirm that you wish to randomise this patient by pressing 1, or press 0 to exit and cancel this randomisation.

Section 2: Complete this section during the randomisation call

2.1 This patient has been allocated identification number: ☐☐☐

2.2 Confirm the patient number by re-entering with leading zeroes, followed by the hash key.

2.3 The treatment assigned to patient is: (tick the box)

1. Usual Care ☐

2. Avatar-based education application ☐

2.3 Please re-enter 0 to confirm *Usual* Care inserts or 1 to confirm *Avatar-based education application*.

Flow of Study Recruiting

Flinders University School of Nursing & Midwifery

FLINDERS MEDICAL CENTRE

A Simple avatar-based Application for improVing Heart attack Education

SAVE Trial

AIM: ***To evaluate the effectiveness of an avatar-based education application on knowledge of symptom recognition and response for cardiac patients***

Inclusion criteria

- *Admitted with any cardiac diagnosis where chest pain or any other symptoms of ACS have been experienced previously*
- *Clinically stable*
- *Normal cognitive function*
- *Sufficient English language to communicate and understand study procedure*

Exclusion criteria

- *Already enrolled in another clinical trial at FMC*
- *Clinically unstable*
- *Failure or Unable to give informed consent*
- *Cognitive impairment (MMSE<27)*

Consent

→ **Cognitive Function Assessment(MMSE)**

Health Literacy Assessment / Baseline Questionnaires
Medical Record Review

Allocation to a study group (Randomisation)

Usual Care Group

Usual Care + SAVE app Group

Follow-up at 1-month and 6-month



This research project have been approved by Southern Adelaide Clinical Research Ethic Committee (SAC HREC)
No.OFR#290.15-HREC/15/SAC/247
Site Specific Assessment authorised by SALHN No.SSA/16/SAC/156

Researchers contact details

Jinny	Tel: 0431 730 153	email: tong0076@flinders.edu.au
Tracey (RA)	Tel: 0466 316 699	email: tracey.barry@flinders.edu.au
Dr Hui Du	Tel: 0430 738 362	email: huiyun.du@flinders.edu.au
Prof. Robyn Clark	Tel: 08 8201 3266	email: robyn.clark@flinders.edu.au

Appointment and Contact Detail Postcard for Intervention Group

Thank you for being part of
The SAVE Study

Flinders UNIVERSITY



If you have queries please contact:

Tracey ☎ 0466 316 699
Email: tracey.barry@flinders.edu.au
Jinny ☎ 0431 730 153
Email: tong0076@flinders.edu.au
Dr Hui Du ☎ 0430 738 362
Email: huiyun.du@flinders.edu.au

We have made an appointment to contact you at:

1-month phone call .....

6-month phone call.....

We will contact you the day before to check it's convenient

You have received the "Pre-paid Padded bag with address" for sending the tablets back to the research nurses after 6-month phone call.



We will contact you and provide information to download free the "Heart Attack Action Plan" app on your own tablet after the of the completion the project

Appointment and Contact Details Postcard for Usual Care Group

Thank you for being part of the SAVE Study

Flinders UNIVERSITY



If you have queries please contact:

Tracey ☎ 0466 316 699
Email: tracey.barry@flinders.edu.au
Jinny ☎ 0431 730 153
Email: tong0076@flinders.edu.au
Dr Hui Du ☎ 0430 738 362
Email: huiyun.du@flinders.edu.au

We have made an appointment to contact you at:

1-month phone call .....

6-month phone call.....

We will contact you the day before to check it's convenient

We will contact you and provide information to download free the "Heart Attack Action Plan" app on your own tablet after the of the completion the project



Agreement Letter for Returning Tablet Computer

School of Nursing and midwifery
Office: N212 North Wing Sturt Building
GPO Box 2100
Adelaide SA 5001
Telephone +61 8 +61 8 8201 3266
Facsimile +61 8 +61 8 8276 1602
Robyn.clark@flinders.edu.au

DATE……

TERMS OF AGREEMENT:

I, ……., will return the tablet No…….. that belonging of School of Nursing and Midwifery Flinders University within 6 months after finished telephone call.

I,……., will provide the copy of driver's licence and contact detail .

Signature:……Date……

Printed full name……
Address……
Phone number of borrower……

Signature of Promisor……Date……
Printed full name……
Phone number of promisor……

inspiring
achievement

How to Use the ‘Heart Attack Action Plan’ App

“How to use the “Heart Attack Action Plan” app

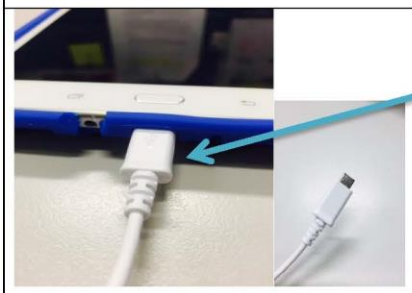
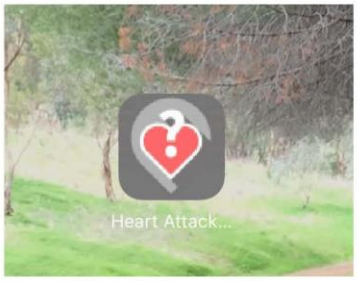
If you have queries please contact:

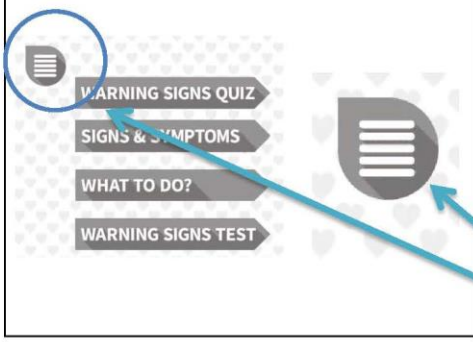
Jinny 0431730153 email: tong0076@flinders.edu.au

Tracey 0466 316 699 email: tracey.barry@flinders.edu.au

Pictures	How to
	Power Lock button Adjust volume button To turn on and off the tablet, press and hold the Power Lock button. To adjust the volume the tablets, press the volume button
	For plug in ear phone For plug in a Charger

CORAAPP_HOW TO_10082016_Page 1 of 4

Pictures	How to
	
	
	
	When the tablet screen opened, you can see the "Heart Attack Action Plan app" Please press on to open the "app"

Pictures	How to
	Please tab on the "START" button
	You will meet "Cora" She will about the contents on the "app" Please follow the instruction from "Nurse Cora " Please press on "START" button
	You can press on the menu button to select the contents section

Pictures	How to
	This is the screen page of content sections Select a section and follow Cora's instruction
	You can stop using the app by pressing on "QUIT" ` QUIT button

Appendix 15: Data Collection Form (Study 2)

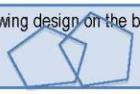
The Mini-Mental State Examination (MMSE)

Flinders University School of Nursing & Midwifery

The SAVE study

Participant ID

The Mini-Metal State Examination (MMSE)

Patient interview	Maximum	Score
ORIENTATION		
What is the (year) (season) (date) (month) (day) (month) *(1 point for each correct answer)*	5	
Where are we: (province)(country)(town or city) (Hospital) (floor) *(1 point for each correct answer)*	5	
REGISTRATION		
Listen to the following: "apple," "table," "penny." Repeat all 3. *(1 point for each correct answer.)* (Repeat the objects until the patient learns all 3. Make a maximum of 6 trials. Record the number of trials.)	3 #Trials:	
ATTENTION AND CALCULATION		
Spell "world" backwards. *(1 point for each letter in correct order.)* Alternate: Subtract 7 from 100. Take the result and subtract 7 from that. Continue until I ask you to stop. *(Continue for 5 subtractions. 1 point for each correct subtraction.)*	5	
RECALL		
What were the 3 objects we repeated earlier? *(1 point for each correct answer.)* (Note: Recall cannot be tested if all 3 objects were not remembered during registration.)	3	
LANGUAGE		
What are these? (pencil) (watch).	2	
Repeat the following: "No ifs, ands, or buts."	1	
Take a piece of paper in your right hand, fold it in half and put it on the floor. (1 point for each section of the command performed)	3	
READ AND OBEY		
Read the following ("Close your eyes.") and do as it says.	1	
Write a sentence.	1	
Copy the following design on the back of this page: 	1	
Total Score	**30**	
ASSESS level of consciousness along a continuum (Alert/Drowsy/Stupor/Coma)	.....	

☐ 27-30=normal cognitive function ☐ 21-26 = mild cognitive function impairment

☐ 11-20=moderate cognitive function impairment ☐ 0-10severe cognitive function

Folstein, MF, Folstein, SE & McHugh, PR 1975, '"Mini-mental state": A practical method for grading the cognitive state of patients for the clinician', *J Psychiatr Res*, vol. 12, no. 3, pp. 189-98.

Mini-Mental State Examination (MMSE)

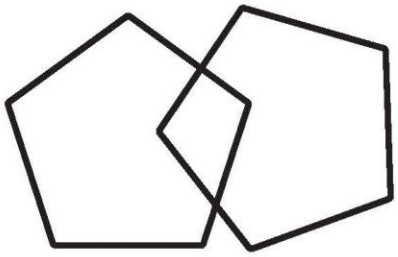
Participant ID

READING:

Close your eyes.

WRITING:

COPYING:



Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF)



Participant ID

Rapid Estimate of Adult Literacy in Medicine-Short Form (REALM-SF)

Patient interview

Highest level of education (please tick one box only)	
No school certificate or other qualification	☐1
School or intermediate certificate (or equivalent)	☐2
Higher school or leaving certificate (or equivalent)	☐3
Trade/apprenticeship(e.g. hairdresser, chef)	☐4
Certificate/diploma(e.g. child care, technician)	☐5
University degree or higher	☐6

Wordlist (Patient is handed a word list without scores)

Fat	Not scored		
Flu	Not scored		
Behaviour	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Exercise	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Menopause	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Rectal	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Antibiotics	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Anemia	Correct ☐1	Mispronounced ☐2	Not attempted ☐3
Jaundice	Correct ☐1	Mispronounced ☐2	Not attempted ☐3

REALM-SF Scoring

Total Correct (0-7)	Grade Level
0	≤ 3rd grade
1-3	4th-6th grade
4-6	7th-8th grade
7	≥9th grade

Literacy Grade _____



Participant ID

Instructions for Administering the REALM-SF

1. Give the patient a laminated copy of the REALM-SF form and score answers on an unlaminated copy that is attached to a clipboard. Hold the clipboard at an angle so that the patient is not distracted by your scoring. Say:

   "I want to hear you read as many words as you can from this list. Begin with the first work and read aloud. When you come to a word you cannot read, do the best you can or say, 'pass' and go on to the next word."

2. If the patient takes more than 5 seconds on a word, say 'blank' and point to the next word, if necessary, to move the patient along. If the patient begins to miss every word, have him or her pronounce only known words.

Scores and Grade Equivalents for the REALM-SF

Score	Grade Range
0	Third grade and below; will not be able to read most low-literacy materials; will need repeated oral instructions, materials composed primarily of illustrations, or audio or video tapes
1-3	Fourth to sixth grade; will need low-literacy materials, may not be able to read prescription labels
4-6	Seventh to eighth grade; will struggle with most patient education materials; will not be offended by low-literacy materials
7	High school; will be able to read most patient education materials

Fat

Flu

Behaviour

Exercise

Menopause

Rectal

Antibiotics

Anemia

Jaundice

Baseline Data Collection Form

Participant ID

The effectiveness of a Simple avatar-based education Application for improVing Heart Attack Education

Baseline data collection and assessment

- **Section 1:**
  Demographic data
- **Section 2:**
  Clinical information
- **Section 3:**
  In-hospital Risk Score (GRACE Risk Score)
- **Section 4:**
  Heart Attack Action Survey
- **Section 5:**
  Acute Coronary Syndrome Response Index





Participant ID

Section 1: General information

Patient Profiles information and Medical record [Case notes]

1. Gender	Female ☐2 Male ☐1
2. Date of birth	D D/M M/Y Y Y Y
3. Country of birth:	
4. Aborigin or Torres Strait islander origin	No ☐0 Yes, Aboriginal ☐1
	Yes, Torres Strait Islander ☐2
5. Language spoken at home:	English☐1
	Other(please specify) ☐0
	Both English & other☐2
	_____
6. Home telephone number:	
Best time to call:	
9. Mobile:	Email:
10. Home address	
11. Contact details of a person who does live with you	
Address:	
Phone: Email:	
Next of Kin:	
Address:	
Phone: Email:	
Alternative person (Who does not live with you)	
Address:	
Phone: Email:	
12. Marital status (please tick one box only)	
Single	☐1
Married	☐2
Defacto	☐3
Separated	☐4
Divorced	☐5
Widowed	☐6

Living alone ☐1 Living with spouse, carer Or relative(s) ☐2

Living with other ☐3 Please specify _____

13. Current occupation

Paid employment ☐1 Home duties☐2 Retired/pensioner☐3

14. Previous occupation_____

Section 2: Clinical information

Patient Profiles information and Medical record [Case notes]

1. Diagnosis: _____

   Procedures (during this admission): _____

   _____

2. Previous medical history

	No	Yes	No data	How long (years) ago was this diagnosis?
Myocardial infarction	☐0	☐1	☐2	If yes→_____
Heart failure	☐0	☐1	☐2	If yes→_____
Pacemaker	☐0	☐1	☐2	If yes→_____
Coronary artery disease	☐0	☐1	☐2	If yes→_____
Hypertension	☐0	☐1	☐2	If yes→_____
High blood cholesterol	☐0	☐1	☐2	If yes→_____
Angina	☐0	☐1	☐2	If yes→_____
Stroke/cerebro-vascular accident	☐0	☐1	☐2	If yes→_____
Vascular disease_____	☐0	☐1	☐2	If yes→_____
Valvular heart disease	☐0	☐1	☐2	If yes→_____
Aneurysm (abdominal, thoracic, leg)	☐0	☐1	☐2	If yes→_____
Renal disease	☐0	☐1	☐2	If yes→_____
Gastric ulcer	☐0	☐1	☐2	If yes→_____
Sleep apnea	☐0	☐1	☐2	If yes→_____
Asthma/Lung disease (e.g. COPD)	☐0	☐1	☐2	If yes→_____
Mental illness	☐0	☐1	☐2	If yes→_____
Diabetes type I	☐0	☐1	☐2	If yes→_____
Diabetes type II	☐0	☐1	☐2	If yes→_____
Arthritis-Rheumatoid	☐0	☐1	☐2	If yes→_____
Arthritis-Osteoarthritis	☐0	☐1	☐2	If yes→_____
Cancer	☐0	☐1	☐2	If yes→_____
Other _____	☐0	☐1	☐2	If yes→_____

1. **Past procedure**

	No	Yes	In what year
Coronary artery bypass operation	☐0	☐1	If yes→_____
Coronary angioplasty/stent	☐0	☐1	If yes→_____
Heart valve surgery	☐0	☐1	If yes→_____
Other cardiac surgery _____	☐0	☐1	If yes→_____

2. **Family history**

Family history of cardiovascular disease: Yes ☐1 No ☐0

If yes please specify:

3. **Smoking status**

Smoking status: Current smoker ☐1 _____packs/day, since_____
Ex-smoker ☐2 _____ packs/day for_____years
Non-smoker ☐3

4. **Charlson comorbidity index**

1.Myocardial infarction	Yes☐1	No ☐0	10.Diabetes	Yes ☐1	No ☐0
2.Congestive heart failure	Yes☐1	No ☐0	11.Hemiplegia	Yes ☐1	No ☐0
3.Peripheral vascular disease	Yes☐1	No ☐0	12.Mod/end organ damage	Yes ☐1	No ☐0
4.Cerebrovascular disease	Yes☐1	No ☐0	13.Any tumour	Yes ☐1	No ☐0
5.Dementia	Yes☐1	No ☐0	14.Leukemia	Yes ☐1	No ☐0
6.Chronic pulmonary disease	Yes☐1	No ☐0	15.Lymphoma	Yes ☐1	No ☐0
7.Connective tissue disease	Yes☐1	No ☐0	16.Mod/severe liver disease	Yes ☐1	No ☐0
8.Ulcer disease	Yes☐1	No ☐0	17.Metastatic tumour	Yes ☐1	No ☐0
9.Mild liver disease	Yes☐1	No ☐0	18.AIDS	Yes ☐1	No ☐0
Score_____					



Participant ID

Section 3: In-hospital Risk Score (GRACE Risk Score)

Patient Profiles information and Medical record [Case notes]

Background		
1. Age	_____years old	
2. History of heart failure	Yes ☐1	No ☐0
3. History of Acute MI	Yes ☐1	No ☐0

Findings at time of admission		
1. Heart Rate at admission	_____ bpm	
2. Systolic Blood Pressure (SBP) at admission	_____ mmHg	
3. ST-segment deviation	Yes ☐1	No ☐0

Findings during hospital stay		
1. Serum creatinine at admission	_____ mg/dl	
2. Elevated troponin	Yes ☐1	No ☐0
3. Cardiac arrest at admission	Yes ☐1	No ☐0

Score _____
Risk (%) _____

Section 4: Heart Attack Action Plan Survey
(Based on Heart Attack Action Plan-Heart Foundation, 2013)

Patient interview

1. When was the last time you experienced chest pain or heart attack symptoms?

   Within the last month ☐1 With in the last 2-5 months ☐2

   Within the last 6-12 months ☐3 Over 1 year ago ☐4

   Comment:

2. How often do you have chest pain or heart attack symptoms?

   Daily ☐1 Weekly ☐2 Monthly ☐3

   Only occasionally ☐4 Once only in the past ☐5

   Comment:

O=Onset

3. Last time you had a heart attack symptoms, how did the discomfort or pain start?

   Suddenly ☐1 Gradually ☐2 During or after eating ☐3 On exertion ☐4

   In certain position (e.g. sitting, lying) ☐5 During emotional episode ☐6 Other ☐7

   Comment:

P = Provoke

4. Did you feel any?

Pressure ☐1 Heaviness ☐2 Tightness ☐3 Nausea ☐4
A cold sweat ☐5 Dizzy ☐6 Short of breath ☐7 Other ☐8

Comment:

5. What made the discomfort or pain better?

Rest ☐1 Moving around ☐2 Stretching ☐3 Belching ☐4

Food ☐5 Medication ☐6 (specify_____)

Other ☐7 _____

Comment:

6. What made the discomfort or pain worse?

Exercise ☐1 Deep breathing ☐2 Specific position ☐3
Eating or swallowing ☐4 Pressing on the painful area ☐5
Other ☐6 _____

Comment:

Q = Quality

7. In your own word, could you please tell me what did the discomfort or pain feel like?

Heavy ☐1 Crushing ☐2 Wave-like ☐3 Sharp ☐4 Burning ☐5
Stabbing ☐6 Dull ache ☐7 Tearing ☐8 Throbbing ☐9 Squeezing ☐10
Stinging ☐11 Hard to describe ☐12 Other ☐13

Comment:

8. Was the discomfort or pain constant or did it come and go?

There all the time ☐1 Comes and goes ☐2

Comment:

R = Region/Radiate

9. Can you tell me where did you feel the discomfort or pain?

Chest ☐1 Jaw ☐2 Neck ☐3 Shoulder(s) ☐4 Arm ☐5
Back ☐6 Upper abdomen ☐7
Other ☐8 _____

Comment:

10. Did the discomfort or pain go anywhere else?

Yes ☐1 No ☐0

11. Can you tell me where?

To the chest ☐1 To the jaw ☐2 To the neck ☐3 To the shoulder (s) ☐4
Down the arm(s) ☐5 To the back ☐6 Down to upper abdomen ☐7
Other ☐8 _____

Comment:

S = Severity

12. On a scale of 1-10, how severe was your discomfort or pain?

Very severe ☐1 Severe ☐2 Medium ☐3 Moderately ☐4 Slightly ☐5

0.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

T = Time

13. How long did the discomfort or pain last?

10 minutes or less ☐1 More than 10 minutes ☐2
Up to one hour ☐3 Few hours ☐4

Comment:

14. When you got a heart attack symptom what did you do?

Stop ☐1 Slowdown ☐2 Continue the same activity ☐3

Other ☐4 _____

Comment:

15. Did you tell anyone that you were having a heart attack symptom?

Yes ☐1 No ☐0

16. Who did you tell?

Husband/wife/partner ☐1 Children ☐2 Workmate ☐3

Neighbour ☐4 Relatives ☐5

Other ☐6 please specify_____

Comment:

17. Did you take a angina medicine / Chest pain medicine/ Heart pill/Heart medicine) or angina spray?

Yes ☐1 No ☐0

18. Did you wait 5 minutes after you took your angina medicine / Chest pain medicine/ Heart pill/Heart medicine or angina spray?

Yes ☐1 No ☐0

19. Did the discomfort or pain go away?

Yes ☐1 No ☐0

20. Did you take another dose of angina medicine/ Chest pain medicine/ Heart pill/Heart medicine)?
Yes ☐1 No ☐0

21. Did you go to hospital?
Yes ☐1 No ☐0

22. How long did you wait before seeking medical care or calling an ambulance?
……hours ……minutes not sure ☐1
Comment:

23. How did you go to hospital?
Drive (by myself) ☐1 Taxi ☐2 Ambulance ☐3
Other ☐4 _____
Comment:

24. Did you or someone call Triple Zero "000"?
Yes ☐1 No ☐0

25. If "Yes" Do you remember what the operator told you (or someone) to do?

Section 5: Acute Coronary Syndrome Response Index

Patient interview

This questionnaire asks about health and perceptions about heart attack symptoms.

Knowledge Subscale

Ask questions: circle "0" if participants think the symptom *is not* a symptom of a heart attack or "1" if participants think the symptom *is* a symptom of heart attack.

		No	Yes
1.	Lower abdominal pain (Reverse coded)	0	1
2.	Arm pain or shoulder pain	0	1
3.	Arm paralysis (Reverse coded) -	0	1
4.	Back pain	0	1
5.	Chest pain/pressure/tightness	0	1
6.	Chest discomfort (heaviness, burning, tenderness)	0	1
7.	Cough (Reverse coded) -	0	1
8.	Dizziness, lightheadedness	0	1
9.	Headache (Reverse coded) -	0	1
10.	Heartburn/indigestion/stomach problem	0	1
11.	Jaw pain	0	1
12.	Loss of consciousness/fainting	0	1
13.	Nausea/vomiting	0	1
14.	Neck pain	0	1
15.	Numbness/tingling in arm or hand (Reverse coded) -	0	1
16.	Pale, ashen, loss/change of colour	0	1
17.	Palpitations/rapid heart rate	0	1
18.	Shortness of breath/difficulty breathing	0	1
19.	Slurred speech	0	1
20.	Sweating	0	1
21.	Weakness/fatigue	0	1

Attitudes Subscale

Next are some questions about some statements of attitude. Please circle "1" for not at all, "2" for a little sure, "3' for pretty sure, and "4" for very sure.

22. How sure are you that you could recognize the signs and symptoms of a heart attack in someone else?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
23. How sure are you that you could recognize the signs and symptoms of a heart attack in yourself?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
24. How sure are you that you could tell the difference between the signs or symptoms of a heart attack and other medical problems?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
25. How sure are you that you could get help for someone if you thought they were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
26. How sure are you that you could get help for yourself if you thought you were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure



Participant ID

Beliefs Subscale

Next are some questions about some statements of opinion. Please circle "1" for strongly agree, "2" for agree, "3' for disagree, and "4" for strongly disagree.

27. If you have chest pain or heart attack symptoms that don't stop after 10 minutes, you should get to the hospital as soon as possible			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
28. Would you embarrassed to go to the hospital if you thought you were having a heart attack but you weren't.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
29. If you thought you were having a heart attack, would you wait until you were very sure before going to the hospital?			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
30. If You thought you were having a heart attack, would you rather have someone drive you to the hospital than have an ambulance come to your home?			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
31. Because of the cost of medical care, would you want to be absolutely sure you were having a heart attack before going to the hospital.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
32. If you are having discomfort or pain in the centre of your chest heart pain and you are not very sure if it's a heart attack, you should go to the hospital anyway			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
33. If you thought you were having a heart attack, would you go to the hospital right away			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree

Riegel, B., et al., *Psychometric evaluation of the acute coronary syndrome (ACS) response index.* Research in nursing & health, 2007. **30**(6): p. 584-594.

Data Collection Form One- and Six-Month Follow-Up (Intervention Group)

Participant ID

The effectiveness of a Simple avatar-based education Application for improVing heart attack Education

1 and 6-month telephone follow-up

Usual Care plus SAVE app group

Participant ID

- **Section 1:**
  Heart Attack Action Plan questionnaire
- **Section 2:**
  Healthcare Utilisation
- **Section 3:**
  Acute Coronary Syndrome Response Index
- **Section 4:**
  SAVE app review
- **Section 5:**
  SAVE Satisfaction Questionnaire

Participant ID

Section 4: Heart Attack Action Plan Survey
(Based on Heart Attack Action Plan-Heart Foundation, 2015)

Patient interview

1. In the past 5-month have you have experienced chest pain or heart attack symptoms?

☐1 Yes go to question 8 ☐2 No go to question 2 to 7

Next I have some questions about chest pain or heart attack symptoms, and what you would do if you experienced them in the future?

2. Is it true that all heart attacks start with severe chest pain?
   ☐1 Yes ☐2 No

3. When you experience any of the warning signs of a heart attack, is it best to stop and rest immediately?
   ☐1 Yes ☐2 No

4. If you think you may be experiencing a heart attack, if you are with someone, tell them what you are feeling?

   ☐1 Yes ☐2 No

3. If you take angina medicine, take one dose of your angina medicine. Wait 5 minutes. Still have symptoms? Take another dose of your medicine.
   ☐1 Yes ☐2 No

6. If you think you are having a heart attack, should you drive yourself to hospital?

   ☐1 Yes ☐2 No

7. If you have chest pain or a heart attack symptom that doesn't stop after 10mins, should you call Triple Zero "000"?

   ☐1 Yes ☐2 No

8. In the past 5 months, how often do you have chest pain or heart attack symptoms?

Comment:

Daily ☐1 Weekly ☐2 Monthly ☐3

Only occasionally ☐4 Once only in the past ☐5

O=Onset

9. Last time you had chest pain or heart attack symptoms, how did it start?

Comment

Suddenly ☐1 Gradually ☐2

P = Provoke

10. What were you doing when the chest pain or heart attack symptom started?

Comment:

☐1 During or after eating ☐2 on exertion
☐3 In a certain position(e.g.sitting,lying) ☐4 During emotion episode?
☐5 other

11. Did anything help ease the pain or discomfort?

Comment

Rest ☐1 Moving around ☐2 Stretching ☐3 Belching ☐4

Food ☐5 Medication ☐6 (specify_____)

Other ☐7 _____

12. Did anything make the chest pain or heart attack symptoms worse?

Comment:

Exercise ☐1 Deep breathing ☐2 Specific position ☐3
Eating or swallowing ☐4 Pressing on the painful area ☐5
Other ☐6 _____

Q = Quality

13. In your own words, could you please tell me what the discomfort or pain felt like?

Comment

Heavy ☐1 Crushing ☐2 Wave-like ☐3 Sharp ☐4 Burning ☐5
Stabbing ☐6 Dull ache ☐7 Tearing ☐8 Throbbing ☐9 Squeezing ☐10
Stinging ☐11 Hard to describe ☐12 Other ☐13

14. Was the pain or heart attack symptom constant or did it come and go?

Comment

There all the time ☐1 Comes and goes ☐2

R = Region/Radiate

15. Can you tell me where you felt the pain or heart attack symptom?

Comment

Chest ☐1 Jaw ☐2 Neck ☐3 Shoulder(s) ☐4 Arm ☐5
Back ☐6 Upper abdomen ☐7
Other ☐8 _____

16. Did the discomfort or pain go anywhere else?

Comment:

Yes ☐1 No ☐0

17. Can you tell me where?

Comment:

To the chest ☐1 To the jaw ☐2 To the neck ☐3 To the shoulder (s) ☐4
Down the arm(s) ☐5 To the back ☐6 Down to upper abdomen ☐7
Other ☐8 _____

S = Severity

18. On a scale of 1-10, how severe was your discomfort or pain?

Very severe ☐1 Severe ☐2 Medium ☐3 Moderately ☐4 Slightly ☐5

0.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

T = Time

19. How long did the r pain or heart attack symptom last?

Comment:

10 minutes or less ☐1 More than 10 minutes ☐2
Up to one hour ☐3 Few hours ☐4

20. When you got theheart attack symptom, what did you do?

Comment:

Stop ☐1 Slowdown ☐2 Continue the same activity ☐3

Other ☐4 _____

21. Did you tell anyone that you were having chest pain or a heart attack symptom?

Yes ☐1 No ☐0

22. Who did you tell?

Comment:

Husband/wife/partner ☐1 Children ☐2 Workmate ☐3

Neighbour ☐4 Relatives ☐5

Other ☐6 please specify_____

23. Did you take any chest pain medicine or spray under your tongue?

Yes ☐1 No ☐0

24. Did you wait 5 minutes after you took the chest pain medicine?

Yes ☐1 No ☐0

25. Did the discomfort or pain go away?

Yes ☐1 No ☐0

26. Did you take another dose of chest pain medicine?

Yes ☐1 No ☐0

27. Did you or someone else call Triple Zero "000"?

Yes ☐1 go to Question 28 and 29 No ☐0 go to Question 30-32

28. How long did you wait before calling Triple Zero "000"

Comment:

29. Do you remember what the operator told you (or someone else) to do?

Comment :

30. How long after the chest pain or heart attack symptoms started did you seek medical attention (GPs, LMO or other clinic)?

Comment:

31. Did you go to hospital? (Advise from GPs /Clinnic /LMO or others)

Yes ☐1 No ☐0

32. How did you go to hospital? -

Comment:

Drive (by myself) ☐1 Car ☐2 Someone drove specify_____

Taxi ☐3 Ambulance ☐4

Other_____

Section 2: Healthcare Utilisation

Patient interview

1. In the past 5 months have you needed to go to see a GP for urgent matter?
   Yes ☐1 No ☐0

2. Can you tell me why?

3. In the past 5 months, have you been to an emergency department?
   Yes ☐1 go to question 4 and 5 No ☐0

4. What was this for?

5. For this event, how did you go to emergency department?

   Comment:

   Drove my own car ☐1 Was driven by others in private car ☐2 Taxi ☐3
   Ambulance ☐4 Other ☐5 ……..

6. Have you been admitted to hospital in the past 5-months?
   Yes ☐1 go to question 7 and 8 No ☐0

7. How many days did you stay overnight in the hospital? (Please record every admission)

Comment:

8. What was the reason you were admitted to hospital? (Please record every admission)

Comment:

9. How often have you seen your GP since discharge?

Comment:

Section 3: Acute Coronary Syndrome Response Index

"Next I would like to see what symptoms you think are symptoms of a heart attack.

I will list them off and I would like you to answer "yes" or "no" if you think the symptom could be a heart attack sign in you or someone else"

Patient interview

This questionnaire asks about health and perceptions about heart attack symptoms.

Knowledge Subscale

		No	Yes
1.	Lower abdominal pain (Reverse coded)	0	1
2.	Arm pain or shoulder pain	0	1
3.	Arm paralysis (Reverse coded) -	0	1
4.	Back pain	0	1
5.	Chest pain/pressure/tightness	0	1
6.	Chest discomfort (heaviness, burning, tenderness)	0	1
7.	Cough (Reverse coded) -	0	1
8.	Dizziness, lightheadedness	0	1
9.	Headache (Reverse coded) -	0	1
10.	Heartburn/indigestion/stomach problem	0	1
11.	Jaw pain	0	1
12.	Loss of consciousness/fainting	0	1
13.	Nausea/vomiting	0	1
14.	Neck pain	0	1
15.	Numbness/tingling in arm or hand (Reverse coded) -	0	1
16.	Pale, ashen, loss/change of colour	0	1
17.	Palpitations/rapid heart rate	0	1
18.	Shortness of breath/difficulty breathing	0	1
19.	Slurred speech	0	1
20.	Sweating	0	1
21.	Weakness/fatigue	0	1

Attitudes Subscale

"Next I would like to find out how sure you are about heart attack symptoms.
The responses are- not at all sure, a little sure, pretty sure, or very sure"

22. How sure are you that you could recognize the signs and symptoms of a heart attack in someone else?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
23. How sure are you that you could recognize the signs and symptoms of a heart attack in yourself?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
24. How sure are you that you could tell the difference between the signs or symptoms of a heart attack and other medical problems?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
25. How sure are you that you could get help for someone if you thought they were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
26. How sure are you that you could get help for yourself if you thought you were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure

"Okay. Great"

"Only 7 more questions to go!"

Beliefs Subscale

"This time I have 7 statements, and I would like to know if you agree or disagree with them, and how strongly you agree or disagree"

27. If you have chest pain or heart attack symptom that didn't stop after 10 minutes, you should get to the hospital as soon as possible			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree
28. You would be embarrassed to go to the hospital if you thought you were having a heart attack but it turned out you weren't.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
29. If you thought you were having a heart attack, you would wait until you were very sure before going to the hospital			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
30. If You thought you were having a heart attack, you would rather have someone drive you to the hospital than have an ambulance come to your home.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
31. Because of the cost of medical care, you would want to be absolutely sure you were having a heart attack before going to the hospital.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
32. If you are having discomfort or pain in the centre of your chest heart pain and you are not very sure if it's a heart attack, you should go to the hospital anyway			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree
33. If you thought you were having a heart attack, you would go to the hospital right away			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree

Riegel, B., et al., *Psychometric evaluation of the acute coronary syndrome (ACS) response index.* Research in nursing & health, 2007. **30**(6): p. 584-594.

Section 4: 'SAVE app" review

Patient interview

1. Have you used the app since you left hospital?

   Yes ☐1 No ☐0

2. How often have you viewed the app?

   Comment:

3. Have you shown the app to anyone else(e.g.family,friends)?

   Yes ☐1 go to question 4 and 5 No ☐0

4. Who did you show the app to and how many times did they use it?

   Comment:

5. Did they have any comments about the app from someone els?

   Comment:

6. What did you like about the app?

   Comment:

7.What didn't you like?

Comment:

8.Do you have any further comments or suggestions?

Comment:



Participant ID

Section 5: "SAVE app" Satisfaction Questionnaires

Patient interview

✓ Tick Box	Strongly Disagree	Disagree	Do Not Agree Nor Disagree	Agree	Strongly Agree
1. I liked the Avatar (Cora) (the character within the app)					
2. The audio of the app was clear and easy enough for me to understand					
3. The size of the print on screen was large enough for easy reading					
4. It was easy to press the buttons on the screen					
5. The app has helped me to better understand symptoms of a heart attack					
6. The app has taught me how to recognise and respond to symptoms of a heart attack					
7. The content was hard to understand					
8. It takes too long to use the app					
9. The information was clear and concise					
10. The app explained things in terms I could understand					
11. I learnt something that I was not taught about before					
12. I now have an action plan if I experience symptoms of a heart attack in the future					
13. The app has helped me to be more confident in recognising and managing heart attack symptoms in the future.					

✓ Tick Box	Strongly Disagree	Disagree	Do Not Agree Nor Disagree	Agree	Strongly Agree
14. The app maintained my interest and attention					
15. My Overall impression is that the app was excellent					
Do you have any feedback for the research team?					

Thank you for your time today.

Data Collection Form One- and Nine-Month Follow-Up (Usual Care Group)

Participant ID

The effectiveness of a Simple avatar-based education Application for improVing heart attack Education

1 and 6-month telephone follow-up

Usual Care

Participant ID

- **Section 1:**
  Heart Attack Action Plan questionnaire
- **Section 2:**
  Healthcare Utilisation
- **Section 3:**
  Acute Coronary Syndrome Response Index

Participant ID

Section 4: Heart Attack Action Plan Survey
(Based on Heart Attack Action Plan-Heart Foundation, 2015)

Patient interview

1. In the past 5-month have you have experienced chest pain or heart attack symptoms?

☐1 Yes go to question 8 ☐2 No go to question 2 to 7

Next I have some questions about chest pain or heart attack symptoms, and what you would do if you experienced them in the future?

2. Is it true that all heart attacks start with severe chest pain?
   ☐1 Yes ☐2 No

3. When you experience any of the warning signs of a heart attack, is it best to stop and rest immediately?
   ☐1 Yes ☐2 No

4. If you think you may be experiencing a heart attack, if you are with someone, tell them what you are feeling?

   ☐1 Yes ☐2 No

3. If you take angina medicine, take one dose of your angina medicine. Wait 5 minutes. Still have symptoms? Take another dose of your medicine.
   ☐1 Yes ☐2 No

6. If you think you are having a heart attack, should you drive yourself to hospital?

   ☐1 Yes ☐2 No

7. If you have chest pain or a heart attack symptom that doesn't stop after 10mins, should you call Triple Zero "000"?

   ☐1 Yes ☐2 No

8. In the past 5 months, how often do you have chest pain or heart attack symptoms?

Comment:

Daily ☐1 Weekly ☐2 Monthly ☐3

Only occasionally ☐4 Once only in the past ☐5

O=Onset

9. Last time you had chest pain or heart attack symptoms, how did it start?

Comment

Suddenly ☐1 Gradually ☐2

P = Provoke

10. What were you doing when the chest pain or heart attack symptom started?

Comment:

☐1 During or after eating ☐2 on exertion
☐3 In a certain position (e.g.sitting,lying) ☐4 During emotion episode?
☐5 other

11. Did anything help ease the pain or discomfort?

Comment

Rest ☐1 Moving around ☐2 Stretching ☐3 Belching ☐4

Food ☐5 Medication ☐6 (specify_____)

Other ☐7 _____

12. Did anything make the chest pain or heart attack symptoms worse?

Comment:

Exercise ☐1 Deep breathing ☐2 Specific position ☐3
Eating or swallowing ☐4 Pressing on the painful area ☐5
Other ☐6 _____

Q = Quality

13. In your own words, could you please tell me what the discomfort or pain felt like?

Comment

Heavy ☐1 Crushing ☐2 Wave-like ☐3 Sharp ☐4 Burning ☐5
Stabbing ☐6 Dull ache ☐7 Tearing ☐8 Throbbing ☐9 Squeezing ☐10
Stinging ☐11 Hard to describe ☐12 Other ☐13

14. Was the pain or heart attack symptom constant or did it come and go?

Comment

There all the time ☐1 Comes and goes ☐2

R = Region/Radiate

15. Can you tell me where you felt the pain or heart attack symptom?

Comment
Chest ☐1 Jaw ☐2 Neck ☐3 Shoulder(s) ☐4 Arm ☐5
Back ☐6 Upper abdomen ☐7
Other ☐8 _____

16. Did the discomfort or pain go anywhere else?

Comment:

Yes ☐1 No ☐0

17. Can you tell me where?

Comment:

To the chest ☐1 To the jaw ☐2 To the neck ☐3 To the shoulder (s) ☐4
Down the arm(s) ☐5 To the back ☐6 Down to upper abdomen ☐7
Other ☐8 _____

S = Severity

18. On a scale of 1-10, how severe was your discomfort or pain?

Very severe ☐1 Severe ☐2 Medium ☐3 Moderately ☐4 Slightly ☐5

0.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

T = Time

19. How long did the r pain or heart attack symptom last?

Comment:

10 minutes or less ☐1 More than 10 minutes ☐2
Up to one hour ☐3 Few hours ☐4

20. When you got the heart attack symptoms, what did you do?

Comment:

Stop ☐1 Slowdown ☐2 Continue the same activity ☐3

Other ☐4 _____

21. Did you tell anyone that you were having chest pain or a heart attack symptom?

Yes ☐1 No ☐0

22. Who did you tell?

Comment:

Husband/wife/partner ☐1 Children ☐2 Workmate ☐3

Neighbour ☐4 Relatives ☐5

Other ☐6 please specify_____

23. Did you take any chest pain medicine or spray under your tongue?

Yes ☐1 No ☐0

24. Did you wait 5 minutes after you took the chest pain medicine?

Yes ☐1 No ☐0

25. Did the discomfort or pain go away?

Yes ☐1 No ☐0

26. Did you take another dose of chest pain medicine?

Yes ☐1 No ☐0

27. Did you or someone else call Triple Zero "000"?

Yes ☐1 go to Question 28 and 29 No ☐0 go to Question 30-32

28. How long did you wait before calling Triple Zero "000"

Comment:

29. Do you remember what the operator told you (or someone else) to do?

Comment :

30. How long after the chest pain or heart attack symptoms started did you seek medical attention (GPs, LMO or other clinic)?

Comment:

31. Did you go to hospital? (Advise from GPs /Clinnic /LMO or others)

Yes ☐1 No ☐0

32. How did you go to hospital? -

Comment:

Drive (by myself) ☐1 Car ☐2 Someone drove specify_____

Taxi ☐3 Ambulance ☐4

Other_____

Participant ID

Section 2: Healthcare Utilisation

Patient interview

1. In the past 5 months have you needed to go to see a GP for urgent matter?
   Yes ☐1 No ☐0

2. Can you tell me why?

3. In the past 5 months, have you been to an emergency department?
   Yes ☐1 go to question 4 and 5 No ☐0

4. What was this for?

5. For this event, how did you go to emergency department?

   Comment:

   Drove my own car ☐1 Was driven by others in private car ☐2 Taxi ☐3
   Ambulance ☐4 Other ☐5 ……..

6. Have you been admitted to hospital in the past 5-months?
   Yes ☐1 go to question 7 and 8 No ☐0

7. How many days did you stay overnight in the hospital? (Please record every admission)

Comment:

8. What was the reason you were admitted to hospital? (Please record every admission)

Comment:

9. How often have you seen your GP since discharge?

Comment:

Section 3: Acute Coronary Syndrome Response Index

"Next I would like to see what symptoms you think are symptoms of a heart attack. I will list them off and I would like you to answer "yes" or "no" if you think the symptom could be a heart attack sign in you or someone else"

Patient interview

This questionnaire asks about health and perceptions about heart attack symptoms.

Knowledge Subscale

		No	Yes
1.	Lower abdominal pain (Reverse coded)	0	1
2.	Arm pain or shoulder pain	0	1
3.	Arm paralysis (Reverse coded) -	0	1
4.	Back pain	0	1
5.	Chest pain/pressure/tightness	0	1
6.	Chest discomfort (heaviness, burning, tenderness)	0	1
7.	Cough (Reverse coded) -	0	1
8.	Dizziness, light-headedness	0	1
9.	Headache (Reverse coded) -	0	1
10.	Heartburn/indigestion/stomach problem	0	1
11.	Jaw pain	0	1
12.	Loss of consciousness/fainting	0	1
13.	Nausea/vomiting	0	1
14.	Neck pain	0	1
15.	Numbness/tingling in arm or hand (Reverse coded) -	0	1
16.	Pale, ashen, loss/change of colour	0	1
17.	Palpitations/rapid heart rate	0	1
18.	Shortness of breath/difficulty breathing	0	1
19.	Slurred speech	0	1
20.	Sweating	0	1
21.	Weakness/fatigue	0	1

Attitudes Subscale

"Next I would like to find out how sure you are about heart attack symptoms.
The responses are- not at all sure, a little sure, pretty sure, or very sure"

22. How sure are you that you could recognize the signs and symptoms of a heart attack in someone else?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
23. How sure are you that you could recognize the signs and symptoms of a heart attack in yourself?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
24. How sure are you that you could tell the difference between the signs or symptoms of a heart attack and other medical problems?			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
25. How sure are you that you could get help for someone if you thought they were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure
26. How sure are you that you could get help for yourself if you thought you were having a heart attack			
1 Not at all	2 Little sure	3 Pretty sure	4 Very sure

"Okay. Great"

"Only 7 more questions to go!"

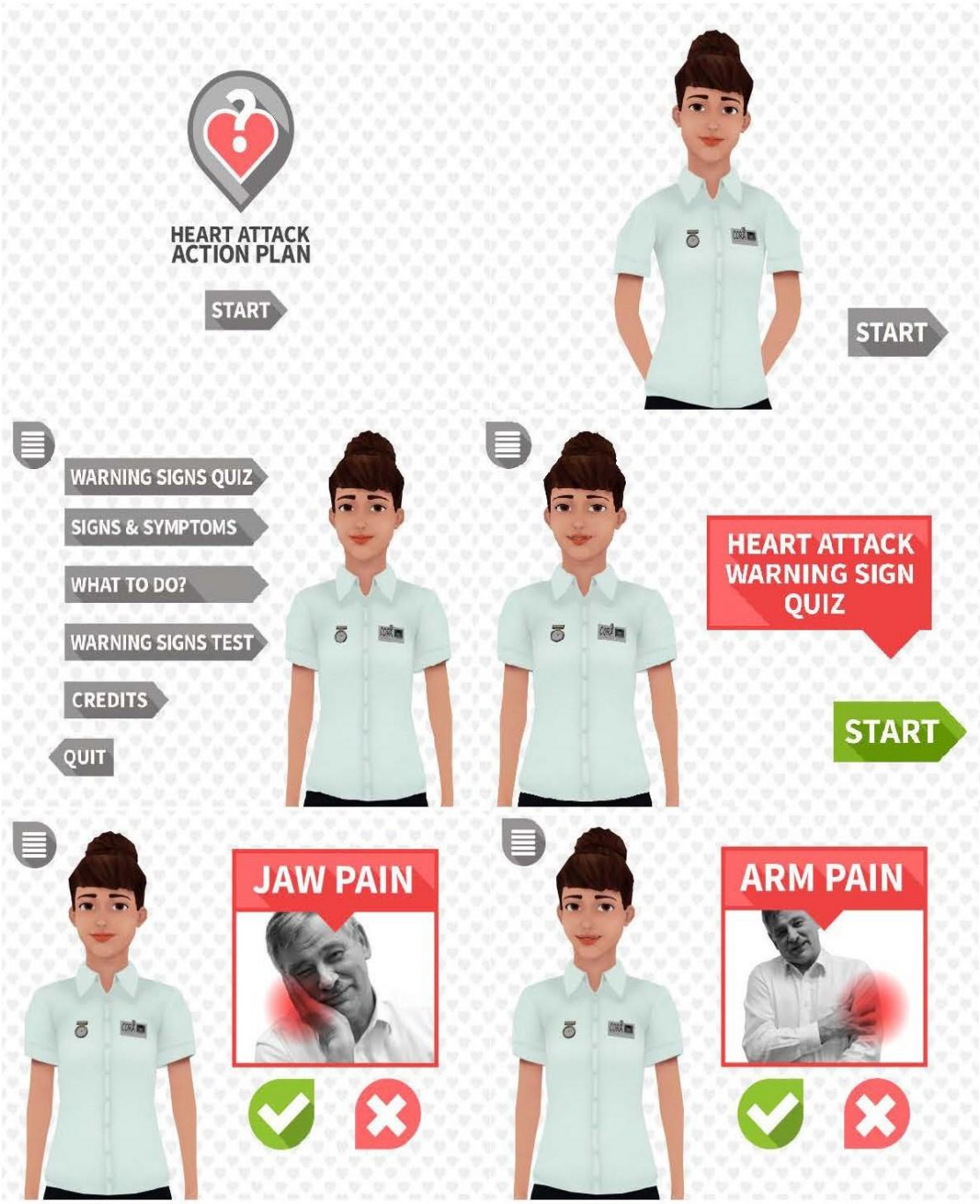
Beliefs Subscale

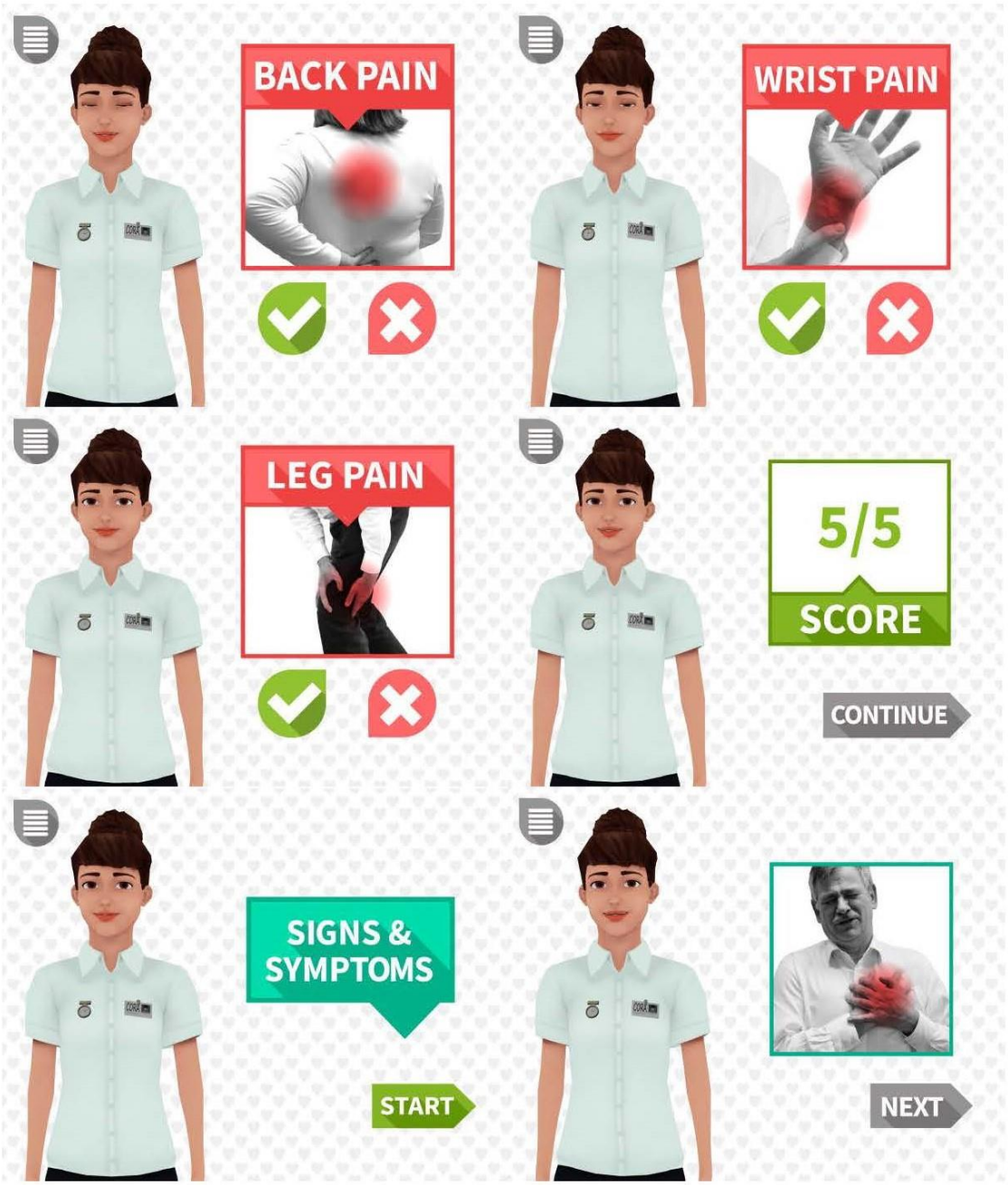
"This time I have 7 statements, and I would like to know if you agree or disagree with them, and how strongly you agree or disagree"

27. If you have chest pain or heart attack symptom that didn't stop after 10 minutes, you should get to the hospital as soon as possible			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree
28. You would be embarrassed to go to the hospital if you thought you were having a heart attack but it turned out you weren't.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
29. If you thought you were having a heart attack, you would wait until you were very sure before going to the hospital			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
30. If You thought you were having a heart attack, you would rather have someone drive you to the hospital than have an ambulance come to your home.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
31. Because of the cost of medical care, you would want to be absolutely sure you were having a heart attack before going to the hospital.			
1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
32. If you are having discomfort or pain in the centre of your chest heart pain and you are not very sure if it's a heart attack, you should go to the hospital anyway			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree
33. If you thought you were having a heart attack, you would go to the hospital right away			
4 Strongly agree	3 Agree	2 Disagree	1 Strongly disagree

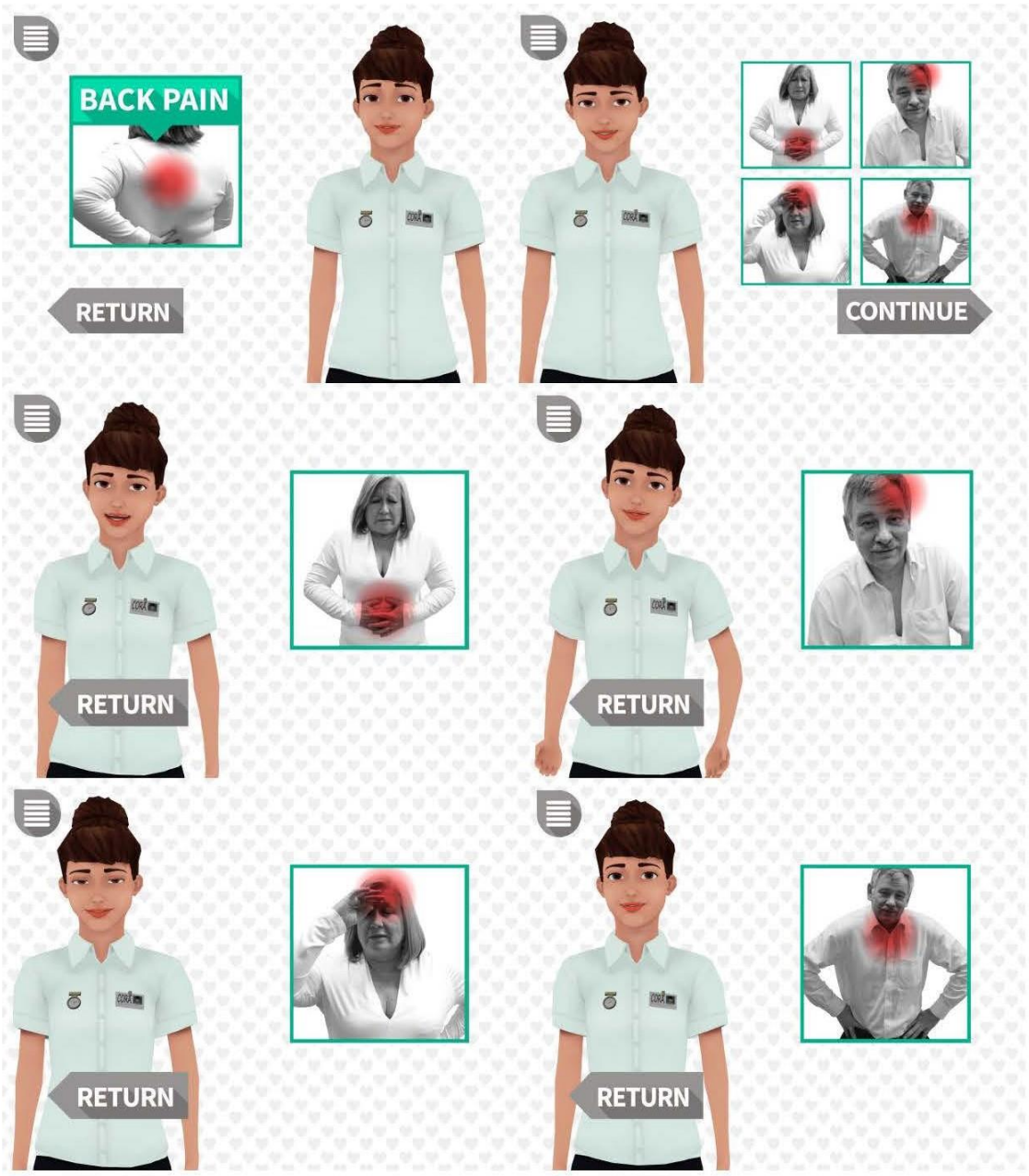
Riegel, B., et al., *Psychometric evaluation of the acute coronary syndrome (ACS) response index.* Research in nursing & health, 2007. **30**(6): p. 584-594.

Appendix 16: Screenshots and Dialogue of the SAVE App

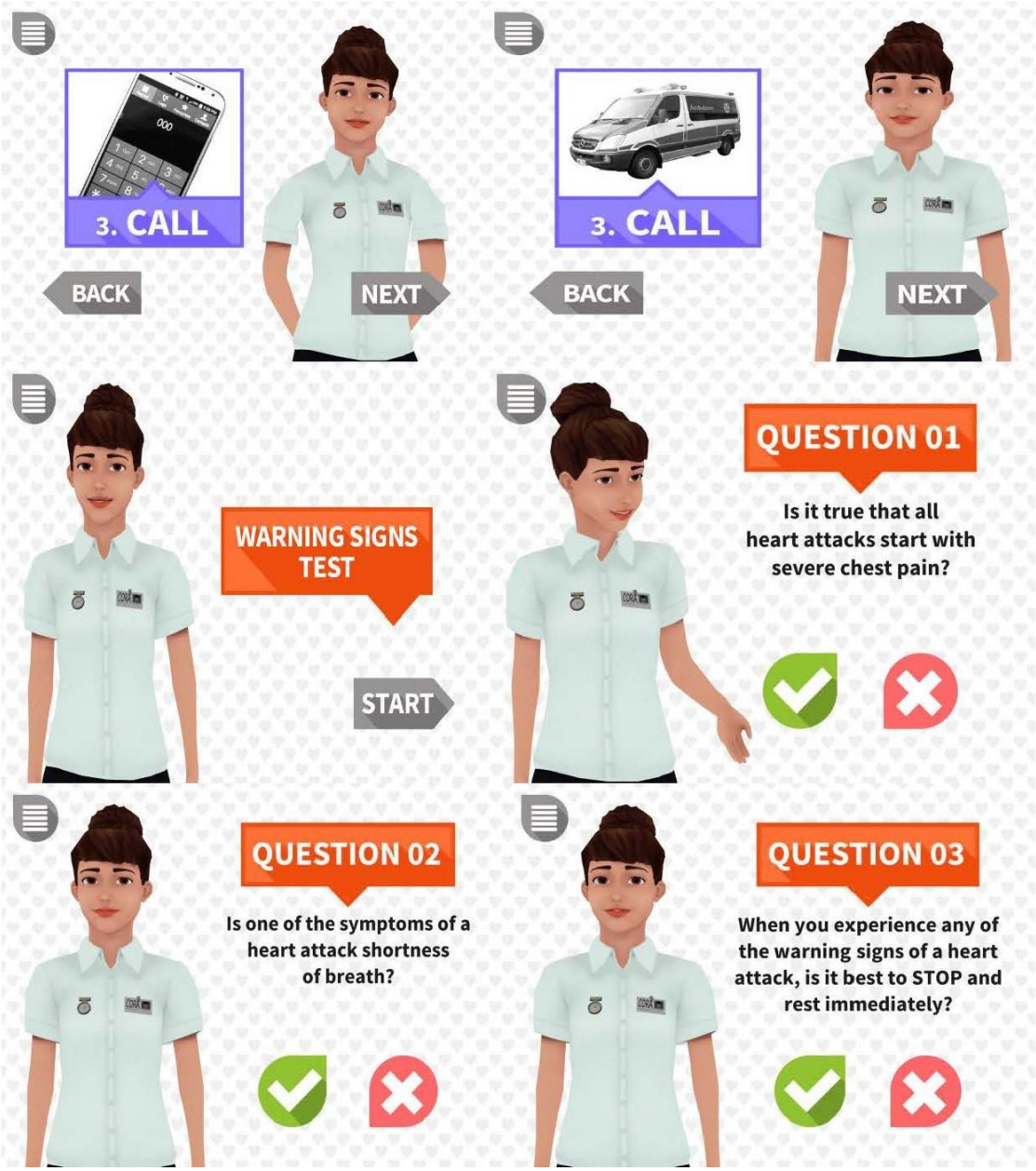



BACK PAIN
WRIST PAIN
LEG PAIN
5/5
SCORE
CONTINUE
SIGNS &
SYMPTOMS
START
NEXT


HEART ATTACK
NEXT
ARM PAIN
SHOULDER PAIN
NECK PAIN
JAW PAIN
BACK PAIN
CONTINUE
NECK PAIN
RETURN
JAW PAIN
RETURN
ARM PAIN
RETURN
SHOULDER PAIN
RETURN


BACK PAIN
RETURN
CONTINUE
RETURN
RETURN
RETURN
RETURN


WHAT TO DO?
NEXT
WHAT TO DO?
1. STOP
2. TALK
3. CALL
NEXT
1. STOP
BACK
NEXT
2. TALK
BACK
NEXT
BACK
NEXT
000
EMERGENCY
3. CALL
BACK
NEXT


3. CALL
BACK
NEXT
3. CALL
BACK
NEXT
WARNING SIGNS TEST
START
QUESTION 01
Is it true that all heart attacks start with severe chest pain?
QUESTION 02
Is one of the symptoms of a heart attack shortness of breath?
QUESTION 03
When you experience any of the warning signs of a heart attack, is it best to STOP and rest immediately?





Flinders UNIVERSITY

The development of this application was supported by the Establishment Grant from the Faculty of Medicine, Nursing and Health Science, Flinders University

Contact:
School of Nursery and Midwifery, Flinders University

CORA DIALOGUE

File Name	Dialogue
Intro_1	Hello, my name is Cora. I am a nurse. I have been looking after people with heart conditions for a long time.
Intro_2	People experience different symptoms before, and during a heart attack, and they can be very difficult to recognize.
Intro_3	I hope I can help you to make more sense of these symptoms, and to know what to do if they do appear.
Intro_4	When you are ready, tap on the “start” button and let's get started!
Intro_5	Or, at any time you can tap on the menu button in the top left hand corner to go to a specific section.
Quiz_Intro	In this activity, we’re going to ask some common questions about the possible warning signs of a heart attack.
Quiz_Correct	Well done! That is Correct.
Quiz_Correct2	Nice work. That is Correct.
Quiz_Incorrect	Sorry, that is not correct!
Quiz_Incorrect2	Uh oh. That is not correct.
Quiz_1	Could discomfort of the jaw possibly indicate a heart attack?
Quiz_2	Could pain or irritation down the arm a possible sign of heart attack?
Quiz_3	Is a possible indication of heart attack discomfort or pain in your back?
Quiz_4	Is irritation or pain in the hand a possible sign of a heart attack?
Quiz_5	Could pain or discomfort in the leg be a possible sign of heart attack?
Quiz_Results_1	Good job! You have identified all of the possible symptoms of a heart attack. But did you know there are some others too? Tap the button below to discover all of the signs and symptoms.
Quiz_Results_2	You have identified most of the warning signs, well done! Let’s have a look at all of the possible signs and symptoms of a heart attack and see which ones you missed.
Quiz_Results_3	You have identified some of the warning signs. Let’s have a look at all of the possible signs and symptoms of a heart attack and see which ones you missed.
Quiz_Results_4	Oh no! You didn’t identify any of the warning signs! That’s ok, let’s have a look at all of the signs and symptoms now.
Signs_Intro_1	It is important to understand that warning signs can vary from person to person, and they may not always be sudden or severe.
Signs_Intro_2	Many start slowly, with only mild pain or discomfort. Some people do not get chest pain at all, only discomfort in other parts of their upper body.
Signs_Intro_3	Someone who has already had a heart attack may have different symptoms the second time.

Signs_Intro_4	Knowing the warning signs of a heart attack and acting quickly can reduce the damage and increase your chances of survival.
Signs_Intro_5	Tap on the start button when you are ready.
Signs_1_1	There are a number of possible warning signs for a heart attack. One of the most common is pain or discomfort in the center of your chest - this can often feel like a heaviness, tightness or pressure.
Signs_1_2	People who have had a heart attack commonly describe it as feeling like an elephant is sitting on your chest, or like a belt is being tightened around it, or even bad indigestion.
Signs_2_1	The discomfort may spread from your chest to different parts of your body. Including the arms, the shoulders, the neck, the jaw, or the back. Some people may have a choking feeling in the throat.
Signs_2_2	Even though chest pain or discomfort is the most common symptom of a heart attack, some people will not experience any chest pain at all, or only mild pain or discomfort in their upper body.
Signs_2_3	Heart attacks are not always sudden or severe. Many start slowly with only mild pain or discomfort. Symptoms usually last for at least 10 minutes.
Signs_2_4	It is important to understand that warning signs can vary from person to person. Some people may experience one symptom, while others experience more than one symptom at the same time.
Signs_2_5	Tap on the pictures for more details, or press continue to move on to the possible symptoms of a heart attack.
Signs_3	Discomfort or pain in your jaw. People who have experienced discomfort during their heart attack describe it as an ache or tightness in and around the lower jaw.
Signs_4_1	Irritation or pain of the arm could be a warning sign of a heart attack. You may feel discomfort, pain, heaviness, or uselessness in one or both arms.
Signs_4_2	People who have had a heart attack describe feelings of discomfort, numbness or tingling in their arms. This is most common down the left arm, but can be on either side.
Signs_5_1	Pain or discomfort in and around one or both of your shoulders.
Signs_5_2	Those who have had heart attacks describe feeling a general ache, heaviness, or pressure, which spreads from their chest to their shoulders.
Signs_6	Discomfort or pain of the neck is a warning sign of a heart attack. People who have had a heart attack describe a general discomfort in their neck, or a choking or burning feeling in their throat.
Signs_7	You may feel pressure, discomfort, pain, heaviness or tightness in your back. People who have had a heart attack describe feeling a dull ache in between their shoulder blades.
Symptoms_Intro_1	Besides the discomfort or pain in your chest and other parts of your upper body, you may also experience other signs and symptoms.

Symptoms_Intro_2	Please tap on a picture to learn more, or press continue to move on to what to do when you are experiencing a heart attack.
Symptoms_1	You may feel nauseous or generally unwell while experiencing other heart attack symptoms.
Symptoms_2	You may break out in a cold sweat, or feel cold and clammy while experiencing other heart attack symptoms.
Symptoms_3	You may feel dizzy or light-headed while experiencing other heart attack symptoms. You may even feel faint, or collapse.
Symptoms_4_1	You may feel short of breath, or have difficulty breathing.
Symptoms_4_2	People who have had a heart attack describe finding it difficult to breathe or to take a deep breath, due to a tight or constricted feeling in their chest.

WhatToDo_Intro_1	Remember! No two heart attacks are the same! Someone who has already had a heart attack may have different symptoms the second time.
WhatToDo_Intro_2	Let's have a look what should you do if you feel any of those signs I have mentioned to you.
WhatToDo_Intro_3	Tap on the next button, when you are ready.
WhatToDo_1_1	What to do if you are experiencing a heart attack. If you notice any of the warning signs you should follow the 3 steps; STOP, TALK, and CALL Triple 0.
WhatToDo_1_2	Please tap the next button to learn more.
WhatToDo_2	The first step is "STOP". If you experience any of the warning signs I have shown to you, you should immediately stop what you are doing and rest.
WhatToDo_3	The second step is "TALK". If you are with someone, tell them what you are feeling, or call a friend or family member on your phone.
WhatToDo_4_1	If you take angina medicine, take a dose.
WhatToDo_4_2	Wait 5 minutes. If you still have symptoms after 5 minutes, take another dose of your medicine. Then wait for another 5 minutes.
WhatToDo_4_3	If the symptoms are severe, getting worse, or do not go away, you need to call Triple 0 and ask for an ambulance.
WhatToDo_5_1	If you experience the warning signs of a heart attack for 10 minutes or more, or if they are severe, or get progressively worse, call Triple 0 immediately and ask for an ambulance.
WhatToDo_5_2	When you call Triple 0, don't hang up. Wait for operator's instructions.
WhatToDo_5_3	If calling Triple Zero does not work on your mobile phone, try dialing 1 1 2.
WhatToDo_5_4	When calling Triple 0, the trained operator will decide if you need an ambulance.
WhatToDo_5_5	You will receive treatment as soon as you phone. You will also be given advice on what to do while waiting for the ambulance to arrive.
WhatToDo_5_6	Press the continue button to move on to the final quiz on the warning signs for a heart attack. It's time to find out what you've learned!

Test_Intro_1	Here are a few questions to see if you've remembered what to do if you are having a heart attack.
Test_Intro_2	Tap on the start button when you are ready.
Test_1_Q	Is it true that all heart attacks start with severe chest pain?
Test_1_A	A heart attack may start slowly with only mild chest pain or discomfort. Some people may not get any chest pain at all, and only have discomfort in other areas of the upper body.
Test_2_Q	Is one of the symptoms of a heart attack shortness of breath?
Test_2_A	Besides discomfort or pain in your chest, or other parts of your upper body, you may also feel shortness of breath, nauseous, dizzy, light-headed, or have a cold sweat.

Test_3_Q	When you experience any of the warning signs of a heart attack, is it best to STOP and rest immediately?
Test_3_A	It is important that you do stop and rest immediately if you experience any of the warning signs we have talked about.
Test_4_Q	If you think you may be experiencing a heart attack, is it a good idea to sit quietly by yourself and wait for the symptoms to go away?
Test_4_A	It is important, when you experience any of the warning signs of a heart attack, that you should talk to someone and tell them what you are feeling.
Test_5_Q	If you think you are having a heart attack, should you drive yourself to the hospital?
Test_5_A	You should not be driving yourself anywhere, but calling Triple 0 for an ambulance. Paramedics are trained to use special lifesaving equipment and to start early treatments inside the ambulance.
Test_6_Q	If you have chest pain that doesn’t stop after 10 minutes, should you call Triple 0?
Test_6_A	Acting quickly can reduce the damage to your heart muscle, and increase your chances of survival. You should call Triple 0 if your symptoms last longer than 10 minutes.
Test_Failure_1	You have scored
Test_Failure_2	Out of 6. Perhaps we should go over some of the information again. It is very important that you are confident about the warning signs of a heart attack, and knowing what to do when they appear.
Test_Failure_3	Please tap on the Signs and Symptoms button to review the warning signs and symptoms, or the 'What To Do' button to review the steps you can take if you think you may be experiencing a heart attack.
Test_Success	Excellent, you have scored 6 out of 6. I hope you feel confident in recognizing the warning signs of a heart attack, and knowing what to do when they appear. Well done!
0	0

1	1
2	2
3	3
4	4
5	5
Outro_1	That’s a lot to go through in a very short time! It can be very difficult to recognise the signs and symptoms of a heart attack.
Outro_2	If you have any questions, make sure you ask your nurse or your doctor. They would be very happy to talk to you about it.
Outro_3	And you can always come back to visit me. I am always here to help! You can also read your booklet from the heart foundation.
Outro_4	Remember, in the back of the booklet is a fridge magnet to remind you of What to do if you are having a heart attack.
Outro_5	If you want to review one of the sections we’ve been through, or close the application, just tap the menu button in the top left corner of the screen.

BIBLIOGRAPHY

Aaby, A, Friis, K, Christensen, B, Rowlands, G & Maindal, HT 2017, 'Health literacy is associated with health behaviour and self-reported health: A large population-based study in individuals with cardiovascular disease', *European Journal of Preventive Cardiology*, vol. 24, no. 17, pp. 1880–8.

Abbott, MB & Shaw, P 2016, 'Virtual nursing avatars: Nurse roles and evolving concepts of care', *OJIN: The Online Journal of Issues in Nursing*, vol. 21, no. 3, (online PubMed).

Abraham, C & Michie, S 2008, 'A taxonomy of behavior change techniques used in interventions', *Health Psychology*, vol. 27, no. 3, pp. 379–87.

Ahmed, I, Ahmad, NS, Ali, S, Ali, S, George, A, Danish, HS, Uppal, E, Soo, J, Mobasheri, MH & King, D 2018, 'Medication adherence apps: Review and content analysis', *The Journal of Medical Internet Research: mHealth and uHealth*, vol. 6, no. 3, p. e62.

Ahmed, MM, El Degwy, HM, Ali, MI & Hegazy, NH 2017, 'The effect of educational intervention on knowledge, attitude and glycemic control in patients with type 2 diabetes mellitus', *International Journal of Community Medicine and Public Health*, vol. 2, no. 3, pp. 302–7.

Akobeng, AK 2008, 'Assessing the validity of clinical trials', *Journal of Pediatric Gastroenterology and Nutrition*, vol. 47, no. 3, pp. 277–82.

Al-Ganmi, AHA, Perry, L, Gholizadeh, L & Alotaibi, AM 2017, 'Behaviour change interventions to improve medication adherence in patients with cardiac disease: Protocol for a mixed methods study including a pilot randomised controlled trial', *Collegian*, vol. 25, no.4, pp. 385–94.

Albarqouni, L, Smenes, K, Meinertz, T, Schunkert, H, Fang, X, Ronel, J & Ladwig, K-H 2016, 'Patients' knowledge about symptoms and adequate behaviour during acute myocardial infarction and its impact on delay time: Findings from the multicentre MEDEA Study', *Patient Education and Counseling*, vol. 99, no. 11, pp. 1845–51.

AlHabib, KF, Sulaiman, K, Al Suwaidi, J, Almahmeed, W, Alsheikh-Ali, AA, Amin, H, Al Jarallah, M, Alfaleh, HF, Panduranga, P & Hersi, A 2016, 'Patient and system-related delays of emergency medical services use in acute ST-elevation myocardial infarction: Results from

the Third Gulf Registry of Acute Coronary Events (Gulf RACE-3Ps)', *PloS One*, vol. 11, no. 1, p. e0147385.

Aliberti, S, Zanaboni, AM, Wiemken, T, Nahas, A, Uppatla, S, Morlacchi, LC, Peyrani, P, Blasi, F & Ramirez, J 2013, 'Criteria for clinical stability in hospitalised patients with community-acquired pneumonia', *European Respiratory Journal*, vol. 52, no. 1, pp. 1008-12.

Allin, S, Shepherd, J, Tomasone, J, Munce, S, Linassi, G, Hossain, SN & Jaglal, S 2018, 'Participatory design of an online self-management tool for users with spinal cord injury: Qualitative study', *The Journal of Medical Internet Research: Rehabilitation and Assistive Technologies*, vol. 5, no. 1, p. e6.

Alm-Roijer, C, Fridlund, B, Stagmo, M & Erhardt, L 2006, 'Knowing your risk factors for coronary heart disease improves adherence to advice on lifestyle changes and medication', *Journal of Cardiovascular Nursing*, vol. 21, no. 5, pp. E24–31.

Alonzo, AA 1984, 'An illness behavior paradigm: A conceptual exploration of a situational-adaptation perspective', *Social Science & Medicine*, vol. 19, no. 5, pp. 499−510.

Alonzo, AA 1986, 'The impact of family and lay others on care-seeking during life-threatening episodes of suspected coronary artery disease', *Social Science and Medicine Journal*, vol. 22, no. 12, pp. 1297–311.

Alshahrani, H, McConkey, R, Wilson, J, Youssef, M & Fitzsimons, D 2014, 'Female gender doubles pre-hospital delay times for patients experiencing ST segment elevation myocardial infarction in Saudi Arabia', *European Journal of Cardiovascular Nursing*, vol. 13, no. 5, pp. 399–407.

Altrichter, H, Kemmis, S, McTaggart, R & Zuber-Skerritt, O 2002, 'The concept of action research', *The Learning Organization*, vol. 9, no. 3, pp. 125–31.

American College of Cardiology 2018, 'TCT-356: Reperfusion delay in patients with ST-elevation myocardial infarction presenting to hospitals without angioplasty capability: Should 'door-to-ambulance' time be the new quality parameter?', *Journal of the American College of Cardiology*, vol. 58, no. 20 Suppl., p. B97.

Aminda, HT, Nordrehaug, JE & Hanestad, BR 2005, 'A qualitative study of the information needs of acute myocardial infarction patients, and their preferences for follow-up contact after discharge', *European Journal of Cardiovascular Nursing*, vol. 4, no. 1, pp. 37–44.

Amini, R, Lisetti, C & Yasavur, U 2014, 'Emotionally responsive virtual counselor for behavior-change health interventions', in MC Tremblay, D VanderMeer, M Rothenberger, A Gupta, V Yoon (eds.), Advancing the impact of design science: Moving from theory to practice. DESRIST 2014. Lecture notes in computer science, vol 8463, Springer, Cham, Switzerland, pp. 433–7.

Amini, R, Lisetti, C, Yasavur, U & Rishe, N 2013, 'On-demand virtual health counselor for delivering behavior-change health interventions', *ICHI '13 Proceedings of the 2013 IEEE International Conference on Healthcare Informatics*, IEEE Computer Society, Washington, pp. 46–55.

Amsterdam, EA, Wenger, NK, Brindis, RG, Casey, DE, Ganiats, TG, Holmes, DR, Jaffe, AS, Jneid, H, Kelly, RF & Kontos, MC 2014, '2014 AHA/ACC guideline for the management of patients with non–ST-elevation acute coronary syndromes: Executive summary: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines', *Journal of the American College of Cardiology*, vol. 64, no. 24, pp. 2645−87.

An, LC, Demers, MR, Kirch, MA, Considine-Dunn, S, Nair, V, Dasgupta, K, Narisetty, N, Resnicow, K & Ahluwalia, J 2013, 'A randomized trial of an avatar-hosted multiple behavior change intervention for young adult smokers', *Journal of the National Cancer Institute. Monographs*, vol. 2013, no. 47, p. 209–15.

Anam, R, Andrade, AD & Ruiz, JG 2016, 'Promoting lifestyle change through medical avatars', in MM Cruz-Cuhna, IM Miranda, R Martinho & R Rijo (eds.), Encyclopedia of e-health and telemedicine, IGI Global, Hershey, USA, pp. 316−30.

Anderson, ES, Winett, RA, Wojcik, JR & Williams, DM 2010, 'Social cognitive mediators of change in a group randomized nutrition and physical activity intervention: Social support, self-efficacy, outcome expectations and self-regulation in the guide-to-health trial', *Journal of Health Psychology*, vol. 15, no. 1, pp. 21–32.

Anderson, JL & Morrow, DA 2017, 'Acute myocardial infarction', *New England Journal of Medicine*, vol. 376, no. 21, pp. 2053−64.

Andersson, H, Ullgren, A, Holmberg, M, Karlsson, T, Herlitz, J & Sundström, BW 2017, 'Acute coronary syndrome in relation to the occurrence of associated symptoms: A quantitative study in prehospital emergency care', *International Emergency Nursing*, vol. 33, pp. 43–7.

Andrade, AD, Anam, R, Karanam, C, Downey, P & Ruiz, JG 2015, 'An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy', *Urology*, vol. 85, no. 3, pp. 561–7.

Andrei, S, Joshi, M, Rudani, C, Shah, A & Tejwani, B 2016, 'Modeling, designing, and implementing an avatar-based interactive map', *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, vol. 7, no. 1, pp. 50–60.

Andrew, S & Halcomb, EJ 2009, *Mixed methods research for nursing and the health sciences*, John Wiley & Sons, West Sussex, UK.

Annaim, A, Lassiter, M, Viera, AJ & Ferris, M 2015, 'Interactive media for parental education on managing children chronic condition: A systematic review of the literature', *BMC Pediatrics*, vol. 15, no. 1, p. 201.

Anttila, M, Koivunen, M & Välimäki, M 2008, 'Information technology-based standardized patient education in psychiatric inpatient care', *Journal of Advanced Nursing*, vol. 64, no. 2, pp. 147–56.

Armin, J, Johnson, T, Hingle, M, Giacobbi Jr, P & Gordon, JS 2017, 'Development of a multi-behavioral mHealth app for women smokers', *Journal of Health Communication*, vol. 22, no. 2, pp. 153–62.

Arozullah, AM, Yarnold, PR, Bennett, CL, Soltysik, RC, Wolf, MS, Ferreira, RM, Lee, S-YD, Costello, S, Shakir, A & Denwood, C 2007, 'Development and validation of a short-form, rapid estimate of adult literacy in medicine', *Medical Care*, vol. 45, no. 11, pp. 1026–33.

Athilingam, P, Jenkins, BA, Zumpano, H & Labrador, MA 2018, 'Mobile technology to improve heart failure outcomes: A proof of concept paper', *Applied Nursing Research*, vol. 39, pp. 26–33.

Atzema, CL, Austin, PC, Huynh, T, Hassan, A, Chiu, M, Wang, JT & Tu, JV 2011, 'Effect of marriage on duration of chest pain associated with acute myocardial infarction before seeking care', *Canadian Medical Association Journal*, vol. 183, no. 13, pp. 1482–91.

Australian Bureau of Statistics 2015, *Australian health survey: First results, 2014/2015,* cat. no. 4364.0, Australian Bureau of Statistics, Canberra.

Australian Bureau of Statistics 2016, *Causes of death, Australia, 2016,* cat. no. 3303.0, Australian Bureau of Statistics, Canberra.

Australian Commission on Safety and Quality in Health Care 2014, *Acute coronary syndromes clinical care standard*, Australian Comission on Safety and Quality in Health Care, Sydney.

Australian Institute of Health and Welfare 2011, *Cardiovascular disease: Australian facts 2011*, cat. no. CVD 53, Australian Institute of Health and Welfare, Canberra.

Australian Institute of Health and Welfare 2016a, *Australia's health 2016.* Australia's health series no.15, cat. no. AUS 199.

Australian Institute of Health and Welfare 2016b, *Australian hospital statistics 2014–15.* Health services series no. 54. cat. no. HSE 145.

Ayrik, C, Ergene, U, Kinay, O, Nazli, C, Unal, B & Ergene, O 2006, 'Factors influencing emergency department arrival time and in-hospital management of patients with acute myocardial infarction', *Advances in Therapy*, vol. 23, no. 2, pp. 244–55.

Azevedo, R, Bernardes, M, Fonseca, J & Lima, A 2015, 'Smartphone application for rheumatoid arthritis self-management: Cross-sectional study revealed the usefulness, willingness to use and patients' needs', *Rheumatology International*, vol. 35, no. 10, pp. 1675–85.

Azevedo, R & Hadwin, AF 2005, 'Scaffolding self-regulated learning and metacognition–implications for the design of computer-based scaffolds', *Instructional Science*, vol 33, no. 5/6, pp.413–50.

Badr, H, Carmack, CL & Diefenbach, MA 2015, 'Psychosocial interventions for patients and caregivers in the age of new communication technologies: Opportunities and challenges in cancer care', *Journal of Health Communication*, vol. 20, no. 3, pp. 328–42.

Bagheri-Saweh, MI, Lotfi, A & Salawati Ghasemi, S 2018, 'Self-care behaviors and related factors in chronic heart failure patients', *International Journal of Biomedicine and Public Health*, vol. 1, no. 1, pp. 42–7.

Bahall, MU & Legall, G 2017, 'Pre-hospital care in stable patients with acute coronary syndrome: Factors and predictors of pre-hospital delays in a tertiary public health institute', *International Journal of Community Medicine and Public Health*, vol. 5, no. 1, pp. 12–20.

Bandura, A 1977, 'Self-efficacy: Toward a unifying theory of behavioral change', *Psychological Review*, vol. 84, no. 2, p. 191–215.

Bandura, A 1985, 'Model of causality in social learning theory', in MJ Mahoney & A Freeman (eds.), *Cognition and psychotherapy*, Springer, Boston, USA, pp. 81−99.

Bandura, A 1986, *Social foundations of thought and action: A social cognitive theory,* Prentice Hall, Englewood Cliffs, USA.

Bandura, A 1991, 'Social cognitive theory of self-regulation', *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 248−87.

Bandura, A, 1998, 'Health promotion from the perspective of social cognitive theory', *Psychology and Health*, vol. 13, no. 4, pp. 623−49.

Bandura, A, 2002, 'Social cognitive theory in cultural context', *Applied Psychology*, vol. 51, no. 2, pp. 269−90.

Bandura, A, 2005, 'The primacy of self-regulation in health promotion', *Applied Psychology*, vol. 54, no. 2, pp. 245–54.

Bandura, A, 2008, 'Observational learning', in W Donsbach (ed.), *The international encyclopedia of communication,* Blackwell, Oxford, UK, pp. 3359–61.

Bandura, A 2011, 'Social cognitive theory', in PAM Van Lange, AW Kruglanski & ET Huggins (eds.), *Handbook of theories of social psychology,* Sage Publications, Thousand Oaks, USA, pp. 349–73.

Bandura, A, 2012, ‘Social cognitive theory’, in PAM Van Lange, AW Kruglanski & ET Higgins (eds.), *Handbook of social psychological theories*, Sage Publications, London, pp. 349−73.

Bandura, A & Walters, RH 1977, *Social learning theory*, vol. 1, Prentice Hall, Englewood Cliffs, USA.

Banharak, S 2017, ‘Knowledge, belief, and decision making about acute myocardial infarction among younger and older adult Thai and Laotian immigrants in the United States’, PhD thesis, St Louis University, St Louis, USA.

Barnason, S, White-Williams, C, Rossi, LP, Centeno, M, Crabbe, DL, Lee, KS, McCabe, N, Nauser, J, Schulz, P & Stamp, K 2017, ‘Evidence for therapeutic patient education interventions to promote cardiovascular patient self-management: A scientific statement for healthcare professionals from the American Heart Association’, *Circulation: Cardiovascular Quality and Outcomes*, vol. 10, no. 6, p. e000025.

Barnason, S, Zimmerman, L & Young, L 2012, ‘An integrative review of interventions promoting self-care of patients with heart failure’, *Journal of Clinical Nursing*, vol. 21, no. 3–4, pp. 448–75.

Bartholomew, LK & Mullen, PD 2011, ‘Five roles for using theory and evidence in the design and testing of behavior change interventions’, *Journal of Public Health Dentistry*, vol. 71, no. s1, pp. S20–33.

Barton, AJ 2012, ‘The regulation of mobile health applications’, BioMed Central *Medicine*, vol. 10, no. 1, pp. 46–9.

Basu, JBMAM & Sharma, SMDFF 2016, ‘Early recognition vital in acute coronary syndrome’, *Practitioner*, vol. 260, no. 1797, pp. 19–23.

Bauer, AM, Thielke, SM, Katon, W, Unützer, J & Areán, P 2014, ‘Aligning health information technologies with effective service delivery models to improve chronic disease care’, *Preventive Medicine*, vol. 66, pp. 167–72.

Baxter, SK & Allmark, P 2013, ‘Reducing the time-lag between onset of chest pain and seeking professional medical help: A theory-based review’, BioMed Central *Medical Research Methodology*, vol. 13, no. 15, pp. 1–15.

Beale, IL, Kato, PM, Marin-Bowling, VM, Guthrie, N & Cole, SW 2007, 'Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer', *Journal of Adolescent Health*, vol. 41, no. 3, pp. 263–70.

Bedra, M, Wick, E, Brotman, D & Finkelstein, J 2013, 'Avatar-based interactive ileostomy education in hospitalized patients', *Informatics, Management and Technology in Healthcare*, vol. 190, p. 83−5.

Bell, D, Gachuhi, N & Assefi, N 2018, 'Dynamic clinical algorithms: Digital technology can transform health care decision-making', *The American Journal of Tropical Medicine and Hygiene*, vol. 98, no. 1, pp. 9–14.

Bell, M, Lommel, T, Fischer, JG, Lee, JS, Reddy, S & Johnson, MA 2009, 'Improved recognition of heart attack and stroke symptoms after a community-based intervention for older adults, Georgia, 2006–2007', *Preventing Chronic Disease*, vol. 6, no. 2, pp. A41–A.

Bell, ML, Fiero, M, Horton, NJ & Hsu, C-H 2014, 'Handling missing data in RCTs; a review of the top medical journals', *BioMed Central Medical Research Methodology*, vol. 14, no. 1, p. 118.

Bellg, AJ, Borrelli, B, Resnick, B, Hecht, J, Minicucci, DS, Ory, M, Ogedegbe, G, Orwig, D, Ernst, D & Czajkowski, S 2004, 'Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH Behavior Change Consortium', *Health Psychology*, vol. 23, no. 5, p. 443–51.

Benjamin, EJ, Blaha, MJ, Chiuve, SE, Cushman, M, Das, SR, Deo, R, Floyd, J, Fornage, M, Gillespie, C & Isasi, C 2017, 'Heart disease and stroke statistics—2017 update: A report from the American Heart Association', *Circulation*, vol. 135, no. 10, pp. e146–603.

Bennett, SJ & Sauvé, MJ 2003, 'Cognitive deficits in patients with heart failure: A review of the literature', *Journal of Cardiovascular Nursing*, vol. 18, no. 3, pp. 219–42.

Beranova, E & Sykes, C 2007, 'A systematic review of computer-based softwares for educating patients with coronary heart disease', *Patient Education and Counseling*, vol. 66, no. 1, pp. 21–8.

Berger, V 2017, *Randomization, masking, and allocation concealment*, CRC Press, Florida, USA.

Berkman, ND, Sheridan, SL, Donahue, KE, Halpern, DJ & Crotty, K 2011, 'Low health literacy and health outcomes: An updated systematic review', *Annals of Internal Medicine*, vol. 155, no. 2, pp. 97–107.

Bernhardt, JM, Chaney, JD, Chaney, BH & Hall, AK 2013, 'New media for health education: A revolution in progress', *Health Education & Behavior*, vol. 40, no. 2, pp. 129–32.

Bert, F, Giacometti, M, Gualano, MR & Siliquini, R 2014, 'Smartphones and health promotion: A review of the evidence', *Journal of Medical Systems*, vol. 38, no. 1, pp. 1–11.

Bett, J, Tonkin, A, Thompson, P & Aroney, C 2005, 'Failure of current public educational campaigns to impact on the initial response of patients with possible heart attack', *Internal Medicine Journal*, vol. 35, no. 5, pp. 279–82.

Bickmore, TW, Pfeifer, LM & Paasche-Orlow, MK 2009, 'Using computer agents to explain medical documents to patients with low health literacy', *Patient Education and Counseling*, vol. 75, no. 3, pp. 315–20.

Bickmore, TW, Schulman, D & Sidner, C 2013, 'Automated interventions for multiple health behaviors using conversational agents', *Patient Education & Counseling*, vol. 92, no. 2, pp. 142–8.

Bickmore, TW, Silliman, RA, Nelson, K, Cheng, DM, Winter, M, Henault, L & Paasche-Orlow, MK 2013, 'A randomized controlled trial of an automated exercise coach for older adults', *Journal of the American Geriatrics Society*, vol. 61, no. 10, pp. 1676–83.

Blok, AC, May, CN, Sadasivam, RS & Houston, TK 2017, 'Virtual patient technology: Engaging primary care in quality improvement innovations', *Journal of Medical Internet Research Medical Education*, vol. 3, no. 1, p. e3.

Boone, T, Reilly, AJ & Sashkin, M 1977, 'Social learning theory Albert Bandura Englewood Cliffs, N.J.: Prentice-Hall, 1977. 247 pp., paperbound', *Group & Organization Management*, vol. 2, no. 3, pp. 384–5.

Boothroyd, LJ, Lambert, LJ, Segal, E, Ross, D, Kouz, S, Maire, S, Harvey, R, Xiao, Y, Brown, KA & Nasmith, J 2014, 'Comparison of outcomes of ambulance users and nonusers in ST elevation myocardial infarction', *American Journal of Cardiology*, vol. 114, no. 9, pp. 1289–94.

Boren, SA, Gunlock, TL, Peeples, MM & Krishna, S 2008, 'Computerized learning technologies for diabetes: A systematic review', *Journal of Diabetes Science and Technology*, vol. 2, no. 1, pp. 139–46.

Boréus, K & Bergström, G 2017, 'Content analysis', in K Boréus & G Bergström (eds.), *Eight approaches for the social sciences*, Sage Publications, London, UK, pp. 23–52.

Boulos, MNK 2013, 'Social media and mobile health', in I Kickbusch, JM Pelikan, F Apfel & A Tsouros (eds.), *Health literacy: The solid facts*, WHO Regional Office for Europe, Copenhagen, Denmark, pp. 63–7.

Boulos, MNK, Brewer, AC, Karimkhani, C, Buller, DB & Dellavalle, RP 2014, 'Mobile medical and health apps: State of the art, concerns, regulatory control and certification', *Online Journal of Public Health Informatics*, vol. 5, no. 3, p. e229.

Boutron, I, Dutton, S, Ravaud, P & Altman, DG 2010, 'Reporting and interpretation of randomized controlled trials with statistically nonsignificant results for primary outcomes', *The Journal of the American Medical Association*, vol. 303, no. 20, pp. 2058–64.

Bowen, DJ, Kreuter, M, Spring, B, Cofta-Woerpel, L, Linnan, L, Weiner, D, Bakken, S, Kaplan, CP, Squiers, L & Fabrizio, C 2009, 'How we design feasibility studies', *American Journal of Preventive Medicine*, vol. 36, no. 5, pp. 452–7.

Boyde, M & Peters, R 2014, 'Education material for heart failure patients: What works and what does not?', *Current Heart Failure Reports*, vol. 11, no. 3, pp. 314–20.

BPhty, AL, BPhty, AD & BPhty, SB 2015, 'Consumers and health professionals' perceptions of participatory action research in developing a health resource', *New Zealand Journal of Physiotherapy*, vol. 43, no. 3, pp. 93–7.

Bradbury-Huang, H 2010, 'What is good action research? Why the resurgent interest?', *Action Research*, vol. 8, no. 1, pp. 93–109.

Bradbury, H 2015, *The Sage handbook of action research*, Sage Publications, London, UK.

Braun, V & Clarke, V 2013. *Successful qualitative research: A practical guide for beginners*, Sage Publications, London, UK.

Bray, JE, Straney, L, Barger, B & Finn, J 2015, 'Effect of public awareness campaigns on calls to ambulance across Australia', *Stroke*, vol. 46, no. 5, pp. 1377–80.

Bray, JE, Straney, L, Patsamanis, H, Stavreski, B & Finn, J 2016, 'Australian's awareness of heart attack symptoms and action improves with a mass media warning signs campaign, *Heart, Lung and Circulation*, vol. 26, p. S49.

Bray, JE, Stub, D, Ngu, P, Cartledge, S, Straney, L, Stewart, M, Keech, W, Patsamanis, H, Shaw, J & Finn, J 2015, 'Mass media campaigns' influence on prehospital behavior for acute coronary syndromes: An evaluation of the Australian Heart Foundation's warning signs campaign', *Journal of the American Heart Association*, vol. 4, no. 7, p. e001927.

Bressan, V, Bagnasco, A, Aleo, G, Timmins, F, Barisone, M, Bianchi, M, Pellegrini, R & Sasso, L 2017, 'Mixed-methods research in nursing—a critical review', *Journal of Clinical Nursing*, vol. 26, no. 19–20, pp. 2878–90.

Broderick, J, Devine, T, Langhans, E, Lemerise, AJ, Lier, S & Harris, L 2014, *Designing health literate mobile apps: Discussion paper*, Institute of Medicine of the National Academies, Washington, USA.

Bruno, CM 2013, 'Understanding symptom experiences of older individuals with acute coronary syndrome', Ph.D. thesis, The University of Arizona, Arizona, USA.

Buckley, T, McKinley, S, Gallagher, R, Dracup, K, Moser, D & Aitken, L 2007, 'The effect of education and counselling on knowledge, attitudes and beliefs about responses to acute myocardial infarction symptoms', *European Journal of Cardiovascular Nursing*, vol. 6, no. 2, pp. 105–11.

Bulpitt, CJ 2012, *Randomised controlled clinical trials*, Springer, New York, USA.

Bunge, M, Mühlhauser, I & Steckelberg, A 2010, 'What constitutes evidence-based patient information? Overview of discussed criteria', *Patient Education and Counseling*, vol. 78, no. 3, pp. 316–28.

Burns, N & Grove, SK 2010, *Understanding nursing research eBook: Building an evidence-based practice*, Elsevier Health Sciences, Maryland, USA.

Burton, C, Szentagotai Tatar, A, McKinstry, B, Matheson, C, Matu, S, Moldovan, R, Macnab, M, Farrow, E, David, D & Pagliari, C 2016, 'Pilot randomised controlled trial of Help4Mood, an embodied virtual agent-based system to support treatment of depression', *Journal of Telemedicine and Telecare*, vol. 22, no. 6, pp. 348–55.

Bussey, K & Bandura, A 1999, 'Social cognitive theory of gender development and differentiation', *Psychological Review*, vol. 106, no. 4, p. 676–713.

Butterworth, SW, Linden, A & McClay, W 2007, 'Health coaching as an intervention in health management programs', *Disease Management & Health Outcomes*, vol. 15, no. 5, pp. 299–307.

Caburnay, CA 2015, 'Evaluating diabetes mobile applications for health literate designs and functionality, 2014', *Preventing Chronic Disease*, vol. 12, p. E61.

Caligtan, CA, Carroll, DL, Hurley, AC, Gersh-Zaremski, R & Dykes, PC 2012, 'Bedside information technology to support patient-centered care', *International Journal of Medical Informatics*, vol. 81, no. 7, pp. 442–51.

Camden, C, Shikako-Thomas, K, Nguyen, T, Graham, E, Thomas, A, Sprung, J, Morris, C & Russell, DJ 2015, 'Engaging stakeholders in rehabilitation research: A scoping review of strategies used in partnerships and evaluation of impacts', *Disability and Rehabilitation*, vol. 37, no. 15, pp. 1390–400.

Cameron, LD, Durazo, A & Rus, H 2015, 'Illness representations', in Y Benyanini, M Johnston, & EC Karademas (eds.), *Assessment in health psychology,* Hogrefe, Boston, USA, pp. 45–59.

Campbell, DJ, Tam-Tham, H, Dhaliwal, KK, Manns, BJ, Hemmelgarn, BR, Sanmartin, C & King-Shier, K 2017, 'Use of mixed methods research in research on coronary artery disease, diabetes mellitus, and hypertension: A scoping review', *Circulation: Cardiovascular Quality and Outcomes*, vol. 10, no. 1, p. e003310.

Canbazoglu, E, Salman, YB, Yildirim, ME, Merdenyan, B & Ince, IF 2016, 'Developing a mobile application to better inform patients and enable effective consultation in implant dentistry', *Computational and Structural Biotechnology Journal*, vol. 14, pp. 252–61.

Carman, KL, Dardess, P, Maurer, M, Sofaer, S, Adams, K, Bechtel, C & Sweeney, J 2013, 'Patient and family engagement: A framework for understanding the elements and developing interventions and policies', *Health Affairs*, vol. 32, no. 2, pp. 223–31.

Carr, HJ, McDermott, A, Tadbiri, H, Uebbing, A-M & Londrigan, M 2013, 'The effectiveness of computer-based learning in hospitalized adults with heart failure on knowledge, re-admission, self-care, quality of life, and patient satisfaction: A systematic review protocol', *JBI Database of Systematic Reviews and Implementation Reports*, vol. 11, no. 8, pp. 129–45.

Carstensen, S, Nelson, GC, Hansen, PS, Macken, L, Irons, S, Flynn, M, Kovoor, P, Soo Hoo, SY, Ward, MR & Rasmussen, HH 2007, 'Field triage to primary angioplasty combined with emergency department bypass reduces treatment delays and is associated with improved outcome', *European Heart Journal*, vol. 28, no. 19, pp. 2313–9.

Cartledge, S, Feldman, S, Bray, JE, Stub, D & Finn, J 2018, 'Understanding patients and spouses experiences of patient education following a cardiac event and eliciting attitudes and preferences towards incorporating cardiopulmonary resuscitation training: A qualitative study', *Journal of Advanced Nursing*, vol. 74, no. 5, pp.1157–69.

Cartledge, S, Finn, J, Straney, L, Ngu, P, Stub, D, Patsamanis, H, Shaw, J & Bray, J 2017, 'The barriers associated with emergency medical service use for acute coronary syndrome: The awareness and influence of an Australian public mass media campaign', *Emergency Medical Journal*, vol. 34, no. 7, <https://emj.bmj.com/>.

Caruth, GD 2013, 'Demystifying mixed methods research design: A review of the literature', *Online Submission*, vol. 3, no. 2, pp. 112–22.

Casimir, YE, Williams, MM, Liang, MY, Pitakmongkolkul, S & Slyer, JT 2013, 'Effectiveness of patient-centered self-care education for adults with heart failure on knowledge, self-care behaviors, quality of life, and readmissions: A systematic review protocol', *JBI Database of Systematic Reviews and Implementation Reports*, vol. 11, no. 8, pp. 107–28.

Centers for Disease Control and Prevention 2008, 'Disparities in adult awareness of heart attack warning signs and symptoms—14 states, 2005', *MMWR. Morbidity and Mortality Weekly Report*, vol. 57, no. 7, p. 175–9.

Chalkidou, K, Tunis, S, Whicher, D, Fowler, R & Zwarenstein, M 2012, 'The role for pragmatic randomized controlled trials (pRCTs) in comparative effectiveness research', *Clinical Trials*, vol. 9, no. 4, pp. 436–46.

Chan, A-W, Tetzlaff, JM, Altman, DG, Laupacis, A, Gøtzsche, PC, Krleža-Jerić, K, Hróbjartsson, A, Mann, H, Dickersin, K & Berlin, JA 2013, 'SPIRIT 2013 statement: Defining standard protocol items for clinical trials', *Annals of Internal Medicine*, vol. 158, no. 3, pp. 200–7.

Chandrasekhar, J, Marley, P, Allada, C, McGill, D, O'Connor, S, Rahman, M, Tan, R, Hosseiny, AD, Shadbolt, B & Farshid, A 2017, 'Symptom-to-balloon time is a strong predictor of adverse events following primary percutaneous coronary intervention: Results from the Australian Capital Territory PCI Registry', *Heart, Lung and Circulation*, vol. 26, no. 1, pp. 41–8.

Charlier, N, Zupancic, N, Fieuws, S, Denhaerynck, K, Zaman, B & Moons, P 2015, 'Serious games for improving knowledge and self-management in young people with chronic conditions: A systematic review and meta-analysis', *Journal of the American Medical Informatics Association*, vol. 23, no. 1, pp. 230–9.

Charlson, ME, Charlson, RE, Peterson, JC, Marinopoulos, SS, Briggs, WM & Hollenberg, JP 2008, 'The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients', *Journal of Clinical Epidemiology*, vol. 61, no. 12, pp. 1234–40.

Chattaraman, V, Kwon, W-S & Gilbert, JE 2012, 'Virtual agents in retail web sites: Benefits of simulated social interaction for older users', *Computers in Human Behavior*, vol. 28, no. 6, pp. 2055–66.

Chau, PH, Moe, G, Lee, SY, Woo, J, Leung, AY, Chow, C-M, Kong, C, Lo, WT, Yuen, MH & Zerwic, J 2018, 'Low level of knowledge of heart attack symptoms and inappropriate anticipated treatment-seeking behaviour among older Chinese: A cross-sectional survey', *Journal of Epidemiology & Community Health*, vol. 72, no. 7, pp. 645–52.

Chen, YC & Chiang, LC 2007, 'Effectiveness of hand-washing teaching programs for families of children in paediatric intensive care units', *Journal of Clinical Nursing*, vol. 16, no. 6, pp. 1173–9.

Chew, DP, French, J, Briffa, TG, Hammett, CJ, Ellis, CJ, Ranasinghe, I, Aliprandi-Costa, BJ, Astley, CM, Turnbull, FM & Lefkovits, J 2013, 'Acute coronary syndrome care across Australia and New Zealand: The SNAPSHOT ACS study', *Medical Journal of Australia*, vol. 199, no. 3, pp. 185–91.

Chew, DP, Scott, IA, Cullen, L, French, JK, Briffa, TG, Tideman, PA, Woodruffe, S, Kerr, A, Branagan, M & Aylward, PE 2016, 'National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Australian clinical guidelines for the management of acute coronary syndromes 2016', *Heart, Lung and Circulation*, vol. 25, no. 9, pp. 895–951.

Chinn, CHDDSMPH, Levine, JRDCDE, Matos, S, Findley, SP & Edelstein, BLDDSMPH 2013, 'An interprofessional collaborative approach in the development of a caries risk assessment mobile tablet application: My smile buddy', *Journal of Health Care for the Poor and Underserved*, vol. 24, no. 3, pp. 1010–20.

Chiou, CP & Chung, YC 2012, 'Effectiveness of multimedia interactive patient education on knowledge, uncertainty and decision-making in patients with end-stage renal disease', *Journal of Clinical Nursing*, vol. 21, no. 9–10, pp. 1223–31.

Cho, J-H, Kim, S-B, Kim, S-K, Kim, M-H, Kim, G-S, Kim, S-N, Kim, S-Y & Kim, J-W 2013, 'Development of 'children's food avatar' application for dietary education', *Korean Journal of Community Nutrition*, vol. 18, no. 4, pp. 299–311.

Cho, J, Park, D & Lee, HE 2014, 'Cognitive factors of using health apps: Systematic analysis of relationships among health consciousness, health information orientation, eHealth literacy, and health app use efficacy', *Journal of Medical Internet Research*, vol. 16, no. 5, p. e125.

Christmals, CD & Gross, JJ 2017, 'An integrative literature review framework for postgraduate nursing research reviews', *European Journal of Research in Medical Sciences*, vol. 5, no. 1, p. 7.

Ciechanowski, PS, Katon, WJ, Russo, JE & Walker, EA 2014, 'The patient–provider relationship: Attachment theory and adherence to treatment in diabetes', *American Journal of Psychiatry*, vol.158, no.1, pp. 29–35.

Clark, NM, Gong, M & Kaciroti, N 2014, 'A model of self-regulation for control of chronic disease', *Health Education & Behavior*, vol. 41, no. 5, pp. 499–508.

Clark, R, Fredericks, B, Buitendyk, N, Adams, M, Howie-Esquivel, J, Dracup, K, Berry, N, Atherton, J, Johnson, S & Clark, R 2015, 'Development and feasibility testing of an education program to improve knowledge and self-care among Aboriginal and Torres Strait Islander patients with heart failure', *Rural and Remote Health*, vol. 15, no. 3, pp. 231–43.

Clark, RA, Conway, A, Poulsen, V, Keech, W, Tirimacco, R & Tideman, P 2015, 'Alternative models of cardiac rehabilitation: A systematic review', *European Journal of Preventive Cardiology*, vol. 22, no. 1, pp. 35–74.

Clark, RA, Yallop, JJ, Piterman, L, Croucher, J, Tonkin, A, Stewart, S, Krum, H & Team, CS 2007, 'Adherence, adaptation and acceptance of elderly chronic heart failure patients to receiving healthcare via telephone-monitoring', *European Journal of Heart Failure*, vol. 9, no. 11, pp. 1104–11.

Claydon, LS 2015, 'Rigour in quantitative research', *Nursing Standard (2014+)*, vol. 29, no. 47, pp. 43–8.

Clifton, DC, Benjamin, RW, Brown, AR, Ostrovsky, DA & Narayan, AP 2018, 'A tablet-based educational tool: Toward more comprehensive pediatric patient education', *Clinical Pediatrics*, (online PubMed).

Coleman, CA, Hudson, S & Maine, LL 2013, 'Health literacy practices and educational competencies for health professionals: A consensus study', *Journal of Health Communication*, vol. 18, no. suppl. 1, pp. 82–102.

Collings, S, Dew, A & Dowse, L 2018, '"Testing it in the real world": Using action research to apply a conceptual framework to social care planning', *Action Research*, <http://journals.sagepub.com/>.

Commodore-Mensah, Y & Himmelfarb, CRD 2012, 'Patient education strategies for hospitalized cardiovascular patients: A systematic review', *Journal of Cardiovascular Nursing*, vol. 27, no. 2, pp. 154–74.

Connolly, PM & Elfrink, VL 2002, 'Using information technology in community-based psychiatric nursing education: The SJSU/NT Project', *Home Health Care Management & Practice*, vol. 14, no. 5, pp. 344–52.

Contreras, JP 2010, ‘Factors associated with delayed pre-hospital time in patients with suspected acute coronary syndrome: Effect of gender’, MS thesis, Sackler School of Graduate Biomedical Sciences (Tufts University), Boston, USA.

Cook, DJ, Moradkhani, A, Douglas, KSV, Prinsen, SK, Fischer, EN & Schroeder, DR 2014, ‘Patient education self-management during surgical recovery: Combining mobile (iPad) and a content management system’, *Telemedicine and e-Health*, vol. 20, no. 4, pp. 312–7.

Coorey, GM, Neubeck, L, Mulley, J & Redfern, J 2018, ‘Effectiveness, acceptability and usefulness of mobile applications for cardiovascular disease self-management: Systematic review with meta-synthesis of quantitative and qualitative data’, *European Journal of Preventive Cardiology*, vol. 25, no. 5, pp. 505–21.

Coorey, GM, Neubeck, L, Usherwood, T, Peiris, D, Parker, S, Lau, AY, Chow, C, Panaretto, K, Harris, M & Zwar, N 2017, ‘Implementation of a consumer-focused eHealth intervention for people with moderate-to-high cardiovascular disease risk: Protocol for a mixed-methods process evaluation’, *British Medical Journal Open*, vol. 7, no. 1, p. e014353.

Cordeiro, L & Soares, CB 2018, ‘Participation in action research in the context of primary health care’, *EC Psychology and Psychiatry*, vol. 7, pp. 153–9.

Correia, LCL, Brito, M, Kalil, F, Sabino, M, Garcia, G, Ferreira, F, Matos, I, Jacobs, P, Ronzoni, L & Noya-Rabelo, M 2013, ‘Effectiveness of a myocardial infarction protocol in reducing door-to-balloon time’, *Arquivos Brasileiros de Cardiologia*, vol. 101, no. 1, pp. 26–34.

Corry, M, Clarke, M, While, AE & Lalor, J 2013, ‘Developing complex interventions for nursing: A critical review of key guidelines’, *Journal of Clinical Nursing*, vol. 22, no. 17–18, pp. 2366–86.

Cossette, S, Côté, J, Rouleau, G, Robitaille, M, Heppell, S, Mailhot, T, Fontaine, G, Cournoyer, C, Gagnon, M-P & Gallani, M-C 2017, ‘A web-based tailored intervention to support illness management in patients with an acute coronary syndrome: Pilot study’, *Journal of Medical Internet Research Cardiology*, vol. 1, no. 2, p. e4.

Coventry, LL, Schalkwyk, JW, Thompson, PL, Hawkins, SA & Hegney, DG 2017, ‘Myocardial infarction, patient decision delay and help-seeking behaviour: A thematic analysis’, *Journal of Clinical Nursing*, vol. 26, no. 13–14, pp. 1993–2005.

Crea, F & Libby, P 2017, ‘Acute coronary syndromes: The way forward from mechanisms to precision treatment’, *Circulation*, vol. 136, no. 12, pp. 1155−66.

Crea, F & Liuzzo, GN 2013, ‘Pathogenesis of acute coronary syndromes’, *Journal of the American College of Cardiology*, vol. 61, no. 1, pp. 1−11.

Creswell, JW & Clark, VLP 2007, *Designing and conducting mixed methods research*, Sage Publications, California, USA.

Creswell, JW & Creswell, JD 2017, *Research design: Qualitative, quantitative, and mixed methods approaches*, Sage Publications, Thousand Oaks, USA.

Creswell, JW, Plano Clark, VL, Gutmann, ML & Hanson, WE 2003, ‘Advanced mixed methods research designs’, in A Tashakkori & C Teddlie (eds.), *Handbook of mixed methods in social and behavioral research*, Thousand Oaks, USA, pp. 209–40.

Critical Appraisal Skills Programme 2018, *CASP 2018 Randomised controlled trial checklist*, Critical Appraisal Skills Programme, Oxford, <https://casp-uk.net/wp-content/uploads/2018/01/CASP-Randomised-Controlled-Trial-Checklist.pdf>.

Cullen, L, Greenslade, J, Merollini, K, Graves, N, Hammett, CJK, Hawkins, T, Than, MP, Brown, AFT, Huang, CB & Panahi, SE 2015, ‘Cost and outcomes of assessing patients with chest pain in an Australian emergency department’, *The Medical Journal of Australia*, vol. 202, no. 8, pp. 427–32.

Cullen, L, Greenslade, JH, Menzies, L, Leong, A, Than, M, Pemberton, C, Aldous, S, Pickering, J, Dalton, E & Crosling, B 2016, ‘Time to presentation and 12-month health outcomes in patients presenting to the emergency department with symptoms of possible acute coronary syndrome’, *Emergency Medicine Journal*, vol. 33, no. 6, pp. 390–5.

Cusack, C, Cohen, B, Mignone, J, Chartier, MJ & Lutfiyya, Z 2018, ‘Participatory action as a research method with public health nurses’, *Journal of Advanced Nursing*, vol. 74, no. 7, pp. 1544–53.

Cytryn, KN, Yoskowitz, NA, Cimino, JJ & Patel, VL 2009, ‘Lay public’s knowledge and decisions in response to symptoms of acute myocardial infarction’, *Advances in Health Sciences Education*, vol. 14, no. 1, pp. 43–59.

Daly England, MA 2016, ‘Development of a cardiac prodromal symptoms recognition list for the assessment of women in primary care’, DNP thesis, The University of Arizona, Arizona, USA.

Darawad, MW, Alfasfos, N, Saleh, Z, Saleh, AM & Hamdan-Mansour, A 2016, ‘Predictors of delay in seeking treatment by Jordanian patients with acute coronary syndrome’, *International Emergency Nursing*, vol. 26, pp. 20–5.

Darsin Singh, SK, Ahmad, A, Rahmat, N & Hmwe, NT 2016, ‘Nurse-led intervention on knowledge, attitude and beliefs towards acute coronary syndrome’, *Nursing in Critical Care*, (online PubMed).

Davidson, PM, Inglis, SC & Newton, PJ 2013, ‘Self-care in patients with chronic heart failure’, *Expert Review of Pharmacoeconomics and Outcomes Research*, vol. 13, no. 3, pp. 351–9.

Davis, LL, McCoy, TP, Riegel, B, McKinley, S, Doering, L, Dracup, K & Moser, D 2018, ‘Congruence of time from symptom onset according to medical record versus subject interview in patients diagnosed with acute coronary syndrome’, *Journal of the American College of Cardiology*, vol. 65, no. 10 Suppl., p. A150.

de Melo Ghisi, GL, Abdallah, F, Grace, SL, Thomas, S & Oh, P 2014, ‘A systematic review of patient education in cardiac patients: Do they increase knowledge and promote health behavior change?’, *Patient Education and Counseling*, vol. 95, no. 2, pp. 160–74.

Dennison, CR, McEntee, ML, Samuel, L, Johnson, BJ, Rotman, S, Kielty, A & Russell, SD 2011, ‘Adequate health literacy is associated with higher heart failure knowledge and self care confidence in hospitalized patients’, *The Journal of Cardiovascular Nursing*, vol. 26, no. 5, p. 359–67.

Deshmukh, M, Joseph, MA, Verdecias, N, Malka, ES & Larosa, JH 2011, ‘Acute coronary syndrome: Factors affecting time to arrival in a diverse urban setting’, *Journal of Community Health*, vol. 36, no. 6, pp. 895–902.

Devi, B 2014, ‘Effectiveness of video-based teaching program on breastfeeding in terms of knowledge and practice among postnatal mothers in a selected rural community of West Bengal, India’, *Journal of Nursing Science & Practice*, vol. 4, no. 1, pp. 1–8.

Devi, B, Das, M, Das, M & Khandelwal, B 2017, 'Application of Bandura's social cognitive theory in the technology enhanced, blended learning environment', *International Journal of Applied Research*, vol. 3, no. 1, pp. 721–4.

DeVon, HA, Burke, LA, Vuckovic, KM, Haugland, T, Eckhardt, AL, Patmon, F & Rosenfeld, AG 2017, 'Symptoms suggestive of acute coronary syndrome: When is sex important?', *Journal of Cardiovascular Nursing*, vol. 32, no. 4, pp. 383−92.

DeVon, HA, Hogan, N, Ochs, AL & Shapiro, M 2010, 'Time to treatment for acute coronary syndromes: The cost of indecision', *The Journal of Cardiovascular Nursing*, vol. 25, no. 2, p. 106–14.

DeVon, HA, Rankin, SH, Paul, SM & Ochs, AL 2010, 'The Know & Go! program improves knowledge for patients with coronary heart disease in pilot testing', *Heart & Lung: The Journal of Acute and Critical Care*, vol. 39, no. 6, pp. S23–33.

Díaz-Bossini, J-M & Moreno, L 2014, 'Accessibility to mobile interfaces for older people', *Procedia Computer Science*, vol. 27, pp. 57–66.

Dickens, C & Piano, MR 2013, 'Health literacy and nursing: An update', *AJN: The American Journal of Nursing*, vol. 113, no. 6, pp. 52–7.

Dickson, VV, Tkacs, N & Riegel, B 2007, 'Cognitive influences on self-care decision making in persons with heart failure', *American Heart Journal*, vol. 154, no. 3, pp. 424–31.

Diego-Mas, JA & Alcaide-Marzal, J 2015, 'A computer based system to design expressive avatars', *Computers in Human Behavior*, vol. 44, pp. 1–11.

Diercks, DB, Owen, KP, Kontos, MC, Blomkalns, A, Chen, AY, Miller, C, Wiviott, S & Peterson, ED 2010, 'Gender differences in time to presentation for myocardial infarction before and after a national women's cardiovascular awareness campaign: A temporal analysis from the Can Rapid Risk Stratification of Unstable Angina Patients Suppress ADverse Outcomes with Early Implementation (CRUSADE) and the National Cardiovascular Data Registry Acute Coronary Treatment and Intervention Outcomes Network–Get with the Guidelines (NCDR ACTION Registry–GWTG)', *American Heart Journal*, vol. 160, no. 1, pp. 80–7.

Dodin, R 2014, ‘Identification of factors that impact door-to-balloon time in patients with ST-elevation myocardial infarction (STEMI)’, DHA thesis, Central Michigan University, Michigan, USA.

Donkor, F 2010, ‘The comparative instructional effectiveness of print-based and video-based instructional materials for teaching practical skills at a distance’, *The International Review of Research in Open and Distributed Learning*, vol. 11, no. 1, pp. 96–116.

Doyle, M, Noonan, B, O'Connell, E. 2013. Care study: a cardiovascular physical assessment. *British Journal of Cardiac Nursing*, vol. 8, no. 3, pp.122-126.

Dracup, K 2009, ‘The challenge of reducing prehospital delay in patients with acute coronary syndrome’, *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 3, pp. 144–5.

Dracup, K, McKinley, S, Doering, LV, Riegel, B, Meischke, H, Moser, DK, Pelter, M, Carlson, B, Aitken, L, Marshall, A, Cross, R & Paul, SM 2008, ‘Acute coronary syndrome: What do patients know?’, *Archives of Internal Medicine*, vol. 168, no. 10, pp. 1049−54.

Dracup, K, McKinley, S, Riegel, B, Mieschke, H, Doering, LV & Moser, DK 2006, ‘A nursing intervention to reduce prehospital delay in acute coronary syndrome: A randomized clinical trial’, *Journal of Cardiovascular Nursing*, vol. 21, no. 3, pp. 186–93.

Dracup, K, McKinley, S, Riegel, B, Moser, DK, Meischke, H, Doering, LV, Davidson, P, Paul, SM, Baker, H & Pelter, M 2009, ‘A randomized clinical trial to reduce patient prehospital delay to treatment in acute coronary syndrome’, *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 6, pp. 524–32.

Dracup, K, McKinley, SM & Moser, DK 1997, ‘Australian patients’ delay in response to heart attack symptoms’, *Medical Journal of Australia*, vol. 166, no. 5, pp. 233–6.

Dracup, K, Moser, DK, Eisenberg, M, Meischke, H, Alonzo, AA & Braslow, A 1995, ‘Causes of delay in seeking treatment for heart attack symptoms’, *Social Science and Medicine Journal*, vol. 40, no. 3, pp. 379−92.

Dracup, K, Moser, DK, McKinley, S, Ball, C, Yamasaki, K, Kinm, C-J, Doering, LV & Caldwell, MA 2003, ‘An international perspective on the time to treatment for acute myocardial infarction’, *Journal of Nursing Scholarship*, vol. 35, no. 4, pp. 317–23.

Duber, HC, McNellan, CR, Wollum, A, Phillips, B, Allen, K, Brown, JC, Bryant, M, Guptam, RB, Li, YC, Majumdar, P, Roth, GA, Thomson, B, Wilson, S, Woldeab, A, Zhou, MG & Ng, M 2018, 'Public knowledge of cardiovascular disease and response to acute cardiac events in three cities in China and India', *Heart*, vol. 104, no. 1, pp. 67–72.

Dunn, L 2011, *Study: Hospitals' use of interactive technology improves patient satisfaction*, <https://www.beckershospitalreview.com/healthcare-information-technology/study-hospitals-use-of-interactive-technology-improves-patient-satisfaction.html>.

Dunning, H, Williams, A, Abonyi, S & Crooks, V 2008, 'A mixed method approach to quality of life research: A case study approach', *Social Indicators Research*, vol. 85, no. 1, pp. 145–58.

Dworkin, M, Lee, S, Chakraborty, A, Qato, D, Monahan, C, Hightow-Weidman, LB & Garofalo, R 2016, 'Developing a relational, educational, and motivational human avatar-based mobile phone app for young African American men who have sex with men', in *Open Forum Infectious Diseases*, vol. 3, suppl. 1, p. 1532.

Edirippulige, S & Armfield, N 2016, 'Education and training to support the use of clinical telehealth: A review of the literature', *Journal of Telemedicine and Telecare*, vol. 23, no. 2, pp. 273–82.

Edwards, RA, Bickmore, T, Jenkins, L, Foley, M & Manjourides, J 2013, 'Use of an interactive computer agent to support breastfeeding', *Maternal and Child Health Journal*, vol. 17, no. 10, pp. 1961–8.

Ehde, DM, Dillworth, TM & Turner, JA 2014, 'Cognitive-behavioral therapy for individuals with chronic pain: Efficacy, innovations, and directions for research', *American Psychologist*, vol. 69, no. 2, p. 153–66.

Ehde, DM, Wegener, ST, Williams, RM, Ephraim, PL, Stevenson, JE, Isenberg, PJ & MacKenzie, EJ 2013, 'Developing, testing, and sustaining rehabilitation interventions via participatory action research', *Archives of Physical Medicine and Rehabilitation*, vol. 94, no. 1, pp. S30–42.

Eley, R, Fallon, T, Soar, J, Buikstra, E & Hegney, D 2008, 'Nurses' confidence and experience in using information technology', *Australian Journal of Advanced Nursing*, vol. 25, no. 3, pp. 23–35.

Elo, S, Kääriäinen, M, Kanste, O, Pölkki, T, Utriainen, K & Kyngäs, H 2014, 'Qualitative content analysis: A focus on trustworthiness', *Sage Open*, vol. 4, no. 1, <http://journals.sagepub.com/>.

Eng, TR, Gustafson, DH, Henderson, J, Jimison, H & Patrick, K 1999, 'Introduction to evaluation of interactive health communication applications 1', *American Journal of Preventive Medicine*, vol. 16, no. 1, pp. 10–5.

Eshah, NF 2013, 'Seeking medical attention among Jordanian patients with acute myocardial infarction', *European Scientific Journal*, vol. 9, no. 21.

European Society of Cardiology 2012, 'ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation', *European Heart Journal*, vol. 33, no. 20, pp. 2569–619.

Fålun, N, Fridlund, B, Schaufel, MA, Schei, E & Norekvål, TM 2016, 'Patients' goals, resources, and barriers to future change: A qualitative study of patient reflections at hospital discharge after myocardial infarction', *European Journal of Cardiovascular Nursing*, vol. 15, no. 7, pp. 495–503.

Fang, J, Gillespie, C, Keenan, NL & Greenlund, KJ 2011, 'Awareness of heart attack symptoms among US adults in 2007, and changes in awareness from 2001 to 2007', *Future Cardiology*, vol. 7, no. 3, pp. 311–20.

Fang, KY, Bjering, H & Maeder, AJ 2016, 'An avatar-based reminder application for medication adherence', *Proceedings of the 9th Annual International Conference on Computer Games, Multimedia & Allied Technology (CGAT 2016),* Singapore, pp. 42–6.

Fang, X, Albarqouni, L, von Eisenhart Rothe, A, Hoschar, S, Ronel, J & Ladwig, K-H 2016, 'Is denial a maladaptive coping mechanism which prolongs pre-hospital delay in patients with ST-segment elevation myocardial infarction?', *Journal of Psychosomatic Research*, vol. 91, pp. 68–74.

Farahani, MA, Mohammadi, E, Ahmadi, F & Mohammadi, N 2013, 'Factors influencing the patient education: A qualitative research', *Iranian Journal of Nursing and Midwifery Research*, vol. 18, no. 2, p. 133–39.

Farquhar, MC, Ewing, G & Booth, S 2011, 'Using mixed methods to develop and evaluate complex interventions in palliative care research', *Palliative Medicine*, vol. 25, no. 8, pp. 748–57.

Farquharson, B, Johnston, M & Bugge, C 2012, 'Appraisal and illness delay with symptoms of ACS: A questionnaire study of illness representations', *British Journal of Cardiac Nursing*, vol. 7, no. 10, pp. 493–9.

Farquharson, B, Johnston, M, Smith, K, Williams, B, Treweek, S, Dombrowski, SU, Dougall, N, Abhyankar, P & Grindle, M 2017, 'Reducing patient delay in acute coronary syndrome (RAPiD): Research protocol for a web-based randomized controlled trial examining the effect of a behaviour change intervention', *Journal of Advanced Nursing*, vol. 73, no. 5, pp. 1220–34.

Farshidi, H, Rahimi, S, Abdi, A, Salehi, S & Madani, A 2013, 'Factors associated with pre-hospital delay in patients with acute myocardial infarction', *Iranian Red Crescent Medical Journal*, vol. 15, no. 4, pp. 312–6.

Fathi, M, Rahiminiya, A, Zare MA, Tavakoli N 2015, 'Factors of delayed pre-hospital treatment seeking in patients with acute coronary syndrome: A prospective study'. *Turkish Journal of Emergency Medicine*, vol. 15, no. 4, pp. 163–7.

Fernandez, R, Pearce, M, Grand, JA, Rench, TA, Jones, KA, Chao, GT & Kozlowski, SW 2013, 'Evaluation of a computer-based educational intervention to improve medical teamwork and performance during simulated patient resuscitations', *Critical Care Medicine*, vol. 41, no. 11, pp. 2551–62.

Fernandez, RS 2007, 'Development and evaluation of a health-related lifestyle self-management intervention for patients with acute coronary syndrome', PhD thesis, University of Western Sydney, Sydney, Australia.

Fernandez, RS, Everett, B & Sundar, S 2016, 'Predictors of heart disease knowledge among older and younger Asian Indian adults', *Journal of Immigrant and Minority Health*, vol. 18, no. 6, pp. 1378–85.

Fernon, A, Nguyen, A, Baysari, M & Day, R 2016, 'A user-centred approach to designing an eTool for gout management', in A Georgiou, LK Schaper & S Whetton (eds.), *Digital health innovation for consumers, clinicians, connectivity and community: Selected papers from the*

24th Australian National Health Informatics Conference, HIC 2016, vol. 227, IOS Press, Amsterdam, Netherlands, pp. 28–33.

Fetters, MD, Curry, LA & Creswell, JW 2013, 'Achieving integration in mixed methods designs—principles and practices', *Health Services Research*, vol. 48, no. 6, pp. 2134–56.

Finkelstein, J, Knight, A, Marinopoulos, S, Gibbons, MC, Berger, Z, Aboumatar, H, Wilson, RF, Lau, BD, Sharma, R & Bass, EB 2012, 'Enabling patient-centered care through health information technology', *Evidence Report and Technology Assessment*, no. 206, pp. 1–1531.

Finnegan, JR, Meischke, H, Zapka, JG, Leviton, L, Meshack, A, Benjamin-Garner, R, Estabrook, B, Hall, NJ, Schaeffer, S & Smith, C 2000, 'Patient delay in seeking care for heart attack symptoms: Findings from focus groups conducted in five US regions', *Preventive Medicine*, vol. 31, no. 3, pp. 205–13.

Fjeldsoe, B, Neuhaus, M, Winkler, E & Eakin, E 2011, 'Systematic review of maintenance of behavior change following physical activity and dietary interventions', *Health Psychology*, vol. 30, no. 1, p. 99–109.

Flanders, SA 2018, 'Effective patient education: Evidence and common sense', *Medsurg Nursing*, vol. 27, no. 1, pp. 55–8.

Fleisher, L, Buzaglo, J, Collins, M, Millard, J, Miller, SM, Egleston, BL, Solarino, N, Trinastic, J, Cegala, DJ, Benson III, AB, Schulman, KA, Weinfurt, KP, Sulmasy, D, Diefenbach, MA & Meropol, NJ 2008, 'Using health communication best practices to develop a web-based provider–patient communication aid: The CONNECT™ study', *Patient Education and Counseling*, vol. 71, no. 3, pp. 378–87.

Folstein, MF, Folstein, SE & McHugh, P 2010, '"Mini-mental state". A practical method for grading the cognitive state of patients for the clinician', *Journal of Psychiatric Research,* vol. 12, no. 5, pp. 189–198.

Ford, I & Norrie, J 2016, 'Pragmatic trials', *New England Journal of Medicine*, vol. 375, no. 5, pp. 454–63.

Fors, A, Ekman, I, Taft, C, Bjorkelund, C, Frid, K, Larsson, ME, Thorn, J, Ulin, K, Wolf, A & Swedberg, K 2015, 'Person-centred care after acute coronary syndrome, from hospital to

primary care—a randomised controlled trial', *International Journal of Cardiology*, vol. 187, pp. 693–9.

Fors, A, Ulin, K, Cliffordson, C, Ekman, I & Brink, E 2015, 'The Cardiac Self-Efficacy Scale, a useful tool with potential to evaluate person-centred care', *European Journal of Cardiovascular Nursing*, vol. 14, no. 6, pp. 536–43.

Franzosi, R 2017, 'Content analysis', in R Wodak & B Forchtner (eds.), *The Routledge handbook of language and politics,* Sage Publications, New York, USA.

Fredericks, B, Clark, RA, Adams, M, Atherton, J, Taylor-Johnson, S, Wu, J, Esquivel, JH, Dracup, K & Buitendyk, N 2013, 'Using participatory action research to assist heart failure self-care amongst indigenous Australians: A pilot study', *ALAR: Action Learning and Action Research Journal*, vol. 19, no. 2, p. 40–60.

Frenkel, WJ, Jongerius, EJ, Mandjes-van Uitert, MJ, Munster, BC & Rooij, SE 2014, 'Validation of the Charlson comorbidity index in acutely hospitalized elderly adults: A prospective cohort study', *Journal of the American Geriatrics Society*, vol. 62, no. 2, pp. 342–6.

Friedman, AJ, Cosby, R, Boyko, S, Hatton-Bauer, J & Turnbull, G 2011, 'Effective teaching strategies and methods of delivery for patient education: A systematic review and practice guideline recommendations', *Journal of Cancer Education*, vol. 26, no. 1, pp. 12–21.

Friesen-Storms, JH, Moser, A, Loo, S, Beurskens, AJ & Bours, GJ 2015, 'Systematic implementation of evidence-based practice in a clinical nursing setting: A participatory action research project', *Journal of Clinical Nursing*, vol. 24, no. 1–2, pp. 57–68.

Fuchslocher, A, Niesenhaus, J & Krämer, N 2011, 'Serious games for health: An empirical study of the game "Balance" for teenagers with diabetes mellitus', *Entertainment Computing*, vol. 2, no. 2, pp. 97–101.

Fukuoka, Y, Dracup, K, Rankin, SH, Froelicher, ES, Kobayashi, F, Hirayama, H, Ohno, M & Matsumoto, D 2005, 'Prehospital delay and independent/independent construal of self among Japanese patients with acute myocardial infarction', *Social Science & Medicine*, vol. 60, pp. 2025−34.

Fuochi, G & Foà, C 2018, ‘Quality of life, coping strategies, social support and self-efficacy in women after acute myocardial infarction: A mixed methods approach’, *Scandinavian Journal of Caring Sciences*, vol. 32, no. 1, pp. 98–107.

Furie, KL, Kasner, SE, Adams, RJ, Albers, GW, Bush, RL, Fagan, SC, Halperin, JL, Johnston, SC, Katzan, I & Kernan, WN 2010, ‘Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack. A guideline for healthcare professionals from the American Heart Association/American Stroke Association’, *Stroke*, vol. 42, pp. 227−76.

Gabarron, E, Serrano, JA, Wynn, R & Armayones, M 2012, ‘Avatars using computer/smartphone mediated communication and social networking in prevention of sexually transmitted diseases among North-Norwegian youngsters’, *BioMed Central Medical Informatics and Decision Making*, vol. 12, no. 1, pp. 120–5.

Gallagher, R, Roach, K, Belshaw, J, Kirkness, A, Sadler, L & Warrington, D 2013, ‘A pre-test post-test study of a brief educational intervention demonstrates improved knowledge of potential acute myocardial infarction symptoms and appropriate responses in cardiac rehabilitation patients’, *Australian Critical Care*, vol. 26, no. 2, pp. 49–54.

Gallagher, R, Roach, K, Sadler, L, Glinatsis, H, Belshaw, J, Kirkness, A, Zhang, L, Gallagher, P, Paull, G & Gao, Y 2017, ‘Mobile technology use across age groups in patients eligible for cardiac rehabilitation: survey study’, *Journal of Medical Internet Research mHealth and uHealth*, vol. 5, no. 10, p. e161.

Garnweidner-Holme, LM, Borgen, I, Garitano, I, Noll, J & Lukasse, M 2015, ‘Designing and developing a mobile smartphone application for women with gestational diabetes mellitus followed-up at diabetes outpatient clinics in Norway’, *Healthcare*, vol. 3, no. 2, pp. 310–23.

Garofalo, D, Grey, C, Lee, M, Exeter, D & Kerr, AJ 2012, ‘Pre-hospital delay in acute coronary syndromes: PREDICT CVD-18’, *The New Zealand Medical Journal (Online)*, vol. 125, no. 1348, pp. 12–22.

Gearing, RE, El-Bassel, N, Ghesquiere, A, Baldwin, S, Gillies, J & Ngeow, E 2011, ‘Major ingredients of fidelity: A review and scientific guide to improving quality of intervention research implementation’, *Clinical Psychology Review*, vol. 31, no. 1, pp. 79–88.

Gersh, BJ, Stone, GW, White, HD & Holmes, DR 2005, 'Pharmacological facilitation of primary percutaneous coronary intervention for acute myocardial infarction: Is the slope of the curve the shape of the future?', *The Journal of the American Medical Association*, vol. 293, no. 8, pp. 979–86.

Geuens, J, Swinnen, TW, Westhovens, R, de Vlam, K, Geurts, L & Vanden Abeele, V 2016, 'A review of persuasive principles in mobile apps for chronic arthritis patients: Opportunities for improvement', *Journal of Medical Internet Research: mHealth and uHealth*, vol. 4, no. 4, p. e118.

Ghanbarzadeh, R, Ghapanchi, AH, Blumenstein, M & Talaei-Khoei, A 2014, 'A decade of research on the use of three-dimensional virtual worlds in health care: A systematic literature review', *Journal of Medical Internet Research*, vol. 16, no. 2, p. e47.

Ghazawy, ER, Seedhom, AE & Mahfouz, EM 2015, 'Predictors of delay in seeking health care among myocardial infarction patients, Minia District, Egypt', *Advances in Preventive Medicine*, vol. 2015, pp. 1–6.

Ghazi, C, Nyland, J, Whaley, R, Rogers, T, Wera, J & Henzman, C 2018, 'Social cognitive or learning theory use to improve self-efficacy in musculoskeletal rehabilitation: A systematic review and meta-analysis', *Physiotherapy Theory and Practice*, vol. 34, no. 7, pp. 495–504.

Giguère, A, Légaré, F, Grimshaw, J, Turcotte, S, Fiander, M, Grudniewicz, A, Makosso-Kallyth, S, Wolf, FM, Farmer, AP & Gagnon, MP 2012, 'Printed educational materials: Effects on professional practice and healthcare outcomes', *Cochrane Database of Systematic Reviews*, vol. 10, p. CD004398.

Gillis, NK, Arslanian-Engoren, C & Struble, LM 2014, 'Acute coronary syndromes in older adults: A review of literature', *Journal of Emergency Nursing*, vol. 40, no. 3, pp. 270−5.

Giugliano, RP & Braunwald, E 2014, 'The year in acute coronary syndrome', *Journal of the American College of Cardiology*, vol. 63, no. 3, pp. 201−14.

Glanz, K, Rimer, BK & Viswanath, K 2008, *Health behavior and health education: Theory, research, and practice*, John Wiley & Sons, California, USA.

Glasgow, RE, Magid, DJ, Beck, A, Ritzwoller, D & Estabrooks, PA 2005, 'Practical clinical trials for translating research to practice: Design and measurement recommendations', *Medical Care*, vol. 43, no. 6, pp. 551–7.

Glattacker, M, Heyduck, K & Meffert, C 2012, 'Illness beliefs, treatment beliefs and information needs as starting points for patient information—evaluation of an intervention for patients with chronic back pain', *Patient Education and Counseling*, vol. 86, no. 3, pp. 378–89.

Glynn, LG, Hayes, PS, Casey, M, Glynn, F, Alvarez-Iglesias, A, Newell, J, Ó'Laighin, G, Heaney, D, O'Donnell, M & Murphy, AW 2014, 'Effectiveness of a smartphone application to promote physical activity in primary care: The SMART MOVE randomised controlled trial', *British Journal of General Practice*, vol. 64, no. 624, pp. e384–91.

Go, AS 2014, 'Heart disease and stroke statistics—2014 update: A report from the American Heart Association', *Circulation*, vol. 129, no. 3, pp. e28–292.

Go, AS, Mozaffarian, D, Roger, VL, Benjamin, EJ, Berry, JD, Blaha, MJ, Dai, S, Ford, ES, Fox, CS & Franco, S 2014, 'Executive summary: Heart disease and stroke statistics—2014 update', *Circulation*, vol. 129, no. 3, pp. 399–410.

Goff Jr, DC, Feldman, HA, McGovern, PG, Goldberg, RJ, Simons-Morton, DG, Cornell, CE, Osganian, SK, Cooper, LS & Hedges, JR 1999, 'Prehospital delay in patients hospitalized with heart attack symptoms in the United States: The REACT trial', *American Heart Journal*, vol. 138, no. 6, pp. 1046–57.

Goff Jr, DC, Mitchell, P, Finnegan, J, Pandey, D, Bittner, V, Feldman, H, Meischke, H, Goldberg, RJ, Luepker, RV & Raczynski, JM 2004, 'Knowledge of heart attack symptoms in 20 US communities. Results from the Rapid Early Action for Coronary Treatment Community Trial', *Preventive Medicine*, vol. 38, no. 1, pp. 85–93.

Goff Jr, DC, Sellers, DE, McGovern, PG, Meischke, H, Goldberg, RJ, Bittner, V, Hedges, JR, Allender, S & Nichaman, MZ 1998, 'Knowledge of heart attack symptoms in a population survey in United states: The REACT Trial. Rapid Early Action for Coronary Treatment', *Archives of Internal Medicine*, vol. 158, no. 21, pp. 2329–38.

Golbeck, A, Paschal, A, Jones, A & Hsiao, T 2011, 'Correlating reading comprehension and health numeracy among adults with low literacy', *Patient Education and Counseling*, vol. 84, no. 1, pp. 132–4.

Goldberg, RJ, Spencer, F, Fox, KAA, Brieger, D, Steg, G, Gurfinkel, E, Dedrick, R & Gore, JM 2009, 'Prehospital delay in patients with acute coronary syndromes (from the Global Registry of Acute Coronary Events [GRACE])', *American Journal of Cardiology*, vol. 103, no. 5, pp. 596–603.

Goldberg, RJ, Steg, PG, Sadiq, I, Granger, CB, Jackson, EA, Budaj, A, Brieger, D, Avezum, A & Goodman, S 2002, 'Extent of, and factors associated with, delay to hospital presentation in patients with acute coronary disease (the GRACE registry)', *The American Journal of Cardiology*, vol. 89, no. 7, pp. 791–6.

Goldberg, RJ, Yarzebski, J, Lessard, D & Gore, JM 2000, 'Decade-long trends and factors associated with time to hospital presentation in patients with acute myocardial infarction: The Worcester Heart Attack study', *Archives of Internal Medicine*, vol. 160, no. 21, pp. 3217–23.

Goodacre, SW, Bradburn, M, Mohamed, A & Gray, A 2012, 'Evaluation of Global Registry of Acute Cardiac Events and Thrombolysis in Myocardial Infarction scores in patients with suspected acute coronary syndrome', *The American Journal of Emergency Medicine*, vol. 30, no. 1, pp. 37–44.

Goodman, J, Brewster, S & Gray, P 2004, *Older people, mobile devices and navigation*, University of Glasgow, Glasgow, <http://www.dcs.gla.ac.uk/utopia/workshop/goodman.pdf>.

Goulding, L, Furze, G & Birks, Y 2010, 'Randomized controlled trials of interventions to change maladaptive illness beliefs in people with coronary heart disease: Systematic review', *Journal of Advanced Nursing*, vol. 66, no. 5, pp. 946–61.

Gouveia, VdA, Victor, EG & Lima, SGd 2011, 'Pre-hospital attitudes adopted by patients faced with the symptoms of acute myocardial infarction', *Revista Latino-Americana De Enfermagem*, vol. 19, no. 5, pp. 1080–7.

Graffigna, G, Barello, S & Riva, G 2013, 'How to make health information technology effective: The challenge of patient engagement', *Archives of Physical Medicine and Rehabilitation*, vol. 94, no. 10, pp. 2034–5.

Grainger, R, Townsley, H, White, B, Langlotz, T & Taylor, WJ 2017, 'Apps for people with rheumatoid arthritis to monitor their disease activity: A review of apps for best practice and quality', *Journal of Medical Internet Research: mHealth and uHealth*, vol. 5, no. 2, p. e7.

Graneheim, UH, Lindgren, B-M & Lundman, B 2017, 'Methodological challenges in qualitative content analysis: A discussion paper', *Nurse Education Today*, vol. 56, pp. 29–34.

Gratzer, D, Khalid-Khan, F & Khalid-Khan, S 2015, 'Anxiety—is there an app for that? Considering technology, psychiatry, and internet-assisted cognitive behavioral therapy', in F Durbano (ed.), *A fresh look at anxiety disorders*, InTech, Rijecka, Croatia, pp. 325–46.

Green, J & Thorogood, N 2018, *Qualitative methods for health research*, Sage Publications, London, UK.

Greenwood, DJ 2018, 'Action research', in M Ciesielska (eds.), *Qualitative methodologies in organization studies*, Springer, Cham, Switzerland, pp. 75–98.

Griffith, JM 2004, 'An empirical model of patient characteristics, interactive prenatal education program use, and resulting patient knowledge', PhD thesis, The University of North Carolina at Chapel Hill, North Carolina, USA.

Groenwold, RH, Donders, ART, Roes, KC, Harrell Jr, FE & Moons, KG 2011, 'Dealing with missing outcome data in randomized trials and observational studies', *American Journal of Epidemiology*, vol. 175, no. 3, pp. 210–7.

Grove, SK, Burns, N & Gray, J 2012, *The practice of nursing research: Appraisal, synthesis, and generation of evidence*, Elsevier Health Sciences, St. Louis, USA.

Groves, PS, Bunch, JL, Cram, E & Perkhounkova, Y 2018, 'Development and feasibility testing of a patient safety research simulation', *Clinical Simulation in Nursing*, vol. 15, pp. 27–33.

Grudniewicz, A, Kealy, R, Rodseth, RN, Hamid, J, Rudoler, D & Straus, SE 2015, 'What is the effectiveness of printed educational materials on primary care physician knowledge, behaviour, and patient outcomes: A systematic review and meta-analyses', *Implementation Science*, vol. 10, no. 1, p. 164.

Gruman, J, Rovner, MH, French, ME, Jeffress, D, Sofaer, S, Shaller, D & Prager, DJ 2010, 'From patient education to patient engagement: Implications for the field of patient education', *Patient Education and Counseling*, vol. 78, no. 3, pp. 350–6.

Gupta, R & Khurana, H 2016, 'Information technology-based health care delivery: Information technology may be ready, but we and our patients are not!', *Indian Journal of Social Psychiatry*, vol. 32, no. 3, pp. 283–6.

Gupta, SK 2011, 'Intention-to-treat concept: A review', *Perspectives in Clinical Research*, vol. 2, no. 3, p. 109–12.

Gutierrez, N, Kindratt, TB, Pagels, P, Foster, B & Gimpel, NE 2014, 'Health literacy, health information seeking behaviors and internet use among patients attending a private and public clinic in the same geographic area', *Journal of Community Health*, vol. 39, no. 1, pp. 83–9.

Gwadry-Sridhar, F, Guyatt, GH, Arnold, JMO, Massel, D, Brown, J, Nadeau, L & Lawrence, S 2003, 'Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure', *European Journal of Heart Failure*, vol. 5, no. 6, pp. 783–91.

Gysels, M & Higginson, IJ 2007, 'Interactive technologies and videotapes for patient education in cancer care: Systematic review and meta-analysis of randomised trials', *Supportive Care in Cancer*, vol. 15, no. 1, pp. 7–20.

Hafiz, AM, Naidu, SS, DeLeon, J, Islam, S, Alkhatib, B, Lorenz, M, D'Elia, A, Rosenthal, B & Marzo, K 2013, 'Impact of first contact on symptom onset-to-door time in patients presenting for primary percutaneous coronary intervention', *The American Journal of Emergency Medicine*, vol. 31, no. 6, pp. 922–7.

Hagevik, R, Aydeniz, M & Rowell, CG 2012, 'Using action research in middle level teacher education to evaluate and deepen reflective practice', *Teaching and Teacher Education*, vol. 28, no. 5, pp. 675–84.

Halcomb, E & Newton, P 2017, ‘Research in nursing’, in J Daly, S Speedy & D Jackson (eds.), *Contexts of nursing: An introduction*, Elsevier, Sydney, NSW, pp. 129–41.

Hale, ED, Treharne, G & Kitas, G 2007, ‘The common-sense model of self-regulation of health and illness: How can we use it to understand and respond to our patients’ needs?’, *Rheumatology*, vol. 46, no. 6, pp. 904–6.

Halkier, B 2010, ‘Focus groups as social enactments: Integrating interaction and content in the analysis of focus group data’, *Qualitative Research*, vol. 10, no. 1, pp. 71–89.

Hall, HR & Roussel, LA 2016, ‘Critical appraisal of research-based evidence’, in RH Heather, & AR Linda (eds.), *Evidence-based practice*, Jones & Bartelett Learning, Burlington, USA, pp. 125–44.

Hamilton, SJ, Mills, B, Birch, EM & Thompson, SC 2018, ‘Smartphones in the secondary prevention of cardiovascular disease: A systematic review’, *Biomed Central Cardiovascular Disorders*, vol. 18, no. 1, p. 25.

Hansberry, DR, Agarwal, N & Baker, SR 2015, ‘Health literacy and online educational resources: An opportunity to educate patients’, *American Journal of Roentgenology*, vol. 204, no. 1, pp. 111–6.

Heapy, AA, Higgins, DM, Cervone, D, Wandner, L, Fenton, BT & Kerns, RD 2015, ‘A systematic review of technology-assisted self-management interventions for chronic pain’, *The Clinical Journal of Pain*, vol. 31, no. 6, pp. 470–92.

Heffernan, KJ, Chang, S, Maclean, ST, Callegari, ET, Garland, SM, Reavley, NJ, Varigos, GA & Wark, JD 2016, ‘Guidelines and recommendations for developing interactive eHealth apps for complex messaging in health promotion’, *Journal of Medical Internet Research: mHealth and uHealth*, vol. 4, no. 1, p. e14.

Heijmans, M, Waverijn, G, Rademakers, J, van der Vaart, R & Rijken, M 2015, ‘Functional, communicative and critical health literacy of chronic disease patients and their importance for self-management’, *Patient Education and Counseling*, vol. 98, no. 1, pp. 41–8.

Heinrich, E, de Nooijer, J, Schaper, NC, Schoonus-Spit, MH, Janssen, MA & de Vries, NK 2012, ‘Evaluation of the web-based Diabetes Interactive Education Programme (DIEP) for patients with type 2 diabetes’, *Patient Education and Counseling*, vol. 86, no. 2, pp. 172–8.

Hennink, MM 2013, *Focus group discussions*, Oxford University Press, Oxford, UK.

Hennink-Schadenberg, S & Preckel, B 2018, 'The patient with acute coronary syndrome', in J-L Fellahi & M Leone (eds.), *Anesthesia in high-risk patients*, Springer, Cham, Switzerland, pp. 3−17.

Henriksson, C, Larsson, M, Arnetz, J, Berglin-Jarlöv, M, Herlitz, J, Karlsson, J-E, Svensson, L, Thuresson, M, Zedigh, C & Wernroth, L 2011, 'Knowledge and attitudes toward seeking medical care for AMI-symptoms', *International Journal of Cardiology*, vol. 147, no. 2, pp. 224–7.

Henriksson, C, Larsson, M, Arnetz, J, Herlitz, J, Karlsson, J-E, Svensson, L, Thuresson, M, Zedigh, C, Wernroth, L & Lindahl, B 2012, 'Knowledge about acute myocardial infarction (AMI) and attitudes to medical care seeking-a comparison between patients and the general public', *Open Journal of Nursing*, vol. 2, no. 4, pp. 372–8.

Herlitz, J, Thuresson, M, Svensson, L, Lindqvist, J, Lindahl, B, Zedigh, C & Jarlöv, M 2010, 'Factors of importance for patients' decision time in acute coronary syndrome', *International Journal of Cardiology*, vol. 141, no. 3, pp. 236–42.

Hernández-López, M, Luciano, MC, Bricker, JB, Roales-Nieto, JG & Montesinos, F 2009, 'Acceptance and commitment therapy for smoking cessation: A preliminary study of its effectiveness in comparison with cognitive behavioral therapy', *Psychology of Addictive Behaviors*, vol. 23, no. 4, p. 723–30.

Herr, K & Anderson, GL 2014, *The action research dissertation: A guide for students and faculty*, Sage Publications, New York, USA.

Hew, KF & Cheung, WS 2010, 'Use of three-dimensional (3-D) immersive virtual worlds in K-12 and higher education settings: A review of the research', *British Journal of Educational Technology*, vol. 41, no. 1, pp. 33–55.

Hibbard, JH & Greene, J 2013, 'What the evidence shows about patient activation: Better health outcomes and care experiences; fewer data on costs', *Health Affairs*, vol. 32, no. 2, pp. 207–14.

Hoffmann, TC, Glasziou, PP, Boutron, I, Milne, R, Perera, R, Moher, D, Altman, DG, Barbour, V, Macdonald, H & Johnston, M 2014, 'Better reporting of interventions: Template

for intervention description and replication (TIDieR) checklist and guide', *The British Medical Journal*, vol. 348, p. g1687.

Holloway, I & Galvin, K 2016, *Qualitative research in nursing and healthcare*, John Wiley & Sons, West Sussex, UK.

Holzinger, A, Searle, G & Nischelwitzer, A 2007, 'On some aspects of improving mobile applications for the elderly', in C Stephanidis (ed.), *Universal access in human computer interaction. Coping with diversity. UAHCI 2007. Lecture notes in computer science, vol 4554*, Springer, Berlin, Heidelberg, pp. 923–32.

Hong, CC, Sultana, P, Wong, ASL, Chan, KP, Pek, PP & Ong, MEH 2011, 'Prehospital delay in patients presenting with acute ST-elevation myocardial infarction', *European Journal of Emergency Medicine*, vol. 18, no. 5, pp. 268–71.

Hooper, R & Smuk, M 2018, 'Finding the best answer: Randomised controlled trials', in R Jones (ed.), *Critical appraisal for primary care*, British Journal of General Practice, London, UK, pp. 17–51.

Hopkins, WG 2017, 'Spreadsheets for analysis of validity and reliability', *Sportscience*, vol. 21, no.1, pp. 36–44.

Horne, R, James, D, Petrie, K, Weinman, J & Vincent, R 2000, 'Patients' interpretation of symptoms as a cause of delay in reaching hospital during acute myocardial infarction', *Heart*, vol. 83, no. 4, pp. 388–93.

Hswen, Y, Murti, V, Vormawor, AA, Bhattacharjee, R & Naslund, JA 2013, 'Virtual avatars, gaming, and social media: Designing a mobile health app to help children choose healthier food options', *Journal of Mobile Technology in Medicine*, vol. 2, no. 2, p. 8–14.

Huang, JP, Chen, HH & Yeh, ML 2009, 'A comparison of diabetes learning with and without interactive multimedia to improve knowledge, control, and self-care among people with diabetes in Taiwan', *Public Health Nursing*, vol. 26, no. 4, pp. 317–28.

Huberman, AM & Miles, MB 1994, 'Data management and analysis methods', in NK Denzin & YS Lincoln (eds.), *Handbook of qualitative* research, Sage Publications, Thousand Oaks, USA, pp. 428–44.

Humble, JR, Tolley, EA, Krukowski, RA, Womack, CR, Motley, TS & Bailey, JE 2016, 'Use of and interest in mobile health for diabetes self-care in vulnerable populations', *Journal of Telemedicine and Telecare*, vol. 22, no. 1, pp. 32–8.

Hwang, R, Mandrusiak, A, Morris, NR, Peters, R, Korczyk, D & Russell, T 2017, 'Assessing functional exercise capacity using telehealth: Is it valid and reliable in patients with chronic heart failure?', *Journal of Telemedicine and Telecare*, vol. 23, no. 2, pp. 225–32.

Hwang, SY, Park, EH, Shin, ES & Jeong, MH 2009, 'Comparison of factors associated with atypical symptoms in younger and older patients with acute coronary syndromes', *Journal of Korean Medical Science*, vol. 24, no. 5, pp. 789–94.

Ibrahim, SY, Reid, F, Shaw, A, Rowlands, G, Gomez, GB, Chesnokov, M & Ussher, M 2008, 'Validation of a health literacy screening tool (REALM) in a UK population with coronary heart disease', *Journal of Public Health*, vol. 30, no. 4, pp. 449–55.

Irizarry, T, Shoemake, J, Nilsen, ML, Czaja, S, Beach, S & Dabbs, AD 2017, 'Patient portals as a tool for health care engagement: A mixed-method study of older adults with varying levels of health literacy and prior patient portal use', *Journal of Medical Internet Research*, vol. 19, no. 3, p. e99.

Isern, D & Moreno, A 2016, 'A systematic literature review of agents applied in healthcare', *Journal of Medical Systems*, vol. 40, no. 2, pp. 43–57.

Ivankova, NV 2017, 'Applying mixed methods in community-based participatory action research: A framework for engaging stakeholders with research as a means for promoting patient-centredness', *Journal of Research in Nursing*, vol. 22, no. 4, pp. 282–94.

Jack, BW, Chetty, VK, Anthony, D, Greenwald, JL, Sanchez, GM, Johnson, AE, Forsythe, SR, O'Donnell, JK, Paasche-Orlow, MK & Manasseh, C 2009, 'A reengineered hospital discharge program to decrease rehospitalization: A randomized trial', *Annals of Internal Medicine*, vol. 150, no. 3, pp. 178–87.

Jaffery, Z, Hudson, MP, Khanal, S, Ananthasubramaniam, K, Kim, H, Greenbaum, A, Kugelmass, A, Jacobsen, G & McCord, J 2009, 'The recognition of acute coronary ischemia in the outpatient setting', *Journal of Thrombosis and Thrombolysis*, vol. 27, no. 1, pp. 18–23.

Jamshidi, N, Abbaszadeh, A, Kalyani, MN & Sharif, F 2013, 'Effectiveness of video information on coronary angiography patients' outcomes', *Collegian*, vol. 20, no. 3, pp. 153–9.

Jankowski, P, Bednarek, A & Kawecka-Jaszcz, K 2010, 'The influence of educational media campaigns on reduction of prehospital delay in patients with acute coronary syndrome—a systematic review', *Kardiologia Polska (Polish Heart Journal)*, vol. 68, no. 3, pp. 332–8.

Jensen, L, Leeman-Castillo, B, Coronel, SM, Perry, D, Belz, C, Kapral, C & Krantz, MJ 2009, 'Impact of a nurse telephone intervention among high-cardiovascular-risk, health fair participants', *Journal of Cardiovascular Nursing*, vol. 24, no. 6, pp. 447–53.

Jibaja-Weiss, ML, Volk, RJ, Granchi, TS, Neff, NE, Robinson, EK, Spann, SJ, Aoki, N, Friedman, LC & Beck, JR 2011, 'Entertainment education for breast cancer surgery decisions: A randomized trial among patients with low health literacy', *Patient Education and Counseling*, vol. 84, no. 1, pp. 41–8.

Jin, S-AA 2011, '"It feels right. Therefore, I feel present and enjoy": The effects of regulatory fit and the mediating roles of social presence and self-presence in avatar-based 3D virtual environments', *Presence: Teleoperators and Virtual Environments*, vol. 20, no. 2, pp. 105–16.

Joanna Briggs Institute 2017, *Critical appraisal tools for use in JBI systematic reviews, checklist for quasi-experimental studies (non-randomized experimental studies)*, <http://joannabriggs.org/assets/docs/critical-appraisal-tools/JBI_Quasi-Experimental_Appraisal_Tool2017.pdf>.

Johansson, E 2009, 'The history of literacy in Sweden', in HJ Graff, A Mackinnon, B Sadnin & I Winchester, *Understanding literacy in its historical contexts: Socio-cultural history and the legacy of Egil Johansson*, Nordic Academic Press, Lund, Sweden, pp. 28–59.

Johnson, BT, Scott-Sheldon, LA & Carey, MP 2010, 'Meta-synthesis of health behavior change meta-analyses', *American Journal of Public Health*, vol. 100, no. 11, pp. 2193–98.

Johnson, C, Feinglos, M, Pereira, K, Hassell, N, Blascovich, J, Nicollerat, J, Beresford, HF, Levy, J & Vorderstrasse, A 2014, 'Feasibility and preliminary effects of a virtual environment for adults with type 2 diabetes: Pilot study', *The Journal of Medical Internet Research Protocols*, vol. 3, no. 2, p. e23.

Johnson, RB & Onwuegbuzie, AJ 2004, 'Mixed methods research: A research paradigm whose time has come', *Educational Researcher*, vol. 33, no. 7, pp. 14–26.

Johnston, M, Mobasheri, M, King, D & Darzi, A 2015, 'The imperial clarify, design and evaluate (CDE) approach to mHealth app development', *The British Medical Journal Innovations*, vol. 1, no. 2, pp. 2014–20.

Jones, AS, Ellis, CJ, Nash, M, Stanfield, B & Broadbent, E 2016, 'Using animation to improve recovery from acute coronary syndrome: A randomized trial', *Annals of Behavioral Medicine*, vol. 50, no. 1, pp. 108–18.

Jones, KR, Lekhak, N & Kaewluang, N 2014, 'Using mobile phones and short message service to deliver self-management interventions for chronic conditions: A meta-review', *Worldviews on Evidence-Based Nursing*, vol. 11, no. 2, pp. 81–8.

Jones, SS, Rudin, RS, Perry, T & Shekelle, PG 2014, 'Health information technology: An updated systematic review with a focus on meaningful use', *Annals of Internal Medicine*, vol. 160, no. 1, pp. 48–54.

Jorstad, HT, von Birgelen, C, Alings, AM, Liem, A, van Dantzig, JM, Jaarsma, W, Lok, DJ, Kragten, HJ, de Vries, K, de Milliano, PA, Withagen, AJ, Scholte Op Reimer, WJ, Tijssen, JG & Peters, RJ 2013, 'Effect of a nurse-coordinated prevention programme on cardiovascular risk after an acute coronary syndrome: Main results of the RESPONSE randomised trial', *Heart*, vol. 99, no. 19, pp. 1421–30.

Joshi, G, Alexander, J & Kehlet, H 2018, 'Large pragmatic randomised controlled trials in peri-operative decision making: Are they really the gold standard?', *Anaesthesia*, vol. 23, no. 7, pp. 799–803.

Joubert, M, Armand, C, Morera, J, Tokayeva, L, Guillaume, A & Reznik, Y 2016, 'Impact of a serious videogame designed for flexible insulin therapy on the knowledge and behaviors of children with type 1 diabetes: The LUDIDIAB pilot study', *Diabetes Technology and Therapeutics*, vol. 18, no. 2, pp. 52–8.

Julious, SA & Campbell, MJ 2012, 'Tutorial in biostatistics: Sample sizes for parallel group clinical trials with binary data', *Statistics in Medicine*, vol. 31, no. 24, pp. 2904–36.

Kanaoka, T & Mutlu, B 2015, ‘Designing a motivational agent for behavior change in physical activity’, *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, Seoul, Republic of Korea, pp. 1445–50.

Kangovi, S, Grande, D, Carter, T, Barg, FK, Rogers, M, Glanz, K, Shannon, R & Long, JA 2014, ‘The use of participatory action research to design a patient-centered community health worker care transitions intervention’, *Healthcare*, vol. 2, no. 2, pp. 136–44.

Kassebaum, NJ, Arora, M, Barber, RM, Bhutta, ZA, Brown, J, Carter, A, Casey, DC, Charlson, FJ, Coates, MM & Coggeshall, M 2016, ‘Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015’, *The Lancet*, vol. 388, no. 10053, pp. 1603–58.

Kato, PM, Cole, SW, Bradlyn, AS & Pollock, BH 2008, ‘A video game improves behavioral outcomes in adolescents and young adults with cancer: A randomized trial’, *Pediatrics*, vol. 122, no. 2, pp. e305–17.

Katsikitis, M, Lane, BR, Ozols, I & Statham, D 2017, ‘Consumer and carer perspectives in the development of a mental health research, treatment, and teaching facility: A thematic analysis’, *Journal of Psychiatric and Mental Health Nursing*, vol. 24, no .7, pp. 534–44.

Katus, H, Ziegler, A, Ekinci, O, Giannitsis, E, Stough, WG, Achenbach, S, Blankenberg, S, Brueckmann, M, Collinson, P & Comaniciu, D 2017, ‘Early diagnosis of acute coronary syndrome’, *European Heart Journal*, vol. 38, no. 41, pp. 3049–55.

Katz, DA, Graber, M, Birrer, E, Lounsbury, P, Baldwin, A, Hillis, SL & Christensen, AJ 2009, ‘Health beliefs toward cardiovascular risk reduction in patients admitted to chest pain observation units’, *Academic Emergency Medicine*, vol. 16, no. 5, pp. 379–87.

Katz, DA, Graber, M, Lounsbury, P, Vander Weg, MW, Phillips, EK, Clair, C, Horwitz, PA, Cai, X & Christensen, AJ 2017, ‘Multiple risk factor counseling to promote heart-healthy lifestyles in the chest pain observation unit: Pilot randomized controlled trial’, *Academic Emergency Medicine*, vol. 24, no. 8, pp. 968–82.

Kav, S, Yilmaz, AA, Bulut, Y & Dogan, N 2015, ‘Self-efficacy, depression and self-care activities of people with type 2 diabetes in Turkey’, *Collegian*, vol. 24, no. 1, pp. 27–35.

Kayar, NB, Doğan, FG, Özdemir, T, Dalkıran, SB, Gül, F, Gözütok, V, Kayar, Y, Kafadar, D & Dinçkal, MH 2018, 'Awareness and knowledge of patients with acute coronary syndromes about coronary artery disease', *Journal of the American College of Cardiology*, vol. 62, no. 18, Suppl. 2, p. C49.

Kemmis, S, McTaggart, R & Nixon, R 2013, *The action research planner: Doing critical participatory action research*, Springer Science & Business Media, Singapore.

Kemmis, S, McTaggart, R & Nixon, R 2014, 'Introducing critical participatory action research', in S Kemmis, R McTaggart & R Nixon (eds.), *The action research planner: Doing critical participatory research*, Springer Science & Business Media, Singapore, pp. 1−31.

Khan, JA 2011, 'Factors causing delayed presentation of patients with acute myocardial infarction to the hospital', *Pakistan Armed Forces Medical Journal*, vol. 1, no. 4, pp. 20–4.

Khan, MS, Jafary, FH, Faruqui, AM, Rasool, SI, Hatcher, J, Chaturvedi, N & Jafar, TH 2007, 'High prevalence of lack of knowledge of symptoms of acute myocardial infarction in Pakistan and its contribution to delayed presentation to the hospital', *BMC Public Health*, vol. 7, no. 1, p. 284.

Khan, NA, Daskalopoulou, SS, Karp, I, Eisenberg, MJ, Pelletier, R, Tsadok, MA, Dasgupta, K, Norris, CM & Pilote, L 2017, 'Sex differences in prodromal symptoms in acute coronary syndrome in patients aged 55 years or younger', *Heart*, vol. 103, no. 11, pp. 863–9.

Khraim, FM & Carey, MG 2009, 'Predictors of pre-hospital delay among patients with acute myocardial infarction', *Patient Education and Counseling*, vol. 75, no. 2, pp. 155–61.

Khraim, FM, Scherer, YK, Dorn, JM & Carey, MG 2010, 'Patient–surrogate agreement of predictors of decision delay among patients with acute myocardial infarction: A questionnaire survey', *International Journal of Nursing Studies*, vol. 47, no. 11, pp. 1418–24.

Kidd, S, Kenny, A & McKinstry, C 2015, 'The meaning of recovery in a regional mental health service: An action research study', *Journal of Advanced Nursing*, vol. 71, no. 1, pp. 181–92.

Kilkku, N 2018, 'eHealth, Telematics and Telehealth', in JC Santos & JR Cutcliffe (eds.), *European psychiatric/mental health nursing in the 21st century: A person-centred evidence-based approach*, Springer, Cham, Switzerland, pp. 223–33.

Kim, JH 2014, ‘Health avatar: An informatics platform for personal and private big data’, *Healthcare Informatics Research*, vol. 20, no. 1, pp. 1–2.

Kim, S-K, Chun, J, Park, H, Kwon, D & Ro, Y 2011, ‘Interfacing sensors and virtual world health avatar application’, *Proceedings of the 5th International Conference on New Trends in Information Science and Service Science*, Macao, pp. 21–5.

Kim, S-K, Chun, J, Kwon, D, Park, H & Ro, Y 2012, ‘Interfacing sensors and virtual world health avatar for u-wellness park system’, *International Journal of Digital Content Technology & its Applications*, vol. 6, no. 13, pp. 21–5.

Kim, SY, Prestopnik, N & Biocca, FA 2014, ‘Body in the interactive game: How interface embodiment affects physical activity and health behavior change’, *Computers in Human Behavior*, vol. 36, pp. 376–84.

Kindon, S, Pain, R & Kesby, M 2007, *Participatory action research approaches and methods: Connecting people, participation and place*, Routledge, New York, USA.

King, L, Harrington, A, Linedale, E & Tanner, E 2018, ‘A mixed method thematic review: Health related decision making by the older person’, *Journal of Clinical Nursing*, vol. 27, no. 7–8, pp. e1327–43.

King-Shier, KM, Singh, S, LeBlanc, P, Mather, CM, Humphrey, R, Quan, H & Khan, NA 2015, ‘The influence of ethnicity and gender on navigating an acute coronary syndrome event’, *European Journal Cardiovascular Nursing*, vol. 14, no. 3, pp. 240–7.

Kinnane, N, Stuart, E, Thompson, L, Evans, K & Schneider-Kolsky, M 2008, ‘Evaluation of the addition of video-based education for patients receiving standard pre-chemotherapy education’, *European Journal of Cancer Care*, vol. 17, no. 4, pp. 328–39.

Kirchberger, I, Amann, U, Heier, M, Thilo, C, Peters, A & Meisinger, C 2017, ‘Factors associated with emergency services use by patients with recurrent myocardial infarction: From the monitoring trends and determinants in cardiovascular disease/cooperative health research in the region of Augsburg Myocardial Infarction Registry’, *Journal of Cardiovascular Nursing*, vol. 32, no. 4, pp. 409–18.

Kirk, JK, Grzywacz, JG, Arcury, TA, Ip, EH, Nguyen, HT, Bell, RA, Saldana, S & Quandt, SA 2012, 'Performance of health literacy tests among older adults with diabetes', *Journal of General Internal Medicine*, vol. 27, no. 5, pp. 534−40.

Kitakata, H, Kohno, T, Kohsaka, S, Fujino, J, Nakano, N, Fukuoka, R, Yuasa, S, Maekawa, Y & Fukuda, K 2018, 'Patient confidence regarding secondary lifestyle modification and knowledge of 'heart attack' symptoms following percutaneous revascularisation in Japan: A cross-sectional study', *British Medical Journal Open*, vol. 8, no. 3, p. e019119.

Klaassen, R, Bul, K, van der Burg, GJ, Kato, PM & Di Bitonto, P 2018, 'Design and evaluation of a pervasive coaching and gamification platform for young diabetes patients', *Sensors*, vol. 18, no. 2, p. E402.

Kleinman, ME, Goldberger, ZD, Rea, T, Swor, RA, Bobrow, BJ, Brennan, EE, Terry, M, Hemphill, R, Gazmuri, RJ & Hazinski, MF 2018, '2017 American Heart Association focused update on adult basic life support and cardiopulmonary resuscitation quality: An update to the American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care', *Circulation*, vol. 137, no. 1, pp. e7–13.

Kleinpell, RM & Avitall, B 2007, 'Integrating telehealth as a strategy for patient management after discharge for cardiac surgery: Results of a pilot study', *Journal of Cardiovascular Nursing*, vol. 22, no. 1, pp. 38–42.

Kobayashi, Y, Hasegawa, D, Shirakawa, S, Sakuta, H & Nakayama, E 2015, 'Development of web-based platform for privacy protective avatar mediated distance-care', *Proceedings of the 5th International Conference on Pervasive Computing Paradigms for Mental Health*, MindCare 2015, Milan, Italy, pp. 131–9.

Kooij, L, Groen, WG & van Harten, WH 2017, 'The effectiveness of information technology-supported shared care for patients with chronic disease: A systematic review', *Journal of Medical Internet Research*, vol. 19, no. 6, p. e221.

Kothgassner, OD, Hlavacs, H, Beutl, L, Glenk, LM, Palme, R & Felnhofer, A 2016, 'Two experimental virtual paradigms for stress research: Developing avatar-based approaches for interpersonal and evaluative stressors', *Proceeding of the* 15th *International Conference on Entertainment Computing*, Wien, Austria, pp. 51–62.

Krouse, HJ, Fisher, J & Yarandi, HN 2001, 'Utility of video modeling as an adjunct to preoperative education', *Southern Online Journal of Nursing Research*, vol. 2, no. 8, pp. 1–38.

Krzyzanowski, M 2008, 'Analysing focus group discussions', in R Wodak & M Krzyzanowski (eds.), *Qualitative discourse analysis in the social sciences*, Palgrave Macmillan, Basingstoke, USA, pp. 162–81.

Kuhl, J 2018, 'Individual differences in self-regulation', in J Heckhausen & H Heckhausen (eds.), *Motivation and action*, 4th edn, Springer, Cham, Switzerland, pp. 529–77.

Kurich, T, Lasiuk, GC & Norris, CM 2017, 'Acute coronary syndromes symptom presentation among persons of South Asian descent: A comprehensive literature review', *Canadian Journal of Cardiovascular Nursing*, vol. 27, no. 1, pp. 6–13.

Lachin, JM 2016, 'Fallacies of last observation carried forward analyses', *Clinical Trials*, vol. 13, no. 2, pp. 161–8.

Lambert-Kerzner, A, Del Giacco, EJ, Fahdi, IE, Bryson, CL, Melnyk, SD, Bosworth, HB, Davis, R, Mun, H, Weaver, J, Barnett, C, Radcliff, T, Hubbard, A, Bosket, KD, Carey, E, Virchow, A, Mihalko-Corbitt, R, Kaufman, A, Marchant-Miros, K & Ho, PM 2012, 'Patient-centered adherence intervention after acute coronary syndrome hospitalization', *Circulation Cardiovascular Quality Outcomes*, vol. 5, no. 4, pp. 571–6.

Larsen, BH & Lorentzen, V 2016, 'Patients and acute coronary syndrome—prehospital delay and mental and emotional delaying responses—a qualitative study', *Nordisk Sygeplejeforskning*, vol. 5, no. 2, pp. 145–62.

Lauver, DR, Ward, SE, Heidrich, SM, Keller, ML, Bowers, BJ, Brennan, PF, Kirchhoff, KT & Wells, TJ 2002, 'Patient-centered interventions', *Research in Nursing & Health*, vol. 25, no. 4, pp. 246–55.

Lavery, T, Greenslade, JH, Parsonage, WA, Hawkins, T, Dalton, E, Hammett, C & Cullen, L 2017, 'Factors influencing choice of pre-hospital transportation of patients with potential acute coronary syndrome: An observational study', *Emergency Medicine Australasia*, vol. 29, no. 2, pp. 210–6.

Lawn, S & Schoo, A 2010, ‘Supporting self-management of chronic health conditions: Common approaches’, *Patient Education and Counseling*, vol. 80, no. 2, pp. 205–11.

Lee, A & Berge, ZL 2011, ‘Second life in healthcare education: Virtual environment’s potential to improve patient safety’, *Knowledge Management & E-Learning: An International Journal (KM&EL)*, vol. 3, no. 1, pp. 17–23.

Lee, E, Han, S & Jo, SH 2017, ‘Consumer choice of on-demand mHealth app services: Context and contents values using structural equation modeling’, *International Journal of Medical Informatics*, vol. 97, pp. 229–38.

Lee, I 2015, ‘Health-seeking behavior of Korean women with myocardial infarction’, PhD thesis, University of Washington, Seattle, USA.

Lee, M, Heo, H-H, Oh, S, Kim, E & Yoon, B 2018, ‘Patient-centered evaluation of home-based rehabilitation developed using community-based participatory research approach for people with disabilities: A case series’, *Disability and Rehabilitation*, vol. 40, no. 2, pp. 238–48.

Leifheit-Limson, EC, D’Onofrio, G, Daneshvar, M, Geda, M, Bueno, H, Spertus, JA, Krumholz, HM & Lichtman, JH 2015, ‘Sex differences in cardiac risk factors, perceived risk, and health care provider discussion of risk and risk modification among young patients with acute myocardial infarction: The VIRGO study’, *Journal of the American College of Cardiology*, vol. 66, no. 18, pp. 1949–57.

Leslie, W, Urie, A, Hooper, J & Morrison, C 2000, ‘Delay in calling for help during myocardial infarction: Reasons for the delay and subsequent pattern of accessing care’, *Heart*, vol. 84, no. 2, pp. 137–41.

Leventhal, H, Brissette, I & Leventhal, EA 2003, ‘The common-sense model of self-regulation of health and illness’, in LD Cameron & H Leventhal (eds.), *The self-regulation of health and illness behaviour*, vol. 1, Routledge, New York, USA, pp. 42–65.

Leventhal, H, Leventhal, EA & Contrada, RJ 1998, ‘Self-regulation, health, and behavior: A perceptual-cognitive approach’, *Psychology and Health*, vol. 13, no. 4, pp. 717–33.

Lewin, D & Piper, S 2007, ‘Patient empowerment within a coronary care unit: Insights for health professionals drawn from a patient satisfaction survey’, *Intensive and Critical Care Nursing*, vol. 23, no. 2, pp. 81–90.

Li, M & Song, W 2016, ‘Effects of different pre-hospital emergency patterns on the acute coronary syndrome outcome’, *International Journal of Clinical & Experimental Medicine*, vol. 9, no. 8, pp. 16621–8.

Li, P, Stuart, EA & Allison, DB 2015, ‘Multiple imputation: A flexible tool for handling missing data’, *The Journal of the American Medical Association*, vol. 314, no. 18, pp. 1966–7.

Li, PW, Lee, DT & Doris, S 2014, ‘Psychometric evaluation of the perceived barriers to health care-seeking decision in Chinese patients with acute coronary syndromes’, *Heart & Lung: The Journal of Acute and Critical Care*, vol. 43, no. 2, pp. 140–5.

Li, WC 2014, ‘The development and validation of an integrative theoretical model to explain the prehospital delay in care-seeking of patients with acute myocardial infarction’, PhD thesis, The Chinese University of Hong Kong, Hong Kong.

Lichtman, JH, Leifheit-Limson, EC, Watanabe, E, Allen, NB, Garavalia, B, Garavalia, LS, Spertus, JA, Krumholz, HM & Curry, LA 2015, ‘Symptom recognition and healthcare experiences of young women with acute myocardial infarction’, *Circulation: Cardiovascular Quality and Outcomes*, vol. 8, no. 2 suppl. 1, pp. S31–8.

Licskai, CJMD, Sands, TWP & Ferrone, MRRT 2013, ‘Development and pilot testing of a mobile health solution for asthma self-management: Asthma action plan smartphone application pilot study (L’élaboration et le projet pilote d’une solution mobile pour l’autogestion de l’asthme: Projet pilote d’une application pour téléphone intelligent d’un plan d’action de l’asthme)’, *Canadian Respiratory Journal*, vol. 20, no. 4, pp. 301–6.

Lippi, G, Montagnana, M, Salvagno, GL & Gian Cesare, G 2006, ‘Potential value for new diagnostic markers in the early recognition of acute coronary syndromes’, *CJEM: Journal of the Canadian Association of Emergency Physicians*, vol. 8, no. 1, pp. 27–31.

Lisetti, C, Amini, R, Yasavur, U & Rishe, N 2013, ‘I can help you change! An empathic virtual agent delivers behavior change health interventions’, *ACM Transactions on Management Information Systems (TMIS)*, vol. 4, no. 4, pp. 19–23.

Lisetti, CL 2012, ‘10 advantages of using avatars in patient-centered computer-based interventions for behavior change’, *SIGHIT Record*, vol. 2, no. 1, p. 28.

List TP 2013, *How technology is shaping patient education*, Surrey, <http://www.pmlive.com/pmhub/medical_communications/fti_consulting/white_papers_and_resourcer/how_technology_is_shaping_patient_education>.

Littleton-Kearney, M 2018, ‘Pragmatic clinical trials at the National Institute of Nursing Research’, *Nursing Outlook*, (online PubMed).

Liu, J, Davidson, E, Bhopal, R, White, M, Johnson, M, Netto, G, Deverill, M & Sheikh, A 2012, ‘Adapting health promotion interventions to meet the needs of ethnic minority groups: Mixed-methods evidence synthesis’, *Health Technology Assessment (Winchester, England)*, vol. 16, no. 44, pp. 1–469.

Liu, L, Stroulia, E, Nikolaidis, I, Miguel-Cruz, A & Rincon, AR 2016, ‘Smart homes and home health monitoring technologies for older adults: A systematic review’, *International Journal of Medical Informatics*, vol. 91, pp. 44–59.

Livne, Y, Peterfreund, I & Sheps, J 2017, ‘Barriers to patient education and their relationship to nurses’ perceptions of patient education climate’, *Clinical Nursing Studies*, vol. 5, no. 4, p. 65.

Lo, SF, Wang, YT, Wu, LY, Hsu, MY, Chang, SC & Hayter, M 2011, ‘Multimedia education programme for patients with a stoma: Effectiveness evaluation’, *Journal of Advanced Nursing*, vol. 67, no. 1, pp. 68–76.

LoBiondo-Wood, G & Haber, J 2017, *Nursing research e-book: Methods and critical appraisal for evidence-based practice*, Elsevier Health Sciences, Hong Kong, China.

Loudon, K, Treweek, S, Sullivan, F, Donnan, P, Thorpe, KE & Zwarenstein, M 2015, ‘The PRECIS-2 tool: Designing trials that are fit for purpose’, *The British Medical Journal*, vol. 350, p. h2147.

Lu, M, Tang, J, Wu, J, Yang, J & Yu, J 2015, ‘Discharge planning for acute coronary syndrome patients in a tertiary hospital: A best practice implementation project’, *JBI Database of Systematic Reviews and Implementation Reports*, vol. 13, no. 7, pp. 318–34.

Luepker, RV, Raczynski, JM, Osganian, S, Goldberg, RJ, Finnegan Jr, JR, Hedges, JR, Goff Jr, DC, Eisenberg, MS, Zapka, JG & Feldman, HA 2000, 'Effect of a community intervention on patient delay and emergency medical service use in acute coronary heart disease: The Rapid Early Action for Coronary Treatment (REACT) Trial', *The Journal of the American Medical Association*, vol. 284, no. 1, pp. 60–7.

Lyles, AA, Amresh, A, Huberty, J, Todd, M & Lee, RE 2017, 'A mobile, avatar-based app for improving body perceptions among adolescents: A pilot test', *The Journal of Medical Internet Research Serious Games*, vol. 5, no. 1, p. e4.

Ma, J, Wang, J, Zheng, W, Zheng, J, Wang, H, Wang, G, Zhang, H, Xu, F & Chen, Y 2017, 'Usage of ambulance transport and influencing factors in acute coronary syndrome: A cross-sectional study at a tertiary centre in China', *British Medical Journal Open*, vol. 7, no. 8, p. e015809.

Macabasco-O'Connell, A, DeWalt, DA, Broucksou, KA, Hawk, V, Baker, DW, Schillinger, D, Ruo, B, Bibbins-Domingo, K, Holmes, GM & Erman, B 2011, 'Relationship between literacy, knowledge, self-care behaviors, and heart failure-related quality of life among patients with heart failure', *Journal of General Internal Medicine*, vol. 26, no. 9, pp. 979–86.

MacInnes, J 2011, 'Illness representations, treatment beliefs and the relationship to self-care in heart failure', PhD thesis, Canterbury Christ Church University, Canterbury, New Zealand.

Mackay, MH, Ratner, PA, Nguyen, M, Percy, M, Galdas, P & Grunau, G 2014, 'Inconsistent measurement of acute coronary syndrome patients' pre-hospital delay in research: A review of the literature', *European Journal of Cardiovascular Nursing*, vol. 13, no. 6, pp. 483–93.

MacPherson, H 2004, 'Pragmatic clinical trials', *Complementary Therapies in Medicine*, vol. 12, no. 2–3, pp. 136–40.

Makam, RP, Erskine, N, Yarzebski, J, Lessard, D, Lau, J, Allison, J, Gore, JM, Gurwitz, J, McManus, DD & Goldberg, RJ 2016, 'Decade long trends (2001–2011) in duration of pre-hospital delay among elderly patients hospitalized for an acute myocardial infarction', *Journal of the American Heart Association*, vol. 5, no. 4, p. e002664.

Makkonen, M, Frank, L & Koivisto, K 2017, 'Age differences in technology readiness and its effects on information system acceptance and use: The case of online electricity services in

Finland', *Bled 2017: Proceedings of the 30th Bled eConference. Digital Transformation: From connecting things to transforming our lives,* Bled, Slovenia, pp. 403–420.

Malinauskaite, I, Slapikas, R, Courvoisier, D, Mach, F & Gencer, B 2017, 'The fear of dying and occurrence of posttraumatic stress symptoms after an acute coronary syndrome: A prospective observational study', *Journal of Health Psychology*, vol. 22, no. 2, pp. 208–17.

Marsh, P, Gartrell, G, Egg, G, Nolan, A & Cross, M 2017, 'End-of-life care in a community garden: Findings from a participatory action research project in regional Australia', *Health & Place*, vol. 45, pp. 110–6.

Maslakpak, MH & Shams, S 2015, 'A comparison of face to face and video-based self care education on quality of life of hemodialysis patients', *International Journal of Community Based Nursing and Midwifery*, vol. 3, no. 3, p. 234–43.

Mata, J, Frank, R & Gigerenzer, G 2014, 'Symptom recognition of heart attack and stroke in nine European countries: A representative survey', *Health Expectations*, vol. 17, no. 3, pp. 376–87.

Mathews, R, Peterson, ED, Li, S, Roe, MT, Glickman, SW, Wiviott, SD, Saucedo, JF, Antman, EM, Jacobs, AK & Wang, TY 2011, 'Use of emergency medical service transport among patients with ST-segment elevation myocardial infarction. Clinical perspective: Findings from the National Cardiovascular Data Registry Acute Coronary Treatment Intervention Outcomes Network Registry–Get with the Guidelines', *Circulation*, vol. 124, no. 2, pp. 154–63.

McClelland, M, Geldhof, J, Morrison, F, Gestsdóttir, S, Cameron, C, Bowers, E, Duckworth, A, Little, T & Grammer, J 2018, 'Self-regulation', in N Halfon, CB Forrest, RM Lerner & EM Faustman (eds.), *Handbook of life course health development*, Springer, Cham, Switzerland, pp. 275–98.

McCurdie, T, Taneva, S, Casselman, M, Yeung, M, McDaniel, C, Ho, W & Cafazzo, J 2012, 'mHealth consumer apps: The case for user-centered design', *Biomedical Instrumentation & Technology*, vol. 46, no. s2, pp. 49–56.

McDermott, MS & While, AE 2013, 'Maximizing the healthcare environment: A systematic review exploring the potential of computer technology to promote self-management of

chronic illness in healthcare settings', *Patient Education and Counseling*, vol. 92, no. 1, pp. 13–22.

McGilton, KS, Sorin-Peters, R, Rochon, E, Boscart, V, Fox, M, Chu, CH, Stewart, SC & Sidani, S 2018, 'The effects of an interprofessional patient-centered communication intervention for patients with communication disorders', *Applied Nursing Research*, vol. 39, pp. 189–94.

McGinn, AP, Rosamond, WD, Goff Jr, DC, Taylor, HA, Miles, JS & Chambless, L 2005, 'Trends in prehospital delay time and use of emergency medical services for acute myocardial infarction: Experience in 4 US communities from 1987–2000', *American Heart Journal*, vol. 150, no. 3, pp. 392–400.

McInnes, S, Peters, K, Bonney, A & Halcomb, E 2015, 'An integrative review of facilitators and barriers influencing collaboration and teamwork between general practitioners and nurses working in general practice', *Journal of Advanced Nursing*, vol. 71, no. 9, pp. 1973–85.

McKee, G, Mooney, M, O'Donnell, S, O'Brien, F, Biddle, MJ & Moser, DK 2013, 'Multivariate analysis of predictors of pre-hospital delay in acute coronary syndrome', *International Journal of Cardiology*, vol. 168, no. 3, pp. 2706–13.

McKinley, S, Dracup, K, Moser, DK, Ball, C, Yamasaki, K, Kim, CJ & Barnett, M 2004, 'International comparison of factors associated with delay in presentation for AMI treatment', *European Journal of Cardiovascular Nursing*, vol. 3, no. 3, pp. 225–30.

McKinley, S, Dracup, K, Moser, DK, Riegel, B, Doering, LV, Meischke, H, Aitken, LM, Buckley, T, Marshall, A & Pelter, M 2009, 'The effect of a short one-on-one nursing intervention on knowledge, attitudes and beliefs related to response to acute coronary syndrome in people with coronary heart disease: A randomized controlled trial', *International Journal of Nursing Studies*, vol. 46, no. 8, p. 1037–46.

McKinley, SM, Moser, DK & Dracup, K 2000, 'Treatment-seeking behavior for acute myocardial infarction symptoms in North America and Australia', *Heart and Lung*, vol. 29, no. 4, pp. 237–47.

McManus, DD, Saczynski, JS, Lessard, D, Waring, ME, Allison, J, Parish, DC, Goldberg, RJ, Ash, A, Kiefe, CI & Investigators, T-C 2016, 'Reliability of predicting early hospital

readmission after discharge for an acute coronary syndrome using claims-based data', *The American Journal of Cardiology*, vol. 117, no. 4, pp. 501–7.

McNaughton, CD, Collins, SP, Kripalani, S, Rothman, R, Self, WH, Jenkins, C, Miller, K, Arbogast, P, Naftilan, A & Dittus, RS 2013, 'Low numeracy is associated with increased odds of 30-day emergency department or hospital recidivism for patients with acute heart failure: Clinical perspective', *Circulation: Heart Failure*, vol. 6, no. 1, pp. 40–6.

McTaggart, R, Nixon, R & Kemmis, S 2017, 'Critical participatory action research', in LL Rowell, CD Bruce, MJ Shosh & MR Margaret (eds.), *The Palgrave international handbook of action research*, Springer, New York, USA, pp. 21–35.

Meadows-Pitt, M & Fields, W 2014, 'The impact of prehospital 12-lead electrocardiograms on door-to-balloon time in patients with ST-elevation myocardial infarction', *Journal of Emergency Nursing*, vol. 40, no. 3, p. e63.

Meischke, H, Diehr, P, Rowe, S, Cagle, A & Eisenberg, M 2004, 'Evaluation of a public education program delivered by firefighters on early recognition of a heart attack', *Evaluation & the Health Professions*, vol. 27, no. 1, pp. 3–21.

Melnyk, BM & Fineout-Overholt, E 2011, *Evidence-based practice in nursing & healthcare: A guide to best practice*, 2nd edn, Lippincott Williams & Wilkinsm, Hong Kong, China.

Members, WG, Go, AS, Mozaffarian, D, Roger, VL, Benjamin, EJ, Berry, JD, Blaha, MJ, Dai, S, Ford, ES & Fox, CS 2014, 'Heart disease and stroke statistics—2014 update: A report from the American Heart Association', *Circulation*, vol. 129, no. 3, p. e28.

Menzies, A 2015, 'Developing a sexual health app: Time for review', *British Journal of School Nursing*, vol. 10, no. 9, pp. 462–3.

Mercuri, M, Connolly, K, Natarajan, MK, Welsford, M & Schwalm, J 2017, 'Barriers to the use of emergency medical services for ST-elevation myocardial infarction: Determining why many patients opt for self-transport', *Journal of Evaluation in Clinical Practice*, vol. 24, no. 4, pp. 375–9.

Mercuri, M, Velianou, J, Welsford, M, Gauthier, L & Natarajan, M 2010, 'Improving the timeliness of care for patients with acute ST-elevation myocardial infarction: Implications of

“self-transport” versus use of EMS’, *Healthcare Quarterly (Toronto, Ont.)*, vol. 13, no. 1, pp. 105–9.

Merola, N & Peña, J 2009, ‘The effects of avatar appearance in virtual worlds’, *Journal for Virtual Worlds Research*, vol. 2, no. 5, pp. 4–12.

Merz, CNB, Andersen, H, Sprague, E, Burns, A, Keida, M, Mary Norine, W, Greenberger, P, Campbell, S, Pollin, I, McCullough, C, Brown, N, Jenkins, M, Redberg, R, Johnson, P & Robinson, B 2017, ‘Knowledge, attitudes, and beliefs regarding cardiovascular disease in women’, *Journal of the American College of Cardiology*, vol. 70, no. 2, pp. 123–32.

Metzler, CW, Sanders, MR, Rusby, JC & Crowley, RN 2012, ‘Using consumer preference information to increase the reach and impact of media-based parenting interventions in a public health approach to parenting support’, *Behavior Therapy*, vol. 43, no. 2, pp. 257–70.

Milošević, M, Shrove, MT & Jovanov, E 2011, ‘Applications of smartphones for ubiquitous health monitoring and wellbeing management’, *Journal of Information Technology and Applications (Banja Luka)*, vol. 1, no. 1, pp. 5–13.

Mohammadpour, A, Rahmati Sharghi, N, Khosravan, S, Alami, A & Akhond, M 2015, ‘The effect of a supportive educational intervention developed based on the Orem’s self-care theory on the self-care ability of patients with myocardial infarction: A randomised controlled trial’, *Journal of Clinical Nursing*, vol. 24, no. 11–12, pp. 1686–92.

Moher, D, Liberati, A, Tetzlaff, J & Altman, DG 2010, ‘Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement’, *International Journal of Surgery*, vol. 8, no. 5, pp. 336–41.

Mol, K, Rahel, B, Meeder, J, van Casteren, B, Doevendans, P & Cramer, M 2016, ‘Delays in the treatment of patients with acute coronary syndrome: Focus on pre-hospital delays and non–ST-elevated myocardial infarction’, *International Journal of Cardiology*, vol. 221, pp. 1061–6.

Molnar, FJ, Hutton, B & Fergusson, D 2008, ‘Does analysis using “last observation carried forward” introduce bias in dementia research?’, *Canadian Medical Association Journal*, vol. 179, no. 8, pp. 751–3.

Monkman, H & Kushniruk, A 2013, 'A health literacy and usability heuristic evaluation of a mobile consumer health application', *Medical and Health Informatics*, pp. 724–8.

Mooney, M, McKee, G, Fealy, G, O'Brien, F, O'Donnell, S & Moser, D 2012, 'A review of interventions aimed at reducing pre-hospital delay time in acute coronary syndrome: What has worked and why?', *European Journal of Cardiovascular Nursing*, vol. 11, no. 4, pp. 445–53.

Mooney, M, McKee, G, Fealy, G, O'Brien, F, O'Donnell, S & Moser, D 2014, 'A randomized controlled trial to reduce prehospital delay time in patients with acute coronary syndrome (ACS)', *The Journal of Emergency Medicine*, vol. 46, no. 4, pp. 495–506.

Mooney, M, O'Brien, F, McKee, G, O'Donnell, S & Moser, D 2016, 'Ambulance use in acute coronary syndrome in Ireland: A cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 15, no. 5, pp. 345–54.

Moore, GF, Audrey, S, Barker, M, Bond, L, Bonell, C, Hardeman, W, Moore, L, O'Cathain, A, Tinati, T & Wight, D 2015, 'Process evaluation of complex interventions: Medical Research Council guidance', *British Medical Journal*, vol. 350, p. h1258.

Moradian, S, Voelker, N, Brown, C, Liu, G & Howell, D 2018, 'Effectiveness of internet-based interventions in managing chemotherapy-related symptoms in patients with cancer: A systematic literature review', *Supportive Care in Cancer*, vol. 22, no. 3, pp. 1–14.

Moretti, F, van Vliet, L, Bensing, J, Deledda, G, Mazzi, M, Rimondini, M, Zimmermann, C & Fletcher, I 2011, 'A standardized approach to qualitative content analysis of focus group discussions from different countries', *Patient Education and Counseling*, vol. 82, no. 3, pp. 420–8.

Mosca, L, Hammond, G, Mochari-Greenberger, H, Towfighi, A & Albert, MA 2013, 'Fifteen-year trends in awareness of heart disease in women: Results of a 2012 American Heart Association national survey', *Circulation*, vol. 127, no. 11, pp. 1254–63.

Moser, DK, Kimble, LP, Alberts, MJ, Alonzo, A, Croft, JB, Dracup, K, Evenson, KR, Go, AS, Hand, MM & Kothari, RU 2007, 'Reducing delay in seeking treatment by patients with acute coronary syndrome and stroke: A scientific statement from the American Heart Association Council on Cardiovascular Nursing and Stroke Council', *Journal of Cardiovascular Nursing*, vol. 22, no. 4, pp. 326–43.

Moule, P, Aveyard, H & Goodman, M 2016, *Nursing research: An introduction*, 3rd edn, Sage Publications, London, UK.

Muhamad, R, Yahya, R & Yusoff, HM 2012, 'Knowledge, attitude and practice on cardiovascular disease among women in North-Eastcoast Malaysia', *International Journal of Collaborative Research on Internal Medicine & Public Health*, vol. 4, no. 1, pp. 85–98.

Murphy, SL & Gutman, SA 2012, 'Intervention fidelity: A necessary aspect of intervention effectiveness studies', *American Journal of Occupational Therapy*, vol. 66, no. 4, pp. 387–8.

Mussi, FC, Mendes, AS, Queiroz, TLd, Costa, ALS, Pereira, Á & Caramelli, B 2014, 'Pre-hospital delay in acute myocardial infarction: Judgement of symptoms and resistance to pain', *Revista da Associação Médica Brasileira*, vol. 60, no. 1, pp. 63–9.

Nabavi, RT 2012, *Bandura's social learning theory and social cognitive learning theory*, University of Science and Culture, Tehran, Iran, <https://www.researchgate.net/profile/Razieh_Tadayon_Nabavi/publication/267750204_Bandura's_Social_Learning_Theory_Social_Cognitive_Learning_Theory/links/545914d90cf26d5090ad007b.pdf>.

Naegeli, B, Radovanovic, D, Rickli, H, Erne, P, Seifert, B, Duvoisin, N, Pedrazzini, G, Urban, P & Bertel, O 2011, 'Impact of a nationwide public campaign on delays and outcome in Swiss patients with acute coronary syndrome', *European Journal of Cardiovascular Prevention & Rehabilitation*, vol. 18, no. 2, pp. 297–304.

Nahm, E-S, Barker, B, Resnick, B, Covington, B, Magaziner, J & Brennan, PF 2010, 'Effects of a social cognitive theory-based hip fracture prevention website for older adults', *Computers, Informatics, Nursing: CIN*, vol. 28, no. 6, p. 371–9.

Nanthakasikorn W 2008 'Effectiveness of computer based instruction about breast-feeding during the early stages of labour on knowledge and breast-feeding behaviours primiparous adolescent mothers', PhD thesis, Mahidol University, Bangkok, Thailand.

Napolitano, MA, Hayes, S, Russo, G, Muresu, D, Giordano, A & Foster, GD 2013, 'Using avatars to model weight loss behaviors: Participant attitudes and technology development', *Journal of Diabetes Science and Technology*, vol. 7, no. 4, pp. 1057–65.

Näslund, D, Kale, R & Paulraj, A 2010, 'Action research in supply chain management—a framework for relevant and rigorous research', *Journal of Business Logistics*, vol. 31, no. 2, pp. 331–55.

National Heart Foundation of Australia 2012, *A system of care for STEMI: Reducing time to reperfusion for patients with ST-segment elevation myocardial infarction*, National Heart Foundation of Australia, Canberra.

National Heart Foundation of Australia 2015a, *Heart attack action plan: Will you recognise your heart attack?*, viewed 16 June 2015, <https://www.heartfoundation.org.au/images/uploads/publications/WS_Patient_Fact_Sheet_English.pdf>.

National Heart Foundation of Australia 2015b, *My heart, my life: A guide for people living with coronary heart disease*, 2nd edn, National Heart Foundation of Australia, Sydney, Australia.

National Heart Foundation of Australia 2015c, *Living well with chronic heart failure*, National Heart Foundation of Australia, Sydney, Australia.

Navarin, S, Orsini, F, Ballarino, P, Kubica, J, Tubaro, M, Masip, J, Galvani, M, Jaffe, AS & Di Somma, S 2015, 'Is it possible to reduce time to appropriate treatment of acute coronary syndrome through a faster diagnosis? Focus on future innovative technologies and related treatments', *Medical Research Journal*, vol. 3, no. 2, pp. 39–45.

Nehme, Z, Andrew, E, Bernard, S, Patsamanis, H, Cameron, P, Bray, JE, Meredith, IT & Smith, K 2016, 'Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates', *European Heart Journal*, vol. 38, no. 21, pp. 1666–73.

Nehme, Z, Cameron, PA, Akram, M, Patsamanis, H, Bray, JE, Meredith, IT & Smith, K 2017, 'Effect of a mass media campaign on ambulance use for chest pain', The *Medical Journal of Australia*, vol. 206, no. 1, pp. 30–5.

Nestler, DM, Noheria, A, Haro, LH, Stead, LG, Decker, WW, Scanlan-Hanson, LN, Lennon, RJ, Lim, C-C, Holmes, DR & Rihal, CS 2009, 'Sustaining improvement in door-to-balloon time over 4 years', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 5, pp. 508–13.

Neubeck, L, Lowres, N, Benjamin, EJ, Freedman, SB, Coorey, G & Redfern, J 2015, 'The mobile revolution—using smartphone apps to prevent cardiovascular disease', *Nature Reviews Cardiology*, vol. 12, no. 6, p. 350–60.

Neubeck, L & Maiorana, A 2015, 'Time to get help? Acute myocardial infarction and delay in calling an ambulance', *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 1–3.

Neuendorf, KA 2016, *The content analysis guidebook*, Sage Publications, Los Angeles, USA.

Neumann, D & Garay, E 2014, 'Reviewing the literature', in F Hammond, J ,MalecR Buschbacher & T Nick (eds.), *Handbook for clinical research: Design, statistics, and implementation*, Demos Medical Publishing, New York, USA, pp. 218–23.

Neville, RG, Greene, AC & Lewis, S 2006, 'Patient and health care professional views and experiences of computer agent-supported health care', *Informatics in Primary Care*, vol. 14, no. 1, pp. 11–5.

Ng, TW & Lucianetti, L 2016, 'Within-individual increases in innovative behavior and creative, persuasion, and change self-efficacy over time: A social–cognitive theory perspective', *Journal of Applied Psychology*, vol. 101, no. 1, p. 14–34.

Nguyen, HL, Phan, DT, Ha, DA, Nguyen, QN & Goldberg, RJ 2017, 'Pre-hospital delay in Vietnamese patients hospitalized with a first acute myocardial infarction: A short report', *F1000Research*, vol. 4, no. 633, <https://f1000research.com>.

National Health and Medical Research Council 2007, *The Australian code for the responsible conduct of research*, National Health and Medical Research Council, Canberra.

Nielsen, CG, Laut, KG, Jensen, LO, Ravkilde, J, Terkelsen, CJ & Kristensen, SD 2016, 'Patient delay in patients with ST-elevation myocardial infarction: Time patterns and predictors for a prolonged delay', *European Heart Journal: Acute Cardiovascular Care*, vol. 6, no. 7, pp. 583–91.

Nielsen, D, Ryg, J, Nielsen, W, Knold, B, Nissen, N & Brixen, K 2010, 'Patient education in groups increases knowledge of osteoporosis and adherence to treatment: A two-year randomized controlled trial', *Patient Education and Counseling*, vol. 81, no. 2, pp. 155–60.

Nilsson, G, Mooe, T, Söderström, L & Samuelsson, E 2016, 'Pre-hospital delay in patients with first time myocardial infarction: An observational study in a northern Swedish population', *BioMed Central Cardiovascular Disorders*, vol. 16, no. 1, p. 93–103.

Nimkar, S 2016, 'Promoting individual health using information technology: Trends in the US health system', *The Health Education Journal*, vol. 75, no. 6, pp. 744–52.

Nishiyama, EE 2014, 'Discharge education in the emergency department: Are we effectively teaching chest pain patients?', MSN. thesis, Gardner-Webb University, North Carolina, USA.

Noble, H & Smith, J 2018, 'Reviewing the literature: Choosing a review design,' *Evidence-Based Nursing*, vol. 21, no. 2, pp. 39–41.

Norris, R 2007, 'The pre-hospital phase of acute myocardial infarction: A national audit is needed in New Zealand', *The New Zealand Medical Journal (Online)*, vol. 120, no. 1255, pp. 61–8.

Norris, RM 2012, 'Delay in the treatment of acute coronary syndromes', *The New Zealand Medical Journal (Online)*, vol. 125, no. 1348, pp. 7–10.

Noureddine, S, Adra, M, Arevian, M, Dumit, NY, Puzantian, H, Shehab, D & Abchee, A 2006, 'Delay in seeking health care for acute coronary syndromes in a Lebanese sample', *Journal of Transcultural Nursing*, vol. 17, no. 4, pp. 341–8.

Noureddine, S, Arevian, M, Adra, M & Puzantian, H 2008, 'Response to signs and symptoms of acute coronary syndrome: Differences between Lebanese men and women', *American Journal of Critical Care*, vol. 17, no. 1, pp. 26–35.

Noureddine, S, Dumit, NY & Saab, M 2015, 'Deciding to seek emergency care for acute myocardial infarction', *Clinical Nursing Research*, vol. 24, no. 5, pp. 487–503.

Nymark, C, Mattiasson, AC, Henriksson, P & Kiessling, A 2009, 'The turning point: From self-regulative illness behaviour to care-seeking in patients with an acute myocardial infarction', *Journal of Clinical Nursing,* vol. 18, no. 23, pp. 3358–65.

Nymark, C, Mattiasson, AC, Henriksson, P & Kiessling, A 2014, 'Emotions delay care-seeking in patients with an acute myocardial infarction', *European Journal of Cardiovascular Nursing*, vol.13, no. 1, pp. 41–7.

Nymark, C, Saboonchi, F, Mattiasson, AC, Henriksson, P & Kiessling, A 2017, 'Development and validation of an instrument to assess patients' appraisal, emotions and action tendencies preceding care-seeking in acute myocardial infarction: The PA-AMI questionnaire', *European Journal of Cardiovascular Nursing*, vol. 16, no. 3, pp. 240–8.

O'Brien, D, Butler, MM & Casey, M 2017, 'A participatory action research study exploring women's understandings of the concept of informed choice during pregnancy and childbirth in Ireland', *Midwifery*, vol. 46, pp. 1–7.

O'Brien, F, McKee, G, Mooney, M, O'Donnell, S & Moser, D 2014, 'Improving knowledge, attitudes and beliefs about acute coronary syndrome through an individualized educational intervention: A randomized controlled trial', *Patient Education and Counseling*, vol. 96, no. 2, pp. 179–87.

O'Brien, F, O'Donnell, S, McKee, G, Mooney, M & Moser, D 2013, 'Knowledge, attitudes, and beliefs about acute coronary syndrome in patients diagnosed with ACS: An Irish cross-sectional study', *European Journal of Cardiovascular Nursing*, vol. 12, no. 2, pp. 201–8.

O'Connor, RE, Nichol, G, Gonzales, L, Manoukian, SV, Moyer, PH, Rokos, I, Sayre, MR, Solomon, RC, Wingrove, GL & Brady, WJ 2014, 'Emergency medical services management of ST-segment elevation myocardial infarction in the United States—a report from the American Heart Association Mission: Lifeline Program', *The American Journal of Emergency Medicine*, vol. 32, no. 8, pp. 856–63.

O'Donnell, S, McKee, G, Mooney, M, O'Brien, F & Moser, DK 2014, 'Slow-onset and fast-onset symptom presentations in acute coronary syndrome (ACS): New perspectives on prehospital delay in patients with ACS', *Journal of Emergency Medicine*, vol. 46, no. 4, pp. 507–15.

O'Donnell, S, McKee, G, O'Brien, F, Mooney, M & Moser, DK 2012, 'Gendered symptom presentation in acute coronary syndrome: A cross sectional analysis', *International Journal of Nursing Studies*, vol. 49, no. 11, pp. 1325–32.

Olsen, JM & Nesbitt, BJ 2010, 'Health coaching to improve healthy lifestyle behaviors: An integrative review', *American Journal of Health Promotion*, vol. 25, no. 1, pp. e1–12.

Oluwafemi, AJ & Olanrewaju, KM 2014, 'Mobile-health application software design and development', *International Journal of Computer Science and Information Security*, vol. 12, no. 7, pp. 59–66.

Or, CK & Karsh, B-T 2009, 'A systematic review of patient acceptance of consumer health information technology', *Journal of the American Medical Informatics Association*, vol. 16, no. 4, pp. 550–60.

Or, CK, Tao, D & Wang, H 2017, 'The effectiveness of the use of consumer health information technology in patients with heart failure: A meta-analysis and narrative review of randomized controlled trials', *Journal of Telemedicine and Telecare*, vol. 23, no. 1, pp. 155–66.

Ostini, R & Kairuz, T 2014, 'Investigating the association between health literacy and non-adherence', *International Journal of Clinical Pharmacy*, vol. 36, no. 1, pp. 36–44.

Östlund, U, Kidd, L, Wengström, Y & Rowa-Dewar, N 2011, 'Combining qualitative and quantitative research within mixed method research designs: A methodological review', *International Journal of Nursing Studies*, vol. 48, no. 3, pp. 369–83.

Ottesen, MM, Dixen, U, Torp-Pedersen, C & Køber, L 2004, 'Prehospital delay in acute coronary syndrome—an analysis of the components of delay', *International Journal of Cardiology*, vol. 96, no. 1, pp. 97–103.

Ottesen, MM, Køber, L, Jørgensen, S, Torp-Pedersen, C & Group, TS 1996, 'Determinants of delay between symptoms and hospital admission in 5978 patients with acute myocardial infarction', *European Heart Journal*, vol. 17, no. 3, pp. 429–37.

Ottmann, G, Laragy, C & Damonze, G 2009, 'Consumer participation in designing community based consumer-directed disability care: Lessons from a participatory action research-inspired project', *Systemic Practice and Action Research*, vol. 22, no. 1, pp. 31–44.

Ottmann, GF & Laragy, C 2010, 'Developing consumer-directed care for people with a disability: 10 lessons for user participation in health and community care policy and program development', *Australian Health Review*, vol. 34, no. 4, pp. 390–4.

Ozanne, J, Saatcioglu, B & Corus, C 2007, 'Participatory action research as engaged practice: Implications for transformative consumer research', in G Fitzsimons & V Morwitz (eds.), *Advances in consumer research*, vol. 34, Association for Consumer Research, Duluth, USA, pp. 20–2.

Ozanne, JL & Saatcioglu, B 2008, 'Participatory action research', *Journal of Consumer Research*, vol. 35, no. 3, pp. 423–39.

Pal, K, Dack, C, Ross, J, Michie, S, May, C, Stevenson, F, Farmer, A, Yardley, L, Barnard, M & Murray, E 2018, 'Digital health interventions for adults with type 2 diabetes: Qualitative study of patient perspectives on diabetes self-management education and support', *Journal of Medical Internet Research*, vol. 20, no. 2, p. e40.

Paredes-Chi, AA & Castillo-Burguete, MT 2018, 'Is participatory action research an innovative pedagogical alternative for training teachers as researchers? The training plan and evaluation for normal schools', *Evaluation and Program Planning*, vol. 68, pp. 176–84.

Patel, A, Mohanan, PP, Prabhakaran, D & Huffman, MD 2017, 'Pre-hospital acute coronary syndrome care in Kerala, India: A qualitative analysis', *Indian Heart Journal*, vol. 69, no. 1, pp. 93–100.

Patsopoulos, NA 2011, 'A pragmatic view on pragmatic trials', *Dialogues in Clinical Neuroscience*, vol. 13, no. 2, pp. 217–24.

Patten, ML & Newhart, M 2017, *Understanding research methods: An overview of the essentials*, 10th edn, Taylor & Francis, New York, USA.

Pearson, ES 2012, 'Goal setting as a health behavior change strategy in overweight and obese adults: A systematic literature review examining intervention components', *Patient Education and Counseling*, vol. 87, no. 1, pp. 32–42.

Pelletier, J-F, Lesage, A, Boisvert, C, Denis, F, Bonin, J-P & Kisely, S 2015, 'Feasibility and acceptability of patient partnership to improve access to primary care for the physical health of patients with severe mental illnesses: An interactive guide', *International Journal for Equity in Health*, vol. 14, no. 1, pp. 78–86.

Peng, YG, Feng, JJ, Guo, LF, Li, N, Liu, WH, Li, GJ, Hao, G & Zu, XL 2014, 'Factors associated with prehospital delay in patients with ST-segment elevation acute myocardial

infarction in China', *The American Journal of Emergency Medicine*, vol. 32, no. 4, pp. 349–55.

Perkins-Porras, L, Whitehead, DL, Strike, PC & Steptoe, A 2008, 'Causal beliefs, cardiac denial and pre-hospital delays following the onset of acute coronary syndromes', *Journal of Behavioral Medicine*, vol. 31, no. 6, pp. 498–505.

Perkins-Porras, L, Whitehead, DL, Strike, PC & Steptoe, A 2009, 'Pre-hospital delay in patients with acute coronary syndrome: Factors associated with patient decision time and home-to-hospital delay', *European Journal of Cardiovascular Nursing*, vol. 8, no. 1, pp. 26–33.

Petrova, D, Garcia-Retamero, R, Catena, A, Cokely, E, Heredia Carrasco, A, Arrebola Moreno, A & Ramírez Hernández, JA 2016, 'Numeracy predicts risk of pre-hospital decision delay: A retrospective study of acute coronary syndrome survival', *Annals of Behavioral Medicine*, vol. 51, no. 2, pp. 292–306.

Pfaeffli Dale, L, Dobson, R, Whittaker, R & Maddison, R 2016, 'The effectiveness of mobile-health behaviour change interventions for cardiovascular disease self-management: A systematic review', *European Journal of Preventive Cardiology*, vol. 23, no. 8, pp. 801–17.

Piaggio, G, Elbourne, DR, Pocock, SJ, Evans, SJ, Altman, DG & Group, C 2012, 'Reporting of noninferiority and equivalence randomized trials: Extension of the CONSORT 2010 statement', *The Journal of the American Medical Association*, vol. 308, no. 24, pp. 2594–604.

Pickham, D, Berte, N, Pihulic, M, Valdez, A, Mayer, B & Desai, M 2018, 'Effect of a wearable patient sensor on care delivery for preventing pressure injuries in acutely ill adults: A pragmatic randomized clinical trial (LS-HAPI study)', *International Journal of Nursing Studies*, vol. 80, pp. 12–9.

Pierce, MA, Hess, EP, Kline, JA, Shah, ND, Breslin, M, Branda, ME, Pencille, LJ, Asplin, BR, Nestler, DM, Sadosty, AT, Stiell, IG, Ting, HH & Montori, VM 2010, 'The Chest Pain Choice trial: A pilot randomized trial of a decision aid for patients with chest pain in the emergency department', *Trials*, vol. 11, no. 1, pp. 57–64.

Pinto, MD, Hickman, RL, Clochesy, J & Buchner, M 2013, ‘Avatar-based depression self-management technology: Promising approach to improve depressive symptoms among young adults’, *Applied Nursing Research*, vol. 26, no. 1, pp. 45–8.

Pitsavos, C, Kourlaba, G, Panagiotakos, DB & Stefanadis, C 2006, ‘Factors associated with delay in seeking health care for hospitalized patients with acute coronary syndromes: The GREECS study’, *Hellenic Journal of Cardiology*, vol. 47, no. 6, pp. 329−36.

Plow, M & Golding, M 2017, ‘Using mHealth technology in a self-management intervention to promote physical activity among adults with chronic disabling conditions: Randomized controlled trial’, *The Journal of Medical Internet Research: mHealth and uHealth*, vol. 5, no. 12, p. e185.

Plummer-D’Amato, P 2008, ‘Focus group methodology part 2: Considerations for analysis’, *International Journal of Therapy and Rehabilitation*, vol. 15, no. 3, pp. 123–9.

Polit, D & Beck, C 2016, *Nursing research: Generating and assessing evidence for nursing practice*, 10th edn, Lippincott Williams & Wilkins, Philadelphia, USA.

Polit, DF 2017, ‘Clinical significance in nursing research: A discussion and descriptive analysis’, *International Journal of Nursing Studies*, vol. 73, pp. 17–23.

Polit, DF & Beck, CT 2010, *Essentials of nursing research: Appraising evidence for nursing practice*, Lippincott Williams & Wilkins, Philadelphia, USA.

Polit-O’Hara, D & Beck, CT 2006, *Essentials of nursing research: Methods, appraisal, and utilization*, vol. 1, Lippincott Williams & Wilkins, Philadelphia, USA.

Poltawski, L, Norris, M & Dean, S 2014, ‘Intervention fidelity: Developing an experience-based model for rehabilitation research’, *Journal of Rehabilitation Medicine*, vol. 46, no. 7, pp. 609–15.

Poomsrikaew, O, Ryan, CJ & Zerwic, JJ 2010, ‘Knowledge of heart attack symptoms and risk factors among native Thais: A street-intercept survey method’, *International Journal of Nursing Practice*, vol. 16, no. 5, pp. 492–8.

Popay, J, Roberts, H, Sowden, A, Petticrew, M, Arai, L, Rodgers, M, Britten, N, Roen, K & Duffy, S 2006, *Guidance on the conduct of narrative synthesis in systematic reviews: A product from the ESRC methods programme,* Lancaster University, Lancaster, UK.

Pope, Z, Lee, JE, Zeng, N, Lee, HY & Gao, Z 2018, 'Feasibility of smartphone application and social media intervention on breast cancer survivors' health outcomes', *Translational Behavioral Medicine*, <https://academic.oup.com/tbm/>.

Portney, LG & Watkins, MP 2000, *Foundations of clinical research: Applications to practice*, vol. 2, Prentice Hall, Upper Saddle River, USA.

Pouke, M & Häkkilä, J 2013, 'Elderly healthcare monitoring using an avatar-based 3D virtual environment', *International Journal of Environmental Research and Public Health*, vol. 10, no. 12, pp. 7283–98.

Provoost, S, Lau, HM, Ruwaard, J & Riper, H 2017, 'Embodied conversational agents in clinical psychology: A scoping review', *Journal of Medical Internet Research*, vol. 19, no. 5, p. e151.

Pulman, A, Hill, J & Masding, M 2013, 'The development of an innovative mobile phone app for type 1 diabetes alcohol education', *Diabetes UK Professional Conference*, Manchester, UK.

Rabin, C & Bock, B 2011, 'Desired features of smartphone applications promoting physical activity', *Telemedicine and e-Health*, vol. 17, no. 10, pp. 801–3.

Rasmussen, C, Munck, A, Kragstrup, J & Haghfelt, T 2003, 'Patient delay from onset of chest pain suggesting acute coronary syndrome to hospital admission', *Scandinavian Cardiovascular Journal*, vol. 37, no. 4, pp. 183–6.

Ratner, J, Mullins, D, Buesching, DP & Cantrell, RA 2013, 'Pragmatic clinical trials: US payers' views on their value', *The American Journal of Managed Care*, vol. 19, no. 5, pp. e158–65.

Ratner, PA, Tzianetas, R, Tu, AW, Johnson, JL, Mackay, M, Buller, CE, Rowlands, M & Reime, B 2006, 'Myocardial infarction symptom recognition by the lay public: The role of gender and ethnicity', *Journal of Epidemiology and Community Health*, vol. 60, no. 7, pp. 606–15.

Ratzan, SC, Weinberger, MB, Apfel, F & Kocharian, G 2013, 'The digital health scorecard: A new health literacy metric for NCD prevention and care', *Global Heart*, vol. 8, no. 2, pp. 171–9.

Ray, KN & Miller, E 2017, 'Strengthening stakeholder-engaged research and research on stakeholder engagement', *Journal of Comparative Effectiveness Research*, vol. 6, no. 4, pp. 375–89.

Reason, PE 1994, *Participation in human inquiry*, Sage Publications, Thousand Oaks, USA.

Reason, P & Bradbury, H (eds.) 2005, *The Sage handbook of action research: Participatory inquiry and practice*, 2nd edn, Sage Publications, Thousand Oaks, USA.

Reeder, KM 2007, 'Impact of lay consultation on pre-hospital delay in acute myocardial infarction', PhD thesis, The University of Iowa, Iowa, USA.

Reges, O, Vilchinsky, N, Leibowitz, M, Khaskia, A, Mosseri, M & Kark, JD 2015, 'Change in health behaviours following acute coronary syndrome: Arab-Jewish differences', *The European Journal of Preventive Cardiology*, vol. 22, no. 4, pp. 458–67.

Reid, SC, Kauer, SD, Hearps, SJC, Crooke, AHD, Khor, AS, Sanci, LA & Patton, GC 2011, 'A mobile phone application for the assessment and management of youth mental health problems in primary care: A randomised controlled trial', *BioMed Central Family Practice*, vol. 12, pp. 131–44.

Relton, C, Torgerson, D, O'Cathain, A & Nicholl, J 2010, 'Rethinking pragmatic randomised controlled trials: Introducing the "cohort multiple randomised controlled trial" design', *British Medical Journal*, vol. 340, p. c1066.

Richards, D & Caldwell, P 2016, 'Building a working alliance with a knowledge based system through an embodied conversational agent', in H Ohwada & K Yoshida (eds.), *Knowledge management and acquisition for intelligent systems. PKAW 2016. Lecture notes in computer science, vol* 9806, Springer, Cham, Switzerland, pp. 213–27.

Richards, D & Caldwell, P 2017, 'Improving health outcomes sooner rather than later via an interactive website & virtual specialist', *IEEE Journal of Biomedical and Health Informatics*, <https://ieeexplore.ieee.org>.

Richardson-Tench, M, Nicholson, P, Taylor, B & Kermode, S 2018, *Research in nursing, midwifery and allied health: Evidence for best practice*, Cengage, Victoria, Australia.

Riegel, B, Dickson, VV, Lee, CS, Daus, M, Hill, J, Irani, E, Lee, S, Wald, JW, Moelter, ST & Rathman, L 2018, 'A mixed methods study of symptom perception in patients with chronic heart failure', *Heart & Lung*, vol. 47, no. 2, pp. 107–14.

Riegel, B, Hanlon, AL, McKinley, S, Moser, DK, Meischke, H, Doering, LV, Davidson, P, Pelter, MM & Dracup, K 2010, 'Differences in mortality in acute coronary syndrome symptom clusters', *American Heart Journal*, vol. 159, no. 3, pp. 392–8.

Riegel, B, McKinley, S, Moser, DK, Meischke, H, Doering, L & Dracup, K 2007, 'Psychometric evaluation of the acute coronary syndrome (ACS) response index', *Research in Nursing & Health*, vol. 30, no. 6, pp. 584–94.

Ringer, NE 2014, 'The use of mobile applications in preventive care and health-related conditions: A review of the literature', honours thesis, University of Central Florida, Orlando, USA.

Rivero, F, Bastante, T, Cuesta, J, Benedicto, A, Salamanca, J, Restrepo, J-A, Aguilar, R, Gordo, F, Batlle, M & Alfonso, F 2016, 'Factors associated with delays in seeking medical attention in patients with ST-segment elevation acute coronary syndrome', *Revista Española de Cardiología (English Edition)*, vol. 69, no. 3, pp. 279–85.

Roberts, M, Healey, C, Garcia, C, Fazzari, M & Naidu, S 2018, 'Factors associated with prehospital delay in patients with ST-elevation myocardial infarction', *Journal of the American College of Cardiology*, vol. 67, no. 13, Suppl., p. 627.

Roberts, S, Chaboyer, W, Gonzalez, R & Marshall, A 2017, 'Using technology to engage hospitalised patients in their care: A realist review', *Biomed Central: Health Services Research*, vol. 17, p. 388.

Rodriguez, F & Mahaffey, KW 2016, 'Management of patients with NSTE-ACS: A comparison of the recent AHA/ACC and ESC guidelines', *Journal of the American College of Cardiology*, vol. 68, no. 3, pp. 313−21.

Roffi, M, Patrono, C, Collet, J-P, Mueller, C, Valgimigli, M, Andreotti, F, Bax, JJ, Borger, MA, Brotons, C & Chew, DP 2016, '2015 ESC guidelines for the management of acute coronary

syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC)', *European Heart Journal*, vol. 37, no. 3, pp. 267−315.

Roffman, CE, Buchanan, J & Allison, GT 2016, 'Charlson comorbidities index', *Journal of Physiotherapy*, vol. 62, no. 3, pp. 1836–1993.

Rollando, D, Puggioni, E, Robotti, S, De Lisi, A, Ferrari Bravo, M, Vardanega, A, Pattaro, I, De Benedetti, F & Brignole, M 2012, 'Symptom onset-to-balloon time and mortality in the first seven years after STEMI treated with primary percutaneous coronary intervention', *Heart*, vol. 98, no. 23, pp. 1738–42.

Rosal, MC, Heyden, R, Mejilla, R, Capelson, R, Chalmers, KA, DePaoli, MR, Veerappa, C & Wiecha, JM 2014, 'A virtual world versus face-to-face intervention format to promote diabetes self-management among African American women: A pilot randomized clinical trial', *Journal of Medical Internet Research: Research Protocols*, vol. 3, no. 4, p. e54.

Rosneck, JS, Hughes, J, Gunstad, J, Josephson, R, Noe, DA & Waechter, D 2014, 'Development and psychometric evaluation of a cardiovascular risk and disease management knowledge assessment tool', *The Journal of Cardiovascular Nursing*, vol. 29, no. 3, p. 242–56.

Ross, R 1999, 'Atherosclerosis—an inflammatory disease', *The New England Journal of Medicine*, vol. 340, no. 2, pp. 115−26.

Ruggiero, L, Moadsiri, A, Quinn, LT, Riley, BB, Danielson, KK, Monahan, C, Bangs, VA & Gerber, BS 2014, 'Diabetes island: preliminary impact of a virtual world self-care educational intervention for African Americans with type 2 diabetes', *Journal of Medical Internet Research: Serious Games*, vol. 2, no. 2, p. e10.

Russell, CL 2005, 'An overview of the integrative research review', *Progress in Transplantation*, vol. 15, no. 1, pp. 8–13.

Ruston, A, Clayton, J & Calnan, M 1998, 'Patients' action during their cardiac event: Qualitive study exploring different and modifiable factors', *The British Medical Journal*, vol. 316, no. 7137, pp. 1060–5.

Ruxton, G 2017, ‘Allocation concealment as a potentially useful aspect of randomised experiments’, *Behavioral Ecology and Sociobiology*, vol. 71, no. 2, pp. 31–2.

Rymer, JA, Kaltenbach, LA, Anstrom, KJ, Fonarow, GC, Erskine, N, Peterson, ED & Wang, TY 2018, ‘Hospital evaluation of health literacy and associated outcomes in patients after acute myocardial infarction’, *American Heart Journal*, vol. 198, pp. 97–107.

Saberi, F, Adib-Hajbaghery, M & Zohrehea, J 2014, ‘Predictors of prehospital delay in patients with acute myocardial infarction in Kashan city’, *Nursing and Midwifery Studies*, vol. 3, no. 4, p. e24238.

Saha, C & Jones, MP 2016, ‘Type I and type II error rates in the last observation carried forward method under informative dropout’, *Journal of Applied Statistics*, vol. 43, no. 2, pp. 336–50.

Sahin, C & Naylor, P-J 2017, ‘Mixed-methods research in diabetes management via mobile health technologies: A scoping review’, *Journal of Medical Internet Research: Diabetes*, vol. 2, no. 1, p. e3.

Sanchis-Gomar, F, Perez-Quilis, C, Leischik, R & Lucia, A 2016, ‘Epidemiology of coronary heart disease and acute coronary syndrome’, *Annals of Translational Medicine*, vol. 4, no. 13, pp. 1−12.

Sanders, MR & Kirby, JN 2012, ‘Consumer engagement and the development, evaluation, and dissemination of evidence-based parenting programs’, *Behavior Therapy*, vol. 43, no. 2, pp. 236–50.

Santos-Gallego, CG, Picatoste, B & Badimón, JJ 2014, ‘Pathophysiology of acute coronary syndrome’, *Current Atherosclerosis Reports*, vol. 16, no. 4, p. 401.

Sarkis, N & Mwanri, L 2014, ‘The role of information technology in strengthening human resources for health’, *Health Education*, vol. 114, no. 1, pp. 67–79.

Savage, ML, Poon, KK, Johnston, EM, Raffel, OC, Incani, A, Bryant, J, Rashford, S, Pincus, M & Walters, DL 2014, ‘Pre-hospital ambulance notification and initiation of treatment of ST elevation myocardial infarction is associated with significant reduction in door-to-balloon time for primary PCI’, *Heart, Lung and Circulation*, vol. 23, no. 5, pp. 435–43.

Sax, HC 2017, ‘Healthcare transformation: What are the challenges?’, in HC Sax (ed.), *Measurement and analysis in transforming healthcare delivery*, Springer, Los Angeles, USA, pp. 1–6.

Scholten, MR, Kelders, SM & Van Gemert-Pijnen, JE 2017, ‘Self-guided web-based interventions: Scoping review on user needs and the potential of embodied conversational agents to address them’, *Journal of Medical Internet Research*, vol. 19, no. 11, p. e383.

Schulman, D & Bickmore, T 2009, ‘Persuading users through counseling dialogue with a conversational agent’, *Proceedings of the 4th International Conference on Persuasive Technology*, Claremont, p. 25.

Schulz, KF, Altman, DG & Moher, D 2010, ‘CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials’, *Annals of Internal Medicine,* vol. 152, no. 11, pp. 726–32.

Sedgwick, P 2011, ‘Analysis by intention to treat’, *The British Medical Journal*, vol. 342, p. d2212.

Shand, JA & Menown, IB 2010, ‘A timely diagnosis of myocardial infarction’, *Biomarkers in Medicine*, vol. 4, no. 3, pp. 385–93.

Shaw, T, Yates, P, Moore, B, Ash, K, Nolte, L, Krishnasamy, M, Nicholson, J, Rynderman, M, Avery, J & Jefford, M 2017, ‘Development and evaluation of an online educational resource about cancer survivorship for cancer nurses: A mixed-methods sequential study’, *European Journal of Cancer Care*, vol. 26, no. 4, p. e12567.

Shenoy, R & Kumar, P 2014, ‘Clinical presentation, management and outcome of acute coronary syndromes’, *Indian Journal of Respiratory Care*, vol. 3, no. 2, pp. 512−6.

Shyr, WJ & Chen, CH 2018, ‘Designing a technology-enhanced flipped learning system to facilitate students’ self-regulation and performance’, *Journal of Computer Assisted Learning*, vol. 34, no. 1, pp. 53–62.

Singh, D, Sukhbeer, K, Ahmad, A, Rahmat, N & Hmwe, NTT 2016, ‘Nurse-led intervention on knowledge, attitude and beliefs towards acute coronary syndrome’, *Nursing in Critical Care*, (online Wiley Online Library).

Smith, C 2012, ‘A comparison of acute and prodromal myocardial infarction symptoms and treatment-seeking behavior in women diagnosed with and without an acute myocardial infarction where all have presented with a potential acute myocardial infarction’, PhD thesis, University of Kentucky, Lexington, USA.

Smith, JN, Negrelli, JM, Manek, MB, Hawes, EM & Viera, AJ 2015, ‘Diagnosis and management of acute coronary syndrome: An evidence-based update’, *The Journal of the American Board of Family Medicine*, vol. 28, no. 2, pp. 283−93.

Song, H, Kim, J, Kwon, RJ & Jung, Y 2013, ‘Anti-smoking educational game using avatars as visualized possible selves’, *Computers in Human Behavior*, vol. 29, no. 5, pp. 2029–36.

Song, L, Yan, H & Hu, D 2010, ‘Patients with acute myocardial infarction using ambulance or private transport to reach definitive care: Which mode is quicker?’, *Internal Medicine Journal*, vol. 40, no. 2, pp. 112–6.

Sorathiya, V, Kapupara, P & Shah, K 2016, ‘Technology based patient education information system’, *Research Journal of Pharmacy and Technology*, vol. 9, no. 1, pp. 101–7.

Sorita, A, Ahmed, A, Starr, SR, Thompson, KM, Reed, DA, Prokop, L, Shah, ND, Murad, MH & Ting, HH 2014, ‘Off-hour presentation and outcomes in patients with acute myocardial infarction: Systematic review and meta-analysis’, *British Medical Journal*, vol. 348, p. f7393.

Souza, MTd, Silva, MDd & Carvalho, Rd 2010, ‘Integrative review: What is it? How to do it?’, *Einstein (São Paulo)*, vol. 8, no. 1, pp. 102–6.

Spieth, PM, Kubasch, AS, Penzlin, AI, Illigens, BM-W, Barlinn, K & Siepmann, T 2016, ‘Randomized controlled trials—a matter of design’, *Neuropsychiatric Disease and Treatment*, vol. 12, pp. 1341–9.

Spinler, SA & de Denus, S 2016, *Acute coronary syndrome,* <https://basicmedicalkey.com/acute-coronary-syndromes/>.

Srimahachota, S, Kanjanavanit, R, Boonyaratavej, S, Boonsom, W, Veerakul, G & Tresukosol, D 2007, ‘Demograghic, management practices and in-hospital outcomes of Thai Acute Coronary Syndrome Registry (TACSR): The difference from the western world’, *Journal of the Medical Association of Thailand*, vol. 90, no. 1, pp. 1−11.

Stapleton, SR 2018, ‘Teacher participatory action research (TPAR): A methodological framework for political teacher research’, *Action Research*, <http://journals.sagepub.com/>.

StataCorp 2018, *Stata Statistical Software: Release 15*, version 15.1, StatCorp LP, College Station, USA.

Stenberg, U, Haaland-Øverby, M, Fredriksen, K, Westermann, KF & Kvisvik, T 2016, ‘A scoping review of the literature on benefits and challenges of participating in patient education programs aimed at promoting self-management for people living with chronic illness’, *Patient Education and Counseling*, vol. 99, no. 11, pp. 1759–71.

Stergiannis, P 2015, ‘Do Greek citizens have minimum knowledge about heart attack? A survey’, *Health Science Journal*, vol. 9, no. 5, pp. 1–6.

Stern, C & Lockwood, C 2005, ‘Knowledge retention from preoperative patient information’, *International Journal of Evidence-Based Healthcare*, vol. 3, no. 3, pp. 45–63.

Stevens, K 2013, ‘The impact of evidence-based practice in nursing and the next big ideas’, *OJIN: The Online Journal of Issues in Nursing*, vol. 18, no. 2, p. 4.

Stewart, DW & Shamdasani, PN 2014, *Focus groups: Theory and practice*, 3rd edn, Sage Publications, Thousand Oaks, USA.

Stinson, JN, Jibb, LA, Nguyen, C, Nathan, PC, Maloney, AM, Dupuis, LL, Gerstle, JT, Alman, B, Hopyan, S & Strahlendorf, C 2013, ‘Development and testing of a multidimensional iPhone pain assessment application for adolescents with cancer’, *Journal of Medical Internet Research*, vol. 15, no. 3, p. e51.

Stochkendahl, MJ, Christensen, HW, Vach, W, Høilund-Carlsen, PF, Haghfelt, T & Hartvigsen, J 2012, ‘Chiropractic treatment vs self-management in patients with acute chest pain: A randomized controlled trial of patients without acute coronary syndrome’, *Journal of Manipulative and Physiological Therapeutics*, vol. 35, no. 1, pp. 7–17.

Strecher, V, Wang, C, Derry, H, Wildenhaus, K & Johnson, C 2002, ‘Tailored interventions for multiple risk behaviors’, *Health Education Research*, vol. 17, no. 5, pp. 619–26.

Strömberg, A, Dahlström, U & Fridlund, B 2006, ‘Computer-based education for patients with chronic heart failure: A randomised, controlled, multicentre trial of the effects on

knowledge, compliance and quality of life', *Patient Education and Counseling*, vol. 64, no. 1, pp. 128–35.

Suhling, H, Rademacher, J, Zinowsky, I, Fuge, J, Greer, M, Warnecke, G, Smits, JM, Bertram, A, Haverich, A & Welte, T 2014, 'Conventional vs. tablet computer-based patient education following lung transplantation—a randomized controlled trial', *PloS One*, vol. 9, no. 3, <http://journals.plos.org/>.

Suhonen, R, Välimäki, M & Leino-Kilpi, H 2008, 'A review of outcomes of individualised nursing interventions on adult patients', *Journal of Clinical Nursing*, vol. 17, no. 7, pp. 843–60.

Sullivan, AL, Beshansky, JR, Ruthazer, R, Murman, DH, Mader, TJ & Selker, HP 2014, 'Factors associated with longer time to treatment for patients with suspected acute coronary syndromes: A cohort study', *Circulation: Cardiovascular Quality and Outcomes*, vol. 7, no. 1, pp. 86–94.

Sullivan, GM 2011, 'Getting off the "gold standard": Randomized controlled trials and education research', *Journal of Graduate Medical Education*, vol. 3, no. 3, pp. 285–9.

Sullivan, MD, Ciechanowski, PS, Russo, JE, Soine, LA, Jordan-Keith, K, Ting, HH & Caldwell, JH 2009, 'Understanding why patients delay seeking care for acute coronary syndromes', *Circulation: Cardiovascular Quality and Outcomes*, vol. 2, no. 3, pp. 148–54.

Sundberg, R, Tunsäter, A, Palmqvist, M, Ellbjär, S, Löwhagen, O & Torén, K 2005, 'A randomized controlled study of a computerized limited education program among young adults with asthma', *Respiratory Medicine*, vol. 99, no. 3, pp. 321–8.

Suresh, K & Chandrashekara, S 2012, 'Sample size estimation and power analysis for clinical research studies', *Journal of Human Reproductive Sciences*, vol. 5, no. 1, pp. 7–13.

Swallow, V, Carolan, I, Smith, T, Webb, NJ, Knafl, K, Santacroce, S, Campbell, M, Harper-Jones, M, Hanif, N & Hall, A 2016, 'A novel interactive health communication application (IHCA) for parents of children with long-term conditions: Development, implementation and feasibility assessment', *Informatics for Health and Social Care*, vol. 41, no. 1, pp. 20–46.

Swanoski, MT, Lutfiyya, MN, Amaro, ML, Akers, MF & Huot, KL 2012, 'Knowledge of heart attack and stroke symptomology: A cross-sectional comparison of rural and non-rural US adults', *BMC Public Health*, vol. 12, no. 1, p. 283.

Tabriz, AA, Sohrabi, M-R, Kiapour, N & Yazdani, S 2012, 'Factors associated with delay in thrombolytic therapy in patients with ST-elevation myocardial infarction', *The Journal of Tehran Heart Center*, vol. 7, no. 2, p. 65−71.

Taggart, J, Williams, A, Dennis, S, Newall, A, Shortus, T, Zwar, N, Denney-Wilson, E & Harris, MF 2012, 'A systematic review of interventions in primary care to improve health literacy for chronic disease behavioral risk factors', *Biomed Central Family Practice*, vol. 13, p. 49.

Tait, AR, Voepel-Lewis, T, Chetcuti, SJ, Brennan-Martinez, C & Levine, R 2014, 'Enhancing patient understanding of medical procedures: Evaluation of an interactive multimedia program with in-line exercises', *International Journal of Medical Informatics*, vol. 83, no. 5, pp. 376–84.

Tanner, H, Larsen, P, Lever, N & Galletly, D 2006, 'Early recognition and early access for acute coronary syndromes in New Zealand: Key links in the chain of survival', *The New Zealand Medical Journal (Online)*, vol. 119, no. 1232, p. U1927.

Tawalbeh, LI & Ahmad, MM 2014, 'The effect of cardiac education on knowledge and adherence to healthy lifestyle', *Clinical Nursing Research*, vol. 23, no. 3, pp. 245–58.

Taylor, DM, Garewal, D, Carter, M, Bailey, M & Aggarwal, A 2005, 'Factors that impact upon the time to hospital presentation following the onset of chest pain', *Emergency Medicine Australasia*, vol. 17, no. 3, pp. 204–11.

Teixeira, PJ, Carraça, EV, Marques, MM, Rutter, H, Oppert, J-M, De Bourdeaudhuij, I, Lakerveld, J & Brug, J 2015, 'Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators', *Biomed Central Medicine*, vol. 13, p. 84.

Thabane, L & Akhtar-Danesh, N 2008, 'Guidelines for reporting descriptive statistics in health research', *Nurse Researcher*, vol. 15, no. 2, pp. 72–81.

Thang, ND, Karlson, BW, Bergman, B, Santos, M, Karlsson, T, Bengtson, A, Johanson, P, Rawshani, A & Herlitz, J 2012, 'Characteristics of and outcome for patients with chest pain

in relation to transport by the emergency medical services in a 20-year perspective', *The American Journal of Emergency Medicine*, vol. 30, no. 9, pp. 1788–95.

Thorpe, KE, Zwarenstein, M, Oxman, AD, Treweek, S, Furberg, CD, Altman, DG, Tunis, S, Bergel, E, Harvey, I & Magid, DJ 2009, 'A pragmatic–explanatory continuum indicator summary (PRECIS): A tool to help trial designers', *Journal of Clinical Epidemiology*, vol. 62, no. 5, pp. 464–75.

Thuresson, M, Haglund, P, Ryttberg, B, Herlitz, J & Nilsson, U 2015, 'Impact of an information campaign on delays and ambulance use in acute coronary syndrome', *The American Journal of Emergency Medicine*, vol. 33, no. 2, pp. 297–8.

Ting, HH & Bradley, EH 2009, Patient education to reduce prehospital delay time in acute coronary syndrome, *Circulation: Cardiovascular Quality and Outcomes,* vol. 2, no. 6, pp. 1941–7705.

Ting, HH, Bradley, EH, Wang, Y, Nallamothu, BK, Gersh, BJ, Roger, VL, Lichtman, JH, Curtis, JP & Krumholz, HM 2008, 'Delay in presentation and reperfusion therapy in ST-elevation myocardial infarction', *The American Journal of Medicine*, vol. 121, no. 4, pp. 316–23.

Ting, HH, Chen, AY, Roe, MT, Chan, PS, Spertus, JA, Nallamothu, BK, Sullivan, MD, DeLong, ER, Bradley, EH, Krumholz, HM & Peterson, ED 2010, 'Delay from symptom onset to hospital presentation for patients with non–ST-segment elevation myocardial infarction', *Archives of Internal Medicine*, vol. 170, no. 20, pp. 1834−41.

Ting, HH, Krumholz, HM, Bradley, EH, Cone, DC, Curtis, JP, Drew, BJ, Field, JM, French, WJ, Gibler, WB & Goff, DC 2008, 'Implementation and integration of prehospital ECGs into systems of care for acute coronary syndrome: A scientific statement from the American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research, Emergency Cardiovascular Care Committee, Council on Cardiovascular Nursing, and Council on Clinical Cardiology', *Circulation*, vol. 118, no. 10, pp. 1066–79.

Ting, HH, Shojania, KG, Montori, VM & Bradley, EH 2009, 'Quality improvement: Science and action', *Circulation*, vol. 119, no. 14, pp. 1962–74.

Tongpeth, J, Du, H & Clark, R 2018a, ‘An avatar-based education application to improve patients’ knowledge of and response to heart attack symptoms: A pragmatic randomized controlled trial protocol’, *Journal of Advanced Nursing*, (online Wiley Online Library).

Tongpeth, J, Du, H & Clark, R 2018b, ‘Development and feasibility testing of an avatar-based education application for patients with acute coronary syndrome’, *Journal of Clinical Nursing*, (online Wiley Online Library).

Torraco, RJ 2005, ‘Writing integrative literature reviews: Guidelines and examples’, *Human Resource Development Review*, vol. 4, no. 3, pp. 356–67.

Townsend, N, Wilson, L, Bhatnagar, P, Wickramasinghe, K, Rayner, M & Nichols, M 2016, ‘Cardiovascular disease in Europe: Epidemiological update 2016’, *European Heart Journal*, vol. 37, no. 42, pp. 3232–45.

Treskes, R, Van der Velde, E, Schoones, JW & Schalij, MJ 2018, ‘Implementation of smart technology to improve medication adherence in patients with cardiovascular disease: Is it effective?’, *Expert Review of Medical Devices*, vol.15, no. 2, pp. 119–26.

Tsai, C-H 2014, ‘Integrating social capital theory, social cognitive theory, and the technology acceptance model to explore a behavioral model of telehealth systems’, *International Journal of Environmental Research and Public Health*, vol. 11, no. 5, pp. 4905–25.

Tsai, S-T & Chou, F-H 2012, ‘The effectiveness of multimedia nursing education on reducing illness-related anxiety and uncertainty in myocardial infarction patients after percutaneous coronary intervention’, *Hu Li Aa Zhi (The Journal of Nursing)*, vol. 59, no. 4, p. 43–53.

Tubaro, M 2010, ‘An organized system of emergency care for patients with myocardial infarction: A reality?’, *Future Cardiology*, vol. 6, no. 4, pp. 483–9.

Tullmann, DF & Dracup, K 2005, ‘Knowledge of heart attack symptoms in older men and women at risk for acute myocardial infarction’, *Journal of Cardiopulmonary Rehabilitation and Prevention*, vol. 25, no. 1, pp. 33–9.

Tullmann, DF, Haugh, KH, Dracup, KA & Bourguignon, C 2007, ‘A randomized controlled trial to reduce delay in older adults seeking help for symptoms of acute myocardial infarction’, *Research in Nursing & Health*, vol. 30, no. 5, pp. 485–97.

Tummala, SR & Farshid, A 2015, 'Patients' understanding of their heart attack and the impact of exposure to a media campaign on pre-hospital time', *Heart, Lung and Circulation*, vol. 24, no. 1, pp. 4–10.

Tunis, SR, Stryer, DB & Clancy, CM 2003, 'Practical clinical trials: Increasing the value of clinical research for decision making in clinical and health policy', *The Journal of the American Medical Association*, vol. 290, no. 12, pp. 1624–32.

Vaismoradi, M, Jones, J, Turunen, H & Snelgrove, S 2016, 'Theme development in qualitative content analysis and thematic analysis', *Journal of Nursing Education and Practice*, vol. 6, no. 5, p. 100.

Välimäki, M, Hatonen, H, Lahti, M, Kuosmanen, L & Adams, CE 2012, 'Information and communication technology in patient education and support for people with schizophrenia', *Cochrane Database Systematic Review*, vol. 10, p. CD007198.

van Meeuwen, LW, Brand-Gruwel, S, Kirschner, PA, de Bock, JJ & van Merriënboer, JJ 2018, 'Fostering self-regulation in training complex cognitive tasks', *Educational Technology Research and Development*, vol. 66, no. 1, pp. 53–73.

van Schaik, TM, Jørstad, HT, Twickler, TB, Peters, RJG, Tijssen, JPG, Essink-Bot, ML & Fransen, MP 2017, 'Cardiovascular disease risk and secondary prevention of cardiovascular disease among patients with low health literacy', *Netherlands Heart Journal*, vol. 25, no. 7–8, pp. 446–54.

Vancouver, JB 2018, 'Self-efficacy's role in unifying self-regulation theories', in JA Elliot (ed.), *Advances in motivation science*, Elsevier, San Diego, USA. pp. 203-230.

Veneri, DA & Zdanis, K 2018, 'Are technology-informed methods better than traditional approaches in educating patients? A meta-analysis', *Health Education Journal*, <http://journals.sagepub.com/>.

Ventola, CL 2014, 'Mobile devices and apps for health care professionals: Uses and benefits', *Pharmacy and Therapeutics*, vol. 39, no. 5, pp. 356–64.

Voncken-Brewster, V, Tange, H, Moser, A, Nagykaldi, Z, de Vries, H & van der Weijden, T 2014, 'Integrating a tailored e-health self-management application for chronic obstructive

pulmonary disease patients into primary care: A pilot study', *Biomed Central Family Practice*, vol. 15, p. 4.

Voshaar, MJH, Nota, I, van de Laar, M & van den Bemt, BJF 2015, 'Patient-centred care in established rheumatoid arthritis', *Best Practice & Research in Clinical Rheumatology*, vol. 29, no. 4–5, pp. 643–63.

Voss, D 2010, 'The use of iPods® to deliver patient education and treatment recommendations for depression within an underserved primary care setting', PsyD thesis, Wheaton College, Illinois, USA.

Wagner III, WE 2016, *Using IBM® SPSS® statistics for research methods and social science statistics*, 6th edn, Sage Publications, Washington, USA.

Wakefield, MA, Loken, B & Hornik, RC 2010, 'Use of mass media campaigns to change health behaviour', *The Lancet*, vol. 376, no. 9748, pp. 1261–71.

Wallentin, L, Kristensen, SD, Anderson, JL, Tubaro, M, Sendon, JLL, Granger, CB, Bode, C, Huber, K, Bates, ER & Valgimigli, M 2014, 'How can we optimize the processes of care for acute coronary syndromes to improve outcomes?', *American Heart Journal*, vol. 168, no. 5, pp. 622–31. e2.

Walters, GA 2015, 'Women and pre-hospital delays associated with myocardial infarction', PhD thesis, The University of North Carolina at Greensboro, North Carolina, USA.

Wang, L, Zhang, Z, McArdle, JJ & Salthouse, TA 2008, 'Investigating ceiling effects in longitudinal data analysis', *Multivariate Behavioral Research*, vol. 43, no. 3, pp. 476–96.

Wang, TY, Nallamothu, BK, Krumholz, HM, Li, S, Roe, MT, Jollis, JG, Jacobs, AK, Holmes, DR, Peterson, ED & Ting, HH 2011, 'Association of door-in to door-out time with reperfusion delays and outcomes among patients transferred for primary percutaneous coronary intervention', *The Journal of the American Medical Association*, vol. 305, no. 24, pp. 2540–7.

Waring, ME, McManus, DD, Lemon, SC, Gore, JM, Anatchkova, MD, McManus, RH, Ash, AS, Goldberg, RJ, Kiefe, CI & Saczynski, JS 2016, 'Perceiving one's heart condition to be cured following hospitalization for acute coronary syndromes: Implications for patient–provider communication', *Patient Education and Counseling*, vol. 99, no. 3, pp. 455–61.

Warsi, A, Wang, PS, LaValley, MP, Avorn, J & Solomon, DH 2004, 'Self-management education programs in chronic disease: a systematic review and methodological critique of the literature', *Archives of Internal Medicine*, vol. 164, no. 15, pp. 1641–9.

Wearing, JR, Nollen, N, Befort, C, Davis, AM & Agemy, CK 2014, 'iPhone app adherence to expert-recommended guidelines for pediatric obesity prevention', *Childhood Obesity*, vol. 10, no. 2, pp. 132–44.

Webb, T, Joseph, J, Yardley, L & Michie, S 2010, 'Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy', *Journal of Medical Internet Research*, vol. 12, no. 1, p. e4.

Wechkunanukul, K, Grantham, H & Clark, RA 2017, 'Global review of delay time in seeking medical care for chest pain: An integrative literature review', *Australian Critical Care*, vol. 30, no. 1, pp. 13–20.

Weibel, L, Massarotto, P, Hediger, H & Mahrer-Imhof, R 2016, 'Early education and counselling of patients with acute coronary syndrome. A pilot study for a randomized controlled trial', *European Journal of Cardiovascular Nursing*, vol. 15, no. 4, pp. 213–22.

Weibell, C 2011, *Principles of learning: 7 principles to guide personalized, student-centered learning in the technology enhanced, blended learning environment*, viewed July, <https://principlesoflearning.wordpress.com/>.

Whitaker, S, Baldwin, T, Tahir, M, Choudhry, O, Senior, A & Greenfield, S 2011, 'Public knowledge of the symptoms of myocardial infarction: A street survey in Birmingham, England', *Family Practice*, vol. 29, no. 2, pp. 168–73.

White, BK, Burns, SK, Giglia, RC & Scott, JA 2017, 'Designing evaluation plans for health promotion mHealth interventions: A case study of the Milk Man mobile app', *Health Promotion Journal of Australia*, vol. 27, no. 3, pp. 198–203.

White, IR, Horton, NJ, Carpenter, J & Pocock, SJ 2011, 'Strategy for intention to treat analysis in randomised trials with missing outcome data', *British Medical Journal*, vol. 342, p. d40.

White, KM, Dudley-Brown, S & Terhaar, MF 2016, *Translation of evidence into nursing and health care*, Springer, New York, USA.

Whittemore, R & Knafl, K 2005, 'The integrative review: Updated methodology', *Journal of Advanced Nursing*, vol. 52, no. 5, pp. 546–53.

Wiederhold, BK 2013, 'Avatars: Changing behavior for better or for worse?', *Cyberpsychology, Behavior, and Social Networking, v*ol. 16, no. 5, pp. 319–20.

Williams, GC, Lynch, M & Glasgow, RE 2007, 'Computer-assisted intervention improves patient-centered diabetes care by increasing autonomy support', *Health Psychology*, vol. 26, no. 6, pp. 728–34.

Wilson, EA, Makoul, G, Bojarski, EA, Bailey, SC, Waite, KR, Rapp, DN, Baker, DW & Wolf, MS 2012, 'Comparative analysis of print and multimedia health materials: A review of the literature', *Patient Education and Counseling*, vol. 89, no. 1, pp. 7–14.

Wilson, EA, Park, DC, Curtis, LM, Cameron, KA, Clayman, ML, Makoul, G, vom Eigen, K & Wolf, MS 2010, 'Media and memory: The efficacy of video and print materials for promoting patient education about asthma', *Patient Education and Counseling*, vol. 80, no. 3, pp. 393–8.

Wilson, EA & Wolf, MS 2009, 'Working memory and the design of health materials: A cognitive factors perspective', *Patient Education and Counseling*, vol. 74, no. 3, pp. 318–22.

Win, KT, Hassan, NM, Oinas-Kukkonen, H & Probst, Y 2016, 'Online patient education for chronic disease management: Consumer perspectives', *Journal of Medical Systems*, vol. 40, no. 4, pp. 1–13.

Winston, K, Grendarova, P & Rabi, D 2017, 'Video-based patient decision aids: A scoping review', *Patient Education and Counseling*, vol. 101, no. 4, pp. 558–78.

Worawong, C, Borden, MJ, Cooper, KM, Pérez, OA & Lauver, D 2018, 'Evaluation of a person-centered, theory-based intervention to promote health behaviors', *Nursing Research*, vol. 67, no. 1, pp. 6–15.

World Health Organization 2011, *Global atlas on cardiovascular disease prevention and control*, World Health Organization, Geneva, Switzerland.

World Health Organization 2013, *WHO global NCD action plan 2013–2020*, World Health Organization, Geneva, Switzerland.

World Health Organization 2016, *Health literacy. The solid facts*, World Health Organization, Geneva, Switerland, <http://www.euro.who.int/__data/assets/pdf_file/0008/190655/e96854.pdf>.

World Health Organisation 2017a, *Fact sheet on cardiovascular diseases*, viewed 1 December 2017, <http://www.who.int/cardiovascular_diseases/en/>.

World Health Organization 2017b, *Top 10 causes of death worldwide, fact sheet*, <http://www.who.int/mediacentre/factsheets/fs310/en/>.

World Heart Federation 2013, *Warning sign*, viewed 15 September 2017, <http://www.world-heart-federation.org/cardiovascular-health/heart-disease/warning-signs/>.

Worrall, A & Fletcher, G 2018, 'Acute coronary syndromes—assessment and interventions', *Stroke*, vol. 13, p. 57.

Wu, I, Kee, J, Threapleton, D, Ma, R, Lam, V, Lee, E, Wong, S & Chung, V 2018, 'Effectiveness of smartphone technologies on glycaemic control in patients with type 2 diabetes: Systematic review with meta-analysis of 17 trials', *Obesity Reviews*, vol. 19, no. 6, pp. 825–38.

Wu, J-R, Moser, DK, Riegel, B, McKinley, S & Doering, LV 2011, 'Impact of prehospital delay in treatment seeking on in-hospital complications after acute myocardial infarction', *Journal of Cardiovascular Nursing*, vol. 26, no. 3, pp. 184–93.

Wu, JC 2018, 'Acute myocardial infarction', in SD Solomon, JC Wu & JD Gillam (eds.), *Essential echocardiography: A companion to Braunwald's heart disease*, 10th edn, Elsevier, Philadelphia, USA, pp. 195–9.

Wynn Jr, RE 2013, 'The effects of an educational program on recognition of atypical signs and symptoms of acute coronary syndrome in women in the emergency room', DNP thesis, West Virginia University, Virginia, USA.

Xinyu, D & Pin, J 2008, ‘Development and application of virtual avatar interactive technology’, *ICACTE’08 Proceedings of the 2008 International Conference on Advanced Computer Theory and Engineering*, Phuket, Thailand, pp. 286–9.

Yan, H, Song, L, Yang, J, Sun, Y & Hu, D 2009, ‘The association between pre-infarction angina and care-seeking behaviors and its effects on early reperfusion rates for acute myocardial infarction’, *International Journal of Cardiology*, vol. 135, no. 1, pp. 86–92.

Yanez, BR, Buitrago, D, Buscemi, J, Iacobelli, F, Adler, RF, Corden, ME, Perez-Tamayo, A, Guitelman, J & Penedo, FJ 2018, ‘Study design and protocol for My Guide: An e-health intervention to improve patient-centered outcomes among Hispanic breast cancer survivors’, *Contemporary Clinical Trials*, vol. 65, pp. 61–8.

Yasavur, U, Lisetti, C & Rishe, N 2014, ‘Intelligent virtual agents and spoken dialog systems come together to deliver brief health interventions’, *Journal of Multimodal User Interfaces*, vol. 8, pp. 391–8.

Yeh, M-Y, Wu, S-C & Tung, T-H 2018, ‘The relation between patient education, patient empowerment and patient satisfaction: A cross-sectional-comparison study’, *Applied Nursing Research*, vol. 39, pp. 11–7.

Ying Chair, S, Yi Chau, M, Wing Hung Sit, J, Mei Ling Wong, E & Wai Kiu Chan, A 2012, ‘The psychological effects of a videotape educational intervention on cardiac catheterization patients’, *Contemporary Nurse*, vol. 40, no. 2, pp. 225–33.

Yonemoto, N, Kada, A, Yokoyama, H & Nonogi, H 2018, ‘Public awareness of the need to call emergency medical services following the onset of acute myocardial infarction and associated factors in Japan’, *Journal of International Medical Research*, vo. 46, no. 5, pp. 1747–55.

Youssef, G, Kassem, H, Ameen, O, Al Taaban, H & Rizk, H 2017, ‘Pre-hospital and hospital delay in patients with non–ST-elevation acute coronary syndromes in tertiary care’, *The Egyptian Heart Journal*, vol. 69, no. 3, pp. 177–81.

Yousuf, G, Kianoush, S, Kelli, HM, Misra, S, Urrea, B, Blaha, MJ, Graham, G, Marvel, FA & Martin, SS 2016, ‘The role of mHealth for improving medication adherence in patients with cardiovascular disease: A systematic review’, *European Heart Journal. Quality of Care and Clinical Outcomes*, vol. 2, no. 4, pp. 237–44.

Yulin Hswen, M 2013, ‘Virtual avatars, gaming, and social media: Designing a mobile health app to help children choose healthier food options’, *Journal of Mobile Technology in Medicine*, vol. 2, no. 2, pp. 8–14.

Zamanzadeh, V, Rassouli, M, Abbaszadeh, A, Majd, HA, Nikanfar, A & Ghahramanian, A 2015, ‘Details of content validity and objectifying it in instrument development’, *Nursing Practice Today*, vol. 1, no. 3, pp. 163–71.

Zimmerman, BJ 2002, ‘Becoming a self-regulated learner: An overview’, *Theory into Practice*, vol. 41, no. 2, pp. 64–70.

Zorca, SM & Mizuguchi, KA 2017, ‘Coronary artery disease’, in LS Aglio & RD Urman (eds.), *Anesthesiology*, Springer, Boston, USA. pp. 3−11.

Zuidgeest, MG, Welsing, P, van Thiel, G, Ciaglia, A, Alfonso-Cristancho, R, Eckert, L, Eijkemans, MJ & Egger, M 2017, ‘Pragmatic trials: Defining questions, choosing comparators, allocating treatments’, *Journal of Clinical Epidemiology*, vol. 90, pp. 92–8.

Zuidgeest, MG, Welsing, PM, van Thiel, GJ, Ciaglia, A, Alfonso-Cristancho, R, Eckert, L, Eijkemans, MJ & Egger, M 2017, ‘Series: Pragmatic trials and real world evidence: Paper 5. Usual care and real life comparators’, *Journal of Clinical Epidemiology*, vol. 90, pp. 92–8.

Zulkosky, K 2009, ‘Self-efficacy: A concept analysis’, *Nursing Forum*, vol. 44, no. 2, pp. 93–102.

Zwarenstein, M, Treweek, S, Gagnier, JJ, Altman, DG, Tunis, S, Haynes, B, Oxman, AD & Moher, D 2008, ‘Improving the reporting of pragmatic trials: An extension of the CONSORT statement’, *British Medical Journal*, vol. 337, p. a2390.