STEPPING FORWARD - KEEPING PACE

TEACHING JUNIOR DOCTORS THE MANAGEMENT OF DIABETES IN HOSPITALISED PATIENTS

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GLOSSARY

DKA	diabetic ketoacidosis
DNAT	Diabetes Needs Assessment Tool
FMC	Flinders Medical Centre
FY1	foundation year 1
FY2	foundation year 2
HONK	hyperosmolar non-ketotic acidosis
IV	intravenous
NHS	Noarlunga Health Services
PGY1	post-graduate year 1
PGY2	post-graduate year 2
RGH	Repatriation General Hospital
SACHREC	Southern Adelaide Clinical Human Research Ethics Committee
SALHN	Southern Adelaide Local Health Network
T2DM	Type 2 Diabetes Mellitus
UK	United Kingdom
USA	United States of America

SUMMARY

The increasing prevalence of diabetes mellitus in the Australian population has led to an increasing number of patients being admitted to hospitals with diabetes, either as a primary problem or as a comorbidity. Medical errors in diabetes management lead to excessive morbidity, complications, and even death. Doctors practicing within any clinical field of medicine in hospitals, where they care for acutely unwell patients, are faced with managing diabetes related issues. Prevocational junior doctors working within teaching hospitals are at the bed face of managing these patients and are the first line of clinicians who handle diabetes related issues within the hospital. The actual performance of junior doctors in managing diabetes has been shown to be sub-optimal, potentially leading to poor patient outcomes.

The sub-optimal performance of junior doctors has been attributed to multiple reasons, including lack of confidence and lack of knowledge. Efforts have been made at various sites around the world to address the need for greater knowledge and confidence among junior doctors in managing diabetes care of acutely unwell patients, and some of these have been documented in the medical literature. This study sought to explore the literature to understand the efforts taken at different sites across the world, to find out what methods worked and what could be adapted to an Australian teaching hospital environment. It then explored the needs of the doctors working within the local health system and developed a customised educational intervention to suit the needs of the local situation while looking more broadly to address the issue on a larger scale by exploring design principles for future interventions.

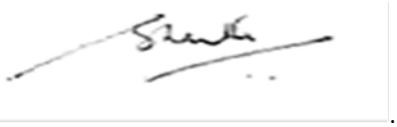
The study was a tri-phasic design-based research project. It was targeted at prevocational trainees working within one local health network in the first two years following completion of a university medical degree. Consistent with design-based research, mixed methods were used, combining qualitative and quantitative data gathering and analysis. In the first phase, a detailed learning needs analysis was done through questionnaires and focus groups. The second phase involved design and development of a customised educational intervention and assessment tool. The final phase included delivery of the intervention and evaluation of the outcomes.

Learning needs analysis revealed that some of the most pertinent challenges faced by junior doctors were that of transitions in diabetes care of patients admitted to hospital, and knowledge of types of insulin. A case based workshop was developed which incorporated these concepts. Assessment of learning was done through a combination of different written

assessment methods to provide a comprehensive measure of the achievement of listed learning objectives, and to provide feedback to guide modification and refinement of the process. The case based workshop was trialed and analysis of the outcome data suggested a significant gain in learning as measured in confidence, knowledge and application, and successful design of the educational intervention. The next iteration will see the intervention being refined and delivered to a broader group of trainee doctors.

DECLARATION OF AUTHORSHIP

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

Signature....  .....Date.....7/9/17...

CHAPTER 1: INTRODUCTION

1.1: STATEMENT OF THE PROBLEM

The prevalence of diabetes mellitus (henceforth referred to as diabetes for the purpose of brevity) is increasing worldwide, and a combination of environmental, epigenetic and genetic factors are implicated in this scenario (Chen, Magliano et al. 2012). The Australian Diabetes, Obesity and Lifestyle Study (AusDiab) was a pioneering study which evaluated this in Australia and reported more than twofold increase in diabetes prevalence since 1981, with Australia having one of the highest recorded prevalence of diabetes for a developed nation (Dunstan, Zimmet et al. 2002).This has consequently led to increasing number of patients presenting to hospitals with complications related to the disease. An increasing proportion of all hospitalisations is attributed to diabetes (Australian Institute of Health and Welfare 2008). Diabetes is the leading cause of a host of medical complications including non-traumatic lower limb amputation (Siitonen, Niskanen et al. 1993, Global Lower Extremity Amputation Study Group 2000), end stage kidney disease (Australian Institute of Health and Welfare 2009), and new-onset blindness due to retinopathy(Antonetti, Klein et al. 2012, Fante, Gardner et al. 2013). This situation places an increasing demand on various services within the hospital systems and also significantly impacts the medical personnel involved in the care of these patients.

Doctors from a wide scope of practice, involved in the care of acutely unwell patients admitted to hospitals, are constantly required to manage diabetes related issues. Within teaching hospitals, these doctors are at various stages of training and handle the evolving day-to-day clinical management of most of these patients. The expectation within the health service is that all doctors will be astute in identifying diabetes related issues as they arise, be knowledgeable and skilled in managing them, and seek expert input as and when appropriate (Tallentire, Smith et al. 2011, South Australian Medical Education and Training Unit 2016). However, there exists a gap in the aforesaid expectations and the actual performance of doctors in this area, which has been shown to lead to poor patient outcomes (Mayberry 2007). Medical errors in diabetes management can lead to excessive morbidity, complications, and even death. For example, medication errors involving insulin therapy have been found responsible for 33% of deaths occurring within 48 hours of a medical error in an inpatient setting (Hellman 2004).

The suboptimal performance of clinicians in medical management of diabetes among inpatients has been attributed in part to the lack of confidence, and partly to the lack of relevant knowledge and skills among doctors, especially those early in their career (George, Warriner et al. 2011). Prevocational junior doctors are often the first-line clinicians who are called to manage diabetes related issues in patients admitted to hospitals regardless of their area of work (Knecht, Gauthier et al. 2006). This project sought to improve the performance of junior doctors in managing diabetes among patients admitted to hospital. It endeavored to do this through the development and trial of an educational intervention to address the challenges faced by them, related to lack of confidence, knowledge and skills.

1.2 The Junior Doctor

The term 'junior doctor' or 'junior medical officer' is a very broad umbrella term that refers to medical officers at various stages of training but usually to those within one to four years following completion of the medical undergraduate course. Within the Australian context this term refers to: 1) prevocational trainees such as interns and resident medical officers who are not in an accredited training program, 2) basic trainees (also referred to as resident medical officers in some programs and registrars in other) in an accredited training program, and at times includes 3) advanced trainees who are in specialist training programs such as fellows (Figure 1). The term junior doctor does not cover doctors who have completed vocational specialty training. Apart from this, there exist multiple other commonly used terms and titles for the junior doctor in the workplace (e.g. intern, resident medical officer, house medical officer), which are unique to each health service, lending a layer of complexity. Although these are broadly similar within states or countries, they differ with reference to the job and person specifications linked to each title.

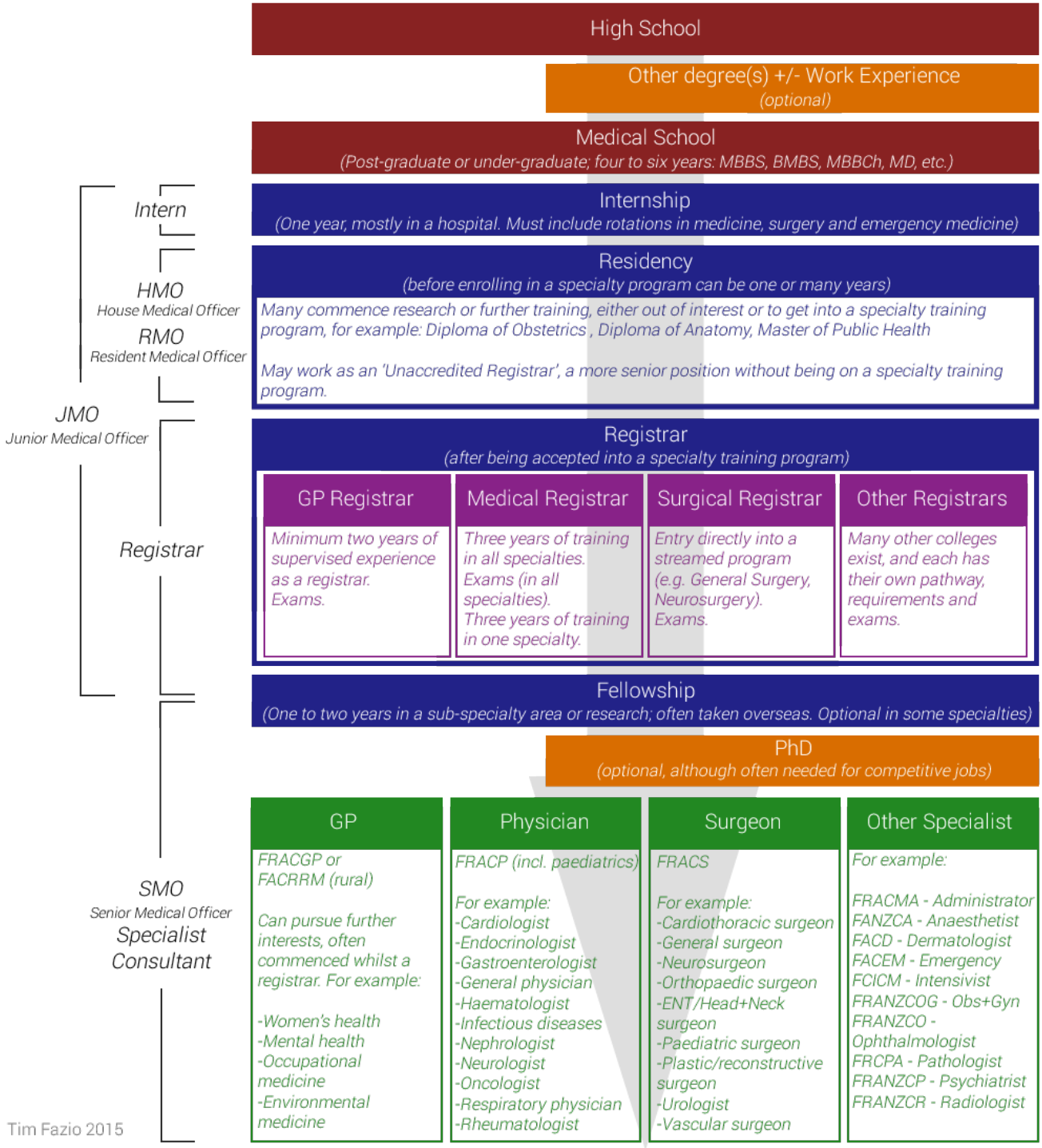


Figure 1 Junior medical officers/ junior doctors in the pathway to an established medical career (Australian Medical Association 2015).

Within the Southern Adelaide Local Health Network (SALHN) where this project was executed, and within the state of South Australia, the professional career of a doctor spans four stages (Royal Australasian College of Surgeons n.d.) as depicted in the graphic shown in Figure 2.

Stage 1 - University based medical education, the entry to which is either directly from secondary school or after completion of an undergraduate course.

Stage 2 - Prevocational training - overseen by state postgraduate medical councils.

Stage 3 - Vocational training in accredited training programs - overseen by specialist medical colleges.

Stage 4 - Specialist medical practice - overseen by specialist medical colleges.

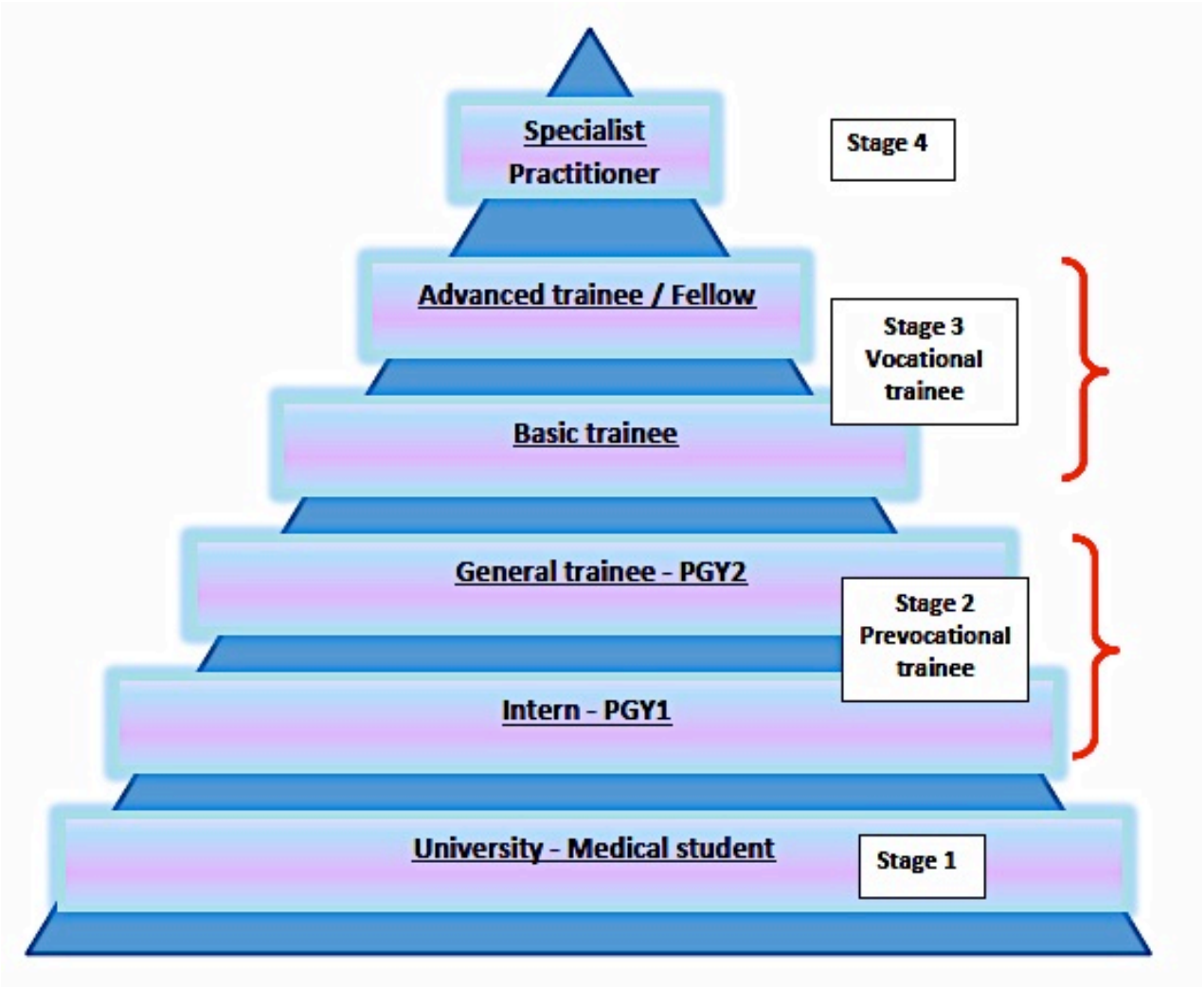


Figure 2 Stages in the medical career continuum

The prevocational phase is an early, undifferentiated phase of a doctor's career, which through a variety of pathways, leads to an established career in a specialised field of medicine (Figure 1). There are twelve major options for specialisation in Australia, governed by specialist colleges, each of which have their own training program and structure, and training periods ranging from three to seven years (Jolly 2009).

On acceptance into specialist training programs, trainees apply for accredited registrar positions within hospitals. Except for general practice training, which takes place within general practice clinic settings, most of the advanced training in specialties is undertaken in public hospitals. On completion of advanced training, specialists can work independently in their area of specialisation (Australian Medical Association 2015). Prevocational trainees are in the early stages of this career pathway. They come with experience ranging from a few weeks to a couple of years after completion of medical school. Although broadly grouped under one stage, their experience and expertise can be quite variable. Prevocational trainees are usually referred to as PGY1 (post-graduate year 1) or PGY2 (post-graduate year 2) in reference to the number of years since leaving medical school. This is broadly equivalent to FY1 (foundation year 1) and FY2 (foundation year 2) in the United Kingdom (UK) where the foundation program refers to the two year, general postgraduate medical training undertaken by junior doctors that works as a bridge between completion of medical school and starting specialist/general practice training. The focus of this project was on the prevocational junior doctor in their postgraduate years 1-2 (PGY1 and PGY2). The term junior doctor is used in this thesis to refer to the prevocational trainee alone and is used interchangeably.

1.2.1 The important role of junior doctors in the health service.

Junior doctors fulfill an important role in the tertiary hospital based health services, and provide the bulk of the medical workforce after normal working hour. Their role is critical to fulfilling the healthcare obligations and functions of the hospital system. Normal working hours in hospitals within the SALHN, as is common in most public hospitals, cover only a period of 45 hours of a week (8am – 5pm Monday to Friday). Added to this, during public holidays, hospitals function on minimal services and again rely on junior doctors. While elective procedures and active outpatient consulting cease after hours, care of patients admitted to hospital continues around the clock. Junior doctors mostly provide this care, with onsite supervision in high acuity areas like intensive care units and emergency departments or with offsite support and supervision from remote on-call specialists. Their service is critical to the functioning of the health system within tertiary hospitals.

1.2.2 The challenge of transition faced by junior doctors

Junior doctors are in the transitional stage between university education and specialist or general medical practice (Leeder 2007). Learning opportunities customised to the specific work environment are needed to enable junior doctors to handle these transitions safely. The transition from being a medical student to a medical practitioner is a very significant step in

one's medical career, and is fraught with multiple challenges which include that of translating theoretical knowledge to daily practice (Leeder 2007, Brennan, Corrigan et al. 2010). The unpredictability of clinical presentations, and patient and workplace dynamics adds to the complexity of this. Further, medical professionals make multiple other transitions in the course of their training and career. These may include but not be exclusive to: 1) moving from university to another unfamiliar health service, 2) moving from one clinical posting to another, 3) moving between medical specialty careers, and 4) moving in levels of increasing expertise and seniority within their teams.

The transition from a junior doctor to an advanced trainee brings increasing levels of medical and legal responsibilities such as prescription of medications and certification of death (Hilmer, Seale et al. 2009, Kilminster, Zukas et al. 2011) (Figure 3).

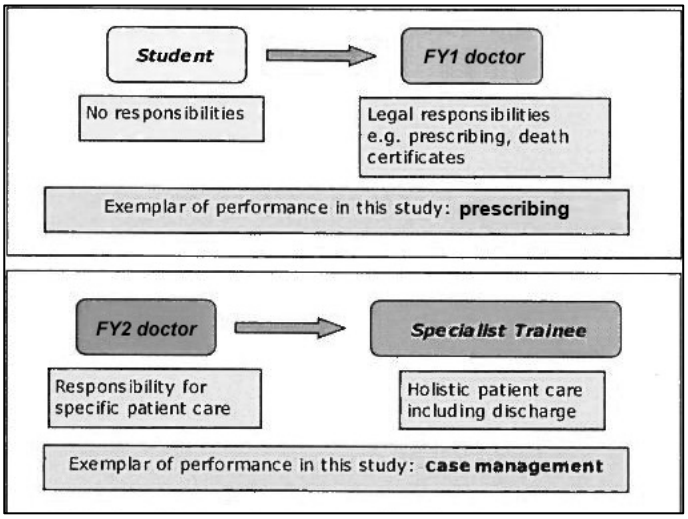


Figure 3 Increasing levels of responsibility with each transition (Kilminster, Zukas et al. 2011 p1008).
FYI corresponds to PGY1 and FY2 corresponds to PGY2

Within Australian hospitals PGY1 doctors undertake internship, which is a period of mandatory supervised general clinical experience, and receive level 1 supervision that refers to the supervisor taking principal responsibility for individual patients who are cared for by the junior doctor. They are not expected to certify death and they have limited registration with the medical board for practice of medicine. PGY2 on the other hand, are fully registered for independent practice holding a general registration and start shouldering increasing responsibilities such as certifying death. Specialist trainees move into specific scopes of practice and after completion of their training and obtaining a fellowship qualification from

an AMC accredited specialist college, they receive specialist registration for independent practice (Medical Board of Australia 2016).

Junior doctors in the early stages of training are often daunted by the maze of local and national protocols and guidelines, and the complexity and variety that exists in patient care. Further, experience gained through training in a certain health system as part of undergraduate medical education may not always be interchangeably used in another (McGrath, Graham et al. 2006). Transitions and change are part and parcel of a junior doctor's journey through their career and customised learning opportunities provide them the tools to handle these effectively and safely.

1.2.3 Junior doctors at the bed-face of health care

In teaching hospitals, junior doctors often represent the first direct contact that patients have with a medical professional on presentation to hospital (Kelly, Brandom et al. 2015). Further, as part of their role in patient care, junior doctors are frequently called upon, to independently assess and manage glycemic control in hospitalised patients with diabetes mellitus, regardless of whether this is the presenting problem, a co-existing condition, or newly diagnosed disorder during the hospital stay.

Diabetes assessment and management has become a crucial clinical management skill expected of all junior doctors, as it influences further clinical decisions made throughout the patient's journey in hospital. Importantly, in time-poor hospital environments, more senior clinicians rely on junior doctors to perform this early assessment and management. An example for this is the after-hours clinical work in teaching hospitals that run round-the-clock emergency services. Junior doctors at varying levels of experience and expertise are rostered to admit patients into hospitals on presentation. They are provided offsite supervision by consultants who can be contacted by phone and they are expected to seek advice for emergent management as deemed necessary. Their accurate assessment and handover is the key to informed clinical decisions, which translates to effective and safe patient management (Pascoe, Gill et al. 2014). It is important to equip junior doctors to handle this critical expectation that rests on them to manage the varied presentations of diabetes in hospitalised patients.

1.3 Factors that influence the ability of junior doctors to manage diabetes

There are various factors which impact the ability of junior doctors to manage diabetes related issues in patients admitted to hospitals. These can be grouped under five major categories, which are explored below:

1) The increasing burden of diabetes
2) The variability of diabetic presentations in patients admitted to hospitals
3) The complex nature of diabetes
4) Barriers to workplace based learning
5) Lack of confidence in managing diabetes in hospital based settings

1.3.1 The increasing burden of diabetes

Since 1997, diabetes has been identified as a national health priority in Australia due to its increasing prevalence and its impact on multiple health indices including disability and quality of life (Australian Institute of Health and Welfare 2014). It is estimated that about 6% of adult Australians live with diabetes currently, compared to 1.5% of Australians in 1989 (Australian Institute of Health and Welfare 2017). This increasing prevalence of diabetes in the population has led to increasing presentation of patients to hospitals with diabetes. Multiple studies have highlighted this high prevalence of diabetes among inpatients in hospital settings. Within the city of Adelaide, evidence from a study conducted at the Flinders Medical Centre (FMC) suggests a three times higher prevalence of diabetes among hospitalised patients when compared to the prevalence in the community (Valentine, Alhawassi et al. 2011, Bach, Ekinci et al. 2014). The increasing prevalence of diabetes among hospitalised patients is also evident nationally. In 2014-15, 10% of all hospitalisations in Australia, accounting for one million hospitalisations per year, were attributed to diabetes as either the principal and/or additional diagnosis (Australian Institute of Health and Welfare 2017). Of these, 46,600 hospitalisations were attributed to diabetes as the principal diagnosis leading to the hospitalisation and 964,000 hospitalisations involved diabetes as a coexisting condition that affected patient management (Australian Institute of Health and Welfare 2017). In a span of four years from 2000/01 to 2004/05, the Australian national rates of hospitalisation related to diabetes increased by 35% (Australian Institute of Health and Welfare 2008). This meant that while in 2000/01 a total of 1,932 hospitalisations per 100,000 people were attributed to diabetes, by 2004/05 this number had increased to 2,608 (Australian Institute of Health and Welfare 2008). Thus, it is evident that diabetes and its related

complications contribute to an increasing proportion of all hospitalisations. This situation is not unique to Australia. Rising prevalence of diabetes and increasing hospitalisations related to diabetes have been documented in other related health systems including the United States of America (USA) and the UK (Centers for Disease Control and Prevention 2010, Centers for Disease Control and Prevention 2010, Rayman and Kilvert 2012). This frequently places the junior doctor in situations requiring their skill and knowledge to manage diabetes related issues in patients admitted to the hospital.

1.3.2 The variability of diabetic presentations in patients admitted to hospitals

The range of diabetes related clinical presentations is varied, and the breadth of knowledge needed by junior doctors to handle this is wide. In most patients, the primary cause for admission may or may not be related to their diabetes. However, presence of diabetes as co-morbidity requires specific focused inpatient consideration and management. For instance, patients with diabetes may be admitted for management of infective exacerbation of chronic airways disease and be treated with steroid therapy. This has a significant impact on their diabetes management and consequently on their recovery from their acute illness. Another example would be that of patients with end-stage renal disease secondary to diabetes hospitalised for initiation of or management of complications from renal replacement therapies like haemodialysis or peritoneal dialysis. The process of dialysis significantly impacts the control of their diabetes, which subsequently affects their clinical outcomes. In this cohort of patients, poorly controlled diabetes is associated with adverse outcomes such as increased frequency of infections like peritonitis, and increased length of stay (Duong, Mehrotra et al. 2011). A further example is that of patients with significant peripheral vascular disease leading to chronic foot ulcers and the condition called ‘diabetic foot’, who need stringent control of blood sugar levels to promote better wound healing and prevent limb loss (Bakker, Apelqvist et al. 2012). Further, diabetes can also be present as an underlying co-morbidity in patients admitted to hospital for other reasons such as elective surgery (Adams, Paxton et al. 2013), chemotherapy (Busaidy, Farooki et al. 2012), or severe sepsis (Kushimoto, Gando et al. 2014). Inpatient hyperglycaemia in these cohorts of patients has been associated with a host of adverse outcomes including increased risk of complications, admission to intensive care units and increased mortality (Busaidy, Farooki et al. 2012, Adams, Paxton et al. 2013, Kushimoto, Gando et al. 2014).

In some select cohorts of patients, rigorous therapy to achieve quick and effective control of diabetes is critical to ensure safe and healthy outcomes. This is true for patients such as pregnant diabetic mothers (Kalra, Kalra et al. 2014). On the other hand, rigorous therapy of other clinical conditions can precipitate hyperglycaemia or a major deterioration in control of diabetes. This is evident in patients who are treated with acute short courses of high doses of steroids for management of inflammatory conditions, like inflammatory arthritis or inflammatory bowel disease, or following chemotherapy (Oyer, Shah et al. 2006).

Hospitalisation of diabetic patients can be due to acute issues related to the disease, such as diabetic ketoacidosis (DKA), hyperglycemic hyperosmolar state or hypoglycemia with reduced consciousness. Whilst these presentations make up a small proportion of all hospitalisations, the potential lethality of these conditions in an acute setting calls for sound knowledge of medical management strategies.

Finally, diabetes can at times be diagnosed for the first time in patients during their admission to hospital for another cause (MacIntyre, Majumdar et al. 2012). Newly diagnosed diabetes poses multiple challenges that range from handling the psychosocial impact of a diagnosis of chronic disease to ascertaining the type of diabetes and ensuring appropriate therapy and follow-up.

Acquiring knowledge and skills in managing a wide array of presentations can be challenging for junior doctors. Although the principles underpinning management of these wide and varying presentations have been fairly well studied and well defined in the literature, as well as in local and national guidelines, the challenge remains in providing an effective medium for junior doctors to learn to integrate these principles and guidelines in their daily practice of medicine.

1.3.3 The complex nature of diabetes

The rapidly expanding breadth of knowledge about diabetes, newly available drugs, varying modes of therapy, and changing paradigms of management in the acute setting, make it difficult for junior doctors to be familiar with up-to-date management strategies. For instance, in many hospitals, using non-standardised sliding scale insulin has traditionally been the strategy for acute management of hyperglycemia. There exist multiple studies that have explored the benefits versus risks of this, and have proposed the robust alternative of basal bolus insulin regimens with provision for additional correctional insulin (Umpierrez, Smiley

et al. 2011, Bogun and Inzucchi 2013, Badlani, Ford Jr et al. 2014, Roderman, Haire et al. 2014). The implementation of this change in practice has met with multiple barriers, including clinician's fear of hypoglycemia, and resistance due to the complex nature of the orders and the concepts involved (Roderman, Haire et al. 2014). Identified barriers to change include the lack of clinician education on the various aspects of basal bolus insulin therapy (Arif and Escano 2010, Beliard, Muzykovsky et al. 2015).

This lack of clinician education and awareness also extends into knowledge of new drugs available for diabetes therapy. Junior doctors are daunted by the complexity and intricacies of diabetes management and may inappropriately relegate it to lower priority (George, Warriner et al. 2011, Hillson 2011). This can prove harmful to patient safety. To illustrate this, doctors in training are often posted in pre-admission anesthetic clinics for elective surgical procedures. With the availability and use of multiple new drugs and new modalities of diabetic therapy like GLP1 agonists (e.g. exenatide twice daily or weekly injections), increasing numbers of patients present for operative procedures while being on such treatment. The junior doctor is then faced with the challenging task of identifying these medications and making appropriate decisions regarding their use in the peri-operative setting, while assessing various clinical conditions in a patient with multiple co-morbidities. Lack of knowledge and experience with the new medications affects the ability to make safe clinical decisions for management peri-operatively often leading to adverse clinical events.

Practitioners of almost every discipline of medicine require a significantly deep understanding of diabetes management strategies. However, the multiple innovations, variety of treatment options and changing protocols makes it challenging for doctors to keep abreast of best evidence based care.

1.3.4 Barriers to workplace based learning

Workplace based learning is an effective strategy which holds an important place in helping adult learners translate theoretical knowledge to practical skills, and develop clinical competence in the workplace (Georgsena and Løvstad 2014). Workplace based learning models usually range from low-level support to high 'mentoring' support depending on the needs of the trainee. Various approaches have been used in different workplaces to enable health professional learners to practice and learn in a safe environment. These include approaches using a clinical coach who acts as a mentor and provides point of care educational interventions to achieve clinical skill development (Annette Faithfull-Byrnea, Lorraine

Thompsona et al. 2017). Project based learning is another approach that has been successfully implemented in workplaces (Musa 2011). Other approaches use information and communication technology (ICT) to support learning in the workplace, either as online-courses or blended learning methods using a mix of various forms of knowledge delivery (Georgsena and Løvstad 2014). However, most trainee doctors are well attuned to the constant struggle of balancing service priorities of the health system with self-directed learning and reflection in practice. With increasing external work pressures and internal psychosocial pressures, opportunities to reflect on daily practice and learn are usually lost, swamped by the number of other demands on one's time. Hence, the workplace, which is meant to afford the ideal ground for learning, does not always succeed in doing this (McGrath, Graham et al. 2006). Further, there are very limited avenues for bolstering learning in the workplace and these are not always tailored to meet the specific educational needs of prevocational junior doctors. The educational initiatives dealing with diabetes provided to the prevocational medical officers working within the SALHN have included a face-to-face lecture and a couple of simulation sessions in the course of a year for PGY1 and a single simulation session for PGY2. The access to these can be limited by work priorities such as being on call, working offsite or working night shifts, and such resources are not often available at the time junior doctors need them.

While not all workplace experiences are equal in affording a safe and stable learning environment for the trainee doctor, with increasing awareness of the needs of junior doctors, health services are endeavoring to bridge the gap. Junior doctors working within South Australian health services are provided electronic access to resources such as Australian Medicines Handbook, Therapeutic Guidelines and UpToDate, (AMH 2017, eTG 2017, UpToDate 2017). However, knowledge resources do not adequately address the need to learn clinical reasoning and decision-making to integrate knowledge into practice.

Learning within the workplace is mostly a self-directed initiative, and clinical decision-making skills are best learnt when the junior doctor is involved directly in assessing patients and making management plans (Manley, Titchen et al. 2009). Often in large teams within health systems, the role of junior doctors is limited to enacting clinical decisions made by more senior clinicians (Dent 2013). This leads to the loss of opportunities to reflect and learn from undifferentiated clinical problems. Furthermore, as early learners in the medical work-environment, junior doctors are busy adapting to their new responsibilities and roles while

staying in step with the clinical demands placed on them. They often have no time to stop and reflect, and miss the opportunity to be guided in their learning about clinical decision-making. They are still in the stage of learning about what algorithms and guidelines exist for different issues and often are unable to explore the reasoning that exists behind these protocols.

1.3.5 Lack of confidence in managing diabetes in hospital based settings

Multiple studies have pointed to a lack of confidence and skills among junior doctors in treating diabetes within the hospital setting (Conn, Dodds et al. 2003, George, Warriner et al. 2011). This issue is explored in more detail in Chapter 2.

The management of diabetes in an inpatient setting can be a complex challenging process for a doctor in training, particularly during the early years in their career. The acquisition of experience and skills in this stage needs to be augmented with effective delivery of accessible learning at the workplace, related to their learning needs.

1.4 Benefits of addressing the learning needs of junior doctors- The bigger picture

1.4.1 Benefits to the community

In a broader sense, education delivered to doctors in training has multiple flow-on benefits to the community at large and is potentially an investment in long-term returns. Improved training of doctors, and particularly in reference to this project, diabetes related education for junior doctors potentially translates to: 1) better assessment of patients, right from the initial presentation. It leads to institution of appropriate management strategies in a timely fashion, 2) better utilisation of health resources such as timely referral, and 3) avoidance of adverse outcomes. Within the scope of diabetes this can be viewed as follows. Firstly, with regards to improved patient assessment and management, training to recognise hyper and hypoglycaemia in hospitalised patients and to manage it appropriately helps to avoid the increased morbidity and mortality that stems from poorly controlled diabetes in a variety of settings such as acute myocardial infarction and stroke (Mellbin, Malmberg et al. 2011). Secondly, there is better utilisation of health resources. As in the case of newly diagnosed diabetics, not all patients with diabetes require prolonged stay in hospital or even admission. Junior doctor awareness of the resources available and means to access these can lead to avoidance of unnecessary admissions. This has the double benefit of providing the patient a safe and secure opportunity to learn and adapt to their new disease with support from trained professionals without risking exposure to nosocomial infections during the process (Jasinski, Rodriguez-Monguio et al. 2013). Finally, this leads to avoidance of adverse health outcomes. Much of a patient's journey in hospital is fraught with the vulnerability of medication changes, which he/she is potentially unable to monitor or influence. Better training of junior doctors to watch for common pitfalls in medication prescription potentially avoids adverse events from drug errors which are unfortunately too common with diabetic medications (Cobaugh, Maynard et al. 2013). This leads to enhancing the quality and safety of health care delivery.

1.4.2 Junior doctors as agents of change

Well-trained junior doctors can be agents of change within their own respective clinical work environment (Hawkes 2009). The first few years of supervised clinical practice are part of a phase when consolidation of learning acquired during undergraduate years occurs. This is true with respect to management of diabetes as well. The prevocational phase is a period of increased flux in a doctor's career where these trainees are posted in widely varying clinical

services. As they progress in their careers doctors specialise and carry with them the training and experience from the early-undifferentiated medical phase of their careers. In the long run, effective learning during the early stages of a medical career would translate to improved confidence in managing patients with diabetes irrespective of the discipline chosen for specialisation. Furthermore, with advancement of their medical careers, doctors become restricted within silos of their specialisation. A psychiatry trainee would have limited interaction with a surgical specialty unless it involves a patient with both a psychiatric and surgical problem presenting with equal acuity during their admission to hospital. Similarly, a surgical trainee will have limited access to the latest trends and pharmaceutical advances in medical management of diabetes and would relegate the responsibility of medical management to the junior doctors on the team. Providing a nurturing learning experience in the work place during the formative stages of a doctor's career potentially has an impact for years to come and within various disciplines of medical practice.

1.5 Aim and objectives of the Research

The complexity of managing a chronic disease like diabetes cannot be overstated. It is obvious that the burgeoning problem of diabetes within hospitals coupled with the lack of confidence and skills among junior doctors, who deal with it daily, raises the need for effective measures for education. There is a need for sustained initiatives to bridge the gap between established best care practice and the ability of junior doctors to deliver it in a safe manner. Studies have repeatedly called for well-designed educational interventions to help bridge this gap (Shotliff, Lodge et al. 2008). This research project was initiated with the aim to explore the learning needs of prevocational trainees in the area of diabetes related knowledge, skills and confidence, in managing hospitalised patients. It also aimed to design and develop a customised educational intervention to address these learning needs and trial its administration. It was targeted at the junior doctors working within the SALHN.

1.6 Research questions

The research questions addressed by this study were:

- What are the learning needs of junior doctors with regards to diabetes related confidence, knowledge and skills for managing hospitalised patients with diabetes?
- What are effective means to deliver an educational intervention to address these learning needs?

1.7 OUTLINE OF RESEARCH AND THESIS

This study has used an educational design based method and therefore will be presented chronologically through each stage of the process. As such, methods and findings of each phase will be presented in their own chapter. The overall structure of the thesis is shown in Table 1. Chapter one has introduced the problem of diabetes management and the role of the junior doctor. Chapter two explores the literature dealing with junior doctor learning in general and more specifically their learning related to diabetes management. Chapter three outlines the overall methodology used. Chapter four presents the methods employed in and the results of phase 1 – the learning needs analysis. The design and development of intervention and assessment tool, which constituted the second phase, is presented in chapter five. Chapter six details the trial of the intervention and evaluation of outcomes that formed phase 3 of the project. The overall outcome of the study in the context of known existing literature is discussed in chapter seven and draws the thesis to conclusion. Appendices include the tools that were designed specifically for the project.

Table 1-*Outline of theses*

Chapter	Title
Chapter 1	Introduction
Chapter 2	Literature review
Chapter 3	Methodology
Chapter 4	Phase1 - Learning needs analysis
Chapter 5	Phase2 - Design and development of intervention and assessment tool
Chapter 6	Phase3 - Trial of the intervention and evaluation of outcomes
Chapter 7	Conclusion of study and future direction

1.8 CONCLUSION

The increasing proportion of diabetes and related co-morbidities in hospitalised patients, in conjunction with the complexity of the disease and therapeutic regimens, proves challenging for junior doctors to manage. Together with sparse opportunities for good quality work-place based learning, this scenario sets up these young professionals, who are at the bed-face of patient management in hospitals, at a disadvantage, and leads to lack of confidence in managing diabetes related issues. The benefits from addressing this issue extend beyond the immediate results of improved patient safety, and include multiple flow-on returns for patients, communities, health services and the medical profession and could potentially also

provide a model for developing education on other complex chronic diseases important in the hospital context.

This chapter has explored the problem; Issues relating to management of diabetes in the hospital setting and its relevance to junior doctor education and practice. It also provided a brief oversight into the relevance of these issues to health services and to society. Chapter 2 will present the current knowledge of how best to prepare junior doctors for their role in diabetes management of inpatients.

CHAPTER 2: LITERATURE REVIEW

A comprehensive literature review was undertaken to explore the experiences of local and international health systems on the issue of junior doctor practice and learning related to in-hospital management of diabetes. All literature published in peer-reviewed journals as well as abstracts of conference presentations were searched through the PubMed database, Google scholar and through the 'Find it at Flinders' website. The key terms used included 'intern', 'junior doctor', 'resident medical officers', 'diabetes education', 'insulin', 'insulin therapy', 'insulin infusion', 'junior doctor confidence', 'inpatient', 'diabetes', 'resident and basic trainee'. The aim of the review was to provide sufficient understanding of three themes:

1) How confident do junior doctors feel in managing diabetes in hospitalised patients?
2) What are the challenges faced by junior doctors in managing diabetes in inpatients?
3) Experience of other health systems in preparing junior doctors for their role in management of diabetes in inpatients.

While the available literature was studied systematically, this review does not attempt to be an exhaustive treatise or comprehensive summary of all that has been published on this topic. This chapter summarises key published literature on management of diabetes in hospitalised patients by junior doctors for each of the three themes.

2.1 THEME 1: HOW CONFIDENT DO JUNIOR DOCTORS FEEL IN MANAGING DIABETES IN HOSPITALISED PATIENTS

Junior doctors frequently encounter diabetes presentations in patients admitted to hospital. Much of the evidence in the literature points to junior doctors feeling under prepared and lacking confidence in managing and prescribing for diabetes (Conn, Dodds et al. 2003, Cook, McNaughton et al. 2007, George, Warriner et al. 2011, Bui, Barrie et al. 2016).

The Trainees Own Perception of Delivery of Care Diabetes Study (George, Warriner et al. 2011) was a benchmark national online survey conducted in the United Kingdom (UK) for the express purpose of assessing the confidence of junior doctors in managing diabetes, while also identifying their specific learning needs relevant to this field. The confidence of respondents was assessed using the Royal College of Physicians 'Confidence Rating' four-point scale (CR1: 'not confident', CR2: 'satisfactory but lacking confidence', CR3: 'confident in some cases', and CR4: 'fully confident in most cases'). The study was done using a questionnaire that had been pre-validated in a four-stage process: (1) initial review by

external experts in the field of diabetes, (2) administration of initial draft on a sample cohort, (3) revision of questionnaire based on feedback received, and (4) final external review. The survey was distributed to all trainees ranging from junior doctors to advanced trainees, practicing in the UK in the year of the study. The study was well designed and achieved a good response rate with 2149 completed responses, and represented a varied geographic as well future career intention group. Broadly, the self-rated confidence scales assessed confidence in areas of diabetes management which related to: 1) clinical assessment and management skills like diagnosing and managing diabetic ketoacidosis, and 2) practical skills like commencing, titrating and discontinuing intravenous (IV) insulin. The key findings showed suboptimal self-reported confidence levels in all areas of inpatient diabetes management (George, Warriner et al. 2011). This was lower than self-reported confidence levels in managing two other comparable areas of medicine - namely angina and asthma (George, Warriner et al. 2011). The lack of confidence was evident in both clinical assessment and management, such as altering diabetes treatment prior to surgery, managing IV insulin infusions, and in diagnosing and managing hyperosmolar non-ketotic states (George, Warriner et al. 2011).

A similar lack of junior doctor confidence in diabetes management was also noted in a study from United States of America (USA) (Cook, McNaughton et al. 2007). In response to a previous analysis done within their institution (Knecht, Gauthier et al. 2006), which revealed that approximately half of the inpatients with diabetes were treated by junior doctors (referred to as resident medical officers), investigators chose these residents as subjects for a survey to determine their attitudes about three aspects of inpatient hyperglycemia. Specifically, they investigated 1) perceived importance of glucose control in the hospital, 2) optimal glucose targets, and 3) barriers to successful treatment of hyperglycemia. In addition, they explored the residents' degree of comfort with managing hyperglycemia and using insulin therapy. A total of 52 responses were obtained from 70 residents (74% response) (Cook, McNaughton et al. 2007). These residents were drawn from teams with inpatient responsibilities in general internal medicine, family medicine, and general surgery as they provided care for two-thirds of the inpatients admitted to their hospital. In response to the survey, most residents indicated they were only "somewhat comfortable" in treating hyperglycemia and hypoglycemia and with using subcutaneous insulin therapy in the hospital (Cook, McNaughton et al. 2007), which is quite concerning, considering that subcutaneous insulin therapy forms the core of many acute interventions in hospital to manage hyperglycemia. Further, 48% of respondents

were “not at all comfortable” with using intravenous insulin infusion therapy (Cook, McNaughton et al. 2007). Most residents were only “somewhat familiar” with hospital policies relating to insulin pumps and hypoglycemia and intravenously administered insulin and a substantial proportion of residents surveyed indicated that they were “not at all familiar” with these hospital policies (Cook, McNaughton et al. 2007).

In the Australian context, this lack in confidence of junior doctors can be inferred from a study from Melbourne (Conn, Dodds et al. 2003). This study was designed to trial an educational intervention that attempted to impart practical ward-based skills that were deemed necessary for junior doctors to effectively manage diabetes among insulin treated inpatients. The study involved 15 junior doctors who took part in a simulated diabetes scenario workshop that addressed practical skills required to manage diabetes in insulin-treated patients admitted to hospital. Participants were administered a questionnaire on three occasions; one prior to the educational workshop, one immediately after the workshop, and a last one, three months after the workshop. On all of these occasions junior doctors were asked to rate their confidence in overall management of diabetics, as well as for specific tasks including peak time of insulin action, glycemic control, sliding scale insulin and management of severe hypoglycemia, using a 5-point Likert scale (0-4, 0=not confident at all, and 4=very confident). It was found that the pretest level of overall confidence measured in at an average of 13.2 from a total of 20 points (Conn, Dodds et al. 2003). Confidence was even lower in the domain of instituting therapies for glycaemic control (Conn, Dodds et al. 2003).

More recently, the Inpatient Diabetes and Glucose Optimization study (InDiGO) (Bui, Barrie et al. 2016, Bui, Barrie et al. 2016) looked at another aspect of junior doctor management of diabetes among inpatients – referral to appropriate services and their confidence level in identifying patients needing specialist services. Twenty junior doctors were surveyed, and they found that 75% did not use any criteria for deciding which patients with diabetes would require referral to the endocrinology service (Bui, Barrie et al. 2016). Further, 50% of junior doctors rated their level of confidence as three out of five in knowing which patients require referral (Bui, Barrie et al. 2016). This led to an observed 64% of inpatients with diabetes being referred late in the final third of their inpatient admission.

The overwhelming evidence in the literature points to a lack of confidence among junior doctors in managing inpatient diabetes. This leads to the question of what challenges were

faced by junior doctors which impacted on their confidence, and consequently on their ability to handle diabetes management in hospitalised patients.

2.2 Theme 2: Challenges faced by junior doctors in managing diabetes in inpatients

There are multiple factors that impact the ability of junior doctors in managing diabetes effectively. These include lack of knowledge in diabetes management (Cook, Jameson et al. 2008), and challenges of transitioning from being a medical student to a medical practitioner (Brennan, Corrigan et al. 2010).

2.2.1 Gaps in knowledge

One of the key challenges faced by junior doctors is the lack of knowledge of principles that underpin diabetes management in hospitalised patients. This leads to a state of diabetes care in hospitals that has been termed as one of "glycemic chaos" (Cook, Zimmerman et al. 2008). This is due to a combination of factors that include heterogeneity of the population of inpatients and their presentations, including pre-existing diabetes, previously undiagnosed diabetes, and hyperglycemia due to acute illness. Variable timing of procedures and changing forms of nutritional support add to the complexity. In this setting the inability of junior doctors to institute insulin therapy and initiate appropriate measures for glycemic control is significantly impacted by their lack of knowledge of diabetes related issues.

In the study from the Mayo clinic in Arizona, USA (also cited in 2.1 above), it was found that junior doctors and mid-level providers felt that the most common barrier to successful management of diabetes in hospital was "knowing what insulin type or regimen works best" (58% of respondents) (Cook, Jameson et al. 2008 p120). The second major concern was that of the "risk of causing patient hypoglycemia" (38% of respondents) due to use of inappropriate doses or regimens- stemming from a lack of knowledge of these (Cook, Jameson et al. 2008 p120). This lack of knowledge of insulin types and regimens was also evident in a study from the UK (Harding, Britten et al. 2010) where it was demonstrated that approximately two-thirds of the FY1 doctors were prescribing inappropriately due to inadequate knowledge. Insulin selection for diabetes management was among the various prescribing skills tested. Prescribing consists of two related areas; 1) basic pharmacological knowledge of mechanisms of action and indications for medications, and 2) the actual mechanics of prescribing. Both these areas were tested by using two different question formats: extended matching questions (EMQ) assessing knowledge recall, and written

unobserved structured clinical examination (WUSCE) looking at application of knowledge and prescribing skills. EMQs are designed to test a theme. It includes an "extended" list of options relevant to the chosen theme and a lead in statement that outlines the question. This type of questioning is designed to reduce the effect of guessing or cueing. The EMQ is discussed in more detail in Chapter 5. Of the 128 junior doctors completing the assessments, approximately two-thirds of them were prescribing and applying knowledge inappropriately (Harding, Britten et al. 2010). There were 'suboptimal' errors in process tasks such as poor charting of prescriptions including not completing patient details, failing to complete all sections of a drug chart, or selecting a poorer choice of drug for the relevant scenario. Twenty percent of the scripts were deemed to have 'dangerous' or 'lethal' errors due to lack of appropriate reaction to an investigation or not treating the significant part of a medical problem, or errors in making unsafe medication choices (Harding, Britten et al. 2010). This is especially concerning as previous research has shown that newly qualified doctors take sole responsibility for around 20–35% of the prescriptions that they chart (Pearson, Rolfe et al. 2002). Not only did junior doctors lack confidence, many also really did not know enough to prescribe safely and if they did know, they did not translate this to practice. This underlines the need for better education of this group.

2.2.2 The challenge of transition and what can be done about it

The transition period from a university student to a practising medical clinician is fraught with the stress of multiple challenges, one of which is the ability to transfer theoretical knowledge into practical skills, including clinical reasoning (Hyppola, Kumpusalo et al. 1996). Reports, including the 'Tomorrow's Doctors' undergraduate curriculum change (Warlow 2009) and 'Modernising Medical Careers' (Delamothe 2008) led to the implementation of the Foundation Programme in the UK. This requires medical graduates to have two years of supervised curriculum based practice prior to applying for entry into vocational training. This was implemented to bridge the gap between university education and vocational training in a specialty or general practice. These changes were set in place to ensure that medical graduates are fit for workplace practice in a changed health service environment with added emphasis on communication skills and maintenance of good medical practice. It encompassed learning and teaching, professional behavior and ethics in addition to good clinical skill based education (Neville 2003). Significant resources were redirected to supporting these new curriculum frameworks.

In the setting of the newly implemented Foundation Programme in the UK, a qualitative study was conducted to explore the experiences of junior doctors in their first year of their medical practice. Semi-structured interviews and audio diaries were used to gather information about the transition from medical studentship (Brennan, Corrigan et al. 2010). The study found that despite increased expenditure of resources towards preparing medical students for the transition, the stress levels continued to remain high, especially in situations which involved dying patients, medical decision making and prescription of medications (Brennan, Corrigan et al. 2010). The challenge of transition from 'knowing to doing' therefore remained important.

A lot of effort has been spent on anticipating and preparing junior doctors for the transition during their undergraduate period. On the contrary, it has been argued that the emphasis of medical education would be better if shifted to the transition phase itself rather than the preparation during medical studentship, as the phase of transition to being a medical practitioner can be viewed as an opportunity to learn if scaffolded with adequate learning opportunities (Kilminster, Zukas et al. 2011). Kilminster et al (2011) questioned the 'misplaced emphasis' on medical student preparation for transition and explored the impact and consequences of changes in medical performance during transitions. They proposed that although it is possible to empower and prepare medical students to eventually handle medical practice, in reality, the situation is more complex as medical practice does not run to formal scripts, but is dynamic, depending on the situation and context in which it is done. Transitions hence function in their words as "critically intensive learning periods" (Kilminster, Zukas et al. 2011 p1014). Tapping into this concept further they suggest that enhancing the work situation by providing access to learning in the work place through regulated clinical protocols and care pathways enhances performance (Kilminster, Zukas et al. 2011). By suggesting that learning is situated in the context where it is practiced, and enhanced by this very same practice, they provide an elegant argument in favor of work place based learning.(Kilminster, Zukas et al. 2011). This, they propose, will help smooth out transitions and make this phase more productive for learning and performance and in the end for patient safety. As stated by Salisbury and Frankel (2012 p363), "Competence is not a singular concept but a point on the road to professional expertise". Transitions are milestones on this road, which help define new proficiencies, and skills acquired and new responsibilities. Structured workplace based learning can be instrumental in helping junior doctors handle

their transition from medical studentship to experienced medical practitioners, provided the right setting to learn and consolidate their skills, knowledge and attitudes exists.

2.3 Theme 3: Experience of other systems

The lack of confidence, knowledge and skills among junior doctors in managing diabetes has prompted various efforts in health systems all around the world to bridge the gaps (Kirkman, Sevdalis et al. 2015). Successful interventions have included multi-modal, online and face-to-face teaching interventions. This section will explore some of these attempts made in health systems similar to Australia, to understand which initiatives worked and why.

2.3.1 Multi-modal interventions

The review identified one multi-modal intervention, based in the USA that had many synergies with the aims of this project. Despite traditional lectures on diabetes management delivered by faculty members there was a persistence of resident errors in inpatient management. This prompted the development of a learner-centered diabetes curriculum, as part of an educational initiative run at the Children's National Medical Center, Washington (Desalvo, Greenberg et al. 2012). This was designed to actively involve residents in their learning rather than relying on the passive learning in traditional lectures. It was delivered over an eight-week period and consisted of four modules. Module 1 - "Principles of Diabetes Management," was delivered as an online tutorial to enhance knowledge of baseline diabetes management. Module 2 - "Diabetes Pathway and Pitfalls" was an interactive open forum discussion on the diabetes pathways implemented in the hospital. Module 3 - "Diabetes Potpourri," was a learner-initiated diabetes question and answer session, about all inpatient diabetes-related topics, and Module 4 - "Diabetes Case Presentation" featured embedded subtle errors for residents working in teams to recognise, resolve, and prevent poor outcomes (Desalvo, Greenberg et al. 2012). The outcome of the intervention was measured by analysing and comparing the incidence of reported medical errors in the nine months before the intervention with those in the following ten months. Errors were identified through an incident reporting system and were classified into five pathway-error categories; relating to insulin, communication, intravenous fluids, nutrition, and discharge delay. A statistically significant reduction in errors was observed associated with the introduction of the educational intervention (Desalvo, Greenberg et al. 2012). For three of the five categories of pathway-errors, there was a decrease in total number of resident errors (Desalvo, Greenberg

et al. 2012). The overall approach was highly successful and this makes it attractive for adaptation to local needs.

2.3.2 Online interventions

There is an overabundance of literature on online computer based teaching in the field of inpatient diabetes management. A few of the more robust interventions are presented here. A study published in 2009 from Mayo Clinic described a computer-based training curriculum on inpatient diabetes management that was developed and implemented for use by junior doctors (Cook, Wilson et al. 2009). The curriculum had first been delivered as a series of lectures, and then modified into an online training program available on the institution's intranet. It focused on seven pre-stated areas of inpatient diabetes management categorised as modules. These included 1) importance of inpatient glucose control, 2) institution-specific data, 3) triaging and initial admission actions for diabetes or hyperglycemia, 4) overview of pharmacologic management, 5) insulin-dosing calculations and ordering simulations, 6) review of existing policies and procedures, and 7) discharge planning (Cook, Wilson et al. 2009). While this intervention did not investigate whether knowledge was successfully applied in real-world hospital settings, it was remarkably successful in addressing perceived transfer of knowledge with most (≥90%) junior doctors agreeing that the information in each module was valuable to their inpatient practice (Cook, Wilson et al. 2009).

An online educational intervention can be economical from the perspective of time and financial expenses, and convenient for the faculty delivering the intervention and the junior doctors accessing the intervention. Transfer of factual knowledge can also be effectively done through an online medium. This point is reinforced by analysing a study from New York where 108 junior doctors at Mount Sinai Hospital undertook a curriculum with 10 case studies that illustrated management of inpatient dysglycemia (Tamler, Green et al. 2011). They were split into two groups, one of which was assigned to two 90-minute small-group classroom sessions, and the other group undertook online training of similar duration with flexible timing. Further, a 45-min online refresher course with seven short modules for all participants was subsequently provided. Participants received a financial incentive of $600 for completing the entire program. The intervention was successful in achieving its stated primary aim of reducing median blood glucose levels within the hospital after the intervention was delivered (Tamler, Green et al. 2011). Further, it was observed that online-trained junior doctors outscored their classroom-educated peers in knowledge tests (Tamler,

Green et al. 2011). However, it was also observed that there was an increased prevalence and worse documentation of hypoglycemia as well as wide blood glucose fluctuations. This was felt to be due to the overemphasis of the training on tight glycaemia with the lack of clinical judgement to temper decision-making, although the study did not explore difference in behavior between the two cohorts (Tamler, Green et al. 2011). With online interventions there does exist a risk of lack of interaction during knowledge transfer, negating the potential beneficial effects of discussion (Kemp and Grieve 2014). Face-to-face interactions generate discussions that are rich in clinical storytelling, and aid in understanding of nuances of clinical reasoning, which can be lost in an online digital interface (Kemp and Grieve 2014). While this can occur with any kind of intervention, the danger of this occurring was more with the online computer based training (Tamler, Green et al. 2011).

2.3.3 Face to face interventions

Face to face interventions are also widely described in literature. This section therefore, focuses on two relevant interventions, which have informed this project. In one study done in the UK, an interactive, case-based, educational program for junior doctors was designed using principles of situated learning theory (Taylor, Morris et al. 2012). This was delivered over an hour and covered multiple areas of inpatient diabetes care with a predominant focus on expounding insulin types, titration and the avoidance of prescription errors. The five key areas covered by the programme were: insulin dose adjustment, insulin infusions, avoidance of insulin errors, treatment of severe hypoglycaemia and the appropriate identification of patients to be referred to the diabetes team (Taylor, Morris et al. 2012). The programme was designed around a real case involving an acutely unwell patient with sepsis and hyperglycaemia. It incorporated common clinical scenarios that junior doctors would face when managing inpatients with diabetes. Members of the hospital diabetes team including two consultants, two registrars and a specialist nurse delivered the programme across four centres. The target group included 264 junior doctors within four years of graduation. The study was designed using an iterative action research methodology to fine-tune the design and content. Statistically significant increase in junior doctor confidence level was seen in all five of the prespecified key areas (Taylor, Morris et al. 2012). More importantly, quality of diabetes care of patients was also measured, and showed a significant reduction in insulin prescription errors by 49% following the intervention (Taylor, Morris et al. 2012). There was no statistically significant impact on the quality of patient care in other areas.

Closer to home, in a study done in Melbourne, a short education programme was designed to improve the skills and confidence of junior doctors in managing inpatients with diabetes mellitus (Conn, Dodds et al. 2003). Fifteen junior doctors participated in two workshops of one-hour duration each, on the practical skills required to manage the blood sugar levels of insulin-treated inpatients. The workshops included simulated case scenarios that were presented in a workbook format. Performance in clinical problem solving as well as confidence levels were tested pre- and post-workshops, and three months after completion of all workshops. The performance tasks involved insulin profile, simple dose adjustment, management of hypoglycaemia, complex dose adjustment and sliding scale. The questions assessing confidence included managing patients with diabetes, peak time of action, glycaemic control, sliding scale and management of severe hypoglycaemia A significant gain in overall performance and confidence levels was found after the intervention (Conn, Dodds et al. 2003). This study did not explore real life clinical impact of the educational intervention, but successfully demonstrated the lack of confidence and performance skills in junior doctors' pre-workshop, which was subsequently enhanced by a brief but targeted intervention.

2.4 Conclusion

When considering junior doctor management of diabetes among inpatients, the overarching theme in the literature was one of lack of confidence, as well as poor performance of inadequately trained junior doctors. As a consequence, and considering the significance of diabetes management in acutely unwell hospitalised patients, there have been multiple interventions trialed to bridge the evident gaps. This chapter has explored the published peer-reviewed literature to understand challenges faced by junior doctors in managing diabetes among inpatients, which has included gaps in knowledge and inability to convert theoretical knowledge into practical skills. On exploring the experience of other systems in dealing with these issues it is evident that there is no absolute ideal way to address the lack of knowledge and confidence of junior doctors. The contexts in which they learn and practise are variable, and so is the dynamic state of patient presentations and local guidelines to manage these. The emphasis of this project was therefore on identifying the context specific learning needs of junior doctors working within the SALHN, and to work out the best way to support and prepare them to practice and learn safely through a customised educational intervention. In this process, the project also endeavored to explore principles, which could help in generalising the outcomes to education related to other chronic health issues impacting hospitalisations. Chapter 3 will explore the methodology adopted in this project.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research approach used in this project and the rationale for the choice of research methodology, as well as the ethical considerations relating to the project. The overall aim of this project was to improve inpatient management of diabetes by junior doctors. The objectives were to identify the learning needs of junior doctors in the context of management of diabetes in hospitalised patients and to address the learning needs through a customised educational intervention in a non-clinical but practical simulated setting. As presented in Chapter 1, the research questions were: 1) what are the learning needs of junior doctors with regards to diabetes related confidence, knowledge and skills for managing hospitalised patients with diabetes? And 2) what are effective means to deliver an educational intervention to address these learning needs? To achieve the aim and objectives a three-phase educational design research approach was used. The subsequent chapters will describe each phase of the project, as well as specific details of target population, tools for data collection, tools for assessment of outcomes and evaluation of the project. The setting of this project was the three major public hospitals in the SALHN (Flinders Medical Centre - FMC, Noarlunga Health Service - NHS, and Repatriation General Hospital - RGH), targeting the prevocational junior doctors working within these hospitals.

3.2 RESEARCH DESIGN

The research design for any project is the basic framework that specifies the procedures involved in the research process. Research processes usually involve six sequential steps as summarised by Creswell: 1) identifying a research problem, 2) reviewing the relevant literature, 3) specifying a purpose for research, 4) collecting data, 5) analysing and interpreting the data, and 6) reporting and evaluating the research (Creswell 2014 p8).

In addition, specific to the context of educational research, the research process involves designing the research to flow through one of three major pathways - namely quantitative research, qualitative research or mixed methods research (Creswell 2014 p12). The choice of pathway depends on the nature of the research problem and the research question that is to be answered by the process. Review of literature helps in fine-tuning this process further.

A research design is therefore the framework that incorporates all aspects and procedures involved in the research process, such as methods of data collection, analysis of data, and processes of reporting such as writing, publishing and oral presentations.

3.2.1 TYPES OF RESEARCH DESIGNS

Creswell (2014 p20) describes ***eight*** different research designs that are used by educational researchers. Three of these research designs are grouped under ***quantitative design method***. These include: 1) Experimental design_- where the researcher determines whether an intervention makes a difference in results for participants; 2) Correlational design - where the researcher measures the degree of association between two or more variables using statistical methods of analysis, and 3) Survey design_- where the researcher ascertains trends in a large population of individuals by administering a survey or questionnaire to a small sample group from the population. He next describes three types of research designs that he groups under the category of ***qualitative design,*** including 4) Grounded theory design – a systematic, qualitative procedure used by researchers that is grounded in the views of participants (called grounded theory) that seeks to explain processes or interactions among people and construct predictions about the experiences of individuals; 5) Ethnographic design_- procedures used by researchers for describing, analysing, and interpreting shared patterns of behavior or beliefs of a group and 6) Narrative research design - qualitative procedures used by researchers to describe the lives of individuals as a narrative about their experiences. Finally, two types of research designs are grouped under the ***combined research method***. These are: 7) Mixed methods design wherein the researcher collects both quantitative and qualitative data to provide a better understanding of the research problem than can be achieved by either quantitative or qualitative data by itself; and 8) Action research design- wherein the researcher uses both quantitative and qualitative data in systematic processes to gain data and to address improvements in the educational setting.

To address the key issues in our study- namely, junior doctors' learning needs in diabetes management among hospitalised patients and to design an educational intervention to address these learning needs, a ***combined research design*** was deemed most suitable. This choice was made to gain a better comprehension of the research problem and to develop a more in-depth understanding of the learning needs of the junior doctors and the outcomes of the educational intervention. As stated by Johnson and Onwuegbuzie (2004 p21), the mixed method of research is useful to answer a wider spectrum of research questions and affording

the benefit of using multiple synergistic approaches that contributed to stronger evidence for conclusions. More specifically however, this project was suited to the ***action research design,*** which is similar to mixed methods research in the format of data collection, but differs in that action research has a more applied focus. Action research refers to integration of action (implementing educational interventions) with research (assessing what interventions are best suited and how well were they implemented) (Creswell 2014). It is an applied, practical form of research design, that enables educational researchers to explore a practical problem through adopting a systematic procedure, with the pre-stated aim of developing solutions to the problem. Although it has been used widely to address educational issues within varying teaching environments it has been held to account for the lack of rigor and scientific approach (Creswell 2014).

3.2.2 EDUCATIONAL DESIGN BASED RESEARCH

While the research designs described by Creswell encompass the majority of research effort in the educational context, more recent literature has described a new form of research design termed 'educational design-based research', also referred to as just 'educational design research' or 'design-based research' (van den Akker, Bannan et al. 2010). At its core, educational design based research incorporates several key ideas from practical action research but differs in some critical aspects. While it is seeks to identify specific educational issues and find solutions, similar to action research, it extends to inform further scientific understanding within the theoretical framework of educational research. It aims to do this by incorporating a reflection on underpinning design principles (Reeves, McKenney et al. 2011). Research using this approach in health professional education research is becoming popular, with increasing published outcomes. In a study from the University of Notre Dame, Australia, educational design-based research methodology was used to explore the problem of a lack of clinician involvement, and poor uptake, of an educational professional development course designed to enhance the teaching skills of hospital based clinician-teachers involved in work-place based teaching (Steketee and Bate 2013). This led to the development of a hybrid mobile-web based learning solution to address the barriers, which prevented clinicians from accessing the course. The educational design-based research methodology provided a means by which there was concurrent development of design, research and practice, without losing focus on the issue at hand. Educational design based research was envisaged as an appropriate framework for design of this study to address the issue of junior doctor education for optimal management of inpatients with diabetes.

Educational design-based research attempts to find solutions to complex problems within educational contexts through the medium of research within that very context. The steps of educational design-based research are shown in Figure 4. It is proposed as a systematic study of designing and developing educational interventions to address specific educational problems and evaluate their outcomes in efficiently providing solutions to these problems (Reeves, McKenney et al. 2011). However, in contrast to action research, it also incorporates further insight into knowledge about the characteristics of successful interventions and the process involved in designing and developing them. In doing so, educational design-based research goes further than just finding solutions to educational problems and aims at generating generalisable design principles, with an emphasis on sharing and disseminating or publishing the principles derived. It has a focus to increase the relevance of research for educational policy and practice (van den Akker, Bannan et al. 2010).

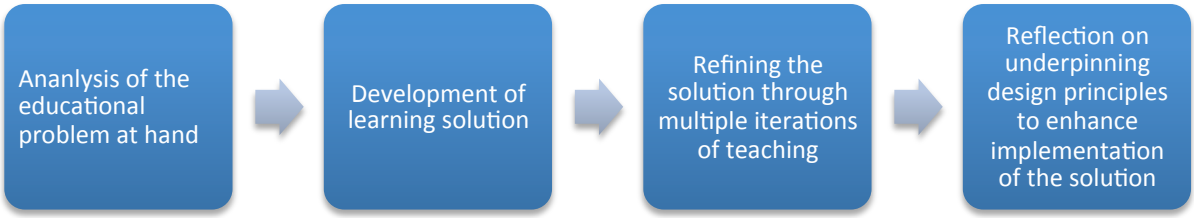


Figure 4 Educational design based research approach - adapted from (Herrington, McKenney et al. 2007)

3.2.3 Rationale for choice of research methodology

As a specific genre of research, educational design-based research is gaining wide credence among health professionals involved in teaching in the workplace (Shattuck 2012). Educational endeavors in the medical workplace are predominantly focused on achieving pre-defined set targets, which are identified as essential or critical. Much of this endeavor is spent in designing educational processes, which are conventionally considered to be a quick fix solution to the immediate problem at hand. Further, a simplistic view of the issue tends to look at a problem as it is perceived by the person designing the delivery rather than the end-user, 'the learner' (Holley and Oliver 2009). To add to this, time pressures of both the learners and the educators could potentially impact on the resources spent on designing and

delivering the intervention. And to top it all, evaluation of such interventions could tend to be cursory and not valuable in informing the further development of the process. This unfortunately leads to few worthwhile outcomes and repetition of education of potentially limited value. As described by Reeves this leads to "a legacy of ill-conceived and poorly conducted research that results in no significant differences or, at best, in modest effect sizes" (cited by Van den Akker, Gravemeijer et al. 2006 p94). It is critical to understand the scientific underpinnings of a process to refine the intervention. An educational design-based research approach, aims to develop a body of design principles to guide future development efforts while working through solving teaching/learning, and performance problems (van den Akker, Bannan et al. 2010).This has the benefit of streamlining the process during each iteration and provides for a structure to help with generalising the intervention, and increasing its adaptability. This adaptability is crucial in the medical workplace where educators are faced with teaching and training junior doctors who move between postings in short time frames ranging from weeks to months. Educational design-based research has been used in the context of workplace based learning to create effective solutions to educational problems and generate sound design principles. In a study undertaken using an educational design based approach in the UK, an initial framework on scaling informal learning was used to analyse workplace based challenges and opportunities for learning (Ley, Cook et al. 2014). In the healthcare sector, this was undertaken at three general practitioner (GP) practices in Yorkshire in the UK. The process included in-depth contextual inquiry of staff, observations, interviews and focus group discussions. This produced a wide range of data pertaining to working and learning practices as well as information on enhancers and barriers to workplace based learning such as the limited opportunities to take time away from clinical work to attend networking or cross organizational training. This was then used to refine resources available and implement beneficial change. In the example cited earlier from the University of Notre Dame, workplace based teaching was addressed successfully through an educational design-based approach (Steketee and Bate 2013). As such, educational design-based research was found to be a widely adaptable model offering a structured framework to explore complex workplace based educational research problems in a systematic manner and was considered well suited for this project.

This project was designed along the principles of educational design-based research with the emphasis on exploring local need and focusing on junior doctor learning, with a plan to implement an educational intervention while researching its delivery and impact. It was

intended to be executed as a practical multi-phase project mixing both qualitative and quantitative data, collected concurrently and given equal emphasis, integrating outcomes from both strands at the end of every phase. The specific data collection tools selected to address each question in line with the educational design-based research approach as well as the sampling methods used will be detailed in the Chapters 4 and 5, that describe each phase in detail.

The overall project included three phases, which are depicted in Figure 5. The first phase of the project was designed to assess the educational needs of the junior doctors involved in caring for inpatients with diabetes. The second phase of the project encompassed the design stage for developing an educational intervention in response to the learning needs identified in the first phase. It also included the process of designing a tool for assessment. The third phase of the project was designed to implement the educational intervention and assess the overall outcomes.

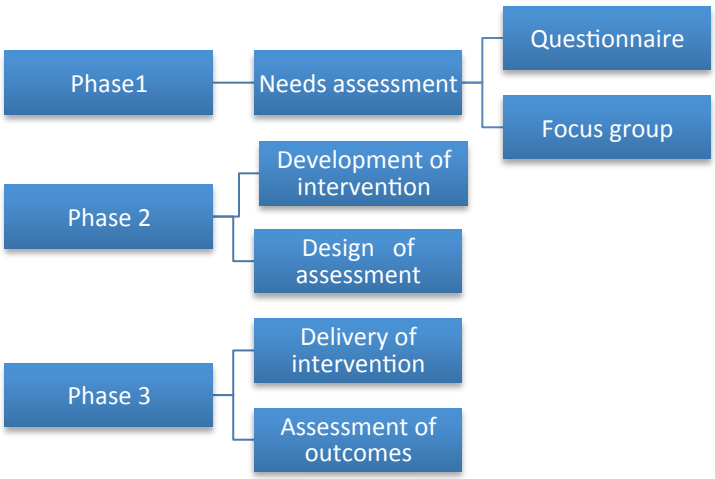


Figure 5 Phases of the study

3.3 Study Site

This project was run within the hospitals of the SALHN. Within the context of health delivery in South Australia, 'Local Health Networks' (LHNs) manage the delivery of public hospital services and other community based health services, as determined by the State Government. LHNs have a geographical or functional connection and comprise small groups of public hospitals or an individual hospital. LHNs have been established across Australia to improve delivery, coordination and access to health services in a way that is attuned to local need (Australian Institute of Health and Welfare 2014). There are 136 LHNs in Australia, 123

which are geographically based, and 13, which are state or territory-wide networks that provide specialised hospital services. Within South Australia, there are five LHNs; 1) Central Adelaide Local Health Network, 2) Northern Adelaide Local Health Network, 3) Southern Adelaide Local Health Network, 4) Women's and Children's Health Network, and 5) Country Health SA Local Health Network (SA Health 2016). SALHN includes Flinders Medical Centre (FMC), Repatriation General Hospital (RGH) and Noarlunga Hospital (NH). Other services provided by SALHN include Southern Mental Health inpatient services, Intermediate Care Services provided at the GP Plus Super Clinic at Noarlunga and the GP Plus Health Care Centres at Marion and Aldinga/Seaford, in addition to Aboriginal health services and Aboriginal family clinics, health services in people's homes and the Aged Care Assessment Team (ACAT). Prevocational junior doctors working in the SALHN rotate through postings within all the three hospitals of the network and through the other linked services.

3.3.1 The Hospitals

The hospitals of the SALHN provide care for 350,000 people living in the southern metropolitan area of Adelaide, service those in regional areas, and employ more than 7,000 skilled staff to provide patient care, education and research. At the time of writing this thesis, the hospitals were undergoing a process of redefinition of services through the "Transforming Health" program run by the State Government of South Australia (SA Health 2016). Interns working within the hospitals of the SALHN receive a robust, engaging and well-supported internship experience, which incorporates an integrated workplace based teaching program, and opportunities to expand on their work experience.

Flinders Medical Centre

Flinders Medical Centre is the major hospital of this network. It is a 566-bed public teaching hospital co-located with the 130-bed Flinders Private Hospital and the Flinders University School of Medicine. It provides an extensive range of services for patients of all ages and is one of two major trauma centres in the state, which provides multiple emergency services around the clock. The emergency retrieval service brings patients to FMC by road or helicopter to the emergency department. The hospital offers a range of medical and surgical services, which includes 24-hour on-call service for acute coronary syndrome, on-site stroke service for thrombolysis, elective multi-day surgery, complex surgery and trauma surgery. Other services include level three neonatal nursery, cardiac care unit, intensive and critical

care unit, mental health services, rehabilitation and palliative care, paediatric care, and obstetrics and gynaecology services. Flinders Medical Centre is also the base for the South Australian Eye Bank and the South Australian and Northern Territory Liver Transplant Unit.

NOARLUNGA HOSPITAL

Noarlunga hospital is a 100-bed multispecialty hospital located further south, in the outer southern metropolitan area of Adelaide and provides services to a population of 170,000 people. It is also co-located with the Noarlunga Private Hospital and provides medical, surgical and mental health care. Services provided at Noarlunga hospital include a 24-hour emergency department, inpatient mental health services and dialysis.

REPATRIATION GENERAL HOSPITAL

Repatriation General Hospital, at the time of writing this thesis, is a 260-bed public hospital located in the southern metropolitan region of Adelaide. It is due to undergo multiple changes as part of the state government run "Transforming Health' program. At the time of the delivery of the educational intervention, this hospital was an acute care hospital with emergency services running for a major part of the day, 24-hour intensive care services, inpatient medical services in various specialties including cardiology, respiratory medicine, general medicine and geriatrics, and elective surgical services including urology and orthopedics.

3.4 STUDY CONTEXT

After completion of the undergraduate medical course, students complete a year as a paid hospital intern before qualifying for full registration in Australia (South Australian Medical Education and Training 2016). After receiving full registration, interns (Post graduate year 1-PGY1) move on to become resident medical officers (PGY2 and further) (South Australian Medical Education and Training). General trainees are resident medical officers (RMOs) who are not in any accredited training program and work within a wide range of clinical postings. Basic trainees are RMOs who are in an accredited training program such as physician training, surgical training etc. Junior doctors (PGY1 and PGY2s) working within the SALHN are posted in different departments across the three hospitals in the network. Interns (PGY1) rotate through these postings every 10 weeks while resident medical officers (PGY2) rotate every 13 weeks. Through the course of the year each junior doctor would have had the opportunity to work in each of the three sites through various postings.

3.5 Ethical considerations

The research project was submitted to the Southern Adelaide Clinical Human Research Ethics Committee (SAC HREC) for ethics approval as it involved junior doctors and faculty employed across the SALHN. Final ethics approval was received in May 2012 (Ethics approval number - 216.12). A subsequent amendment was approved in May 2012. The study was considered to be of low to negligible risk to the participants.

3.5.1 Participant information

Contact with potential participants was made by a letter of invitation sent by e-mail through the Trainee Medical Officer unit group e-mail system or through e-mails sent through the global health network of SALHN. Participation in each phase of the study was entirely voluntary, and each participant was provided a detailed participant information sheet outlining the steps of the proposed study and explaining the implied consent on accepting the invitation to participate. If participants had any further queries, the contact details of the researcher, study supervisors and the Flinders University ethics committee were provided, for any clarification.

3.5.2 Confidentiality and anonymity

The contact with participants was during the first and last phase of the study. During both of these phases, participant details were de-identified from all data prior to analysis. Paper copies of responses did not contain any identifiable data except broad demographic details used for sorting responses. Digital responses were accessed by the researcher using a password protected secure access. In producing this thesis, all data is presented as a collective set and no individual identified. Whilst quotes from individuals are presented, only the role that person played such as junior doctor or faculty will be reported to ensure participant anonymity.

3.6 Conclusion

This chapter has explored various research designs and introduced educational design-based research on which the current study is based. It explained the rationale for choosing an educational design-based research approach while also introducing the three phases of the study. The next chapter will describe the first phase of the study – the needs analysis, and will explain in detail the research methods used and outcomes in this phase.

CHAPTER 4: PHASE 1 – ASSESSMENT OF NEED

4.1 INTRODUCTION

The first phase of this project aimed to assess educational needs of the junior doctors who were involved in caring for patients with diabetes admitted to hospital. The focus was on educational needs specific to diabetes related issues. This was undertaken by exploring two perspectives, that of the junior doctors, and also of the faculty, who were directly involved in the clinical management of diabetic patients as well as in supervising the junior doctors in the hospital setting. The framework suggested by Kern et al in his six-step approach to curriculum development was adopted in the design of this phase (Kern, Thomas et al. 2009 p5-9). The six steps elucidated by Kern were 1) problem identification and general needs assessment, 2) needs assessment for targeted learners, 3) setting goals and objectives, 4) educational strategies, 5) implementation and 6) evaluation and feedback. The first 2 steps were relevant to this phase of the project. Kern et al suggested that to address a health care related problem effectively and efficiently it needs to be first defined carefully by a general needs analysis and any gaps or deficiencies in skills, attitudes and knowledge need to be identified so that educational efforts can be targeted to close those gaps. However, this in itself would be inadequate as it may or may not apply to the specific group of learners targeted by the researcher, which in this study were the junior doctors managing inpatients with diabetes. This then leads to the second step-targeted needs assessment, which is a process by which knowledge gained from the first step of general needs assessment is applied to the specific target group and their specific learning environment. This second step serves the purpose of framing the problem in its context and allowing stakeholders to be involved in finding solutions. It prevents duplication of effort, such as doing what has already been done or teaching what is already known. This occurs in 2 levels: 1) that of the target group of learners in relation to their inherent knowledge and skills and 2) that of the targeted learning environment with regards to what is available currently and what needs to be added or reinforced and exploring characteristics of the learning environment that influence how learning occurs(Kern, Thomas et al. 2009). In this project these two steps were incorporated in the first phase with the aim to identify specific learning needs of the junior doctors (target group) working within the hospitals of Southern Adelaide Local Health Network (SALHN) (target learning environment). This chapter will detail the methods, approach and findings of the first phase of this project.

4.2 AIMS

The primary purpose of this phase was to identify the educational needs of junior doctors in the domain of knowledge and practical skills related to the management of diabetes among inpatients. The secondary purposes of this phase were 1) to explore the optimal methods of education delivery, and 2) to explore how junior doctors perceived their needs, and whether and how this differed or concurred with the view held by faculty. The purpose of including the faculty in the needs analysis process was to account for the expectations that the health service would have from the junior doctor.

4.3 STUDY POPULATION AND SAMPLING

A purposive sampling technique was used to identify relevant participants to contribute to the needs assessment process (Table 2). The study required a mix of junior doctors, and key faculty members who either provide specialist care for hospitalised patients with diabetes or oversee the practice of the junior doctors. Purposive sampling (Morgan, Schreiber et al. 2008) refers to a well recognised form of non-probability sampling used in qualitative or mixed method research where participants are chosen expressly for the purpose of informing the process, due to their involvement with the various aspects of the stated primary aim (Morgan, Schreiber et al. 2008). In contrast to nonprobability sampling, probability sampling has a focus on selecting a representative group where each participant has the same chance of being selected (eliminating bias) and where the central tendency or median probability of outcomes is sought in an effort to extrapolate to a related population (enabling generalisation or transferability) (Morgan, Schreiber et al. 2008). However, in non-probability sampling, a form of purposive sampling, participants are chosen because they meet pre-established criteria set to answer the research query. For this study, participants were required who could provide relevant information on the three aspects under study: 1) the learning needs of junior doctors in acute diabetes related care, 2) the preferred methods of delivery of education, and 3) the level of alignment between the perceptions of junior doctors and faculty.

Purposive sampling includes a variety of sampling strategies such as typical case sampling, homogenous sampling, stakeholder/expert sampling and extreme variant case sampling (Patton 1990, Morgan, Schreiber et al. 2008). For this project, two variant forms were used for selecting junior doctors and faculty, homogenous and stakeholder/expert sampling respectively.

Homogenous sampling is a form of purposive sampling which targets a homogenous cohort with similar characteristics or traits relevant to the study (Patton 1990). In this instance, the cohort was that of prevocational junior doctors in the early stages of their career, working within the hospitals of the SALHN. This form of sampling was chosen as the respondents were at the same level of training and medical experience, and the needs assessed would be specific to this particular cohort. There were 150 junior doctors employed at either the PGY1 or PGY2 level across the three hospitals of SALHN. All of these junior doctors were invited to participate in the needs analysis.

Stakeholder/expert sampling (Patton 1990) is a form of purposive sampling that includes identifying the major stakeholders involved in administering and overseeing a process, which in this project was the clinical care of diabetic issues among inpatients. This form of sampling was used to select the faculty involved in overseeing junior doctors caring for hospitalised patients with diabetic issues. This method of sampling was chosen to obtain perspectives from key stakeholders and experts in the field of diabetes management in the hospital. A multi-disciplinary team of health professionals including doctors, diabetes nurse educators and pharmacists often provides care for inpatients with diabetes. Therefore, faculty participants were drawn from the Southern Adelaide Diabetes and Endocrine Services and the Department of General Medicine. The selected individuals represented a broad range of expertise and included: 1) Endocrinologists and General Physicians involved in treating patients with diabetes within the hospital, as well as in the overall supervision of junior doctors involved in the management of diabetes in inpatients; 2) Advanced trainee registrars involved in medical management of diabetes in the hospital and supervising the junior doctors in day-to-day management of medical issues; and 3) Allied health staff including Diabetes Nurse Educators and Diabetes Pharmacists involved in delivering care in the hospitals. All faculty members chosen were employed through the SALHN and had direct supervisory and/or education relationships with the junior doctors. At the time when the project was conceptualised, the Southern Adelaide Diabetes and Endocrine Services within the SALHN comprised of five staff specialist Endocrinologists working in varying full time equivalent capacities across the three major hospitals in the network. In addition, there were three advanced trainee registrars, three full-time and two part-time diabetes nurse educators and a specialist pharmacist with interest in diabetes, who were all invited to participate.

Table 2- Sampling methods

Population	Sampling method	
Junior doctors	Purposive sampling	Homogenous sampling
Faculty		Stakeholder/expert sampling

4.4 DATA COLLECTION METHODS:

A mixed qualitative and quantitative format of research was employed to collect data for this phase. A multi-pronged approach was used, involving two main tools that interacted with each other. These included: 1) a questionnaire and, 2) focus group discussions or face-to-face interviews. This approach was used to enable the consultation of a range of people in different roles, through customised formats to suit individual respondents. It was intended to bring a breadth of viewpoints to bear on the results of the needs assessment, while also allowing a deeper interrogation of the issues and was considered to be best suited to address the research questions. Qualitative data was useful in adding meaning and value to objective quantitative data while objective data added precision to the qualitative narrative (Patton 1990). Manual data coding was performed to analyse and make sense of the collected data. Data derived from questionnaires was systematically entered using Microsoft Excel and Word, and categorised with the purpose of condensing extensive datasets into smaller analyzable units. Data codes for questionnaires were finalized as the questionnaire was completed while data codes for interviews and focus group observations were developed inductively after data collection and during data analysis. Verbal data was converted into variables and categories of variables using numbers for enabling analysis.

All potential respondents were sent an introductory e-mail (Appendix A) extending an invitation to participate in focus group discussions with their peers. If they were unable to attend a scheduled focus group interview or if they preferred private participation, an individual face-to-face interview was offered. The questionnaire (Appendix B) was used both during focus group discussions and also as a standalone tool for data collection. The questionnaire responses provided both quantitative and qualitative data while the focus group discussions and interviews were used to provide a deeper qualitative perspective adding richer dialogue and exploration of contexts and themes.

4.4.1 QUESTIONNAIRE

The primary tool used for data collection was a customised questionnaire based on published examples that explored educational needs of junior doctors in managing diabetes in general, and more specifically on diabetes among hospitalised patients. The questionnaire was administered as an anonymous tool and was employed to collect information and objectively gain an understanding of the outlined areas. It formed the core of the quantitative data gathering process. The rationale behind using a questionnaire was that a wider sample could be reached, as opposed to that which would be possible with only interviews or focus groups (Patton 1990). Use of a questionnaire approach was intended to enable participation by those unable to attend in person, such as those working night shift or working offsite in peripheral postings. There was also the added benefit of completion of the survey at the respondent's convenience (Patton 1990).

Two versions of the questionnaire were used, each being tailored to the group it was being sent to – faculty and junior doctors, with questions modified to address the intended respondent. The content of the questionnaire was similar for both groups. This tool was further used to guide the focus group discussions and interviews, which enabled elaboration on the responses as well as to help trigger focused discussion (Patton 1990).

4.4.1.1 DESIGN OF THE QUESTIONNAIRE:

Experience from other centres

A literature search was conducted to explore examples of questionnaires delivered for similar purposes. One of the identified questionnaires was the Diabetes Needs Assessment Tool (DNAT), a web-based interactive tool developed by a collaboration of Endocrinologists and Educationalists in the UK (Schroter, Jenkins et al. 2009) to deliver targeted learning opportunities in diabetes education. The intended end-user was the medical professional involved in caring for diabetes patients. The aim of the DNAT was to identify individual learning needs and to indicate an appropriate learning source to meet those needs. It was used to assess learning needs in six categories specific to knowledge of diabetes, and was used as a step towards customising learning modules after identifying the common learning needs (Schroter, Jenkins et al. 2011). The six categories included in the DNAT were 1) Principles of Diabetes, 2) Lifestyle, 3) Drug Treatment, 4) Cardiovascular System/Macro-vascular complications, 5) Acute Complications and 6) Micro-vascular Complications. The tool was

used in a randomised controlled trial that tested the hypotheses that customised learning tailored to one's specific learning needs would yield better uptake. In that study, health professionals were randomised into two groups. The intervention group used the DNAT to have a customised learning module provided for study over a four-month period, while the control group were provided with access to all the diabetes learning modules over the same time frame and undertook self-directed learning. Pre- and post-intervention knowledge tests were used to assess improvement, and surveys of self-reported changes to clinical practice were done. The results of the trial showed significant gains in knowledge equally in both groups (Schroter, Jenkins et al. 2011). Although there was no significant difference in outcomes from customised learning as opposed to general access to educational resources, the trial highlighted that provision of high quality learning materials was useful, in any format, in improving the knowledge of learners (Schroter, Jenkins et al. 2011).

In exploring the possibility of adapting the DNAT tool for the purposes of this study there were a few barriers. Firstly, the tool was designed to explore learning needs in a broader context of all diabetes related knowledge and was not exclusive to the care of the hospitalised diabetic patients. Further, using the tool was a very involved process that included answering 253 questions and took 90-120 minutes over several sessions to complete (Schroter, Jenkins et al. 2011). Hence, it was considered that while this tool was impractical to adopt in its entirety, it provided a structure that would cater to the intended need of this study. The DNAT was useful in developing the questionnaire for this study as it aided in categorising the domains in inpatient management of diabetes.

Another questionnaire considered was the 'Insulin-Related Knowledge Among Health Care Professionals in Internal Medicine' questionnaire (Derr, Sivanandy et al. 2007). This was developed to evaluate health practitioners' knowledge of insulin in four teaching hospitals in Baltimore, USA. The focus was on evaluating the knowledge of new insulin formulations and inpatient diabetes management among faculty, house staff, and nurses (house staff are equivalent to junior doctors in the Australian system). It comprised 20 items and was based on a multiple-choice, single best response format. Both the content and format of this questionnaire were useful in formulating the questionnaire developed for this study. A few of the multiple-choice questions eliciting responses regarding demographics of respondents and insulin knowledge related questions were used as a model to design questions customised to

our own setting. However, as our focus was not to evaluate insulin knowledge alone, it was not adopted in its entirety.

Content of the questionnaire

The questionnaire for this study was designed to evaluate the learning needs of junior doctors and their order of priority in inpatient management of diabetes. It included a combination of closed and open questions, and used a varied layout, to avoid repetitive ticking of boxes and to encourage thoughtful reflection (Patton 1990). Responses to closed questions are easier to analyse and provide consistent response categories. However, the disadvantages of using a purely closed format of questioning would include eliciting responses where no prior knowledge or opinion exists, and therefore forcing answers as well as oversimplifying issues based on the questioner's biases. On the other hand, narrative responses to open questions provide relevant qualitative data, which help to contextualize the quantitative responses and add depth and richness to the information obtained. This aspect can potentially be lost with use of closed questions alone (Patton 1990). A good questionnaire would hence be designed to incorporate both these formats of questions (Patton 1990).

The area of inpatient management of diabetes was categorised into 10 domains, and elements of the DNAT that focused on drug treatment especially insulin treatment and acute complications were used in this process (see Figure 6).

Overview of the questionnaire
Domain 1: Newly diagnosed diabetic
Domain 2: Type 1 diabetes patients
Domain 3: Type 2 diabetes patients
Domain 4: Diabetes in special situations (e.g. pregnancy)
Domain 5: Basic knowledge/principles of diabetes
Domain 6: Insulin therapy
Domain 7: In-patient targets of diabetes management
Domain 8: Hypoglycaemia management
Domain 9: Hyperglycaemia management
Domain 10: Referral/ handover processes within the hospital

Figure 6 Overview of questionnaire domains

Within these ten domains, the issues relating to inpatient management of diabetes were broadly grouped under the following educational needs: 1) knowledge; 2) practical application of theoretical knowledge; and 3) intervention options - methods to deliver education with the highest impact. Respondents were asked to grade all domains at four pre-specified levels of priority. These levels of priority were explained and defined as follows:

Critical areas: defined as those that were imperative for the junior doctor to know to practice safely within the hospital.

Core areas: defined as those that were important for basic knowledge and management but which could be acquired gradually with experience.

Non-core areas: defined as those, which would be useful and good to know, but not absolutely needed to function safely.

Areas of specialist knowledge: defined as those that were more complex but could be acquired by self-directed learning.

The questionnaire (see Appendix B) started with a personal address to the respondent and a dot point summary of the background to this project. After providing details as to how the questionnaire should be completed, the overview of the questionnaire was provided. The introduction clearly stated that completion therewith implied consent. The introductory section sought demographics with an intent to ensure as well as to demonstrate that the right sample of participants was chosen, for whom inpatient diabetes management was relevant. The questionnaire then set out to gain a perspective of the main challenges in management of diabetes, specifically among inpatients, resources that would be of assistance to junior doctors in diabetes management, and the best way to deal with these challenges. The questionnaire then delved deeper into the individual domains in detail. These were set out in sections, which covered the pre-specified domains in inpatient diabetes management such as management of diabetes in special situations (e.g. pregnancy), in-patient targets for diabetes management, and are outlined in Figure 6.

4.4.1.2 Pilot

A pilot study is one, which is run as a trial for the express purpose of pre-testing a particular research instrument with the aim of refining it and ironing out the flaws before it is used on a larger scale in a study (van Teijlingen and Hundley 2002, Morgan, Schreiber et al. 2008). To improve the internal validity of the questionnaire tool (Peat 2002) it was administered to two faculty members of the Endocrine Department and three of the then serving junior doctors, to refine it and simplify the terms and details. Consultation with the junior doctors further helped in content validation. The questionnaire was used for the pilot in exactly the same way as it was meant to be administered in the main study. The questionnaire was designed to be accessible online and also used in hard copy. The pilot explored both formats of the questionnaire and helped in refining these. Feedback from the pilot subjects was sought to

record the time taken to complete the questionnaire and to discard or refine ambiguous questions and assess that each question provided an adequate range of responses. The data collected from the pilot studies were not included in the main results. Adjustments were made following the pilot testing process to enhance flow and clarity. Ambiguous questions were discarded and questions that went unanswered but were felt to be important to address the research question were reworded and rescaled, and piloted again. The time taken to complete the questionnaire was assessed as being 10 -15 minutes and this was used to inform respondents, to encourage response rates.

4.4.1.3 QUESTIONNAIRE DELIVERY

All potential respondents were sent an introductory letter in the internal mail and/or e-mail along with the questionnaire. The study was also presented to the interns at their weekly tutorial, and to the General Physicians and the Endocrine Department staff during their respective weekly meetings at the hospital. The questionnaires were provided in hard copy at the end of these sessions for the attendees to fill out if they accepted the invitation. Respondents were advised that if they had completed the questionnaire once they need not do it again. This was done to exclude duplication of responses, especially in the case of doctors who overlapped attending the weekly intern tutorial and General Medicine or Endocrine meetings. Junior doctors and faculty who were absent at these sessions were sent a repeat e-mail with copy of the questionnaire requesting their responses. All hard copy responses sought no identifying information and therefore were not traceable. The respondents who chose to use the digital version of the questionnaire and replied through e-mail were de-identified when the responses were collated and analysed.

4.4.1.4 QUESTIONNAIRE ANALYSIS

The responses to the questionnaires were collated from all respondents and sorted into junior doctors and faculty responses. The quantitative analysis of this data required conversion of answers into numbers. This was hence done by grouping and categorising the response variables and manually coding the data. Data coding, data checking and entry were done meticulously by the researcher. Missing data refers to sampled participants failing to provide adequate responses to one or more of the questionnaire items (items non-response) or providing a partial response to a category of questions (Brick and Kalton 1996). This was mostly dealt with by expressing the outcomes as is, without deleting the entire response of the participant or the specific category of response, and without attempting imputation (i.e.

substitution of the missing value by best guess). The rationale behind this was to attempt to gain a good understanding of junior doctor need while avoiding potential researcher bias.

Descriptive statistics refers to statistical methods that summarise information collected and deals with presentation of this information as tables or graphs to provide an overview (Shafer and Zhang 2013). On the contrary, inferential statistics refers to statistical methods that aid in making inferences from data and extrapolating findings from a sample group to a larger population. Descriptive statistical methods were used for comparison of the responses of junior doctors and faculty in this study. The outcomes from the quantitative data were grouped into clusters as follows: 1) Main challenges in management of diabetes, specifically among inpatients, 2) Educational needs pertaining to knowledge of diabetes, 3) Educational needs pertaining to practice or application of theoretical knowledge, 4) Educational intervention options- methods to deliver education with the highest impact.

4.4.2 Focus group discussions and interviews

Focus group discussions and individual interviews were used as the qualitative methods for data collection in this study. Focus group discussions are typically described as groups of between six to twelve people led by a facilitator, and brought together to explore perspectives on a given topic in a group format and in a non-threatening environment (Litosseliti 2003, Holloway 2005). Participants are generally chosen on the basis of some shared characteristics that would help them contribute to the topic at hand. The facilitator is an impartial, neutral person who moderates the interaction between the participants, using a series of predetermined and carefully planned open ended questions and topics for discussion (Holloway 2005). Focus groups usually tend to be one to two hours in duration and produce qualitative data that aid in obtaining insights into specific perceptions or attitudes of participants. They help to generate information on beliefs and feelings of participants and do not aim to reach a consensus or finalise decisions.

Individual interviews

The interview is an approach for qualitative data collection in which the researcher asks participants a series of questions (Morgan, Schreiber et al. 2008 p839). This is done as part of a dialogue, which enables the exploration of issues in depth and the meaning behind responses and is guided by a set of topics. A structured interview format was used, with questions following all aspects of the questionnaire and incorporating the 10 preset domains covering the wide-ranging aspects of inpatient diabetes management.

4.4.2.1 Design and content

A literature search was conducted to adopt best practice principles in running focus groups and interviews. There is an abundance of literature available on focus group and interview methodologies especially in the area of healthcare information. The work of Kitzinger (cited in Holloway 2005) was used as a baseline tool to guide in designing a robust process for running the focus group sessions. Further health related websites which provided elaborate detail regarding planning of these sessions were also used to design the details (Department of Health 2004, The Royal Australian College of General Practitioners 2013). The content of the focus group sessions was carefully tailored and customised to each specific group, with content adapted for junior doctors and faculty. For example, in the focus group sessions run for faculty the questions included: What are the skills that you feel a) junior doctors lack, b) want these doctors to learn, c) think they need practise in? On the other hand, the same types of questions were modified for junior doctors, such as: What are the skills that you a) feel you lack/ are least confident in, b) want to learn, c) think you need practise in. Clear aims were set prior to the running of the focus groups. The advantages of the focus group method include the ability to delve deeper into participant responses and obtain rich real-life qualitative data. However, they do not always represent the views of the entire cohort and can be very subjective in nature. This limitation can be partially overcome by conducting multiple focus groups with varying participant groups each representative of the sections of the entire cohort (Department of Health 2004, The Royal Australian College of General Practitioners 2013). Therefore, multiple focus groups were used within this project. Focus groups were conducted with different participant groups in an attempt to gather as much generalised data as possible, representing the multiple stakeholders including junior doctors and faculty involved in delivering diabetes related care within the hospitals. Interviews were offered for those individuals unable or unwilling to participate in the focus group discussion. Thus, the focus groups were designed to include participants from all groups and multiple focus group discussion were planned to be held to obtain a broad overview of opinions regarding the learning needs of junior doctors. With focus groups being the preferred method, individual interviews were offered to those individuals unable or unwilling to attend a focus group, but who wanted to discuss their ideas on junior doctor learning needs.

4.4.2.2 Delivery

The focus group discussions and interviews were conducted in partnership with the Trainee Medical Officer unit with logistic help from the Education Support Officer. The Trainee

Medical Officer Unit is a department that helps to oversee the holistic care of junior doctors working within the SALHN hospitals, addressing their educational needs. The Education Support Officer provided direct contact with junior doctors and facilitated the scheduling of the interviews, booking of venues, sending out invitations and coordinating participants' availability. Attendance at the focus groups was requested by targeted advertising through emails and flyers to the specific stakeholder groups. Attendance was entirely voluntary and no payment or enticement was involved. The sessions were run mostly by two facilitators- one who moderated the discussion (the principal researcher) and one who helped scribe the main issues (the Education Support Officer). With the group's permission, the sessions were audio recorded and later transcribed. The participants were de-identified in the transcripts. Venues were chosen in proximity to the participants' workplace, with the facilitators traveling to the site, to enable ease of attendance at the sessions. Individual copies of the study information sheet (Appendix D) explaining implied consent on participation and copies of the questionnaire were provided to participants at each focus group/interview. The sessions were run for a period of approximately one hour each. Each session commenced with introductions and with the moderator outlining the aims of the project with a short PowerPoint presentation. The introduction explained the process of the focus group/interviews, and established consent and permission to audio-record the session. After this, successive rounds of predetermined questions were used to guide the discussions. These were structured in a similar format as the questionnaire and helped to prompt individual reflection while at the same time capture the consensus. The focus groups went a step further than the questionnaire in exploring the options of educational interventions and also included assessment of the intervention in detail.

4.4.2.3 Analysis of qualitative data

Qualitative data included textual responses from the questionnaire, notes from the focus group discussions as well as transcripts from the audio-recordings. This combined data set was subjected to a content analysis. Content analysis is the process of categorising qualitative textual data into clusters of similar concepts, with the aim of identifying consistent patterns and relationships between themes expressed within those clusters (Morgan, Schreiber et al. 2008). It is a systematic way of analysing a wide range of data In this study the categories had been set apriori as part of the clusters defined in the analysis of the quantitative questionnaire data namely: 1) Main challenges in management of diabetes, specifically among inpatients, 2) Educational needs pertaining to knowledge of diabetes, 3) Educational

needs pertaining to practice or application of theoretical knowledge, 4) Educational intervention options- methods to deliver education with the highest impact. Qualitative evidence on these clusters was sought through the focus group interviews. The researcher sought evidence from participants' expressions relating to specific themes within these clusters from the content analysis of the qualitative data (Morgan, Schreiber et al. 2008).

4.5 Results of Phase 1: Learning needs analysis

This section of the chapter outlines the results from the first phase of the study exploring the educational needs of junior doctors in managing diabetes among patients admitted to hospital. The results are reported in sections that follow the preset clusters, combining the outcomes of both questionnaires, focus groups and interviews. In each section, the findings from the quantitative analysis are presented first followed by the outcomes from the qualitative analysis.

4.5.1 Results- Study Population

A total of 59 completed questionnaires was received and analysed (see Table 3). These comprised of 41 responses from junior doctors (out of the population of 150) and 18 responses from faculty (out of the invited sample of 26; which comprised 14 from the Southern Adelaide Diabetes and Endocrine Services and 12 from the Department of General Medicine). Questionnaires were completed either directly or as part of a focus groups/interview.

Table 3 Study population

Participant Category	Professional role	Number of questionnaire responses	Number attending focus groups
Junior doctors	RMO	12	23
	Intern	29	
Faculty	Nurse	2	14
	Registrar	8	
	General physician	3	
	Endocrinologist	4	
	Pharmacist	1	

A total of four focus group sessions were conducted with participants drawn from individual cohorts within SALHN. Focus group one was with three PGY1 doctors at FMC, focus group two was attended by seven PGY1 and PGY2 doctors at NHS, focus group three was with

Endocrine staff and attended by 5 faculty members and 3 junior doctors, and the last focus group was in the department of General Medicine at FMC and attended by 9 faculty members and 10 junior doctors. Junior doctors in PGY2 at FMC were also specifically invited for a focus group session but only one volunteer responded. To accommodate this single volunteer an individual interview was conducted. The content of the interview questions was the same as that which was planned for the focus group. All questionnaires were included in the analysis irrespective of whether they were partially or fully completed. Hence, it will be observed that the sum of the responses will not always add up to the total of 59.

Table 4 presents the broad demographic of the respondents. Respondents were predominantly from the main tertiary hospital (FMC), but it should be noted that the same doctors practise across all three hospitals within the SALHN. Almost 100% of the junior doctor respondents spent the majority of their time caring for inpatients, while the faculty were involved in both ambulatory outpatient based care as well as inpatient care. Junior doctors were not always involved in caring for patients admitted with diabetes as the main issue, but a significant proportion of their workload involved caring for patients who had diabetic complications, or diabetes as a co-existing issue.

Table 4 Demographics of questionnaire respondents

	Junior doctor N-41	Faculty N=18	Total N=59
Primary site of practice			
FMC	33	8	41
RGH	4	1	5
NHS	4	2	6
Proportion of time managing inpatients			
<10%	0	0	0
10-50%	1	3	4
>50%	38	5	43
Proportion of inpatients with diabetes as main issue of care			
<10%	32	3	35
10-50%	6	1	7
>50%	1	4	5
Proportion of inpatients with diabetes as co-existing issue			
<10%	9	0	9
10-50%	18	2	20
>50%	11	4	15
Proportion of inpatients with diabetic complications as main issue			
<10%	25	2	27
10-50%	9	2	11
>50%	3	4	7

As stated in the introduction to this chapter, the primary aim of the process of this needs analysis was to identify the educational needs of junior doctors in the domain of knowledge and practical skills related to the management of diabetes among inpatients. The secondary purposes were to explore the optimal methods of education delivery, and to explore how junior doctors perceived their needs, and whether and how this differed or concurred with the view held by faculty. The findings in relation to these aims will now be presented.

4.5.2 Results- Main challenges in management of diabetes, specifically among inpatients

Both junior doctors and faculty were asked what they considered to be the major challenges faced by junior doctors in managing inpatients with diabetes related issues. This was designed as a multiple-choice question with respondents being free to choose more than one area of challenge. There was also provision to provide free comments on this topic. The results are shown in Table 5 below. The majority of respondents among both junior doctors and faculty opined that the most challenging topic was that of transitions of diabetes therapy

in hospital. Transitions in diabetes therapy refer to management protocols for handling acute increases in blood sugar levels when sick patients are admitted to hospital. While this was considered to be the most challenging aspect, knowledge of types of insulin and their varying uses, and pharmacokinetic profiles were also felt to be a major challenge by a significant number of respondents.

Other interesting findings were that a number of both faculty and junior doctor respondents felt that inadequacy of time to provide comprehensive diabetic care as well as lack of easy access to guidelines and protocols were challenges impacting the ability of junior doctors to efficiently deliver safe patient care to diabetic inpatients. While these are not the targets of this study they highlight the importance of how systems need to work in conjunction with knowledge delivery methods to ensure effective practice.

Table 5 Main challenges faced by junior doctors in hospital based diabetes management

Challenges in diabetes management among inpatients	Junior Doctor		Faculty		Total	
	N=41	Percentage	N=18	Percentage	N=59	Percentage
Keeping abreast of advances in diabetes management	14	34.15	2	11.11	16	27.12
Time to provide comprehensive diabetes care	17	41.46	7	38.89	24	40.68
Lack of easy access to guidelines and protocols	14	34.14	6	33.33	20	33.9
Lack of knowledge of who to call for help	1	24.39	4	22.22	5	8.47
Variability of patient presentation and profiles	11	26.83	3	16.67	14	23.73
Insulin management- knowledge of types of insulin and their profiles	22	53.66	5	27.78	27	45.76
Transitions of care- i.e. how to start patients on insulin from oral agents, start new medications in hospital, swap back to usual medications at discharge	30	73.17	7	38.89	37	62.71

These findings were reiterated through the focus group discussions and free comments in the open text responses related to the question, which formed three themes. Examples of these are provided in Figure 7.

Themes-

Transitions of care

"Insulin management- knowledge of types of insulins and their profiles and transitions of care are very challenging"

"Main issue in vascular posting is patient compliance and transition of care"

Knowledge of types of insulin and their profiles

"the different diabetes management varies between general physicians as well as endocrinologists. This can be confusing …."

"in hospital only use novorapid and lantus. No experience in use of other insulin preparations (e.g. Mixtard)"

Lack of easy access to guidelines and protocols

"Important to have clear guidelines for fluid and insulin management of patients who are fasting and patients who are unwell (e.g. metformin)? To hold or not hold (e.g. general guidelines as well as specific)"

"recently worked in CCU. Almost all the post MI patients were referred to endocrine unit which is not necessary. Some printed protocols if made available in CCU (e.g. management of hyperglycemia in MI patients- will be useful(sic)"

Figure 7 Recurring themes in junior doctor responses

While one respondent emphasised that insulin management was a great challenge, especially knowledge of types of insulins and their profiles and transitions of care, another mentioned a similar concern with transitions of care while working in vascular surgery where most patients presented with complications related to diabetes. Further, another respondent mentioned their use of Novorapid and Lantus alone in hospital, and a lack of experience in the use of other insulin preparations such as Mixtard. Another respondent highlighted a system issue:

> "even in patients whose main issue is a complication of diabetes, the focus of care while they are an inpatient is very much on the complication itself, rather than complete chronic disease management".
>
> *-Junior Doctor*

Summarising the above findings, the most pertinent challenge faced by junior doctors was that of transitions in care of diabetic patients admitted to hospital, followed by knowledge of types of insulin. The system issues raised highlight a lack of access to or awareness of existing protocols and guidelines, and missing emphasis on underlying diabetes management.

The educational needs of junior doctors were then assessed in greater detail in all of the 10 domains of inpatient management of diabetes. These were grouped into

1) Educational needs pertaining to knowledge of diabetes

2) Educational needs pertaining to practice or application of theoretical knowledge

3) Educational intervention options- methods to deliver education with the highest impact

4.5.3 Results- Educational needs pertaining to knowledge

Firstly, analysing the broader aspects of knowledge pertaining to diabetes it was found that irrespective of the level of experience, the responses were quite similar across the domains, and showed a measured expectation of educational needs of junior doctors.

Table 6 Knowledge of basic diabetic concepts

	Junior Doctor N-41	Faculty N=18	Total N=59
Knowledge of diagnostic criteria for diabetes			
Critical knowledge	13	1	14
Core knowledge	**24**	**6**	**30**
Non-core knowledge	1	0	1
Specialist knowledge	0	0	0
Nil response	3	11	14
Knowledge of oral anti-diabetic medications			
Critical knowledge	7	1	8
Core knowledge	**27**	**6**	**33**
Non-core knowledge	3	0	3
Specialist knowledge	1	0	1
Nil response	3	11	14
Knowledge of types of insulin, pharmacokinetics, application			
Critical knowledge	3	2	3
Core knowledge	**22**	**4**	**26**
Non-core knowledge	6	1	7
Specialist knowledge	5	0	5
Nil response	5	11	16

The majority of both faculty and junior doctor respondents considered knowledge of basic diabetic concepts such as diagnostic criteria, oral hypoglycemic agents, types of insulins and their varied pharmacokinetics as core knowledge (see Table 6). This implied that knowledge of these concepts was important for basic management of diabetic issues in hospitalised patients but could be acquired overtime. Further, this trend continued when the focus was on areas pertaining to junior doctor knowledge of inpatient diabetes management (see Table 7). The majority of respondents felt that knowledge of inpatient targets of blood sugar levels was again core knowledge; important for day-to-day management, but not critical. This trend was not found however when knowledge of concepts of insulin therapy, and basal bolus insulin,

as well as knowledge of stress hyperglycemia was considered, a significant proportion of junior doctor respondents and faculty felt that these were critical for junior doctors to know.

Table 7 Knowledge of inpatient diabetes management

	Junior Doctor N-41	Faculty N=18	Total N=59
Concepts of insulin therapy and basal bolus insulin			
Critical knowledge	**21**	**4**	25
Core knowledge	19	**4**	23
Non-core knowledge	0	0	0
Specialist knowledge	0	0	0
Nil response	1	10	11
Stress hyperglycemia- knowledge of effect of acute illness in insulin requirement			
Critical knowledge	15	**5**	20
Core knowledge	**19**	2	21
Non-core knowledge	2	1	3
Specialist knowledge	2	0	2
Nil response	3	10	13
Knowledge of inpatient targets of diabetes management			
Critical knowledge	6	1	7
Core knowledge	**27**	**7**	34
Non-core knowledge	4	0	4
Specialist knowledge	0	0	0
Nil response	4	10	14

4.5.4 Results- Educational needs pertaining to practice or application of theoretical knowledge

The questionnaire explored educational needs about knowledge of practical aspects of management in more detail. For Type 1 diabetes, most aspects of management for this group of patients including sick day management and prevention of DKA were felt to be topics of core importance (Table 8). Interestingly, while knowledge about caring for newly diagnosed type 1 diabetics was considered as critical knowledge by faculty this was not so by the majority of junior doctors who considered it core knowledge. A similar incongruence in viewpoints was found in the knowledge of insulin pump management where a majority of faculty felt this was specialist knowledge while the junior doctors were split in their opinion ranging from core to specialist knowledge.

Table 8 Type 1 Diabetes knowledge needs

	Junior Doctor N=41	Faculty N=18	Total N=59
Newly diagnosed type 1 diabetes- baseline management			
Critical knowledge	11	**6**	17
Core knowledge	**29**	2	31
Non-core knowledge	0	0	0
Specialist knowledge	0	0	0
Nil response	1	10	11
Sick day management			
Critical knowledge	7	1	8
Core knowledge	**22**	**7**	29
Non-core knowledge	8	1	9
Specialist knowledge	0	0	0
Nil response	4	9	13
Prevention of DKA- pre-hospital care of ketosis			
Critical knowledge	13	**3**	16
Core knowledge	**27**	**3**	30
Non-core knowledge	0	2	2
Specialist knowledge	0	0	0
Nil response	1	10	11
Insulin pumps management			
Critical knowledge	1	1	2
Core knowledge	10	2	12
Non-core knowledge	**15**	0	15
Specialist knowledge	14	**5**	19
Nil response	2	10	12

For type 2 diabetes management (Table 9) peri-operative management of insulin therapy was felt to be of critical importance by both faculty and junior doctors. The knowledge of transitions in therapy while an inpatient was considered to be core knowledge by both junior doctors and faculty.

Table 9 Type 2 Diabetes knowledge needs

	Junior doctor N=41	Faculty N=18	Total N=59
Peri-operative insulin therapy			
Critical knowledge	**16**	**6**	22
Core knowledge	8	2	10
Non-core knowledge	5	0	5
Specialist knowledge	3	0	3
Nil response	9	10	19
Type 2- transitions in therapy during admission			
Critical knowledge	6	3	9
Core knowledge	**25**	**5**	30
Non-core knowledge	6	0	6
Specialist knowledge	2	0	2
Nil response	2	10	12

On the topic of acute complications related to diabetes (Table 10), including management of hypoglycemia. hyperglycaemia, DKA and hyperosmolar non-ketotic acidosis (HONK) there was an overwhelming agreement among majority of the faculty and junior doctors that knowledge of management of these issues was critical. Both groups felt that management of in-hospital hyperglycemia was core knowledge.

Table 10 Acute complications

	Junior doctor N=41	Faculty N= 18	Total N=59
Management of hypoglycaemia			
Critical knowledge	**28**	**8**	36
Core knowledge	10	0	10
Non-core knowledge	0	0	0
Specialist knowledge	0	0	0
Nil response	3	10	13
Management of in hospital hyperglycaemia			
Critical knowledge	8	2	10
Core knowledge	**26**	**6**	32
Non-core knowledge	3	0	3
Specialist knowledge	0	0	0
Nil response	4	10	14
DKA management			
Critical knowledge	**35**	**7**	42
Core knowledge	5	1	6
Non-core knowledge	0	0	0
Specialist knowledge	0	0	0
Nil response	1	10	11
HONK management			
Critical knowledge	**17**	**6**	33
Core knowledge	14	2	16
Non-core knowledge	3	0	3
Specialist knowledge	4	0	4
Nil response	3	10	13

When the focus was on specific types of diabetes as listed in Table 11, the junior doctors felt that knowledge of the management of glucocorticoid-induced diabetes was critical, but that of secondary diabetes was core knowledge. However, opinion was split about management of gestational diabetes with an equal number ascribing critical importance to it, as those who felt it was core knowledge. This trend was similar in the faculty responses. Apart from this, the faculty responses were congruent with the junior doctor view on secondary diabetes. However, a majority of faculty felt that management of glucocorticoid-induced diabetes was core knowledge. Finally, both faculty and junior doctors opined that knowledge of seeking inpatient or outpatient review of patient by specialist services was core knowledge (Table 12).

Table 11 Specific types of diabetes

	Junior Doctor N=41	Faculty N=18	Total N=59
Glucocorticoid induced diabetes management			
Critical knowledge	**17**	1	18
Core knowledge	14	**7**	**21**
Non-core knowledge	5	0	5
Specialist knowledge	2	0	2
Nil response	1	10	11
Gestational diabetes management			
Critical knowledge	**13**	**3**	**16**
Core knowledge	**13**	**3**	**16**
Non-core knowledge	5	1	6
Specialist knowledge	4	2	6
Nil response	6	9	15
Secondary diabetes management			
Critical knowledge	7	1	8
Core knowledge	**20**	**4**	**24**
Non-core knowledge	3	2	5
Specialist knowledge	2	0	2
Nil response	9	11	20

Table 12 Referral and handover

	Junior Doctor N=41	Faculty N=18	Total N=59
Inpatient Referral			
Critical knowledge	13	3	16
Core knowledge	**17**	**5**	**22**
Non-core knowledge	4	0	4
Specialist knowledge	0	0	0
Nil response	7	10	17
Outpatient referral			
Critical knowledge	3	1	4
Core knowledge	**25**	**4**	**29**
Non-core knowledge	4	2	6
Specialist knowledge	1	0	1
Nil response	8	11	19

4.5.5 RESULTS-EDUCATIONAL INTERVENTION OPTIONS- METHODS TO DELIVER EDUCATION WITH THE HIGHEST IMPACT

The respondents' opinions regarding educational interventions for assisting junior doctors in learning the nuances of inpatient diabetes management are presented below in Table 13.

Table 13 Resources that will be of assistance to junior doctors in diabetes management

Option chosen (multiple options permitted)	Junior Doctor N=41	Faculty N=18	Total N=59
Clinical practice guidelines /algorithms/protocols for patient management in specific scenarios	34	8	42
Easy online access to these above guidelines	32	7	39
Regular electronic updates on diabetes management online	14	3	17
Access to teaching sessions	26	7	33

Comments about methods to deliver education with the highest impact formed two themes- one that emphasized guidelines and one that focused on teaching sessions, as listed below. The major proportion of respondents opined that availability of clinical practice guidelines and algorithms or protocols for patient management in specific scenarios, along with easy online access to these would be the most valuable resource. This was reiterated in the comments with respondents suggesting that hospital-based intranet resources and who to contact for specialist/ ongoing help would be useful. Furthermore, the comments suggested that junior doctors have concerns regarding guidelines and protocols, when to apply them and when to vary them. Another respondent extended this by suggesting that consultants and registrars (in units other than endocrine) need to be more aware of the current trends and guide juniors (instead of referring all patients to Endocrine unit). While this was so, a predominant group of respondents felt that access to teaching sessions would also be valuable.

On guidelines

"junior doctors have concerns re guidelines and protocols and when to apply them and when to vary them"
-Junior doctor
"guidelines on DKA/HONK…."
-Faculty

- ***On teaching sessions***

"Workshops and compulsory teaching sessions"
-Junior doctor
"Teaching sessions should include acute management of severe hypoglycaemia, DKA, and HONK (as simulation)" *-Junior doctor*

"frequent teaching sessions about management of diabetes and its complications"
-Junior doctor
"teaching sessions will aid junior doctors in feeling comfortable with the issues at hand which will make them more likely to seek the appropriate resources……
-Junior doctor
"question answer type teaching most useful similar to online learning modules."
-Junior doctor

4.5.5.1- RESULTS-IDEAL MEANS OF DELIVERING KNOWLEDGE TO JUNIOR DOCTORS

Respondents at the focus groups were asked for what they considered to be ideal modes of education delivery for junior doctors (see Table 14). The majority of combined responses pointed to the preference for case based discussions at a forum or practical teaching session. This was followed by a preference for workshops to cover key concepts and then by lectures/presentations to a group.

Table 14 Modes of education delivery

	Junior Doctor N =24	Faculty N = 14	Total N =38
Lecture/ presentations to a group	4	2	6
Online tutorial with reference to handy guide	3	1	4
Workshops designed to cover key concepts	2	5	7
Case based discussions at forum/practical teaching session	4	7	11
Other: Simulation	1	2	3
Standardised patient	0	1	1
Refresher courses	2	2	4

To explore this deeper participants were asked during focus group discussions, to comment on the concepts which they felt were addressed best by particular modes of education delivery- more specifically, 1) discussed as part of a forum, 2) as part of a workshop, 3) taught as lectures and 4) taught online. The focus on protocols and transitions in diabetic therapy resurfaced in this section as well, with respondents commenting on this as follows.

CONCEPTS BEST DISCUSSED IN A FORUM

Some junior doctors suggested that the concept of starting basal bolus therapy in terms of indications (when to start therapy) and transition (how to change the treatment back to the patients' own medications at discharge) was best covered in a practical forum where case based discussions could be held. They also suggested including discussions on brittle diabetes management, as well as switching between various modes of diabetes therapy, as concepts that could be best addressed in a forum. This was extended to suggest covering intricacies of care including when to aggressively treat hyperglycaemia and when to leave it as it is, and

when to consider insulin pump therapy for a patient. The faculty on the other hand suggested forums would be best to address common clinical and diagnostic dilemmas providing strategies for trouble shooting, initiation and adjustment of insulin, and insulin in hospital situations such as fasting patients.

CONCEPTS BEST TAUGHT AS PART OF A WORKSHOP

Questions about which concepts are best taught as part of a workshop attracted rich commentary. These have been summarised in broad themes as follows as they are difficult to quantify as a percentage due to the variable response rates:

- ***Transitions in diabetic therapy***
  - Changing between therapies
  - Starting and adjusting insulin. Transition to usual therapy
  - Changing from basal bolus insulin to oral agents (e.g. equivalent doses)
  - Titration of insulin/oral agents to blood sugar profiles
  - When to check blood sugar levels in different cases
- ***Acute complications***
  - DKA
  - HONK
  - Hypoglycemia
- ***Special conditions with Diabetes Mellitus***
  - Pregnancy in diabetic women
  - Gestational diabetes
  - Surgery
  - Co-morbidity with infection
  - Patients who are fasting with diabetes
  - Management of steroid induced hyperglycemia
  - Management of poorly controlled T2DM in patients with interventions
- ***Other concepts***
  - Which patients to intensively treat and how
  - Different insulins and how to use them (e.g. novomix)
  - Different oral hypoglycaemic agents
  - Insulin pumps
  - Non-insulin medical management for T2DM
  - Insulin type and usage guideline

CONCEPTS BEST TAUGHT AS LECTURES

Junior doctors commented on education regarding basics of diabetes knowledge, such as HbA1C on presentation to hospital, new management guidelines, new oral agents and insulin dose adjustment strategies, as being concepts that could be taught best through lectures. While one of the respondents also mentioned education about when to access protocols such as basal bolus insulin, and starting and weaning off insulin infusions, converting back to

usual medications prior to discharge, as being best delivered through lectures, faculty thought the focus was best on more general issues. While acknowledging that it was difficult to capture and engage the whole group of junior doctors at once, they felt this could be best achieved through lectures. Clinical principles and management of diabetes including concepts of why it matters to control blood sugar levels and rationale for up-to-date management and peri-operative management of diabetes, were concepts they felt could be addressed best by lectures.

CONCEPTS BEST TAUGHT ONLINE

Junior doctors felt that concepts of insulin pump management (as to who could be referred for insulin pump), diabetic emergencies like DKA protocols and medication management could be taught online, faculty suggested online guidelines and providing access to these as a means of online learning.

4.6 CONCLUSION

In summary, the most pertinent challenge faced by junior doctors was that of transitions in diabetes care of patients admitted to hospital. Knowledge of types of insulin was also considered to be fairly challenging. This assumes greater significance in the light of the needs analysis outcomes suggesting that knowledge of concepts of insulin therapy and basal bolus insulin is critical for junior doctors. The knowledge of basic diabetic concepts such as diagnostic criteria and oral hypoglycemic agents was considered as core knowledge implying that these concepts was important for basic management of diabetic issues in hospitalised patients but the junior doctors could acquire a working knowledge of this through their year of training.

With regards to type 1 diabetes, a discordant response was obtained between junior doctors and faculty. The knowledge of caring for newly diagnosed type 1 diabetics was considered as critical knowledge by faculty, but this was not so by the majority of junior doctors who considered it core knowledge. In relation to type 2 diabetes management, peri-operative management of insulin therapy was felt to be of critical importance by both faculty and junior doctors. The discordance in the viewpoints of faculty and junior doctors has not been previously described in detail in literature. This difference could be attributed to varying expectations of the role of a junior doctor within the health system. While the viewpoints are different, it emphasises the need to incorporate views from both faculty and junior doctors in designing an educational intervention to ensure effective implementation and response.

System issues highlighted lack of access to or awareness of existing protocols and guidelines, and the majority of respondents marked accessible clinical practice guidelines and algorithms as the most valuable resource for junior doctors. In reference to the best means of addressing the educational challenges and needs of junior doctors, the majority preferred case based discussions at a forum or practical teaching session or workshops to cover key concepts.

This chapter highlighted the design and delivery and analysis of outcomes of the first phase of this study – the needs analysis. The next chapter will focus on the consequent phase - design of the educational intervention.

CHAPTER 5: PHASE 2: DEVELOPMENT OF INTERVENTION AND ASSESSMENT TOOL

5.1 INTRODUCTION

This phase of the project encompassed the design stage for developing an educational intervention in response to the learning needs identified in phase 1, and for designing a tool for assessment of meeting those learning needs. As summarised in the previous chapter, the majority of respondents had indicated that the most challenging facet of in-hospital management of diabetes for junior doctors was that of transitions in diabetes management. This referred to making changes in the regimens of diabetes medications of hospitalised sick patients to manage acute glycemic variations, and optimising therapy at the time of discharge. Knowledge of types of insulin and their varying uses and pharmacokinetic profiles were also highlighted as a major challenge. The intervention therefore sought to address these needs. A case based-workshop format was considered the most appropriate to address these topics as will be explained in more detail in this chapter. The content was delivered in stages during the workshop with each stage designed to delve to a deeper understanding of the topics. A handbook was designed to help this process, and included the case and the related documents, such as protocols and guidelines available and used within the hospital (The case and its stages are shown in Appendix E). The handbook also had extensive detail of learning themes summarised with key points highlighting the learning objectives at each stage. Each participant was provided with their own copy of the handbook to use for further reading following completion of the workshop. This chapter describes the process and outcome of development of the intervention and the assessment tool.

5.2 CONTENT OF EDUCATIONAL INTERVENTION

To address the educational needs of junior doctors identified in management of a diabetic patient admitted to hospital, a case study was used based on a real-life example illustrating a diabetic patient's journey through a hospital admission. Case based learning is an engaging and effective teaching and learning method along the same lines as problem based learning. When delivered in a small group format as part of a workshop, case based learning has the potential to foster learning and help in the development of relevant skills and attitudes (Williams 2005). The use of a clinical case as the learning stimulus serves the purpose of anchoring the learning in the learner's own work experiences. Real life problems are used to generate questions to understand the underpinning clinical and non-clinical aspects of

managing the case, using relevant details and supporting information such as related guidelines, protocols and literature similar to the problem based learning format (Wood 2003). The added advantage of using a case based learning workshop format is that it can be run within a structured time frame. This requires additional time from the expert facilitator to prepare but a lesser time commitment from the learner, helping overcome one of the barriers to accessing learning at the work place, which was limitation of time (Siggins Miller Consultants 2012). The case based format is also efficient for covering large amounts of clinical content within a relatively short time frame, compared with a problem based learning approach.

Based on the findings from the first phase, this project was designed to cover the management of transitions in medical management of diabetic patients, as well as other aspects of inpatient diabetes management which were identified as critical educational needs (Figure 8).

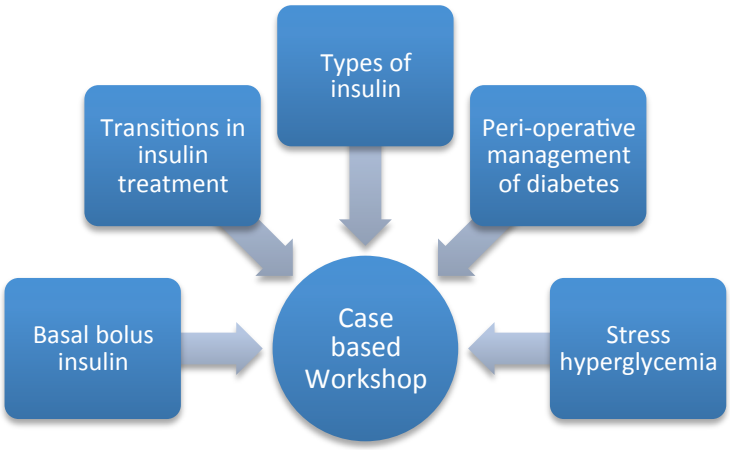


Figure 8 Content of the case based workshop

The elements of inpatient management of diabetes that were identified as critical knowledge needs for junior doctors from phase 1 included types of insulin, basal bolus insulin, stress hyperglycemia, and perioperative management of patients with diabetes. Other learning needs that were identified in phase 1 included management of newly diagnosed type 1 diabetes, management of diabetic ketoacidosis/hyperosmolar non ketotic hyperglycemia, and management of hypoglycemia. These later concepts were not included in the case based workshop as these were covered through the hospital run simulation education program that was already offered to junior doctors in PGY1 and PGY2. These simulation sessions included

management of hypoglycaemia and management of newly diagnosed type 1 diabetes with diabetic ketoacidosis. At the time of this project, these simulation scenarios were reviewed and conjointly delivered by me as part of my medical education role within SALHN. The learning objectives for the case based learning intervention were defined as follows (Table 15).

Table 15 Learning outcomes of case based workshop

Intended Learning Outcomes
At the end of the workshop the participant will be able to ● Identify abnormal blood sugar levels in acutely unwell patients ● Describe how to start and cease an insulin infusion ● Describe how to start and titrate a basal bolus insulin regimen ● Manage diabetes peri-operatively in patients ● Evaluate optimal discharge planning in diabetic in-patients Secondary outcomes: ● Describe the types of insulin ● Improve the use of hospital based charts for diabetes management – by identifying appropriate charts for relevant clinical situations (e.g. basal bolus insulin chart).

The case chosen was that of an elderly female patient admitted with a fractured neck of femur following a fall, and awaiting emergency surgery. The clinical details were modified for learning purposes to incorporate the intended learning outcomes and patient details were de-identified. The patient's case was presented in stages (Figure 9), which reflected the learning themes of the respective stage.

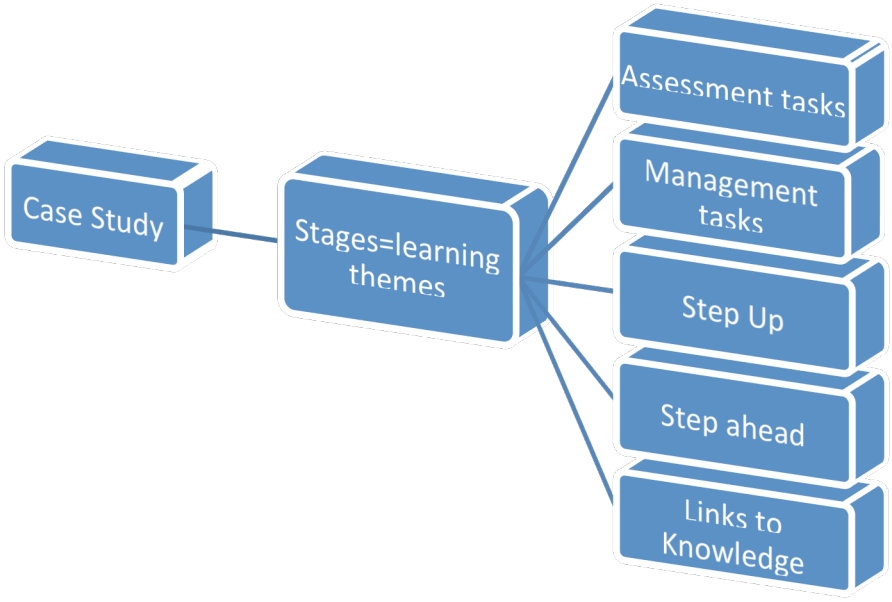


Figure 9 Components of the case based workshop

These stages were-

Stage 1- Assessment and management of an acutely unwell diabetic patient

Related learning outcome- Identify abnormal blood sugar levels in acutely unwell patients

Stage 2- Pre-operative care of a diabetic patient

Related learning outcomes-

Describe how to start and cease an insulin infusion

Describe the types of insulin

Manage diabetes peri-operatively in patients

Stage 3- Immediate post-operative care of a diabetic patient

Related learning outcomes-

Improve the use of hospital based charts for diabetes management – by identifying appropriate charts for relevant clinical situations (e.g. basal bolus insulin chart).

Describe how to start and titrate a basal bolus insulin regimen

Stage 4- Late post-operative care and discharge planning of a diabetic patient

Related learning outcome- Evaluate optimal discharge planning in diabetic in-patients

The learning themes were classified into assessment tasks and management tasks relevant to each stage (see Table 16). Further, the practical aspects of each stage were extended where relevant, through two steps, each exploring the basic management needed, and ways to stay

head of potential complications. These were listed as ‘step-up’ and ‘step-ahead’ tasks. Step-up tasks extended the knowledge needed to handle the relevant stage and step-ahead concepts were designed to guide the learner to see the big picture from within each stage. Each stage also included ‘links to knowledge’. Links to knowledge refers to additional resources provided to workshop participants such as guidelines and protocols related to that particular stage of the case. Established validated sources such protocols and guidelines where used were available (e.g. ‘Perioperative diabetes management guidelines Australian Diabetes Society’ (2012)), insulin infusion order sets, and basal bolus insulin order sets. Existing hospital protocols were also used to further the discussion wherever relevant at each stage. Where information had to be collated from literature and presented in a summarised, way relevant to the learning needs of the junior doctors and relevant to the practice in SALHN, this was done and provided as part of links to knowledge (e.g. types of insulin document created by researcher). Key points were highlighted while progressing through each stage. Further information regarding the concepts covered and the tools provided under each stage are explained in each relevant section of this chapter in more detail.

Table 16 Components of each stage of the case based workshop

	Stage 1	Stage2	Stage3	Stage4
Learning theme	Stress hyperglycaemia and understanding of target blood sugar levels	Pre-operative care of diabetic patient	Immediate post-operative care of diabetic patient	Late post-operative care of diabetic patient, Discharge planning, management of acute increases in blood sugar levels
Assessment task	Identifying abnormal blood sugar levels	Blood sugar monitoring	Clinical priorities in the immediate post-operative phase	Target blood sugar levels relevant to this stage, stabilisation of blood glucose levels and optimisation of therapy
Management task	Management options to achieve euglycemia	Management of hyperglycemia	Step-wise management of blood sugars in the post-op phase	Options for management of hyperglycemia relevant to this stage and transition back to the patient's usual medications
Step up task	Peri-operative metformin use	Setting up insulin infusions	Cessation of insulin infusions and transition to basal bolus insulin	Handover and discharge procedures
Step ahead	Discharge planning	Referral and escalation of care	Basal bolus insulin	Comprehensive diabetes checklist at time of discharge
Links to knowledge	Target blood sugar levels in acutely unwell patients	Types of insulin and peri-operative diabetes management guidelines of the Australian Diabetes Society	Management of hypoglycemia	Goals in outpatient management of diabetes

5.2.1 Stage 1 Assessment and management of an acutely unwell diabetic patient

The first stage of the educational intervention focused on assessment and management of glycemic control in an acutely unwell diabetic patient who was on anti-diabetic medications that included metformin and insulin Glargine. This stage explored identification of stress hyperglycaemia and understanding of target blood sugar levels in this setting. Assessment tasks were set to guide the learner through identifying abnormal blood sugar levels and gathering relevant information, such as time to surgery, and time to next dose of insulin. Management tasks were set to help the learner explore options available to efficiently and safely bring the blood sugar levels to target range. The 'step-up' tasks covered the issues of

metformin use around the time of surgery. The 'step-ahead' tasks covered anticipation of discharge even at this early stage, and the steps involved for planning ahead for this. This stage incorporated links to knowledge of target blood sugar levels in acutely unwell patients. The parts of stage 1 are summarized below.

Stage 1

Learning theme- Stress hyperglycaemia and understanding of target blood sugar levels
Assessment tasks- Identifying abnormal blood sugar levels
Management tasks- management options to achieve euglycemia
Step-up task- Peri-operative metformin use
Step-ahead- Discharge planning
Links to knowledge - Target blood sugar levels in acutely unwell patients.

5.2.2 Stage 2 Pre-operative care of a diabetic patient

This phase dwelt in detail on the pre-operative phase in a diabetic patient's journey. Assessment tasks focused on the frequency of monitoring blood sugar levels, while management tasks explored options for definitive management of hyperglycemia. The 'step-up' tasks focused on the broader principles of peri-operative management in diabetic patients, while also elaborating on the details of setting up an insulin infusion. 'Step-ahead' tasks included referral and escalation of care processes. These were included to encourage the junior doctors to consider when to call for help, and to identify who to call to notify of a patient's condition especially with regards to glycemic management pre-operatively. This referral and escalation process was designed in line with existing hospital referral policies for after-hours care. The links to knowledge expanded on specific information on metformin use peri-operatively, as well as the types of insulin, their classification and common names and included the 'Peri-operative diabetes management guidelines Australian Diabetes Society' (2012). The parts of stage 2 are summarized below.

Stage 2

Learning theme- Pre-operative care of diabetic patient
Assessment tasks- Blood sugar monitoring
Management tasks- Management of hyperglycemia
Step-up task- Setting up insulin infusions
Step-ahead- Referral and escalation of care
Links to knowledge – Types of insulin and peri-operative diabetes management guidelines of the Australian Diabetes Society

5.2.3 Stage 3 Immediate post-operative care of a diabetic patient

Stage 3 focused on the immediate post-operative care of the patient with diabetes. Assessment tasks led the learner to explore clinical priorities and the role of blood sugar management within this context. Management tasks directed the learner to decision-making regarding ongoing step-wise management of blood sugars. 'Step-up' tasks elaborated the clinical thinking involved in cessation of insulin infusions and transition to basal bolus insulin. 'Step-ahead' tasks were used to again explore the bigger picture while comparing the initiation of basal bolus insulin to insulin infusion in an acutely unwell patient. The learning link covered the topic of hypoglycaemia management. The parts of stage 3 are summarized below.

Stage 3

Learning theme- Immediate post-operative care of diabetic patient
Assessment tasks- Clinical priorities in the immediate post-operative phase
Management tasks- Step-wise management of blood sugars in the post-op phase
Step-up task- Cessation of insulin infusions and transition to basal bolus insulin
Step-ahead- Basal bolus insulin
Links to knowledge – Management of hypoglycemia

5.2.4 Stage 4 Late post-operative care and discharge planning of a diabetic patient

This stage looked at a longer time frame in the patient's journey incorporating the late post-operative period up to discharge. It included the potential complication of wound infection, to help learners further explore intricacies of basal bolus insulin titration in response to blood sugar levels.

The assessment tasks and management tasks were provided in two parts. The assessment tasks in the first part were designed to revisit target blood sugar levels and the management task explored options for management of hyperglycemia in this stage of the patient's journey. This was not set up as a separate stage as these tasks were covered in an altered format from stage one of the case. However, it was included to assist learners to understand and apply different strategies of blood glucose management depending on the relevant clinical stage of their inpatient journey. In the subsequent part, the assessment task explored understanding concepts of stabilisation of blood glucose levels and optimisation of therapy, while management tasks explored the transition back to the patient's usual medications. The 'step-up' tasks included handover and discharge procedures, while the 'step-ahead' task explored

what would constitute a comprehensive diabetes checklist at time of discharge. The learning links then led to extension of this knowledge to goals in outpatient management of diabetes, which are relevant to inpatient care as well as to provide a continuum of care to patients with diabetes. The parts of stage 4 are summarized below.

Stage 4

> ***Learning theme-*** Late post-operative care of diabetic patient, discharge planning, management of acute increases in blood sugar levels
> ***Assessment tasks***- Target blood sugar levels relevant to this stage, stabilisation of blood glucose levels and optimisation of therapy
> ***Management tasks***- Options for management of hyperglycemia relevant to this stage and transition back to the patient's usual medications
> ***Step-up task-*** Handover and discharge procedures
> ***Step-ahead***- Comprehensive diabetes checklist at time of discharge
> ***Links to knowledge*** – Goals in outpatient management of diabetes

The case study followed the stages in the inpatient journey of an acutely unwell diabetic patient from her initial presentation, through her pre-operative, immediate post-operative, and late post-operative to discharge phases. It was written out in a format incorporating the learning themes in a stepwise manner with discussion planned at each stage to help in building knowledge through small blocks of learning (Figure 10).

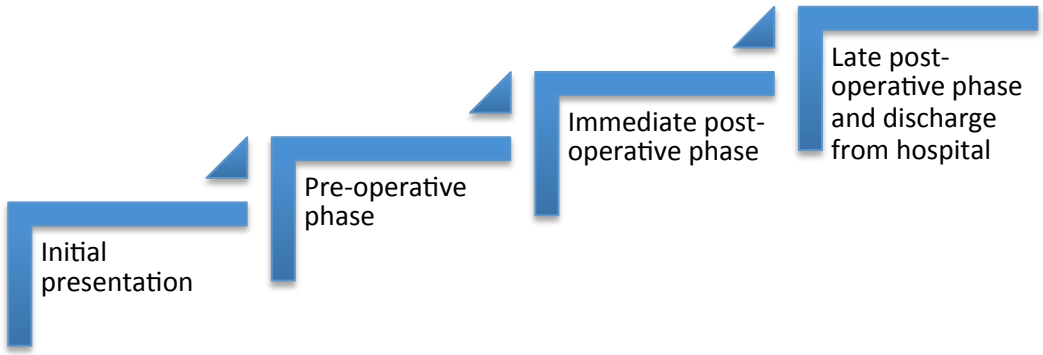


Figure 10- Stages of the case based workshop

5.3 Delivery of Educational Intervention

The preference for a case based workshop was reflected in outcomes from the needs analysis of our cohort of junior doctors. During the needs analysis phase of this project, junior doctors and faculty provided their insights into varied formats of education delivery. The majority of combined responses pointed to the preference for 'case based discussions at a forum' or

'practical teaching session'. This was followed by a preference for 'workshops' to cover key concepts. When the needs analysis stage was undertaken, 'Case based discussion at a forum' was proposed by respondents as a live forum facilitated by Endocrine faculty members, where junior doctors could come to meet at a set frequency once every 4-6 weeks to discuss 'hot and happening' cases, and related issues from their ward experience. The faculty member's role was envisaged to guide the junior doctors through their clinical decision making, teaching through this process the current practices in diabetes inpatient management. Practical teaching sessions were considered to be a modified version of the case based workshops where Endocrine faculty would bring relevant cases from their most recent consults and discuss management in an informal way. Workshops were envisaged as a pre-planned activity, not occurring at set frequency but planned in advance with a set date and time with an aim to capture a reasonably large audience/target group of junior doctors. These would focus on specific concepts such as how to start a patient on basal bolus insulin, how to set up an insulin infusion etc. While it was beyond the scope of this project to provide multiple formats, the concept of case based discussion was combined with that of a workshop to provide a blended learning experience in a relaxed non-threatening atmosphere. The hybrid outcome was thus a case based workshop, which incorporated real life case based discussion on pre-specified concepts.

5.3.1 Clinical reasoning- a skill that can be taught

The case based step-wise scaffolded learning process, was chosen to meet the educational objectives. as it parallels the clinical process and decision making in real life. It aids in the development of the skill of clinical reasoning which was until recently considered a skill attained with experience, but in more recent literature has been promoted as a teachable skill (Linn, Khaw et al. 2012). Clinical reasoning is a dynamic process by which clinicians gather and process information from each clinical scenario, to come to an understanding of the patient's problem at hand (Benner, Hughes et al.). This then leads to effective planning and implementation of interventions, assessment of outcomes of the interventions, and reflection and learning from each experience (Tucker and Bradshaw 2016). With increasing experience and expertise this process moves smoothly between the various phases (Levett-Jones, Hoffman et al. 2009) (Figure 11). The workshop was designed to foster clinical reasoning by providing step-wise progression and rich clinical contextual description at each step.

Figure 11 The clinical reasoning cycle. adapted from Levett-Jones, Hoffman et al. (2009 p5).

5.3.2 CLINICAL REASONING TAUGHT THROUGH CASE-BASED WORKSHOPS

When considering the concept of clinical reasoning it is helpful to classify it into two broad categories, being inductive and deductive reasoning (Singmann and Klauer 2011, Bolton 2015) Deductive reasoning involves starting from a general perspective and narrowing down to a more specific end point. In the case of clinical reasoning this would translate to considering a long list of possible diagnoses or solutions to clinical situations, and then working through the various hypotheses to reach a clinical decision. On the other hand, inductive reasoning involves starting from a specific prototype, identifying patterns and the norm, and then incorporating variations and generalisations of the theme. In clinical situations, this involves working from the perspective of the clinical problem at hand and making inferences from observations, integrating pre-existing knowledge and arriving at a clinical decision (Kyriacou 2004, Conn, 2012). Most clinicians use a combination of deductive and inductive reasoning to arrive at a diagnosis and to facilitate further assessment and management of problems in the clinical setting. Inductive reasoning is used to generate a hypothesis and deductive reasoning is used to test the hypothesis and consolidate the possible outcomes, in the process either eliminating or endorsing the hypotheses. Knowledge of basic concepts and illness scripts are needed for successful clinical reasoning. Novice clinicians such as junior doctors tend to learn better from clinical examples, rather than from a logical

development of theory starting from basic concepts and principles, which would be impractical in time-pressured situations (Durning, Ratcliffe et al. 2013).

Case based workshops are a means of learning through inductive reasoning and are effective in fostering this (Prince and Felder 2007). The establishment of an anchoring prototype, development of illness and therapy scripts, and pattern recognition of typical and variations on presentations is important as a starting point for junior doctors, and this is accomplished quite comprehensively through a case based workshop (Prince and Felder 2007). The anchoring prototype case used in this study was designed to include challenges of various types, such as diagnosing stress hyperglycaemia and formulating a treatment plan customised to the specific clinical scenario. It was also designed to be authentic, representing real-life clinical situations likely to be encountered in clinical practice. It was intended that while analysing this complex authentic case, the junior doctors may gain an understanding of the nuances of clinical presentations and become aware of the clinical and practical dilemmas they could potentially face in their management of the patient. In this process, they are expected to gain both theoretical and practical understanding of inpatient management of diabetes, develop their clinical reasoning skills, explore their own knowledge and management algorithms, and make necessary modifications to accommodate the realities of the case. This would then aid in consolidating their learning through clinical exposure in their day-to-day work where they would be able to have a basis for comparing and appreciating further nuances in clinical decision making and explore how what they have learned applies to real world situations (Bowen 2006).

5.3.3 Benefits of group teaching versus lectures

Teaching in most settings from lectures to seminars, and grand round presentations, has been reduced to PowerPoint slides with carefully designed animations to impress. While 'Death by PowerPoint' has become a common phrase, lectures and presentations remain a relatively easy and effective method of education delivery, and hence are widely adopted across various disciplines (Levinson 2010). However, the fact remains that this passive form of teaching/learning is not very engaging and does not lead to efficient transfer of knowledge (Cendan, Silver et al. 2011). A key factor that restricts education is the inability to passively transmit knowledge from teachers without the active involvement of the learners. The learners need to be active participants in the knowledge transfer, proactively constructing concepts in their minds, analyzing and accruing information and revising established

knowledge in the light of new experiences (Bada and Olusegun 2015). This concept forms the basis of the constructivist view of learning which considers 1) learners as active agents keenly participating in the process of knowledge acquisition, and 2) learning environments as critical to this process. The basic characteristics of constructivist learning environments required for promoting active learning, include role of the teacher as a facilitator, guiding small groups of learners of heterogenous abilities (Bada and Olusegun 2015). With increasing advances in medical care, and consequently more complex learning needs, there is shift in the scope of medical education from only learning and teaching pre-established facts and formulas, to that of facilitating concept development and adaptive strategies (Levinson 2010). Case based workshops and small group activities lend themselves well to this process (Cendan, Silver et al. 2011). Active learning based on a constructivist teaching strategy was adopted as a basis for designing case based workshops to develop problem-solving skills for real life clinical problems and consolidate theoretical frameworks of learning.

5.3.4 Didactic versus dialectic teaching

Medical teaching traditionally has focused on a didactic model of teaching that involves a teacher, pre-set course content, and transfer of information from the teacher to the student through various means promoting rote-learning, memorisation and recall of various facts. A variation to this form of teaching is the dialectic model as proposed by Michaelsen and colleagues (2008). This involves knowledge transfer through application or logical discussion. Case based workshops would reflect a more dialectic form of teaching using a constructivist framework as proposed by Kaufman (2003) where the teachers' role is that of a facilitator of learning. Dialectic teaching provides opportunities for learners to explore and reflect on their prior knowledge or lack of it, and gain an understanding of existing expected knowledge (Hrynchak and Batty 2012).

Keeping these concepts in focus a case based workshop incorporating practical elements with the scope for participation of learners in an interactive format was designed. It was planned as a 60-minute workshop with each stage taking up 15 minutes of time for exploration of themes and discussion. The workshop set out to be inclusive in delivery, ensuring that while the slowest learner received individualised attention and enough time to grasp the concepts, there was enough educational stimulus to extend quick learners. A flyer was designed and sent out to junior doctors inviting them to the workshop. Each participant was provided with the option of being part of the pre- and post-workshop assessment if they chose to.

The workshop was run with the assistance of the Medical Education staff of the Trainee Medical Officer unit and a senior staff specialist in Endocrinology supervised the content and delivery. A PowerPoint presentation was used to pivot the discussion and progress the case through its various stages (while not substituting the content of the workshop), and the seating was designed to be in a relaxed semi-circle facing the facilitator.

5.4 Assessment and evaluation- design and delivery

Assessment is a critical part of every educational intervention. The aim of assessment is twofold; to help participants identify and respond to their own learning needs while also providing the educators an insight into the success and impact of a program (Epstein 2007). This could be summarised as assessment of learning and assessment of teaching. The overall process of assessment involved an assessment of competence, assessment of confidence, and evaluation of educational intervention (Figure 12).

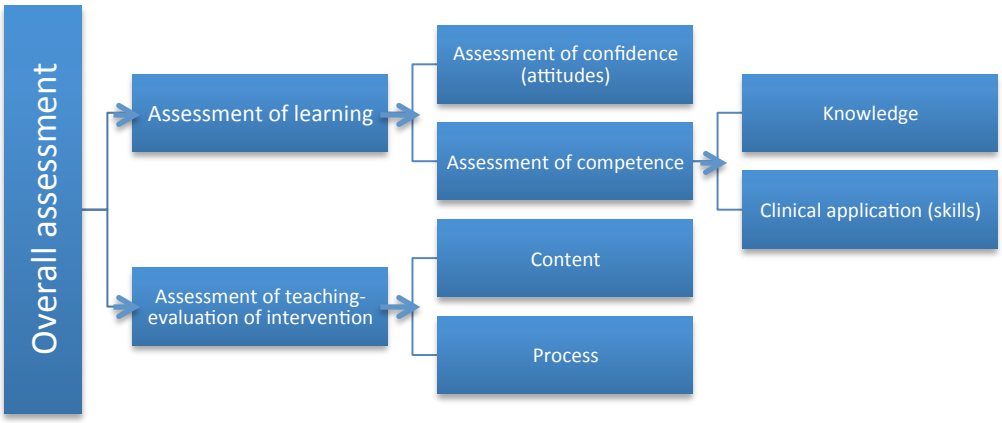


Figure 12 Designing the assessment

5.4.1 Assessment of learning

Assessment of learning is akin to a summative assessment, which aims to measure the level of proficiency or knowledge, gained at the end of an educational intervention. On the other hand, assessment for learning is akin to formative assessment that aims to gather information during the course of education and provide feedback to guide ongoing improvement and learning (Dent and Harden 2013). The assessment process designed for this educational unit was a summative assessment.

One of the principal purposes of assessment of learning is to help in "optimising the capabilities of all learners through the provision of direction for future learning" (Epstein

2007 p388). To fulfill this purpose, multiple methods of assessment of learning exist in literature and practice. Of these methods, the written method of assessment was best suited to incorporate in a case based workshop due to the cost-effectiveness and ease of administering it and the ability of participants to complete it within limited timeframes. Further it produces objective reliable scores that are useful in the analysis of outcomes (Dent and Harden 2013 p299) and hence this was adopted. Written exercises include multiple choice questions in either a single answer or an extended matching format. They also include other popular formats such as key feature questions, script concordance testing, short answer questions and structured essays (Epstein 2007). Multiple choice questions assess the domain of knowledge and problem solving ability. They are used widely as part of summative assessments within courses and in certification exams. They offer the advantage of being able to cover a significant amount of content in short time frames and are easy to grade, and have high reliability. However, they are difficult to write in certain content areas and can result in a process called cueing (Epstein 2007). Cueing is a cognitive process that examinees can use to answer MCQs by pattern recognition of a correct option rather than by recalling knowledge and applying it to the scenario to generate a spontaneous response. This may lead to a false assessment outcome.

Written assessments can be classified on the basis of the format of the question, i.e. what the question asks in relation to context and content-stimulus format, or how the response to a question is recorded- response format (Schuwirth and van der Vleuten 2004). Examples of written assessments focusing on a response format include open-ended question types and multiple choice question types (Schuwirth and van der Vleuten 2004). The open-ended questions include short answer questions and essay questions. These are easy to set but time and resource consuming in terms of developing a well-rounded answer key and in marking the answers and calibrating it to the pre-set answer key. Further, their use in a case based workshop setting is limited by the increased time needed to be set aside for assessment as part of the whole process, compromising on the time for education delivery. Multiple-choice questions on the other hand, require greater amount of focus during the question construction phase to avoid the cueing effect and provide realistic answer options to avoid guessing (Epstein 2007). However, at the point of delivery, these take less time to answer and consequently a greater body of knowledge can be assessed. As a means to overcome cueing, different subtypes of MCQs have been used and these include single answer questions, multiple answer questions and questions with negative marking and extended matching

format (although these could also be classified under context rich stimulus format questions which are described further below). Each of these formats has its intrinsic benefits and disadvantages. A robust assessment process would thus incorporate a variety of formats to overcome the disadvantages that could possibly arise while, at the same time, preserving the inherent advantages offered by each format (Dent and Harden 2013).

Written assessments focusing on a stimulus format on the other hand are further subdivided into context free questions and context rich questions. Context free questions are those that are designed to test factual knowledge that is important in understanding concepts and successful problem solving. These involve a simpler cognitive process of recall. While factual knowledge is the not the set goal in itself, it is critical to know basic blocks of knowledge to be able to apply it in problem solving. An example of a context free question with multiple correct responses, used in the workshop is listed in Appendix F

In contrast to this, context rich questions, provide relevant details of clinical scenarios with or without distractors and are designed to test clinical reasoning, problem solving and successful application of knowledge. This involves a higher cognitive process where examinees use the provided information in its relevant context and weigh in various options before choosing the best one available for that specific context.

Context rich format questions come in various forms such as extended matching questions and key feature questions and a hybrid format of script concordance testing. Extended matching questions usually test a theme, which could be based on a clinical condition, diagnostic test or therapy. An “extended” list of realistic answer options relevant to the chosen theme is then provided. This is followed by a lead in statement that outlines the question and finally one or more clinical vignettes are provided. The examinee is expected to match the clinical vignette to the appropriate option from the “extended” list. As the same answer can be correctly chosen for more than one clinical vignette, this type of questioning reduces cueing. It assesses problem-solving skills in varied but interlinked domains. An example of this is taken from the Royal Australasian College of Physicians Website and shown in Appendix F.

Key feature questions on the other hand test the ability to apply knowledge and problem solve clinical scenarios presented in a context rich format. Further, they also provide flexibility in the response format. The critical decision points in the context (clinical scenario)

provided constitute the key features of the problem. They are useful in testing both knowledge and clinical reasoning. Examples of key feature question from the literature are provided in Appendix F.

While these questions are used frequently in high stakes examinations they were found to be too extensive for a post intervention assessment and within the time and resource constraints existing with running our workshop, it was decided to design context rich questions (stimulus) with a multiple-choice answer format (response). This suited our purpose of assessing gain of knowledge as well as an understanding of application and problem solving. An example of a context rich question used in the workshop is provided in Figure 13.

You are reviewing a patient admitted overnight through the emergency department. He is a 48 y/o male with an 8-year history of DM and is currently admitted with pneumonia. His medications for diabetes are metformin and Gliclazide (sulfonylurea). His fasting BSL was 9.6 mmol/L. He reports his GP is happy with his diabetic control and mentions his most recent HbA1C is 8.4%. After a brief clinical evaluation and starting antibiotic therapy, you have to decide on blood sugar management. Given this patient's history and laboratory values, what is the best treatment option for glycaemic management?

a)	Continue oral anti-diabetic agents
b)	Continuous IV insulin infusion
c)	Sliding-scale insulin
d)	Twice daily mixed insulin
e)	Basal bolus regimen

Figure 13- sample of a context rich question used in the workshop

The assessment tool was delivered as a pre- and post-intervention questionnaire (Appendix C) with the aim to measure change in confidence and knowledge acquired through the workshop. It became evident during the design process that the assessment tool needed to be combination of different written assessment methods that were practically suited to a time limited case based workshop delivered in the course of a junior doctor's working day to provide a comprehensive outcome which was in effect 'short and sharp'.

5.4.2 Assessment of Teaching – Evaluation of the Educational Intervention

As stated by Wilkes and Bligh (1999 p1269) "Educational evaluation is the systematic appraisal of the quality of teaching and learning". It is critical to evaluate educational programs to ensure they are delivering what they are designed to do. Participant feedback is important in evaluating content and delivery of educational interventions, and multiple methods to obtain this feedback have been described in the literature. The most commonly

used form is the questionnaire, and lends itself to being merged with the assessment tool which we had designed for the assessment of learning.

There are multiple approaches to evaluation. One system of classification broadly groups these under four categories. The first is student oriented evaluation, which measures student performance, especially in tests as the indicator of success of an educational intervention (Wilkes and Bligh 1999). Second is programme oriented evaluation, which is a more comprehensive measure of the performance of the whole educational intervention and assesses not only the participant's performance but the teaching methods used (course delivery) as well as the content (Wilkes and Bligh 1999). Third is institution oriented evaluation, which has a broader scope and measures the quality of teaching using multiple strategies (Wilkes and Bligh 1999). And fourth is stakeholder oriented evaluation, which focuses on the impact of the learning on the ultimate stakeholders, in this case patients and the health service. Our evaluation tool was designed to be program oriented, to provide a comprehensive understanding of the effectiveness of the intervention.

Another system of classification is that described by Kirkpatrick who set out four levels of evaluation, which reflect the categories of measures of effectiveness of training outcomes where the central focus is on successful transfer of learning from trainers to trainees. These four levels of evaluation with increasing level of complexity are: Reaction, Learning, Behaviour, and Results (Kirkpatrick 1967) (Figure 14). At the base is level I- evaluation of reaction, that surveys responses of participants immediately following an educational intervention and measures their satisfaction. At level 2 is the evaluation of learning that measures observable skills, knowledge, and behaviour. At level 3, evaluation of behaviour, there is switch from classroom to workplace with an emphasis on evaluation of competency, problem solving and application of knowledge. Level 4 evaluations measure the final impact on society and health systems and are in essence is the hardest to quantify reliably. To be effective within the timeframe of the workshop our evaluation tool sought to measure levels 1 and 2- reaction and learning.

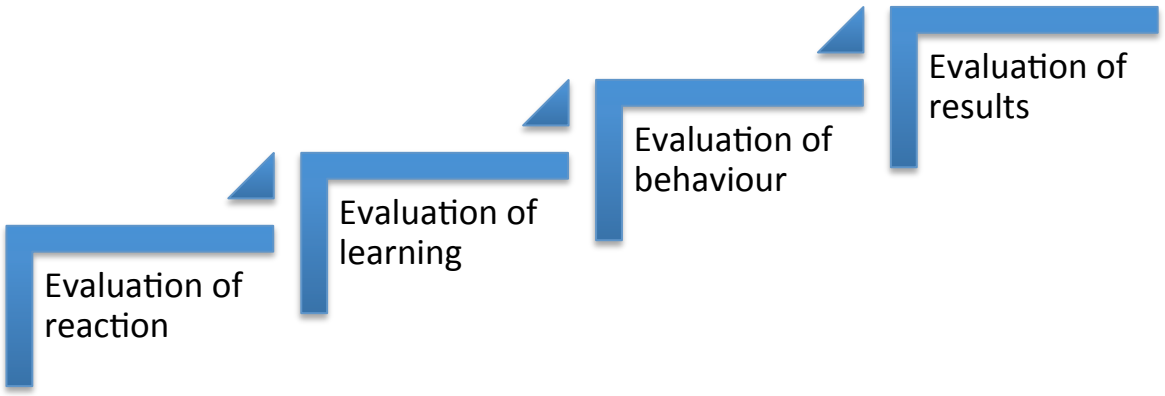


Figure 14 Kirkpatrick's hierarchy of levels of evaluation Adapted from Hutchinson (1999)

5.5 Conclusion

Following the design phase of the project a case based workshop was developed which incorporated real life case based discussion on pre-specified concepts. Learning objectives were clearly defined at the outset, and the workshop was designed to be delivered as a face-to-face small group intervention. Assessment of learning was done through a combination of different written assessment methods to provide a comprehensive measure of the achievement of listed learning objectives and to provide feedback to guide modification and refinement of the process. This chapter has described the design phase of the project. In Chapter 6, the delivery of the intervention and the results of the assessment will be explored.

CHAPTER 6: PHASE 3 – RESULTS AND EVALUATION OF INTERVENTION

6.1 INTRODUCTION:

The aim of the third phase of the educational design based project was to implement the case based workshop to address the learning needs of junior doctors in managing diabetes in patients admitted to hospital. The case based workshop was held at the Flinders Medical Centre, which is a tertiary teaching hospital co-located with the Flinders University of South Australia. The workshop incorporated a pre- and post-workshop questionnaire that formed the source of the assessment data. This chapter commences with the contextual information about the participants (junior doctors) in the program. The chapter then proceeds to describe the outcomes of assessment of the participants' learning, and evaluation of the workshop, presenting it as a combination of qualitative and quantitative data to assist in providing a more comprehensive analysis.

6.2 DEMOGRAPHICS

6.2.1 PARTICIPANTS

The participants in the case based workshop were interns working across the three hospital sites in the SALHN. A total of 75 interns worked within the SALHN at the time of the intervention. The predominant proportion of these interns had done their undergraduate medical education at the School of Medicine, Flinders University. However, not all of them were exposed to the clinical setting within the hospitals of the SALHN as the university has multiple placement options for these students to gain clinical experience in different settings.

6.2.2 THE WORKSHOP

The workshop was delivered as a hospital-based activity with the researcher being the primary facilitator. A senior Staff Specialist Endocrinologist provided medical supervision, and Medical Education Officers and Education Support Officer of the Trainee Medical Officers Unit of SALHN provided the advertising for the workshop and logistic support. Each attendee was provided with the study information sheet on arrival (Appendix D) explaining that participation in the workshop and the questionnaire process was voluntary, and not compulsory. A total of 29 interns attended the case based workshop intervention, giving a 39% participation rate. Responding to pre- and post-workshop questionnaires was accepted as implied consent. Twenty-one participants completed both pre- and post-test questionnaires. A total of 23 interns completed the pre-test questionnaire. Of these, two

interns had to leave midway through the workshop due to on-call requirements and did not complete the post-test questionnaire. Three interns arrived late for the workshop, and did not do the pre-test questionnaire. They did, however, complete the post-test questionnaire. A total of 24 interns completed the post-test questionnaire. All questionnaires were used for the assessment of teaching analysis. However, for purposes of analysis of assessment of learning, to compare change following the intervention, only those 21 responses that had both pre- and post-test questionnaire responses were included. Three interns opted to attend the workshop but did not wish to hand in their completed questionnaires. The pre- and post-test questionnaires were coded with numbers and marked A and B and paired questionnaires were provided to each participant at arrival. The pretest pack was opened on arrival and the post-test pack was opened after completion of the workshop. Each participant was also provided with his or her own copy of the handbook to be used during the workshop.

6.3 Assessment outcomes

The outcomes of the assessment process are outlined in the following paragraphs under the headings of *Assessment of learning* and *Assessment of teaching* as referred to in Chapter 5 (Figure 12).

6.3.1 Assessment of learning - confidence

Participants were asked about their level of confidence in handling diabetes among inpatients prior to the workshop. This was classified into four levels that corresponded to a range of high level of confidence to complete avoidance, with results shown in Figure 15. While none of the respondents felt a high level of confidence, 67% of them reported feeling comfortable with managing diabetes. However, 29% reported lacking confidence and one intern (4%) reported they avoided managing diabetes.

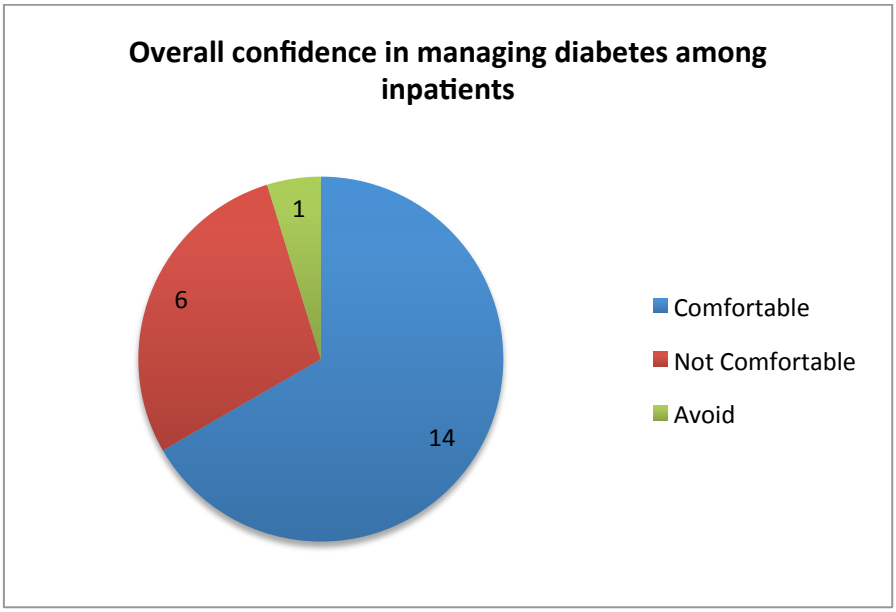


Figure 15 Confidence in managing diabetes among inpatients

Post workshop, 100 % of respondents reported feeling more confident about handling diabetes. One respondent included a comment that he/she would require reading further through the handbook.

The individual domains in inpatient management of diabetes were explored in detail in both the pre- and post-workshop questionnaires. The pre-workshop questionnaire specifically explored the existing level of confidence in these domains and the post-workshop questionnaire explored if there was a difference in number of participants who were more confident in handling these same domains after the intervention. Figure 16 depicts the overall change in confidence. The maximal benefits were observed in the domains of peri-operative management of diabetes, and starting and ceasing insulin infusion. Significant gain in the number of participants who were more confident, was found in every domain evaluated.

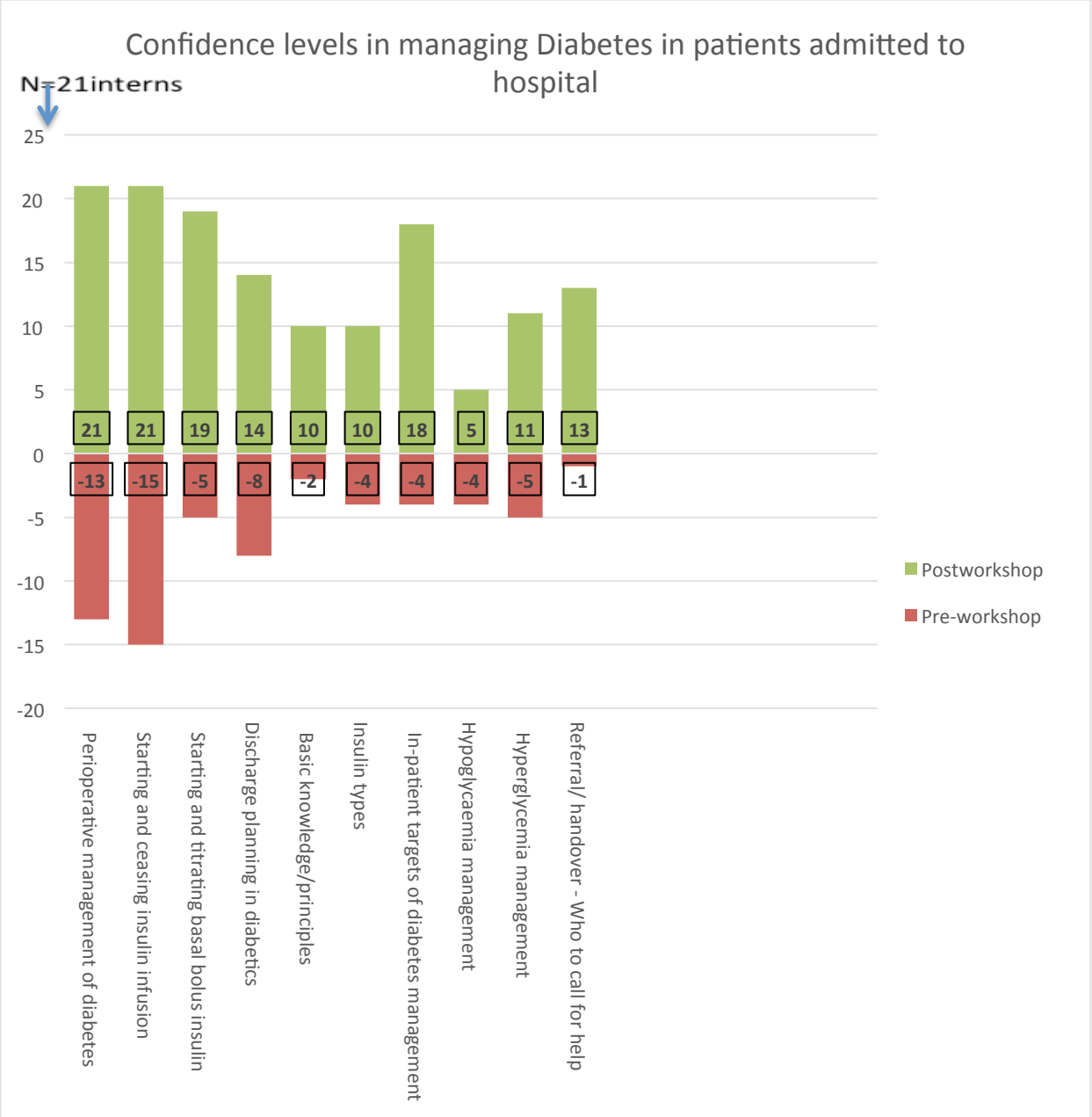


Figure 16 Confidence in individual domains of diabetes management in patients admitted to hospital

6.3.2 Assessment of learning - competence

Knowledge and application

For testing knowledge, multiple-choice questions with more than one best answer format were included. For testing application, context rich questions (stimulus) with a multiple-choice answer format (response) were designed. Each question was assigned one mark per correct answer and the total score was measured. All of the questions testing knowledge and testing application carried six marks each. Further, with a view to assessing critical errors in

knowledge and application, the questionnaires were scored individually with negative marking for wrong answers and the total marks re-tallied. Table 17 below depicts the number of participants who had a gain in score pre- and post-intervention. A significant proportion of participants improved their scores in application of skills following the intervention. Such gains were not evident in the knowledge domains. However, from the results it appears that there was a significant reduction in erroneous assumption in the knowledge domains, based on the score with negative marking.

Table 17 Number of participants with gain in score post workshop

Domain	Gain in score	Percentage
Knowledge scores pre- and post-workshop without negative marking	6/21	29%
Knowledge scores pre- and post-workshop with negative marking	11/21	52%
Application scores pre- and post-workshop without negative marking	15/21	71%
Application scores pre- and post-workshop with negative marking	15/21	71%

Furthermore, on analysing the individual scores of each participant there was an overall increase in the mean scores across both knowledge and application domains, with and without negative marking (shown in Table 18). The gain in score was noticed predominantly in the application domain. The results also indicated through the negative marking, that the error rate was also significantly reduced in both the knowledge and application domains. It was interesting to note the average total scores ranged from 4.8 % of total marks to 52% (measured as average score over a total score of 6 in each domain). The maximum score was again in the practical domain of application. However, when accounting for errors through negative marking, this was the domain where participants made the maximum error as well.

Table 18 Mean scores before and after workshop

	Mean	Difference in mean	SD	SEM
Knowledge scores-pre-workshop	2.81	+0.29	0.87	0.19
Knowledge scores -post workshop	3.10		0.89	0.19
Knowledge scores with negative marking- pre-workshop	1.29	+0.76	1.38	0.30
Knowledge scores with negative marking- post workshop	2.05		1.32	0.29
Application scores pre-workshop	3.14	+1.19	1.01	0.22
Application scores post workshop	4.33		1.06	0.23
Application scores with negative marking pre-workshop	0.29	+1.95	2.10	0.46
Application scores with negative marking post workshop	2.24		1.48	0.32

A paired t-test was used to compare the pre- and post-workshop questionnaire responses to assess gain in knowledge and application. There was a statistically significant gain in knowledge and application skills (Table 19).

Table 19 Gain in knowledge and application following the workshop

	Difference in mean	Confidence interval	p-value	Statistical significance
Assessment of knowledge- pre- and post-workshop without negative marking	+0.29	0.79 to 0.22	0.2487	Not significant
Assessment of knowledge pre- and post-workshop with negative marking	+ 0.76	1.40 to 0.12	0.0224	Statistically significant
Assessment of application without negative marking	+1.19	1.83 to 0.55	0.0009	Extremely significant
Assessment of application with negative marking	+1.95	2.99 to 0.92	0.0008	Extremely significant

To explore individual questions and measure the gain in specific domains, a Wilcoxon signed rank test was used. It was found that there was a significant gain in questions relating to peri-operative care in diabetic patients, initiation of insulin infusion, and understanding the options of insulins available for prandial use (Table 20)

Table 20 Score without negative marking

Diabetes management questions	Score without negative mark		
	Pre-workshop Median, IQR, (Min-Max)	Post-workshop Median, IQR, (Min-Max)	P value
Knowledge of insulins used as prandial insulin	1, 1-1, (0-3)	1, 1-1, (1-3)	**0.08**
Knowledge of which insulins to withhold when fasting	1, 1-2, (1-2)	2, 1-2, (0-2)	0.21
Knowledge of when prandial insulin is used	0, 0-1, (0-1)	0, 0-1, (0-1)	0.56
Application- discharge medication planning in diabetes	2, 1-2, (1-2)	1, 1-2, (1-2)	0.10
Application- Peri-operative insulin use	0, 0-1, (0-2)	2, 1-2, (0-2)	**<0.001**
Application- Peri-operative metformin use	0, 0-0, (0-1)	0, 0-0, (0-1)	0.99
Application- Initiation of basal bolus insulin regimen	1, 1-1, (0-1)	1, 1-1, (1-1)	**0.03**

Maximum and minimum correct scores are 3 and 0 respectively. No negative mark for wrong answer. IQR, Interquartile range; P values are based on Wilcoxon signed rank test.

This significant gain in knowledge of insulins used as prandial insulin, and application of skills in managing peri-operative insulin use was seen, even when negative marking was used (Table 21).

Table 21 Score with negative marking

Diabetes management questions	Score with negative mark		
	Pre-workshop Median, IQR, (Min-Max)	Post- workshop, IQR, (Min-Max)	P value
Knowledge of insulins used as prandial insulin	1, 0-1, (-1-3)	1, 1-1, (1-3)	**<0.01**
Knowledge of which insulins to withhold when fasting	1, 1-1, (0-2)	1, 1-2, (-1-2)	0.35
Knowledge of when prandial insulin is used	-1, -1-1, (-1-1)	-1, -1-1, (-1-1)	0.56
Application- discharge medication planning in diabetes	1, 1-1, (0-2)	1, 1-1, (0-2)	0.18
Application- Peri-operative insulin use	-1, -1--1, (-2-1)	1, 1-2, (-2-2)	**<0.001**
Application- Peri-operative metformin use	-1, -1-0, (-1-1)	-1, -1--1, (-1-1)	0.73
Application- Initiation of basal bolus insulin regimen	1, 0-1, (-2-1)	1, 0-1, (0-1)	0.10

Maximum and minimum correct scores are 5 and -3 respectively. Negative mark for wrong answer. IQR, Interquartile range; P values are based on Wilcoxon signed rank test

6.4 ASSESSMENT OF TEACHING - THE INTERVENTION

6.4.1 THE CONTENT

The case based workshop was evaluated for the content delivered. All the participants' responses for those who completed the questionnaire were included in this analysis. Hence, 23 pre-workshop responses and 24 post-workshop responses were included. Each respondent could choose more than one response, or not answer individual questions.

Pre-workshop, the participants were questioned as to what aspect of their knowledge of in-patient diabetes management they would like to enhance through their participation. Figure 17 shows the common themes that were expressed by the participants.

- Peri-operative management
  - Management in fasting patients
  - Peri-operative control of blood sugar
- Oral agents
  - Types
  - When to increase oral agents or switch to insulin
- Acute issues
  - Management of hypoglycaemia
  - DKA management
- In hospital care of diabetic patients
  - When to commence basal bolus insulin
  - When to initiate insulin
  - Insulin infusions

Figure 17 Learning needs identified by participants prior to the intervention

Post-workshop, participants responded to the query of whether the workshop addressed the learning objectives it set out to achieve, as referred to in Table 14 (page 63) in Chapter 5. Overall, the overwhelming response was that the workshop accomplished what it set out to do. The response of the participants is summarised in Table 22.

Table 22 Evaluation of workshop- Did the workshop achieve its preset learning objectives ?

Objective	N=24
Main objectives:	1 voted for the overall objective
Manage diabetes in-patients' peri-operatively	22
Start and cease an insulin infusion	22
Start and titrate basal bolus insulin regimen	21
Ensure optimal discharge planning in diabetic inpatients	21
Secondary objectives:	2 voted for the overall objective
Briefly describe the types of insulin	21
Understand peri-operative management of metformin use	22
Use hospital based in-patient basal bolus and insulin infusion charts	22

Post workshop, the participants were questioned about what aspect of their practice would change as a consequence of attending the workshop. Their comments have been summarised in Figure 18. These reflect that most of the personal learning needs as well as the pre-stated learning objectives of the participants were covered in the workshop.

- Basal bolus insulin (BBI)
  - Adjusting and titrating off (sic) basal bolus insulin regimen
  - More confidence altering BBI
  - Starting-titrating basal bolus insulin
  - Basal bolus charting
- Insulin infusion
  - Indications for insulin infusion
  - More willing to start insulin infusion
  - Use insulin infusions more comfortably
  - Consider insulin infusion more readily
- Peri-operative care
  - Pre-operative insulin
  - More confident re managing pre- & post-op insulin requirements
  - Metformin use
  - Continuing metformin for day/minor procedures
- Discharge planning
  - Better d/c planning
  - Discharge planning
  - When to call endocrine registrar
  - When to consult endocrine team

Figure 18 Summary of learning needs addressed by the intervention

When participants were provided with the option of open comments and asked if the workshop addressed their personal learning objectives, twelve responses were provided; ten responded in the affirmative, and two suggested they wanted more detail. The specific affirming comments included learning about diabetes management in elderly as opposed to adult patients, management of diabetes in pregnancy, usage of insulin infusion and basal bolus insulin, and pre-operative metformin use and acute management of hyperglycemia. Two respondents sought more learning in the management of DKA.

6.4.2 THE PROCESS

The process of education delivery through the workshop was also evaluated and results shown in Table 23. In response to pre-workshop preferred method of learning 13 respondents chose face to face workshops while 12 chose lectures. The other responses included online modules, bedside learning and even ‘dinner seminars at a good restaurant with wine and a good band ☺’.

Table 23 Preferred methods for learning and teaching

Preferred mode	N=23
Lectures	12
Online modules	4
Face to face work shops	**13**
Other- please give details	Bedside Dinner seminars

Participants then replied to what other incidental learning they had received pre-workshop which had helped them manage diabetes well (Table 24). Bedside ward-based learning was stated predominantly as the means of incidental learning.

Table 24 Incidental teaching at workplace

Learning received	N=23
Bedside ward based learning	**16**
Simulation sessions	7
Other- please give details	1-Med school

Post workshop the participants were asked to provide feedback on the process through free comments. The overwhelming response was that the workshop was an excellent vehicle for education delivery. Some respondents requested this to be done earlier in the year, referring to the time they started in their position as interns. Some of these comments are listed below:

"Excellent! very informative"
"Yes awesome"
"Very useful"
"Excellent workshop"
"Excellent …… earlier in year please!"
"Very good session"

6.5 SUMMARY

The case based workshop for the interns performed well as an educational intervention targeting the learning needs of junior doctors in managing diabetes among patients admitted to hospital. It successfully addressed the confidence levels of the interns, while also improving their competence in both the domains of knowledge and application. The error rate in clinical judgement was measured and found to be reduced following the intervention. Whether this translates into clinical practice is unknown through this study, as was beyond the scope of this project. It however warrants further investigation. The design and mode of

delivery of the workshop, together with the customised content aided in achieving the learning objectives successfully.

6.6 Conclusion

This chapter presented qualitative and quantitative data regarding a case based workshop designed to address the learning needs of junior doctors that were identified as outcomes of phase one of the project. Analysis of the data suggested a significant gain in learning and successful design and delivery of the educational intervention. This chapter concluded the final phase of the educational intervention. The final chapter will draw the study to conclusion, and look at future directions for this project.

CHAPTER 7: CONCLUSION OF STUDY

7.1 INTRODUCTION

The research questions that were being investigated by this study were:

- What are the learning needs of junior doctors in diabetes related knowledge and skills for managing hospitalised patients with diabetes?
- What are effective means to deliver an educational intervention to address these learning needs?

To address these questions, a tri-phasic, mixed method, educational design-based study was conducted, targeting prevocational trainees working within the SALHN in the first two years following completion of a university medical degree. The three phases of the study were 1) Learning needs analysis, done through questionnaires and focus groups; 2) Design and development of a customised educational intervention and an assessment tool; and 3) Delivery of the intervention and evaluation of the outcomes. The chapter will draw the study to conclusion and set out future directions for this project.

7.2 PHASE 1: LEARNING NEEDS ANALYSIS

The first phase of the study involved collecting data on the educational needs of junior doctors related to the management of diabetes among inpatients. Preferred methods of education delivery were also explored, as was the perception of junior doctors of their own educational needs and whether this differed or concurred with the view held by faculty. A mixed qualitative and quantitative format of research was employed to collect data using a customised questionnaire and focus group discussions. This combined approach was found to be useful in answering the question this study raised about learning needs of junior doctors, from a number of perspectives. A total of 59 completed questionnaires were received and analysed. These comprised of 41 responses from junior doctors and 18 responses from faculty. A total of 4 focus group sessions were run, with participants drawn from individual cohorts within SALHN: 1) PGY1 focus group at FMC, 2) Combined PGY1 and PGY2 focus group at NHS, 3) Endocrine Department faculty focus group at FMC and 4) Combined faculty and junior doctor focus group with participants from the Department of General Medicine at FMC. One participant undertook a semi-structured individual interview.

7.2.1 MAIN CHALLENGES IN MANAGEMENT OF DIABETES, SPECIFICALLY AMONG INPATIENTS

The consistent response from junior doctors and faculty was that transitions in diabetic therapy in hospital were the most significant challenge for junior doctors to efficiently deliver safe patient care to diabetic inpatients. Transitions in diabetic therapy refer to the changes in diabetic medications adopted in sick patients admitted to hospital, with the aim to manage their acute variations in blood sugar levels when they are unwell. Following recovery, the patients are then transitioned back to their usual medications while attempting to optimise their regimen. This was found to be the most challenging aspect of inpatient management of diabetes. The other challenges which were highlighted by the study include: 1) lack of knowledge of the different types of insulin and their varying uses and pharmacokinetic profiles, 2) the lack of adequate time and resources to provide comprehensive diabetic care, and 3) lack of easy access to guidelines and protocols.

7.2.2 EDUCATIONAL NEEDS

This project sought to identify the learning needs of junior doctors as part of its initial phase. Respondents were asked to classify all educational needs into pre-determined levels of importance: 1) Critical defined as knowledge imperative for safe practice, 2) Core defined as important knowledge but that which could be gained over time, 3) Non-core defined as useful information but not imperative for safe practice and 4) Specialist knowledge defined as knowledge of more complex nature that could be acquired with experience and further self-directed learning. This classification of learning needs is unique in the literature that pertains to education of junior doctors in the field of diabetes management in hospitalised patients. It provides a framework for structuring the educational intervention and for rationing scarce resources, helping to channel these into areas, which are critical.

When considering learning needs pertaining to basic knowledge, it was found that the knowledge of concepts of insulin therapy and basal bolus insulin, as well as knowledge of stress hyperglycemia were considered critical educational needs. Knowledge of basic diabetic concepts such as diagnostic criteria, oral hypoglycemic agents, types of insulins and their varied pharmacokinetics were considered as core educational needs, implying that these concepts was important for basic management of diabetic issues in hospitalised patients but could be learned by junior doctors overtime.

The project then explored learning needs of junior doctors in the area of practical application of knowledge. This was studied within the various domains of inpatient management of diabetes that were defined at the outset. A majority of respondents among junior doctors and faculty had similar views on the level of importance of various learning needs explored in the first phase of this project. These are summarized below in Table 25. Knowledge of how to manage hypoglycemia, DKA, HONK and Gestational diabetes was considered critical. Knowledge of diagnostic criteria for diabetes, oral anti-diabetic medications, inpatient targets of diabetes management, sick day management, prevention of DKA, pre-hospital care of ketosis, peri-operative insulin therapy, transitions in therapy during admission, management of in hospital hyperglycemia, secondary diabetes management and inpatient/ outpatient referral was considered to be core knowledge.

Table 25 Questions that elicited the same response from faculty and junior doctors

Questions	Response of the majority of participants
Main challenges faced by junior doctors in hospital based diabetes management	Transitions of care
	Insulin management- knowledge of types of insulin and their profiles
Resources that will be of assistance to junior doctors in diabetes management	Clinical practice guidelines, algorithms, protocols for patient management in specific scenarios
Modes of education delivery	Workshops designed to cover key concepts
	Case based discussions at forum/practical teaching session
Critical knowledge	Concepts of insulin therapy and basal bolus insulin
	Management of hypoglycaemia
	DKA management
	HONK management
	Gestational diabetes management
Core knowledge	Knowledge of diagnostic criteria for diabetes
	Knowledge of oral anti-diabetic medications
	Knowledge of inpatient targets of diabetes management
	Sick day management
	Prevention of DKA- pre-hospital care of ketosis
	Peri-operative insulin therapy
	Type 2- transitions in therapy during admission
	Management of in hospital hyperglycaemia
	Secondary diabetes management
	Inpatient Referral
	Outpatient referral

In some responses, however, there was dissimilarity in the opinions expressed by the majority of faculty and junior doctors (Table 26). This was relating to the concepts of stress hyperglycemia, management of newly diagnosed type 1 diabetes, insulin pumps and glucocorticoid-induced diabetes.

Table 26 Questions that elicited dissimilar responses from faculty and junior doctors

Concepts	Response of majority of Junior doctors	Response of majority of Faculty
Stress hyperglycaemia- knowledge of effect of acute illness in insulin requirement	Core knowledge	Critical knowledge
Management of newly diagnosed type 1 diabetes	Core knowledge	Critical knowledge
Insulin pumps management	Non-core knowledge	Specialist knowledge
Glucocorticoid induced diabetes management	Critical knowledge	Core knowledge

This is one of the first studies to have explored the similarities and differences between faculty and junior doctor perceptions of learning needs in diabetes management of hospitalised patients. Comparisons of faculty and junior doctor/medical student perceptions have been made in other areas of education such as clinical learning environments (Pinnock, Shulruf et al. 2011), geriatric education (Drickamer, Levy et al. 2006), beliefs about the ideal clinical teacher (Masunaga and Hitchcock 2010), and teaching and learning during night shifts (Bricker and Markert 2010), but none have explored this in diabetes related education. This study showed that, although junior doctors and faculty were viewing the issue of junior doctor education from totally different perspectives, their viewpoints were mostly congruent in what the majority of them considered to be critical or core learning needs. However, the incongruences are also important as ignoring these and surveying learning needs from only one cohort would adversely influence the design of the intervention, potentially excluding what could be critical knowledge.

7.2.3 Educational intervention options

When exploring preferred tools to deliver education, the resources considered to be the most valuable by the majority of respondents were clinical practice guidelines, algorithms and protocols for patient management in specific scenarios, with easy online access. Access to teaching sessions was also considered to be valuable by a predominant group of respondents. Respondents considered case based discussions at a forum or practical teaching sessions as

the most valuable means of delivering knowledge to junior doctors. This was followed by a preference for workshops to cover key concepts and finally lectures/presentations to a group.

On delving deeper into which methods of education were best suited for which educational concepts, it was found that junior doctors considered the initiation of basal bolus therapy (when and how to start therapy) and transition back to the patient's own medications at discharge, were best covered in a case based discussion. Junior doctors considered that basics of diabetes knowledge, management guidelines and education on newer anti-diabetic agents were concepts that could be taught best through lectures. On the other hand, faculty considered that engaging a large group in the same time frame was best achieved through lectures and opined that clinical principles and management of diabetes including concepts of why it matters to control blood sugar levels and rationale for up-to-date management and peri-operative management of diabetes were concepts which could be addressed best by lectures. The incongruence in the response of junior doctors and faculty is interesting in the analysis of this question. While the junior doctors expressed a preference for more practical interactive forms of educational intervention for learning practical skills, faculty looked at the logistical advantage of lectures, which enable covering more material in a shorter amount of time. The junior doctors did opine on the usefulness of lectures in acquiring knowledge as opposed to skills. Blended learning formats are known to be useful in addressing these divergent views and needs (Lotrecchiano, McDonald et al. 2013). Blended learning is the integration of traditional teaching methods such as lectures or on-site teaching with other non-traditional methods such as case based learning and online learning, with the intent to create a more flexible curriculum which caters to the learning needs of a diverse group of students, while also being realistic in the resources employed to deliver education (Dent and Harden 2013 p160). Although this was beyond the time and scope of the present study, future iterations are intended to incorporate a blended learning format for greater impact and reach.

7.3 Phase 2: Design and development of a customised educational intervention and assessment

Content and delivery of educational intervention

As part of this project, a case based workshop was chosen as the educational intervention and was designed as a step-wise supported learning process. This form of educational intervention was chosen to aid the development of the skill of clinical reasoning. Based on the outcomes of the first phase (learning needs analysis), the focus of the workshop was

designed to be on management of transitions in diabetes management of patients admitted to hospital. Critical educational needs that were identified in phase 1 were incorporated into the workshop. This included knowledge of types of insulin, basal bolus insulin protocol, stress hyperglycemia and perioperative management of patients with diabetes. Clear learning objectives were set and a true patient's case with de-identified details was chosen. The clinical details were modified where appropriate for learning purposes, to incorporate the learning objectives. The patient's case was presented in stages, covering specific learning themes that were tackled through related assessment tasks and management tasks relevant to the stage.

ASSESSMENT AND EVALUATION- DESIGN AND DELIVERY

The process of assessment of learning evaluated changes in participant competence and confidence with respect to the listed learning objectives. A written assessment method involving pre- and post-intervention questionnaires was designed and used along with the educational intervention. The logistical advantages offered by the written assessment made this an attractive format for the case based workshop (Dent and Harden 2013 p290). A variety of question formats were incorporated in the questionnaire to overcome the individual disadvantages while preserving the inherent advantages offered by each format. A robust system of assessment incorporates different test methods each of which addresses a specific purpose (Dent and Harden 2013 p299). To assess learning, both context free questions to test important factual knowledge and context rich questions to test clinical reasoning with a multiple-choice answer format (response) were used. While it is hard to obtain an exhaustive assessment of learning through a single assessment in a specific point in time, combining different question formats again provided for a better and comprehensive assessment (Dent and Harden 2013 p305). The assessment of teaching was done to evaluate the educational intervention in terms of both content and delivery. A programme-oriented evaluation was chosen to comprehensively measure the performance of the educational intervention, the participant's performance and the content and delivery of the teaching method. Assessment of the intervention is a means of evaluating the teaching method used and the effectiveness of the workshop (Goldie 2006). The main purposes of evaluating a programme are to ensure knowledge transfer has effectively occurred, to be accountable for the resources used and to fuel future development (Goldie 2006). The tools used for evaluation of the intervention were pre- and post-intervention questionnaires, which provided the basis for assessing the pre-stated purpose of the project.

7.4 Phase 3: Delivery of the educational intervention and evaluation of the outcomes.

The case based workshop was held at the Flinders Medical Centre. This was attended by 29 interns. Twenty-one participants completed both pre- and post-test questionnaires.

7.4.1 Outcomes of assessment

Assessment of learning

None of the respondents reported a high level of confidence prior to the workshop. Only 67% of them felt comfortable with managing diabetes while 29% reported lacking confidence and 4 % reported they avoided managing diabetes altogether. Following the workshop 100 % of respondents reported feeling more confident about handling diabetes. A significant gain in confidence was observed in every domain evaluated, and the maximal benefits were observed in the domains of peri-operative management of diabetes, and starting and ceasing insulin infusion, which were the focus of the case based workshop.

The overall numbers of respondents, who had a gain in their score as a measure of competence evident following the intervention, was more in the domains relating to application of skills than in the knowledge domains. When scores were re-calculated with negative marking, it was found that there was a significant reduction in erroneous assumption in the knowledge domains with a significant gain in score post-intervention. On assessment of individual scores of each participant, an increase in the mean scores across both knowledge and application domains, with and without negative marking was observed with the greatest change being in the domains relating to application skills. Scores incorporating negative marking again revealed, that the error rate was significantly reduced in both the knowledge and application domains but participants also made the maximum error in the domain of application pointing to an increasing confidence. There was a statistically significant gain in knowledge and application skills, and more specifically, there was a statistically significant gain in scores from questions relating to peri-operative care in diabetic patients, initiation of insulin infusion, and understanding the options of insulins available for prandial use was found. The gains in knowledge and skills when taken together with the gain in confidence showed a marked divergence. The gain in confidence in all domains was greatly higher than the more objective gain in scores pertaining to knowledge and skill. This pattern of junior doctor performance reflects what is called the ‘Dunning Kruger effect’, which describes the correlation between self-assessment and individual performance (Kruger

and Dunning 1999). As defined by Dunning and Kruger (1999), this effect reflects the proposition that incompetent participants will fail to recognize their lack of skill and knowledge. People with lesser competence, such as doctors in the early phase of their careers, have lower insight into their inabilities but greater and misplaced confidence (Kruger and Dunning 1999). With growing experience and competence comes an initial lack of confidence, which is later replaced by confidence and competence as evident in the expert learner. This pattern of confidence more than competence was evident in this project.

EVALUATION OF THE INTERVENTION- CONTENT AND DELIVERY

The overwhelming response was that the workshop accomplished what it set out to do as predetermined by the learning objectives. Analysis of the pre- and post-intervention questionnaires revealed that most of the personal learning needs self-identified by the participants were covered in the workshop, endorsing the content of the workshop. Evaluation of the process of education delivery through the workshop also unanimously elicited a very positive response, with participants requesting this workshop be run earlier in the year when junior doctors start their rotations. While it is reassuring that the intervention achieved its stated purposes the evaluation also provided impetus for future iterations.

7.5 DESIGN PRINCIPLES

The educational design-based research design afforded design principles, which can be adopted in more general settings. Firstly, within the Australian context it provides a framework for developing educational interventions in different chronic diseases which impact hospitalised patients, such as hypertension. Second, it sets forth a stepwise process for developing these interventions, such as undertaking 1) a learning needs analysis process incorporating various stakeholders and end users, 2) a customized learning tool and 3) pre- and post-intervention assessment and evaluation tools. It helps streamline the process into clear phases that flow into the subsequent phase smoothly. Finally, the prioritization of learning needs also enhances the usefulness of the learning needs analysis, helping consequently to increase the impact of the intervention directing resources to where they are needed most.

7.6 LIMITATIONS OF STUDY

The project was ambitious in its design with limited resources at hand, however achieved significant gains. The scope of the project was limited to a single iteration and a single mode of education delivery due to the constraint on time and resources. This limited the ability to

refine and redeliver the intervention and assess iterative outcomes. The project also did not assess the real-life impact of the intervention in terms of clinical outcomes within the workplace as a direct consequence of the intervention. While this would be valuable information, the difficulties presented by dynamically shifting clinical scenarios at the workplace and multiple other variables such as influence of nursing and allied health staff on diabetes management, need for significant resources, need for institutional commitment and the complexity of establishing a true cause and effect, make it impractical (Kirkman, Sevdalis et al. 2015, Moodle 2017). Finally, this was a study, which focused on a defined cohort of junior doctors and did not include a control group for measuring differences. It is therefore impossible to dissect out any difference in the benefits of variable approaches. With this in mind, the study does not answer the question whether knowledge delivered through targeted methods after an intense learning needs analysis is superior to any other form of knowledge delivery, such as that which is accessible at the workplace (e.g. lectures and tutorials). However, it provides a strong foundation for future iterations that can include comparison with other forms of education delivery within the workplace

7.7 Future directions

Future iterations are planned to build on the outcomes of the learning needs analysis and create a suite of resources for blended learning. As a first step the learning needs survey questionnaire is planned to be refined to aid in the ease of analysis, using pre-existing tools and questionnaire software such as Survey Monkey (Survey Monkey 1999). This will then provide input into an online digital based course, using a learning management system such as Moodle (Moodle 2017) that will offer pre-learning prior to case based workshops. Resource allocations will define the extent to which the time intensive workshops will be run. The online course will be run through a workplace based portal and aim to cover a broad range of relevant topics and offer this as a suite of options to the junior doctors with an option to tailor it to their own specific learning needs. To measure the clinical outcomes of the intervention, future iterations can explore the impact on junior doctor practice by evaluating the frequency of diabetes related adverse events recorded in the hospital for time periods preceding and following the intervention, and thus measure change. This would be logistically achievable with limited resources due to the presence of existing adverse event recording systems within the health service. However, it will only be of value if the entire cohort of junior doctors participate in the workshop. This would need administrative will for implementation and is worth pursuing for the multiple benefits that could potentially be

reaped. The educational intervention was successful in increasing confidence more than competence in diabetes related skills. To attempt to increase competence, future iterations could explore blended learning formats with provision for active learning, provided resources are available to deliver the same. Resource allocations would need to incorporate both time for the educational researcher to develop a future iteration as well as an administrative will to provide protected time for junior doctors to access learning.

7.8 Conclusion

Diabetes mellitus is well recognised as a complex challenging disorder to manage among hospitalised patients, and the prevocational junior doctor lacks confidence, knowledge and skill to manage this effectively. Educational needs identified from our cohort of junior doctors resonated with those that have been widely recognised in literature. The customized case based workshop was successful in addressing the learning needs identified through the initial phase of the study. This project set out to achieve a clearly defined set of goals and was largely successful in doing this within the limits of resources and time. Further iterations will refine the process and aim to deliver a blended format of learning with traditional and non-traditional teaching methods.

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APPENDICES

APPENDIX A -INTRODUCTORY LETTER

Dear Interns / General trainees,

As a first step, to assess the training needs in this area and to assist with the development of this intervention I would like to invite 10 volunteers to participate in a focus group type of discussion. The aim is to identify critical knowledge and practical skill areas that you would like targeted and the best means of delivering this education. This is planned as a session of about an hour's duration starting with filling out a questionnaire, which will take about 10 minutes.

The focus group will be held on _____

Kind regards,
Shantha Joseph,
Medical Education registrar,
Flinders Medical Centre

To faculty

Dear _____ (Endocrinologist/ Physician /DNE/Registrar),

In my role as the Medical Education registrar, TMO Unit, I am attempting to develop an educational intervention to teach junior docs the intricacies of inpatient management of diabetes (for PGY1 -post graduate year 1 and PGY2 - post graduate year 2, working in SALHN -Southern Adelaide Local Health Network). As a first step, to assess the training needs in this area and to assist with the development of this intervention I would like to invite you to participate in a focus group type of discussion. The aim is to identify critical knowledge and practical skill areas that you would like targeted and the best means of delivering this education. This is planned as a session of about an hour's duration starting with filling out a questionnaire, which will take about 10 minutes.

The focus group will be held on _____

Kind regards,
Shantha Joseph,
Medical Education registrar,
Flinders Medical Centre

APPENDIX B- QUESTIONNAIRE FOR NEEDS ANALYSIS

We would be grateful if you would complete and return this questionnaire. The aim is to identify the skills that are expected of PGY1 and PGY2 doctors to manage patients admitted to Flinders Medical Centre. This analysis of needs is a first step in a series of interventions planned to enhance the training of junior doctors in managing diabetes and related issues in the hospital setting.

Background-

Prevalence of Diabetes is high among inpatients.
Diabetes impacts multiple areas of care.
Junior doctors are the first direct interface with patients.
Junior doctors need to be in tune with Hospital protocols and guidelines in managing these patients effectively

The responses to the questionnaire will be de-identified and will be used to generate trends, so that the confidentiality of the respondent will be maintained.

The questionnaire takes 10 minutes to complete

- To check or uncheck a box ☐ – double click on the box to open a window 'Check box options'. Under the option 'Default value', choose checked or unchecked.
- To fill in the boxed spaces [ ] - double click on the box and once the cursor appears, type in your response.
- Once the questionnaire is completed please save the file with your responses and return it as an attachment by e-mail to shantha.joseph@health.sa.gov.au

Thank you for your time and interest in helping with this survey.

Overview of the questionnaire

The following tables are used in the questionnaire.

Table 1

The aim of this table is to ascertain what you would consider as important areas of instruction. They are under the headings of

- **Critical knowledge**- Absolutely important to know -dangerous if the junior doctor does not know this
- **Core knowledge** - important for basic know how and management
- **Non- core knowledge**- nice to know but not absolutely important to know
- **Specialist knowledge**- doctor can learn if interested- Self directed learning

Table 2

The aim of this table is to ascertain what you would consider as important areas of improvement. They are under the headings of

- **Well managed** currently- no need for further improvement
- **Average**- needs some ongoing reinforcement but overall okay
- **Poorly managed** – need to intervene seriously

The questionnaire is organised into different parts as stated below.

Background information

Section 1 deals with newly diagnosed diabetic

Section 2 deals with type 1 diabetes patients

Section 3 deals with type 2 diabetes patients

Section 4 deals with special situations

Section 5 deals with basic knowledge/principles

Section 6 deals with insulin therapy

Section 7 deals with in-patient targets of diabetes management

Section 8 deals with hypoglycaemia management

Section 9 deals with hyperglycaemia management

Section 10 deals with referral/ handover - Who to call for help

1. Background information

a) Primary site of practice- FMC, NHS, RGH

Others (specify)

b) Proportion of time managing inpatients - %

c) Proportion of inpatients with diabetes as main issue of care - %

d) Proportion of inpatients with diabetes as co-existing issue - %

e) Proportion of inpatients with diabetic complications as main issue - %

f) Level of training-

- Nurse ☐
- Registrar ☐
- General physician ☐
- Endocrinologist ☐
- Other (specify)

2. **What do you think are the main challenges in management of diabetes, specifically among inpatients?** (check >1 box if applicable)
   a. Keeping abreast of advances in diabetes management ☐
   b. Time to provide comprehensive diabetes care ☐
   c. Lack of easy access to guidelines and protocols ☐
   d. Lack of knowledge of who to call for help ☐
   e. Variability of patient presentation and profiles ☐
   f. Insulin management- knowledge of types of insulins and their profiles ☐
   g. Transitions of care- i.e. how to start patients on insulin from oral agents, start new medications in hospital, swap back to usual medications at discharge ☐
   h. Other

Comment

3. **What resources do you think will be of assistance to junior doctors in diabetes management**?

a. Clinical practice guidelines /algorithms/protocols for patient management in specific scenarios ☐
b. Easy online access to these above guidelines ☐
c. Regular electronic updates on diabetes management online ☐
d. Access to teaching sessions ☐
e. Other ☐

Comment

4. **What is the best way to deliver knowledge and deal with these challenges?**

a. Lecture/ presentations to a group ☐

i) which concepts would be best taught as lectures

Comment

b. Online tutorial with reference to handy guide☐

i) which concepts would be best taught online

Comment

c. Workshops with discussion of case scenarios designed to cover the concepts chosen☐

i) which concepts would be best taught as part of a workshop

Comment

d. Case based challenges brought by junior doctors and presented at a forum/ practical teaching session☐

i) which concepts would be best discussed at a forum

Comment

5. Other options- Simulation☐ standardised patient,☐ refresher courses ☐

Section 1 deals with newly diagnosed diabetics

1) Patient diagnosed with diabetes for the first time

Well managed	Average	Poorly managed
☐	☐	☐

2) Depending on clinical presentation
   a) Knowledge of what to do in a patient who presents with high BSL for the first time

      i) Baseline management- insulin, oral agents

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

      ii) Investigations-Which tests need to be ordered

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

      iii) Clinical handover-Which services to refer patient to-i.e. Endocrine department- outpatient/inpatient, Diabetes nurse educators- outpatient /inpatient ,Dietician

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

b) Identifying that a patient has Diabetic ketoacidosis (DKA) or Hyperosmolar non ketotic state (HONK)

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

c) Knowledge of what to do in a patient who presents with DKA?

i) Baseline management- fluids, insulin, potassium

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

ii) Identifying the unwell patient- markers of critical illness

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

iii) Referral- who to refer patient to and when- referral criteria

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 2 deals with Type 1 diabetic patients

(Some parts of this section dealing with insulin therapy are relevant to Type 2 diabetic patients who are on insulin

1) Patient presenting with an episode of DKA

Well managed	Average	Poorly managed
☐	☐	☐

2) Patient with Type 1 diabetes admitted for other reasons – other than DKA

Well managed	Average	Poorly managed
☐	☐	☐

3) Knowledge of usual daily insulin requirements in patients with type 1 diabetes

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

4) Concepts of basal and bolus insulin, importance of continuing basal doses

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

5) Sick day management

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

6) Medic-alert bracelet

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

7) Knowledge of preventing diabetic ketoacidosis

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

8) Insulin pumps(continuous subcutaneous insulin infusion pumps- CSII) management

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

9) Managing insulin therapy in specific situations (e.g. fasting before surgery)

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 3 deals with Type 2 diabetes patients

1) Transitions in therapy while admitted in hospital

Well managed	Average	Poorly managed
☐	☐	☐

a) Knowledge of when to continue oral agents and which ones to discontinue in specific situations

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

b) Knowledge of when to start insulin (knowledge of transition to insulin therapy)

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

c) Knowledge of how to transition back to oral agents

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

2) HONK- hyperosmolar non ketotic state

Well managed	Average	Poorly managed
☐	☐	☐

a) Diagnosis

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

b) Management

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 4 deals with Special situations

1) Glucocorticoid-induced diabetes

Well managed	Average	Poorly managed
☐	☐	☐

2) Specific management issues

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

3) Knowledge of when to call for help

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

4) Gestational diabetes

Well managed	Average	Poorly managed
☐	☐	☐

5) Specific management issues

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

6) Knowledge of when to call for help

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

7) Secondary diabetes

Well managed	Average	Poorly managed
☐	☐	☐

8) Specific management issues

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

9) Knowledge of when to call for help

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 5 deals with basic knowledge/principles of diabetes

1) Knowledge of diagnostic criteria

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

2) Knowledge of different oral anti-diabetic agents- their mode of action, contraindications and possible serious side effects

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

3) Knowledge of types of insulin and different insulin preparations- their pharmacologic properties, handling their application

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 6 deals with Insulin therapy

1) Insulin therapy in hospitalised patients

Well managed	Average	Poorly managed
☐	☐	☐

2) Basic components of insulin therapy (i.e. basal, prandial and correctional insulin) and their optimal handling

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

3) Calculation of total daily dose of insulin required

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

4) Knowledge of when to consider insulin infusion

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

5) Titrating/adjusting insulin therapy- strategy and doses

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

6) Knowledge of frequency of review of insulins- How often to review insulins

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

7) Knowledge of the effect of acute illnesses on insulin requirement

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

8) Knowledge of peri-interventional insulin therapy- Type 1 and Type 2

When to hold insulin doses and which ones to hold- e.g.- NPO before surgery/short procedure, pre-angioplasty /angiogram, Nasogastric feeds

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 7 deals with In-patient targets of diabetes management

1) Blood sugar level testing- What times to test blood sugars-in Type 1diabetic/Type 2 diabetic/ Gestational diabetic

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

2) Targets in all inpatients- Safe high and low levels

Special patient populations

Acute coronary care
Pregnant women
Very old or very young patients- or high risk from hypoglycaemia
Peri-operative
Acutely ill medical
Impaired consciousness,
Seizure disorder

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 8 deals with hypoglycaemia management

1) Management of hypoglycemia in hospitalised patients

Well managed	Average	Poorly managed
☐	☐	☐

2) Management of hypoglycaemia in conscious patient /unconscious patient

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 9 deals with hyperglycemia management

1) Management of hyperglycemia in hospitalised patients

Well managed	Average	Poorly managed
☐	☐	☐

2) One-off management of hyperglycaemia.
Routine management of patient or during cover shift/ after hours

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

Section 10 deals with referral/ handover

1) Who to call for help- DNE/ Endocrinology registrar

Well managed	Average	Poorly managed
☐	☐	☐

2) Referral procedures

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

3) When to call for help in the inpatient setting

Well managed	Average	Poorly managed
☐	☐	☐

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

4) Which of the following scenarios would you think is appropriate for inpatient referral

Type 1 diabetics with complications ☐

Newly diagnosed diabetic ☐

CSII/insulin pumps ☐

DKA ☐

HONK ☐

GDM ☐

Uncontrolled blood sugar levels ☐

Insulin infusion ☐

Peri-intervention insulin therapy ☐

ACS ☐

Comment – when do you think referral is inappropriate?

5) Referral to outpatient clinic- when , which clinic etc.

Well managed	Average	Poorly managed
☐	☐	☐

Critical knowledge	Core knowledge	Non- core knowledge	Specialist knowledge	COMMENT OR NO ANSWER
☐	☐	☐	☐	

APPENDIX C- PRE- AND POST-INTERVENTION QUESTIONNAIRES

Pre workshop questionnaire

This questionnaire is intended to stimulate your thinking and help you identify your learning needs. Please mark 'x' in the appropriate boxes for the following questions. There may be more than one correct answer for some of the questions

1. How comfortable do you currently feel managing diabetes in hospitalised patients in acute care settings

Very comfortable	Comfortable	Not comfortable	Avoid

2. Which of the following area in inpatient management of diabetes challenges you?

• Perioperative management of diabetes	
• Starting and ceasing insulin infusion	
• Starting and titrating basal bolus insulin	
• Discharge planning in diabetics	
• Basic knowledge/principles	
• Insulin types	
• In-patient targets of diabetes management	
• Hypoglycaemia management	
• Hyperglycemia management	
• Referral/ handover - Who to call for help	
• Other	

3. In a basal bolus regimen what insulins are commonly used as prandial insulin?

Novorapid= insulin aspart	
Humalog	
Apidra	
Actrapid	

4. When a patient is fasting which insulins needs to be withheld?

Prandial insulin	
Correctional insulin	
Basal insulin	
Mixed insulin	

5. The best time to provide prandial insulin is

At bed time	
30 minutes before eating	
At the time of eating	
30 minutes after eating	

6. If the HbA1c is 9.5% in a 60 year old patient admitted with acute coronary syndrome with a history of Type 2 diabetes treated by exercise and diet till admission, the options for treatment at time of discharge include

Consult the Endocrine team regarding management prior to discharge	
Start insulin infusion	
Choose an oral agent +/- insulin	
Refer to GP for diabetes care in the community	

7. In order to avoid complications, when a patient with type 1 diabetes is fasting for a major surgical procedure you should

Consult with the Endocrine team regarding management	
Cease all insulin and switch to insulin infusion	
Continue basal insulin	
Cease correctional insulin alone	
Start insulin infusion	

8. You are reviewing a patient in the pre-admission clinic planned for an elective day procedure in 2 weeks time. She is a known diabetic with HbA1C of 7.4 %. She is currently on metformin and Gliclazide. What advice would you give her about metformin?

Cease metformin 5 days before procedure	
Cease metformin 2 days before surgery	
Cease metformin on day of surgery	
Continue metformin	

9. You are reviewing a patient admitted overnight through the emergency department. He is a 48 y/o male with an 8 year history of DM and is currently admitted with pneumonia. His medications for diabetes are metformin and Gliclazide (sulfonylurea). His fasting BSL was 9.6 mmol/L. He reports his GP is happy with his diabetic control and mentions his most recent HbA1C is 8.4%.After a brief clinical evaluation and starting antibiotic therapy you have to decide on blood sugar management. Given this patient's history and laboratory values, what is the best treatment option for glycaemic management?

Continue oral anti-diabetic agents	
Continuous IV insulin infusion	
Sliding-scale insulin	
Twice daily mixed insulin	
Basal bolus regimen	

10. What aspect of your knowledge of current practice of in-hospital diabetes management you would want to enhance, through your participation today.

11. What is your preferred method of learning

Lectures	
Online modules	
Face to face work shops	
Other- please give details	

12. What other incidental learning have you received which has helped you manage diabetes well?

Simulation sessions	
Bedside ward based learning	
Other- please give details	

Any other comments/feedback you would like to give.

Post workshop questionnaire

This questionnaire is designed to inform you of your progress in achieving your learning needs and to help us fine tune this learning module.

1. Having finished the workshop today do you feel more comfortable/ confident managing diabetes in hospitalised patients in acute care settings

Yes	No	Comments

2. Which aspect of inpatient diabetes care do you feel a bit more confident about?

• Perioperative management of diabetes	
• Starting and ceasing insulin infusion	
• Starting and titrating basal bolus insulin	
• Discharge planning in diabetics	
• Basic knowledge/principles	
• Insulin types	
• In-patient targets of diabetes management	
• Hypoglycaemia management	
• Hyperglycemia management	
• Referral/ handover - Who to call for help	
• Other	

3. In a basal bolus regimen what insulins are commonly used as prandial insulin?

Novorapid= insulin aspart	
Humalog	
Apidra	
Actrapid	

4. When a patient is fasting which insulin needs to be withheld?

Prandial insulin	
Correctional insulin	
Basal insulin	
Mixed insulin	

5. The best time to provide prandial insulin is

At bed time	
30 minutes before eating	
At the time of eating	
30 minutes after eating	

6. If the HbA1c is 9.5% in a 60-year-old patient admitted with acute coronary syndrome with a history of Type 2 diabetes treated by exercise and diet till admission, the options for treatment at time of discharge

Consult with the Endocrine team regarding management	
Start insulin infusion	
Choose an oral agent +/- insulin	
Refer to GP for diabetes care in the community	

7. In order to avoid complications, when a patient with type 1 diabetes is fasting for an elective procedure you should

Consult with the Endocrine team regarding management	
Cease all insulin and switch to insulin infusion	
Continue basal insulin	
Cease correctional insulin alone	
Start insulin infusion	

8. 62 y/o male with a 3 cm thyroid nodule suspicious for papillary thyroid carcinoma is admitted for thyroidectomy. He has a 10 yr history of T2DM treated with metformin and sulfonylurea. BGL 14.4 mmol/L, HbA1C: 8.4% Normal TSH and Free T4. Given this patient's history and laboratory values, what is the best treatment option for glycemic management?

Continue oral anti-diabetic agents	
Continuous IV insulin infusion	
Sliding-scale insulin	
Basal bolus regimen – long + ultra rapid acting analogs	

9. You are reviewing a patient in the pre-admission clinic planned for an elective day procedure in 2 weeks time. She is a known diabetic with HbA1C of 7.4 %. She is currently on metformin and Gliclazide.
   What advice would you give her about metformin?

Cease metformin 5 days before procedure	
Cease metformin 2 days before surgery	
Cease metformin on day of surgery	
Continue metformin	

10. While on call at night on the EMTB you have been requested to review a pregnant patient, primigravida at 30 weeks' gestation admitted with ?preterm rupture of membranes. She has been given Celestone IM and her Blood sugar level is 9 mmol/L

Ask staff to monitor qid- not to worry about current level	
Continuous IV insulin drip	
Provide correctional insulin	
Basal bolus regimen – long + rapid acting analogs	
Consult on call Endocrine registrar	

11. 48 y/o male with an 8 yr history of DM admitted with pneumonia. Currently treated with metformin and sulfonylurea. Random BGL 14.4 mmol/L, HbA1C: 8.4%.After a brief clinical evaluation and starting antibiotic therapy you have to decide on blood sugar management. Given this patient's history and laboratory values, what is the best treatment option for glycemic management?

Continue oral anti-diabetic agents	
Continuous IV insulin drip	
Sliding-scale insulin	
Pre-mixed insulins	
Basal bolus regimen – long + rapid acting analogs	

12. Describe any aspect of your practice that you will change as a consequence of acquiring this knowledge in today's workshop

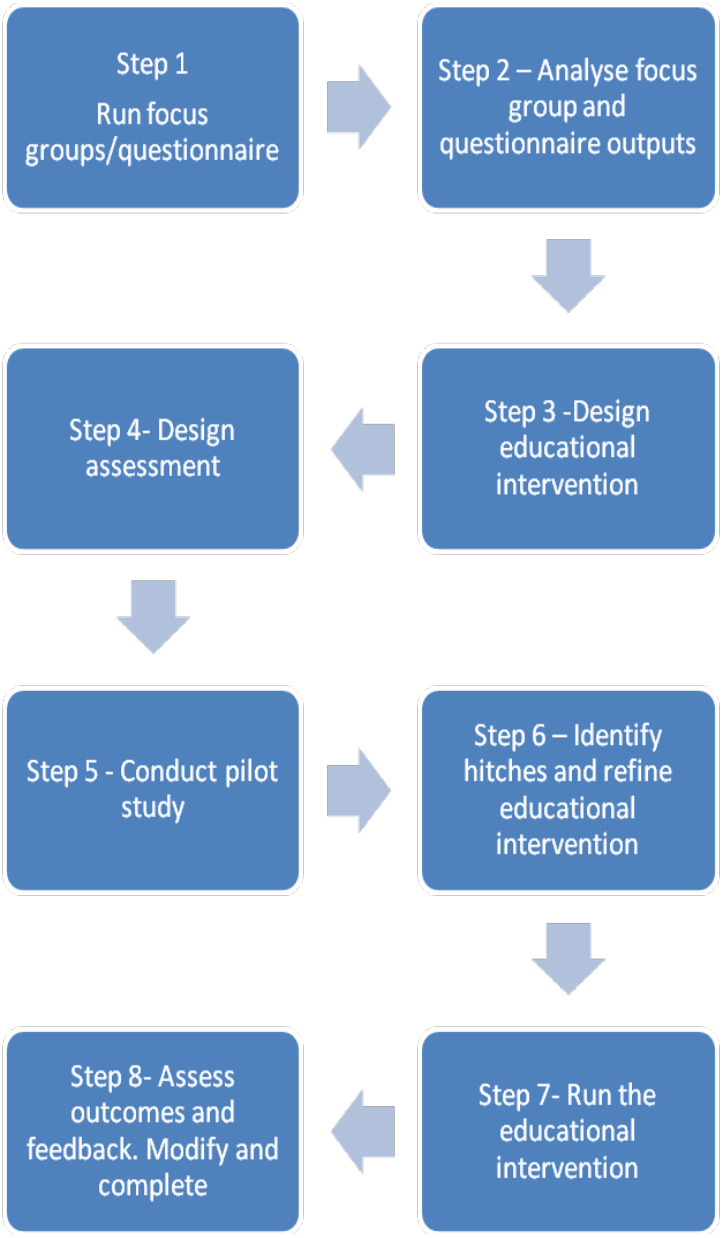
13. Did the workshop address the learning objectives it set out to achieve?

Main objectives:	
Identify abnormal blood sugar levels in acutely unwell patients	
Perioperative management of diabetes	
Starting and ceasing insulin infusion	
Titrating basal bolus insulin	
Discharge planning in diabetics	
Secondary objectives:	
Types of insulin	
Use of in-patient basal bolus and insulin infusion charts	

14. Did the workshop address your personal learning objectives-please specify if you can.

Any comments/feedback

APPENDIX D- PARTICIPANT INFORMATION SHEET



Commitments:

Focus groups are structured to run for an hour. For those participants who are unable to attend the focus group but would like to be involved, electronic version of the questionnaire can be filled and e-mailed to Shantha.Joseph@health.sa.gov.au. This questionnaire takes 10 minutes to complete.

The responses to the needs analysis questionnaire and the discussions in the focus groups, responses to the pre intervention and post intervention questionnaires will be de-identified and will be used to generate trends, so that the confidentiality of the respondent will be maintained. The electronic and hard copies of data will be accessible only to the team

involved and will be securely stored and password protected. The team involved in conducting this study includes:

Dr. Shantha Joseph
Medical Education Registrar,
Trainee Medical Officer Unit,
Flinders Medical Centre
Ph: 82045511, pager 48058

Dr. Linda Sweet
Senior Lecturer | Clinical Educator Development
Rural Clinical School | School of Medicine
Flinders University
Ph: 8204 5017

Dr. Julie Ash
Head, Health Professional Education Unit
Flinders Innovations in Clinical Education
School of Medicine, Faculty of Health Sciences,
Flinders University
Ph: 82045951

Dr. Steve Stranks
Director,
Southern Adelaide Diabetes & Endocrine Services,
Repatriation General Hospital,
Daws Road, Daw Park
Ph: 8275 1094

This study has been reviewed by Southern Adelaide Clinical Human Research Ethics Committee. If you wish to discuss the study with someone not directly involved, in particular in relation to policies, your rights as a participant, or should you wish to make a confidential complaint, you should contact the Executive Officer, Southern Adelaide Clinical Human Research Ethics Committee on 8204 4507 or email research.ethics@health.sa.gov.au

The research outcomes from this educational program will be submitted for a Master of Clinical Education- Research by Shantha Joseph through Flinders University School of Medicine, and are likely to be published in peer reviewed journals.

Contact Information:

If you have any questions regarding this study, or would like additional information about participation, please contact

Dr.Shantha Joseph
Ph: 82045511, pager 48058
Email: Shantha.Joseph@health.sa.gov.au

Handbook for workshop

Managing abnormal blood glucose levels in patients admitted into hospital

Learning outcomes

At the end of the workshop you will be able to

- Identify abnormal blood sugar levels in acutely unwell patients
- Describe how to start and cease an insulin infusion
- Describe how to start and titrate a basal bolus insulin regimen
- Manage diabetes peri-operatively in patients
- Evaluate optimal discharge planning in diabetic in-patients

You will also be able to:

- Describe the types of insulin
- Improve your use of hospital-based charts for diabetes management – by identifying appropriate charts for relevant clinical situations (e.g. basal bolus insulin chart).

Case

Stage 1

Learning theme- Stress hyperglycaemia and understanding of target blood sugar levels
Assessment tasks- Identifying abnormal blood sugar levels
Management tasks- Treatment options to achieve normal blood sugar levels (BSL)
Step-up task- Peri-operative metformin use
Step-ahead- Discharge planning
Links to knowledge - Target blood sugar levels in acutely unwell patients

78-year-old Mrs. F is admitted to hospital following a mechanical fall in her local shopping centre at 13:30. She is brought to the emergency department of Flinders Medical Centre, where she is admitted at 15:00 hours

She has sustained a fracture of her right neck of femur and is scheduled for emergency surgery at some stage in the next 24 hours. You are called to review her in the hospital for ordering some analgesia at 17:00 hours

Her co-morbidities include type 2 diabetes and hypertension, glaucoma and osteoporosis

Her current medications include

Metformin 1 gm twice daily
Lantus 34 units nocte
Perindopril /hydrochlorthiazide 5/1.25mg once daily
Caltrate 1 tablet daily
Vitamin D 1000 IU daily
Xalatan eye drops1 drop in each eye – once daily

On admission her blood sugar level is 15 mmol/l.

What would your first step be in assessing Mrs. F's BSL and managing it?

Assessment tasks

- Is this BSL a cause of worry?
    - What is the target BSL in Mrs. F?
- When is her insulin due?
- When is her surgery due?

Management tasks

- How can I bring her BSL down?
- Can she continue her metformin?
- Can she continue her lantus?

Step up

- Metformin and surgery- when would you need to cease treatment
- What is stress hyperglycemia? When do you need to treat this?

Step ahead

- In planning for her discharge what investigation would help you most with regards to her diabetes?

Links to knowledge - Target blood sugar levels in acutely unwell patients

Stage 2

Learning theme- Pre-operative care of diabetic patient
Assessment tasks- Blood sugar monitoring
Management tasks- Management of hyperglycemia
Step-up task- Setting up insulin infusions
Step-ahead- Referral and escalation of care
Links to knowledge – Types of insulin and 'Peri-operative diabetes management guidelines of the Australian Diabetes Society'

You are informed that her surgery is scheduled for 5:00AM the next day. While she is fasting for surgery what would you do to manage her diabetes?

Assessment tasks

- How often would the blood sugar need to be tested?

Management tasks

- What management strategies can be implemented to keep her blood sugar levels within targets? Which would suit her situation the best?
    - Insulin infusion/Basal bolus insulin/Correctional insulin

Step-up

How to set up and start an insulin infusion?

Step ahead

- Would she need escalation of her diabetic care?
- Who would you need to notify/ who can you call to ask for help?
    - Anaesthetists/ Endocrinologists

Links to knowledge –

- Types of insulin
- 'Peri-operative diabetes management guidelines of the Australian Diabetes Society'

Stage 3

Learning theme- Immediate post-operative care of diabetic patient
Assessment tasks- Clinical priorities in the immediate post-operative phase
Management tasks- Step-wise management of blood sugars in the post-op phase
Step-up task- Cessation of insulin infusions and transition to basal bolus insulin
Step-ahead- Basal bolus insulin
Links to knowledge – Management of hypoglycaemia

Mrs F is called in to theatre 16 hours from the time of admission and undergoes surgery.

Following return to the ward you are asked to review the patient by the ward nurses.

At the time of review she has the insulin infusion and IV dextrose running

Assessment tasks

- What would the immediate priorities for assessment be?
- Immediate post-op checklist-

    Pain management
    Bleeding
    Fluid status
    How good is her blood sugar control?

Management tasks

- What options would you have to manage her diabetes further?

Step up

Cessation of insulin infusion and transition to basal bolus

Step ahead

Initiation of basal bolus insulin in an acutely unwell patient as opposed to initiation in a person on insulin infusion

Learning links

Management of hypoglycaemia

Stage 4

Learning theme- Late post-operative care of diabetic patient, discharge planning, management of acute increases in blood sugar levels
Assessment tasks- target blood sugar levels relevant to this stage, stabilisation of blood glucose levels and optimisation of therapy
Management tasks- Options for management of hyperglycemia relevant to this stage and transition back to the patient's usual medications
Step-up task- Handover and discharge procedures
Step-ahead- Comprehensive diabetes checklist at time of discharge
Links to knowledge – Goals in outpatient management of diabetes

On day 4 post op she develops wound infection and her BSLs are elevated as shown in the attached document.

Assessment tasks

- What are the desired target levels for blood sugar at this stage?

Management tasks

- Options for management of hyperglycemia-What would you do now?

Step up

Basal bolus insulin management/ monitoring

On day 6 she is planned for discharge to a rehabilitation institute

Assessment tasks

- Is her blood sugar level stable and is her treatment optimised?

Management tasks

- How would you manage her diabetes now in preparation for discharge and handover?
    - Would you swap her back to her usual insulin and medications- would you alter the dose?
    - Add medications

Step Up

Handover to next team taking over care of patient- inpatient or GP
Discharge letter

Step ahead

Comprehensive diabetes checklist at discharge

Learning links

Goals for outpatient management of diabetes.

APPENDIX F- EXAMPLES OF WRITTEN ASSESSMENTS

Context free question with multiple correct responses

1. In order to avoid complications, when a patient with type 1 diabetes is fasting for a major surgical procedure you should

a)	Consult with the Endocrine team regarding management
b)	Cease all insulin and switch to insulin infusion
c)	Continue basal insulin
d)	Cease correctional insulin alone
e)	Start insulin infusion

2. In a basal bolus regimen, what insulins are commonly used as prandial insulin?

a)	Novorapid
b)	Humalog
c)	Apidra
d)	Actrapid

Extended matching questions (Royal Australasian College of Physicians 2015).

Example 1:
Option list:

A. Ankylosing spondylitis.
B. Aortic dissection.
C. Prolapsed intervertebral disc.
D. Lumbar spondylosis.
E. Vertebral fracture.
F. Intervertebral disc infection.
G. Pars interarticularis defect.
H. Metastatic malignancy.

Lead-in statement:
For each patient with back pain, select the most likely diagnosis.
Stems:
Question 1
A 23-year-old man has a 6-month history of lower back pain. His pain is predominantly at the thoracolumbar junction and in the right buttock. The pain is worse in the morning and he has difficulty in getting out of bed. There is some improvement during the day. An examination shows a restriction of lumbar spinal movement, particularly in lateral flexion.
Question 2
A 32-year-old lady presents with acute onset of lower back pain. The pain is constant and is not significantly affected by posture. All spinal movements are painful and difficult. Three weeks earlier, she had a urinary tract infection, which had been treated with Amoxicillin.

Key feature questions (Farmer and Page 2005) (Vin 2012).

Example 1

A 35-year-old mother of 3 presents to your office at 17.00 hours with complaints of severe, watery diarrhoea. On questioning, she indicates that she has been ill for about 24 hours. She has had 15 watery bowel movements in the past 24 hours, has been nauseated, but not vomited. She works during the day as a cook in a long-term care facility but left work to come to your office. On her chart, your office nurse notes a resting blood pressure of 105/50 mmHg supine (a pulse of 110/minute), 90/40 standing, and an oral temperature of 36·8 °. On physical examination, you find she has dry mucous membranes and active bowel sounds. A urinalysis (urine microscopy) was normal, with a specific gravity of 1·030.

Q1 What clinical problems would you focus on in your immediate management of this patient? List up to 3

Q2 How should you treat this patient at this time?
Select up to 3
1 Antidiarrhoeal medication
2 Antiemetic medication
3 Intravenous 0.9% NaCl
4 Intravenous 2/3–1/3
5 Intravenous gentamicin
6 Intravenous metronidazole
7 Intravenous Ringer lactate
8 Nasogastric tube and suction
9 Nothing by mouth
10 Oral ampicillin
11 Oral chloramphenicol
12 Oral fluids
13 Rectal tube
14 Send home with close follow-up
15 Surgical consultation
16 Transfer to hospital

Q3 After management of the patient's acute condition,
what additional measures, if any, would you take?
Select up to 4 or select #11, none, if none are indicated
1 Avoid dairy products
2 Colonoscopy
3 Enteric precautions
4 Gastroenterology consultation
5 Give immune serum globulin to patients at long term care facility
6 Infectious disease consultation

Example 2

Mr Smith is a 50 year old male and have been diagnosed with NIDDM for the last 5 years. He has just moved to the area and starts seeing you as his new Doctor. His most recent bloods show a HbA1c of 9%, Cholesterol of 6, TG 3, HDL 0.9, and LDL 3. His BP is 145/90. He smokes 10 cigarettes/day. His BMI is 30. He is currently taking Metformin XR 1000mg nocte, lipitor 40mg and ramipril 2.5mg/day

Question 1

What other investigation results would you like to find out in order to manage his condition more effectively at this point. Fill in up to 5 from the following list.

- TSH
- Renal function: creatinine clearance
- B12 and folate
- ECG
- Renal USS
- CK
- Urine 24-hour protein/albumin
- FBC
- MSU
- Chest Xray
- 24 hour BP result
- Liver function test
- Serum electrolytes
- Nerve conduction studies
- Renal doppler USS
- Cardiac echo
- Waist circumference

Question 2

What action would you consider?
List up to four (4) steps.

Question 3

What BP target are you aiming for in this patient assuming that there is no proteinuria?