A time-conscious, safety-focused exploration of two different nursing models in the rapid response service

By

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SUMMARY

Many acute hospitals do not have sufficient funding to maintain a dedicated Rapid Response Team nursing model. Therefore, Intensive Care Unit nurses are often used in a dual Intensive Care Unit/Rapid Response Team role, this type of model includes concurrent patient care allocation and attendance at rapid response calls as needed. Research has shown that the use of a dual model is associated with high workloads/overload, risks of burnout to nursing staff, and an increase in the number of negative adverse events in the Intensive Care Unit.

A literature review was undertaken to examine the consequences of intensive care nurse absence from the Intensive Care Unit and how Rapid Response Teams can impact Intensive Care Unit work. This led to a single-centre retrospective exploratory cohort study examining two different nursing models for the rapid response service and the associations between nurses' time, adverse events, and rapid response call outcomes. This study examined the difference between a model using an intensive care nurse on patient care with rapid response duties, and a rapid response model with two dedicated rapid response nurses. Two key time points were examined in this retrospective study, each period is eight months, which allowed for data from two different nursing models.

The study data were subject to exploratory data analysis using *IBM SPSS Statistics*. Analysis of data demonstrated that the use of dedicated Rapid Response Team nurses was associated with a reduced reliance on dual Intensive Care Unit/Rapid Response Team nurses, reduced rapid response calls for in-hospital arrests and reduced rapid response calls resulting in patient death. However, increases were noted in the average scene time at rapid response calls and increased Rapid Response Team overall caseload (relative to Intensive Care Unit workload) with the use of the model with dedicated rapid response nurses. A remarkable finding was the increase in patient mortality in this sample when nurses with dual responsibilities were used; where the odds of patient death during rapid response calls were three times more likely than not, when compared with attendance by nurses dedicated to rapid response duties

The results indicate that there were significant differences in patient outcomes between the nurses with dual Intensive Care Unit/Rapid Response Team duties and the nurses with dedicated rapid response duties. The dedicated nursing team model showed numerous benefits. On this basis, it is recommended that hospital organisations use a dedicated Rapid Response Team nursing model and limit the use of the dual Intensive Care Unit/Rapid Response Team nursing model. Further research is needed to confirm these observational, single-centre findings.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment 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.

Signed:

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Clinton Fildes

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
CI	Confidence interval
DOB	Date of birth
ED	Emergency Department
EDA	Exploratory data analysis
HDU	High Dependency Unit
IBM SPSS	International Business Machines Statistical Product and Service Solutions (software)
ICU	Intensive Care Unit
IHA	In-hospital arrest (including both cardiac arrest and respiratory arrest)
IQR	Interquartile range
MET	Medical emergency team
MRN	Medical record number
NC	Nurse Consultant
NHMRC	National Health and Medical Research Council
OR	Odds ratio
OT	Operating Theatre
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RAMR	Risk-adjusted mortality rate
RRT	Rapid response team
SBP	Systolic blood pressure
SD	Standard deviation
SDU	Step Down Unit

CHAPTER ONE: INTRODUCTION

Chapter overview

Chapter one provides an introduction and background to the author and the study, including the study's purpose and significance. The chapter begins by introducing the concept of rapid response systems and the rapid response team (RRT), with context provided globally, nationally, and locally.

Self-introduction

I am a registered nurse with over 10 years' experience and currently work as a Nurse Unit Manager of a Coronary Care Unit. I have lived and worked in Australia and overseas, where my clinical work was predominantly in Intensive Care Units (ICU(s)). Additionally, I have had multiple short-term/casual contracts with a local university in their School of Nursing where I have delivered lectures, tutorials, workshops and assessments. I have a strong interest in the development, education, growth and well-being of nurses, nursing workforce planning and expenditure, and the evolution of rapid response teams. I worked as an RRT and ICU nurse during the study periods, in addition to covering leave for the RRT Nurse Consultant. This research grows from my experience of being part of a team who changed the rapid response model of care at the hospital, my interest in evaluating RRT models of care, and examining the RRT database.

Introduction

Individuals admitted to an acute care hospital are at risk of clinical deterioration. Such deterioration is preventable if identified early and treated promptly (Subbe et al., 2019). Internationally, acute care hospitals utilise rapid response systems to detect and respond to clinical deterioration and provide urgent medical assistance and support around the hospital. The International Society for Rapid Response Systems (Subbe et al., 2019) defines a rapid response system using the words of Devita et. al (2006, p. 2465): "a safety net for patients who suddenly become critically ill and have a mismatch of needs and resources". A rapid response system has four recognised components: an afferent limb (detection and response triggering), an efferent limb (the RRT), a patient safety and process improvement component, and a governance/ administrative structure (Devita et al., 2006).

RRTs consist of specialist staff members, predominately resourced from an ICU, who have the skills to provide prompt clinical assessments of patients who are acutely deteriorating in hospital general wards (Jones, DeVita, & Bellomo, 2011; Jones et al., 2016). The configuration of the RRT is required to accommodate local organisational resources, patient case mix, and acuity; therefore, there is some variation in team structure and naming conventions worldwide (Maharaj, Raffaele, & Wendon, 2015). Nurses who serve on RRTs are highly skilled, advanced life support accredited

Registered Nurses (RNs) who usually have post-graduate qualifications in critical care (Shapiro, Donaldson, & Scott, 2010; Jones, Drennan, Hart, Bellomo, & Web, 2012; Wang et al., 2013; Mitchell, Schatz, & Francis, 2014; Molloy, Pratt, Tiruvoipati, Green, & Plummer, 2018). RRT nurses are often required to undertake dual roles, providing patient care in the ICU while also responding to RRT calls (Jones et al., 2012; Wang et al., 2013; Mitchell et al., 2014; Jones et al., 2016; Flabouris & Mesecke, 2017; Dukes et al., 2019). When participating in an RRT call, the ICU nurse is diverted from their patient care assignment, potentially risking the safety of patients by leaving the ICU under-resourced (Jones et al., 2016; Flabouris & Mesecke, 2017; Dukes et al., 2019).

Background

The World Health Organization (2018) has developed initiatives on collaborative team-based improvements and interventions designed to reduce harm and improve clinical care. These are the core interventions performed by RRTs. RRTs are commonly used in Australasia, North America and the United Kingdom and are gradually being integrated into hospitals in other parts of the world (Hillman, Chen, & Jones, 2014). Europe has been slower to implement RRTs, but there is growing support for implementation (Skrifvars & Martin-Loeches, 2016). In Australia, the uptake and growth of RRTs has been swift, with Jones et al. (2016) reporting that more than 90% of hospitals they surveyed had implemented an RRT or similar model.

Australian RRTs have evolved from pre-existing cardiac arrest teams and have been created in a cost-neutral manner without dedicated funding or staffing resources (Jones et al., 2012; Flabouris & Mesecke, 2017). In an unfunded RRT, ICU resources can become stressed and strained as RRT activity increases, in combination with ad-hoc management and provision of staff. Overlapping calls for the RRT occur when a second, third or additional call is made while other RRT calls remain active (Flabouris & Mesecke, 2017). Overlapping RRT calls result in longer response times and longer times at the scene and is more likely to lead to an ICU admission, compared with non-overlapping RRT calls (Flabouris & Mesecke, 2017). Thus, overlapping RRT calls further stress the finite resources of the ICU (Flabouris & Mesecke, 2017).

At this large metropolitan teaching hospital, there are two tiers/types of RRT responses, a “MET” (Medical Emergency Team) or a “CODE BLUE”. During this study, the term “RRT call” will be used to refer to either tier of response. Refer to **Appendix 1** for further details on the local RRT model, calling criteria and team composition. Senior ICU nurses at this hospital, as part of their role, attend RRT calls throughout the hospital; this practice is historical and dates back to the inception of RRT at this hospital, where activity and call numbers were initially low. Anecdotally, the amount of RRT calls has seen continual growth with a 9% increase in calls recorded from 2015 to 2016, 12% increase from 2016 to 2017 and a 7% increase from 2017 to 2018. In September 2017, the rapid response model at this hospital was changed to meet the increasing rapid response activity targets and reduce the strain on ICU nursing resources. The allocation of nursing resources changed;

instead of a nurse with mixed duties (equipment cleaning and processing, clinical, RRT) and three nurses with dual ICU/RRT responsibilities, funding was provided for two dedicated rapid response nurses 24/7. The two dedicated rapid response nurses were supported by two dual-role nurses who remained as a backup and worked on patient care in the ICU until they were needed. Refer to **Figure 1**.

Figure 1. RRT nursing model 2017 and 2018.

Significance of the study

The absence of available literature regarding ideal RRT nursing models means there is limited evidence for the creation of policy, guidelines, and standards to provide recommendations for safe staffing levels within both the ICU and RRT. Therefore, this project can contribute to knowledge that could be used to further organisational debates on how rapid response services could be managed and may provide evidence to show benefits for or against the use of dedicated RRT nurses. The significance of the study would then be the potential to streamline the nursing workforce to optimise and improve workflows and attract funding support. Furthermore, the project will focus on the nursing aspect of rapid response service, which is often under-reported in the literature.

Aim and purpose of the study

The purpose of this single-centre retrospective cohort study was to explore the difference between two rapid response models by examining the time ICU nurses were absent from patient care duties attending to RRT calls and any association this absence had with adverse events or RRT call outcomes.

Thesis overview

This thesis comprises six chapters:

- Chapter one presents an introduction to the author and the study, and provides an introduction and background of both the rapid response service and rapid response team
- Chapter two provides an integrative literature review that synthesised the available evidence
- Chapter three provides a discussion of the methodology and methods for this single-centre, retrospective exploratory cohort study
- Chapter four presents the results of the statistical analysis of the data
- Chapter five provides a presentation and discussion of the key findings of the results
- Chapter six provides the overall summary conclusion and statement of research contributions from this study.

Chapter summary

Chapter one introduced the concept of the RRT and the potential issues faced with the use of dual ICU/RRT nurses. Furthermore, the background of RRTs was provided globally, nationally and locally. The purpose and significance of the study have been outlined. The following chapter will provide an integrative review of the literature and synthesise evidence that describes the challenges for ICU nurses who undertake dual ICU/RRT responsibilities.

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Degree: Master of Nursing (Coursework and Research) College: College of Nursing and Health Sciences

Title of Thesis: A time-conscious, safety-focused exploration of two different nursing models in the rapid response service

B. CO-AUTHORSHIP APPROVALS (To be completed by the student and co-authors)

If there are more than four co-authors (student plus 3 others), only the three co-authors with the most significant contributions are required to sign below.

Please note: A copy of this page will be provided to the Examiners.

1. **Full publication Details** The impact of dual ICU/RRT nursing roles on service delivery within the ICU: an integrative review

Section of the thesis where the publication is referred to Chapter two: Literature Review

Student's Contribution to the publication:

Research Design 85 %

Data Collection and analysis 90 %

Writing and editing 80 %

Outline your (the student's) contribution to the publication:

Author Contribution (CRediT author statement)

Clinton Fildes: writing – original draft, visualisation

Rebecca Munt: supervision, writing – review and editing

Diane Chamberlain: supervision, writing – review and editing

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CHAPTER TWO: LITERATURE REVIEW

Chapter overview

Chapter two presents an integrative literature review of challenges faced by organisations and nurses working within RRTs. Given the overall prevalence of RRTs in Australasia, and the various challenges faced with attaining funding for dedicated nurses, a review of the literature is appropriate. This chapter includes a detailed discussion on design and method, and includes an appraisal and analysis of the reviewed literature. The findings are organised into key themes and presented under relevant headings. A discussion of the findings including limitations and suggestions for research and practice recommendations were included, along with the identification of a research gap.

The literature review has been published and therefore removed due to copyright restrictions. The full-text article is avaliable by searching for:
Clinton Fildes, Rebecca Munt, Diane Chamberlain; Impact of Dual Intensive Care Unit and Rapid Response Team Nursing Roles on Service Delivery in the Intensive Care Unit. *Crit Care Nurse* 1 October 2022; 42 (5): 23–31.
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Chapter summary

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Having identified future areas for research and a gap in the literature about the impact of the RRT on ICU service delivery, the following chapter will provide the methodology and methods for a single-centre retrospective exploratory cohort study that compares two different RRT nursing models.

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CHAPTER THREE: METHODOLOGY & METHODS

Chapter overview

This chapter outlines a single-centre, retrospective exploratory cohort study of quantitative data using an exploratory descriptive analysis method and time series design within a post-positivist paradigm. The research paradigm, design, and plan are included in addition to ethical considerations. Data collection, cleaning, coding, and statistical analysis are described in detail. The strengths and limitations of the study are declared.

Research paradigm

A research paradigm is a worldview or perspective and has a theoretical framework with assumptions about the ontology, epistemology, methodology and methods and is our way of understanding the reality of the world and studying it (Rehman & Alharthi, 2016; Polit & Beck, 2017). The paradigm that this research project aligns with is positivism and post-positivism. The ontological position of positivist is that of realism, and the epistemological position of positivist is that of objectivism, meaning that truth can be known and the researcher values objectivity (attempts to hold their beliefs and biases in check) with tight research controls in their study to avoid disturbing what is being observed (Rehman & Alharthi, 2016; Polit & Beck, 2017). There exists an array of different positivist methods to utilise, but generally, quantitative data is used to answer a research question and the data undergoes statistical analysis (Rehman & Alharthi, 2016). Positivist research is deemed to be of good quality if it has internal validity, external validity, reliability and objectivity (Rehman & Alharthi, 2016).

The post-positivism paradigm has emerged as a dominant force in nursing literature and builds on the foundation blocks of positivism with a desire to understand, but post-positivism accepts that reality may never be fully known and aims to understand what the state of a phenomenon probably is (Rehman & Alharthi, 2016; Polit & Beck, 2017). Furthermore, post-positivism accepts that total objectivity is impossible and recognises the possibility of the researcher’s own beliefs and values affecting what is being observed, however, objectivity is still desirable and the aim is to be as neutral as possible (Rehman & Alharthi, 2016; Polit & Beck, 2017). A post-positivist approach is beneficial in building an understanding that there may be imperfections, discrepancies and effects on the data by external factors; therefore, aiming to explain these and seek probabilistic evidence to a high degree of likelihood during analysis (Polit & Beck, 2017). Using quantitative data and a time series design underpinned by post-positivism allows for exploring two different rapid response models with a focus on understanding the nurses’ time away at rapid response calls in conjunction with adverse events and call outcomes.

Research design

This single-centre retrospective cohort study examined the ICU nurses' amount of time spent at RRT calls in two different rapid response models and established baseline demographic data in each study period. In addition, the data were examined for associations with adverse events and call outcomes. The study was conducted using a combination of data from three different databases: the RRT database, the ICU activity database, and the adverse event database (see **Table 2**).

Table 2. Database descriptions.

	Database level	Function of database	Database custodian(s)
RRT Database	Hospital-wide database	Required for compliance with National Standard 8*. To monitor and report on the effectiveness and outcomes of the rapid response system and store data from rapid response calls.	Rapid Response Service Medical Lead Rapid Response Nurse Consultant
ICU Activity Database	Local department database	ANZICS COMET (Core Outcome Measurement and Evaluation Tool) database. To collect detailed information on all patient admissions to ICU for benchmarking with other units.	ICU Medical Head of Unit ICU Data Manager
Adverse Event Database	Government databased used by multiple health services	Allows health services to record, manage, investigate, and analyse patient and worker adverse events. In addition, it is used to record information about security services and formal notifications, i.e. coronial matters.	Safety, Quality and Risk Management Unit

*Australian Commission on Safety and Quality in Health Care (2017).

Purpose of the study

A large metropolitan teaching hospital has changed its rapid response model of care. No evaluations have been undertaken at this hospital to examine the differences between the models of care. The purpose of this single-centre retrospective cohort study was to explore the difference between two different rapid response models by examining the time ICU nurses were absent from patient care duties attending to RRT calls, and any associations with ICU adverse events or RRT call outcomes.

Aims

This study aimed to examine the difference between two different rapid response approaches at a single-centre and the associations with nursing time, adverse events in ICU, and RRT call outcomes.

Study objectives

1. To establish the time every nurse, in any rapid response role, spent at all rapid response calls and the time of day RRT calls occurred.
2. To examine the associations between time spent at rapid response calls and ICU adverse events.
3. To compare RRT call outcomes between the nurses with dual ICU/RRT responsibilities and nurses dedicated to rapid response duties.

Outcome measures

The outcome measures for comparing nurses with dual ICU/RRT responsibilities and nurses dedicated to rapid response duties were:

Primary

- Rapid response call duration and time of day calls were made

Secondary

- Adverse events occurring in ICU
- Patient RRT call outcomes (left in the ward, transferred, mortality).

Study periods

The data examined were collected at two critical times:

(1) Jan 2017 – Aug 2017

(2) Jan 2018 – Aug 2018.

A study of these two unique eight-month periods allowed for the examination of two different RRT models – a dual ICU/RRT nursing model (non-dedicated model (2017)), and a dedicated model (2018). Throughout the study these two groups were referred to by the year the results were obtained. The difference between the 2017 and 2018 groups was the introduction of two dedicated RRT nurses in 2018. Historically, there were always four nurses allocated to RRT duties on each shift, all based in ICU. When an RRT call occurred the ICU nurse coordinator would dispatch the next RRT nurse in sequential order. In 2017, responder one was not usually assigned to ICU patient care but had other duties and responders two, three, and four were assigned to both patient care in the ICU and RRT duties. During this study, nurses that work concurrently in the ICU and on an RRT were referred to as **dual ICU/RRT nurses**. In 2018, there were still four nurse responders – but responders one and two were now dedicated RRT nurses and were based in the RRT office – responders three and four remained as dual ICU/RRT nurses with concurrent ICU and RRT duties. Refer to **Figure 1**.

Participants

There was no direct inclusion of active participants in this retrospective cohort study; however, to protect patient privacy, the data from all databases were de-identified. The patient's name, date of birth and hospital medical record number was not downloaded to the study data. To protect staff privacy, the names of staff members on the RRT records were not downloaded.

Sample size

There were large amounts of data from three different databases incorporated into this study. The primary database that was examined was the RRT database. The initial estimated number of RRT cases was based on the local history of at least 350 RRT calls a month, with a total of 16 months in the combined study period it was expected to review at least 5600 cases. Upon collecting the data, the total number of RRT cases for inclusion was 6955 (n=3466 in 2017; n= 3489 in 2018).

Adverse event data from ICU were included in this study, with a total of 811 adverse events recorded during the study period (n=342 in 2017; n=469 in 2018). The ICU admissions database was accessed to obtain the ICU activity during the study period, where a total of 4792 admissions to ICU occurred (n=2398 in 2017; n=2394 in 2018).

Interrupted time-series design

The study used an interrupted time-series (ITS) design, where data was examined over an extended period. An ITS design is "interrupted" by a change, in this study the change was the RRT nursing model of care (Price, Jhangiani, & Chiang, 2015). In comparison with pre-post study designs, a key advantage of ITS design was that it allowed for evaluation of the intervention effect, whilst accounting for pre-intervention trends; because longitudinal data can be used to assess whether the intervention effects are short-lived, or sustained over time (Polit & Beck, 2017; Handley, Lyles, McCulloch, & Cattamanchi, 2018). Furthermore, the ITS design made full use of the longitudinal data, instead of collapsing it into a single pre-post intervention time point as shown in **Appendix 2** (Price et al., 2015; Handley et al., 2018). The preferred method of analysis for ITS studies is a statistical comparison of trends before and after the intervention, with at least three data points in the pre and post-phases and a clearly defined intervention point (EPOC, 2017; Handley et al., 2018). If each month represented a single data point, there were eight data points in 2017 and eight data points in 2018, achieving the minimum recommended by EPOC (2017) and Handley et al. (2018). Though ITS design does not remove the influence of all external factors, the extended time and longitudinal analysis can strengthen the ability to attribute differences to the change in RRT nursing model (Polit & Beck, 2017).

Research plan

Data collection

Data were obtained from three different databases, the data was de-identified and only partial records or specific elements were extracted, not whole records. Refer to **Table 3**.

Table 3. Data collected from each database

	Data to be extracted?	What data will be collected?	How will the data be collected?	Format of the data?
RRT Database	Partial Record	RRT ID, patient age (whole years), date, time called, time departed, location, the reason for the call, result of the call, nurse responder 1, nurse responder 2.	Download with the responsible person to secure SA Health network drive	Microsoft Excel
ICU Activity Database	Partial Record	ICU admit ID, date & time of admission, date & time of discharge, source of admission, the reason for admission, and ICU outcome.	Download with the responsible person to secure SA Health network drive	Microsoft Excel
Adverse Event Database	Specific Elements	ID No., date, time, location "ICU", level 1 detail, reported adverse event level, actual adverse event level, description.	Download with the responsible person to secure SA Health network drive	Microsoft Excel

Data cleaning

In their seminal work, Van den Broeck, Cunningham, Eeckels, and Herbst (2005) introduced a conceptual framework aimed to efficiently and ethically assist researchers with planning and implementing data cleaning. The Society for Clinical Data Management (2013) in their guidelines for good clinical data management suggest that data cleaning should use a collection of activities “to assure the completeness, validity and accuracy of data”. The data cleaning method for this study uses concepts from both Van den Broeck et al. (2005) and The Society for Clinical Data Management (2013) in a simplified three-stage process: (1) reviewing; (2) diagnosis; and (3) editing. The specific tasks undertaken are discussed in the sub-categories below.

Manual screening of data

All 6955 lines of data from the RRT database were manually screened. Filters were applied to each column to look for outliers, sorting by low to high and then high to low. RRT study IDs were flagged if they had outlier values. Outliers were noted on multiple patient ages, i.e. an age had been entered as 1000 years old. A review was undertaken with the RRT data custodian, where the database and original records were accessed by the custodian, it was noted that a transcription error had occurred during database entry. Manual correction to the RRT database and study data was undertaken for this and all other identified data transcription errors.

Confirm that data is logical and numeric values are within predetermined ranges, i.e. for code lists

In reviewing age data outliers some were confirmed to be true, i.e. patient was confirmed to be 100 years old during review with the data custodian. Data columns "reason for call" and "transfer destination ID" both utilise code lists. The reason for the RRT call is coded 1–16 and transfer 1–5, both columns were reviewed with low/high and high/low filters to confirm that they only contained valid values, which they did. The code lists were obtained from the RRT data custodian and variables were formatted into the statistical software according to their established key.

Identify, where possible, the reason for any data anomalies

Transcription errors from the original paper record to RRT database were the main reason for data anomalies. The second reason for data anomalies was that the data was missing from the original record, thus missing from the database too.

Determine if there are missing values, where complete data was required

Routinely, up to two nurses could respond to an RRT call, but at times just one nurse responded to an RRT call. The RRT nurses would routinely write their responder number and name on each RRT documentation record, which was then transcribed into the RRT database by an administration officer who records the nurses responding to that call. Nurse responder numbers were obtained from the RRT database for this study; however, there were 264 records where the nurse responder numbers were missing. A review with the data custodian confirmed missing data where the responder's name and number were blank on the affected records. Unfortunately, due to the retrospective nature of this study identifying what name and responder number that person was is no longer possible. Nevertheless, the records were kept for analysis as they contained other useful variables for analysis such as time spent at RRT call.

Identify and eliminate duplicate data entries

Each database record has a unique RRT database ID attached to it and this was downloaded with the study data. Descriptive statistic frequencies were performed on the RRT ID column and tabled. Performing that function allowed the author to visually identify that each study ID had a frequency of one, meaning there were no duplicate data entries.

Data coding

When the cleaning of data was completed, the data required additional coding before statistical analysis could be undertaken. In *Microsoft Excel*, the separate 2017 and 2018 data files were merged and a new file combining the study data was saved. A study ID number was assigned to each RRT call in order of appearance to make sorting the data back to its original order easier. A formula for RRT call duration was created from RRT start and end times; however, abnormalities in the data when a call started the previous day and went to the next day (i.e. 2345–0110) were noted and displayed incorrect values. Therefore, all 6955 lines of data were individually screened and re-transcribed into a new RRT call duration column (manual entry) by the author. When this transcription was complete, high/low and low/high filters were applied to look for any errors with the new RRT call duration column. The data column that was formula made and the new RRT call duration (manual entry) columns were viewed side by side for comparison, six transcription errors were identified and corrected. The *Microsoft Excel* file was imported into *IBM SPSS Statistics* for statistical analysis.

Once the data was in *IBM SPSS Statistics* further variables were created using the *IBM SPSS Statistics* software. These additional variables would later assist with statistical analysis. Additional variables included separate month, separate year, combined month/year, patient care nurse flag, ICU transfer flag, and age-adjusted groups. Each variable required individual formatting, this involved assigning a measure (scale, ordinal, nominal), decimal spaces, labels, and coding any values. For example, the variable "transfer" was coded "0=no transfer" and "1=yes transferred", similar coding was used for variables "ICU transfer" "death" and "left in ward".

Assigning relevant codes to the data

The variables "transfer ID" and "reason for RRT call" were coded according to the RRT database's established coding processes, obtained from the RRT data custodian. The variable "transfer ID" was coded: "0=no transfer"; "1=ICU"; "2=ED"; "3=OT"; "4=SDU/HDU"; "5=other". The variable "month" was coded numerically to match the chronological order of months: "1=January"; "2=February"; "3=March"; and so on. The variable "age-adjusted groups" required using the *IBM SPSS Statistics* function "recode into different variable" on the existing age data, then setting ranges and limits on the data to code them into the new variable. The age-adjusted groups were defined as "1= patients aged <40", "2= patients aged 41-50", and so on; this variable assisted with the univariate analysis of data.

The nurse responder variable originally had multiple values: responder one; responder two; responder three; responder four; "other"; "student"; and "simc". The nurse responder variable was reduced and recoded the responses: "other"; "student"; and "simc" into a single variable, "other". The variable "nurse on patient care" was more complex in design and required using the *IBM SPSS Statistics* function "recode into different variable" three times. The variable "nurse on patient care" was designed to flag if dual ICU/RRT nurses (on patient care) attended a RRT call. The coding for this variable was: "0= call not attended by a patient-care nurse" (call attended by a dedicated nurse); "1= call attended by a dual ICU/RRT nurse" (a nurse assigned both RRT and ICU patient care duties). For calls in 2017, calls attended by responder one were coded as "0" and calls attended by responders two, three, four and others were coded as "1"; in line with the rationale given above. For calls in 2018, calls attended by responders one and two were coded as "0" and calls attended by responders three, four and others were coded as "1"; in line with the rationale given above. The created variable "nurse on patient care?" allowed for statistical analysis and separating the results between calls that dual ICU/RRT nurses did or did not attend.

Statistical analysis

Seminal work by statistician John Tukey consolidated and set the foundation for exploratory data analysis (EDA) techniques within a single framework (Tukey, 1977). Tukey (1977, p. 1) initially describes EDA as "detective work", including "numerical detective work—or counting detective work—or graphical detective work". In later publications, Tukey (1980, p. 24) defended criticism that EDA is just "descriptive statistics brought somewhat up to date" and argued that "EDA is an attitude and flexibility and some graph paper"; he reported and stressed the need for a visual representation of data to explore the unknown. The need for visual representation of data to explore the unknown aligns with the modern-day perspective of EDA as an "overarching analytic attitude characterised as detective work designed to reveal the structure or patterns in the data" and tries to establish what is occurring within the data (Haig, 2005; Jebb, Parrigon, & Woo, 2017, p. 267). EDA is now seen as the "statistical embodiment of inductive research" and through quantitative techniques, including visual representations of data, phenomena can be detected, visualised, and relationships can be revealed (Jebb et al., 2017, p. 267).

EDA was undertaken using *IBM SPSS Statistics (Version 28)* software and the findings were directly exported to the results; or, were exported to *Microsoft Excel* for improved visual representation, then exported to the results. To manage the complexity of data, general summary demographic information was examined, then more complex relationships of interest in order of: univariate; bivariate; and multivariate relationships (Jebb et al., 2017).

Demographic information

Demographic statistics were performed using *IBM SPSS Statistics*. The results were reported as: counts; percentages; median with interquartile range (IQR); and mean ± standard deviation (SD). Comparisons were made using a binomial proportions test, tests were adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction. Statistical significance was defined as a two-sided $p < 0.05$.

Univariate and bivariate analysis

To explore frequencies of univariate time data, it was viewed as a histogram with the data visually assessed for skewness and normal distribution (Jebb et al., 2017). Histograms are a preferred way of displaying continuous/numerical data as it allows for an examination of the distribution of the data, and later, the histograms will allow for independent evaluation of this research work (Weissgerber, Milic, Winham, & Garovic, 2015). Descriptive statistics were performed on RRT scene time (measured in minutes) for the years 2017 and 2018. The data for both years appeared to be skewed to the right, which explains why the means were greater than the median. Histograms were used again to explore the time of day RRT calls had occurred, visually shown hour by hour for the years 2017 and 2018. In both years, the data appeared to be skewed to the left with the mean less than the median. A third, unique, filtered histogram was created utilising a data split/data filter to explore the time of day RRT calls were attended by dual ICU/RRT nurses, compared with dedicated RRT nurses.

Bivariate data analysis was performed with the age group variable against call outcomes (left in the ward, transferred, mortality) and calls attended by ICU nurses on patient care. The data were initially viewed as a scatter plot to detect clusters and trends within the data including direction, form and strength (Jebb et al., 2017). However, as the data was not of two continuous variables the scatterplots were suboptimal and abandoned in favour of cross-tabulation tables (Jebb et al., 2017). Four cross-tabulation tables were included which demonstrate association between the age groups and: (1) dual ICU/RRT nurses attending RRT calls and RRT call outcomes; (2) transfers during RRT calls; (3) transfers specifically to ICU; and (4) deaths during RRT calls. The cross-tabulation tables feature the patient age groups on the row and the four other variables (one per table) on the column, with counts and percentages to show the distribution of the data.

Multivariate analysis

Increasing numbers of variables carry a greater complexity and require more time to visually analyse, but performing multivariate analysis and visualisation is essential to maximise the value of data (Jebb et al., 2017). Due to the large number of variables required to be visually analysed together, a star plot, also named radar chart, was chosen as it can display complex multivariate data simply. Jebb et al. (2017) suggested star plots as an option for multivariate graphical analysis as they can be useful for detecting trends, clusters and patterns. A star plot allowed for easy visualisation of three key variables simultaneously: (1) the time spent at RRT calls; (2) the nurse responder number; and (3) the month. A separate star plot was created for the 2017 and 2018 data. To create the star plots a customised data table was created in *IBM SPSS Statistics*, then exported and graphically created in *Microsoft Excel*.

Adverse events were examined in combination with time spent at RRT calls. Initially, bar graphs were designed for each year as these easily display categorical/nominal variables (Weissgerber et al., 2015). The nurse responders on ICU patient care were grouped on the x-axis, and minutes spent at call were graphed along the y-axis (left side) and displayed as a bar graph. To include the data from the adverse event database a second y-axis was added (right side), and a line graph was used to show the number of adverse events each month. A linear trend line was also included, and different colours were used to separate and simplify the different information being shown, the result was represented visually in a combination graph. The data were visually presented in two separate graphs for each year. A third graph combined the adverse events and time data for the whole study, incorporating ITS design, and was presented as a line graph. Including these three graphs allowed for data exploration and assisted in revealing the structure of, and patterns within, the data concerning time spent at RRT calls and adverse events that occurred in the ICU (Jebb et al., 2017).

RRT call outcome variables were entered into a logistic regression model with the dual ICU/RRT nurse as the dependent variable. Due to missing data, there are 264/6955 RRT calls where the status of the nurse responder is not known. RRT call outcomes underwent logistic regression separately and thus are unadjusted. Logistic regression allowed for modelling the probability of an RRT call outcome and transforming that probability into its odds, the odds being the ratio of two probabilities (Polit & Beck, 2017). Logistic regression was performed and both significant and insignificant RRT call outcomes for dual ICU/RRT nurses (nurses on ICU patient care) were included for transparency. Following this step, logistic regression was repeated with the dedicated RRT nurses as the dependent variable and a summary table was created to compare with the dual ICU/RRT nurses' results.

Strengths and limitations

Retrospective data usage

A retrospective study has several advantages. One substantial benefit of retrospective studies is avoiding the Hawthorne effect, where people behave differently because they know they are being observed (Zealley, 2021). If this study had used a prospective design with nurses being observed and their time spent at RRT calls closely monitored and recorded, results may have varied. Other advantages of a retrospective study were the reduced costs and no need for follow-up, making retrospective design desirable for this master's research project as data collection, from existing department databases, was quick and efficient (Talari & Goyal, 2020). The utilisation of the RRT database allowed for the inclusion of a large volume of data (6955 RRT calls) over a long study period (a total of 16 months). The retrospective design allowed for the avoidance of selection and recall bias, as all data were included and neither patients nor staff, were questioned (Talari & Goyal, 2020). In this study, all RRT records were included within the specified time frames and data was obtained from the RRT clinical database. The author was involved in the routine operation of the RRT service in 2017 and 2018, but due to the retrospective nature of the study bias is minimised. For example, in prospective design bias may be increased if documentation and data entry was always performed by the author. However, this was not the case in this study as documentation was performed by the RRT nurse at call and database entry by an administration officer.

Retrospective studies are often the first step in understanding an issue. The retrospective study results can later be confirmed in a prospective study with unknown factors that could have influenced the retrospective study being identified and accounted for in the prospective study (Talari & Goyal, 2020).

Missing data

A common limitation experienced in retrospective studies includes obtaining data from departmental clinical databases, where the intent was not to store data for research and as such key desirable data could be missing (Talari & Goyal, 2020). As identified, missing data was an issue in this study. Missing data was a limitation and likely arose due to the complex nature of responding to the RRT call. During an RRT call, the ICU/RRT nurse is obtaining handover, conducts assessments, performs interventions, liaises with other RRT team members, provides patient care, and documents all details of the RRT call on the RRT paper datasheet. The RRT nurse's workload is substantial and this may be distracting and lead to accidental documentation errors or omissions. For RRT calls where data were missing, no assumptions were made about missing data.

Internal validity

The internal validity of retrospective studies is difficult to prove because the variables are not all controlled and are therefore considered less rigorous when determining causal inferences (Rehman & Alharthi, 2016). In retrospective studies, generally, association and not cause-effect of outcomes can be established (Talari & Goyal, 2020). However, as stated previously, incorporating an ITS design increases the validity of the study by making full use of the longitudinal data and assessing whether the impact of changing to dedicated RRT nurses was short-lived or sustained over time (Price et al., 2015; Handley et al., 2018). Furthermore, by comparing the same RRT nurses, working for the same local health network, with similar equipment and tools some inferences were minimised.

External validity

In this study, the selection of "subjects" was not relevant as it was a retrospective study. However, the databases reviewed for the study still contained patient information and clinical records, therefore a waiver of consent was sought and granted by the local health network. One of the research aims was to examine the time nurses spent at RRT calls, therefore, strict selection criteria were not appropriate and all RRT calls were included. By including all RRT calls, data were representative of the local population; but, as this was a single-centre retrospective study the results cannot be over-generalised to the whole international RRT population (Talari & Goyal, 2020). External validity in retrospective studies is limited, to achieve greater validity a multi-site prospective study with stringent and validated selection criteria could be used (Talari & Goyal, 2020).

Reliability

Lack of homogeneity is a limitation of retrospective studies where different people were involved at different times responding to RRT calls and thus their attention to detail in the recording of, and later the data entry of, RRT data may differ (Talari & Goyal, 2020). However, RRT nurses at this hospital regularly transcribe to the RRT datasheet and are highly trained, specialised, senior ICU/RRT nurses whose experience and expertise ensure that the collection methods were valid and reliable.

The RRT datasheets were routinely completed by the RRT nurse that attended the call, and the nurse will differ shift-by-shift and day-by-day. RRT nurses were given training on the minimal documentation standards expected. At the end of an RRT call, the RRT carbonless copy paper sheets were divided with one for the patient medical record and one returned to the RRT office. The RRT datasheet in the office was then reviewed by the RRT Nurse Consultant (NC), or their delegate, the RRT NC is a senior *management level* nurse who oversees the whole hospital's RRT operations. Attempts were made by the RRT NC to correct any illegible, missing or incomplete datasheets by reviewing the patient's electronic medical records. Datasheets were then handed over to the RRT administration officer for data entry, electronic scanning and filing. The datasheets are a recognised medical record form that has undergone consultation and approval for use, in line with local health network policy and procedures. Though different people were involved in the process of data collection and entry of the data used in this study, the process was uniform and different staff following the same process should arrive at the same results.

Aversion to identify adverse events

The information obtained for negative incidents and/or adverse events that occurred within the ICU during the study period had some unique events that if identified may have the potential to identify the patient and/or staff involved. It was not feasible to utilise all the information obtained in a meaningful way within the constraints of this research study and such detail was not required to satisfy the study's research objectives. Therefore, the adverse event data included in the study only included how many adverse events occurred each month, and does not include detailed information on unique adverse events that could identify the patient(s) or staff member(s) involved.

Death is unadjusted

When death is reported it is often adjusted, simply by age or with more well-known quality indicators like the risk-adjusted mortality rate (RAMR)/risk-standardised mortality rate (Shine, 2012; Bilimoria & Pawlik, 2022). The RAMR is “based on the ratio of observed-to-expected deaths being a measure of hospital quality; however, factors beyond ‘quality’ can affect this ratio, including the quality of medical documentation and patient acuity" (Bilimoria & Pawlik, 2022, p. 221). In this study, death was unadjusted as it would have required access to a greater level of hospital-wide data that ethics approval was not sought for or granted. In addition, the use of RAMR has been criticised in the literature with an acknowledged limitation being "its inability to distinguish clinical situations that directly define increased risk from those that are only indirectly associated with increased risk" (Shine, 2012; Bilimoria & Pawlik, 2022, p. 221).

To provide some adjustments to RRT call outcomes, the RRT data was presented in age-adjusted cross-tabulation tables, but no formal risk-adjustment tool was used.

Ethical considerations

This study was defined as a low and negligible-risk, retrospective, de-identified study based upon the National Statement on Ethical Conduct in Human Research (2007) (updated 2018), sub-chapter "2.1.7", published by the National Health and Medical Research Council (NHMRC). This definition states that "where there is no foreseeable risk of harm or discomfort; and any foreseeable risk is no more than inconvenience" research may be considered to have a negligible risk (NHMRC, 2007, p. 15). There was no direct inclusion of active participants and informed consent of participants was therefore not required for this study. The reason for not seeking informed consent from participants was that the data required for the study was accessed from existing clinical databases, not from individuals or their case notes. To satisfy ethical requirements, if a review of the original medical record was required, a waiver of consent was sought and granted based on the requirements of subchapter "2.3.10" (NHMRC, 2007). Ethical and governance approval was granted by the local health network human research ethics committee for 12 months on 5/11/2020 under reference number 13893, refer to Appendix 3. An additional 12-month approval was granted until 16/11/2022 as the project was ongoing.

Conflicts of interest

There were no actual conflicts of interest to declare; however, there were potential conflicts of interest as per clause 5.4.5(a) "personal involvement or participation in the research" (NHMRC, 2007, p. 94). The author worked as a rapid response nurse in the study periods being examined. At that time the author was unaware that this study would later be conducted retrospectively and does not believe their involvement in the routine operation of the hospital RRT in 2017 and 2018 compromises the study in any way.

Data security and storage

To protect patient privacy, the data from all databases were de-identified, and the patient's name, date of birth (DOB) and hospital medical record number (MRN) was not downloaded to the study data. To protect staff privacy, the names of staff members on the records were de-identified.

Permissions were sought from the data custodians of each database and their signed declarations or email approvals were included as attachments in the ethics and governance application. The study data were obtained from three different databases for this research project.

Data format

The data was stored in *Microsoft Excel* worksheets until data cleaning was completed. From *Microsoft Excel*, the data was exported into *IBM SPSS Statistics* for statistical analysis.

Data access, storage and security

The data was stored on the secure local health network server under the author's electronic profile, which requires a unique login and password to access it. To facilitate meetings off-site with supervisors, a mobile data copy was required. After confirming the de-identification of the data, it was uploaded to the local health network-controlled *Microsoft Teams* server. An invitation to join the team was sent to the supervisors' local health network/ university email accounts. Access to the data was restricted as login to *Microsoft Teams* requires the users' unique ID and password associated with their organisation to log in and gain access.

Data disposal

Once the project was completed, there was no need for ongoing to access the data. The only person that has access to the historical project data is the author. The data will be retained for seven years from project completion. The author will be responsible for its confidential disposal. All data files are electronic and disposal will be achieved by deleting the data files.

Data risk mitigation

Managing data risk is complex. The Australian Bureau of Statistics (ABS) (2017) proposed a multi-dimensional approach to managing data risk called 'The Five Safes Framework' in which five key elements should be considered to facilitate safe data use and minimise disclosure risk. These elements were adopted and are provided in **Table 4**.

Table 4. Data risk mitigation strategies (modelled on ABS (2017)).

Safe People *Is the researcher appropriately authorised to access and use the data?*	Permission was sought from each database custodian and a data custodian declaration form was signed and completed, authorising the use of the data for the study. In line with the ethics and governance assessment application form, all researchers have signed that they will adhere to appropriate ethical conduct during the study. Breaches may be subject to legal proceedings.
Safe Projects *Is the data to be used for an appropriate purpose?*	The purpose, aims, objectives and significance of the research project have been stated in this document. The study will not be used for compliance or regulatory purposes.
Safe Settings *Does the access environment prevent unauthorised use?*	Chapter three describes how the data will be accessed and used transparently. The main user was the author, and the data is stored securely under their unique local health network ID. A mobile copy was required to facilitate meetings with supervisors, this exists on a secure *Microsoft Teams* server. No further copies of the study data were allowed.
Safe Data *Has appropriate and sufficient protection been applied to the data?*	All direct identifiers were removed (name, DOB, MRN) to protect patient and staff privacy.
Safe Outputs *What processes are in place to check outputs before data is made public?*	All research outputs were assessed by the author and supervisors for disclosure before being released. The outputs were compared for consistency with the original project proposal, aims and objectives during the study.

Chapter summary

Chapter three detailed the methodology and methods used in the study, providing the foundations for data analysis and discussion in the following chapters. The collection, cleaning, coding and statistical analysis of data were described in detail. Rigour was established by discussing the validity and reliability of the study, whilst acknowledging limitations. Finally, ethical approval and considerations were declared. Having explained how the results will be obtained, the following chapter will provide the results of the statistical analysis of the data.

CHAPTER FOUR: RESULTS

Chapter overview

This chapter describes and provides the results of the statistical analysis of the data. Data is presented from the RRT and adverse event database with the ICU activity database only used to validate the data from the RRT database. Demographic data and reasons for RRT calls are provided and comparisons for significant pairs are noted. Descriptive statistics are reported about the length of time nurses spend at RRT calls and the time of day RRT calls occur, this is presented as tables and histograms. Comparative time information is then shown between dual ICU/RRT nurses and dedicated nurses, this is represented in tables and star plots. Combination charts are used to represent time data, nurse responder data, and adverse events simultaneously to reveal relationships and patterns in the data. Age-adjusted cross-tabulation tables demonstrate the relationship between a patient's age and its effect on RRT call outcomes. Finally, logistic regression was used to assess the effect of dual ICU/RRT nurses, compared with dedicated nurses, on RRT call outcomes.

Research question

What are the differences, characteristics and relationships of nursing time, ICU activity and adverse events at a large metropolitan teaching hospital between a rapid response model that has dedicated, compared with non-dedicated nursing team members?

Demographic information

A comparison of column proportions was performed and results are shown for each significant pair. The total number of RRT calls included in the study was 6955, with both study periods having a similar number of calls in 2017 (n=3466 [49.9%]) and 2018 (n=3489 [50.1%], **Table 5**). The median age of all patients was 71 (IQR 57-82) with a mean age of 67 (SD 19). The mean number of overall calls per month and day were similar in 2017 and 2018; however, 39% (n=1366) of RRT calls were attended by dual ICU/RRT nurses in 2017, compared with 12% (n=403, **Table 5**) in 2018. Therefore, a 71% reduction in the number of RRT calls dual ICU/RRT nurses attended was observed with the introduction of the dedicated nursing model in 2018. The number of total admissions to the ICU hospital-wide and from RRT calls was similar in each group. There was a significant difference in the number of RRT calls for cardiac/respiratory arrest (defined jointly as "in-hospital arrests" (IHA)), in 2017 (n=57 [1.7%]) compared with 2018 (n=33 [0.9%]). There was a significant difference for deaths during RRT call, in 2017 (n=44 [1.3%]) compared with 2018 (n=20 [0.6%]). Refer to **Table 5**.

Table 5. Demographic information of rapid response calls, including admissions to ICU and comparison of column proportions [y].

Variable	All RRT	2017	2018
Median patient age, years (IQR)	71 (57–82)	72 (57–83)	69 (56–81)
Mean patient age, years (SD)	67 (19)	68 (18)	66 (19)
No. total RRT calls	6955	3466	3489
Mean no. RRT calls per month (SD)	435 (41)	433 (45)	436 (39)
Mean no. RRT calls per day	14.31	14.26	14.36
No. RRT calls attended by nurses on ICU patient care	1769	1366*B	403
No. of total admissions to the ICU	4792	2398	2394
No. ICU/HDU* admissions from RRT call	418	213	205
No. RRT calls for in-hospital arrests (IHA)	90	57*B	33
Median IHAs per month (IQR)		6 (5–8)	4 (4–5)
No. RRT calls where death is recorded	64	44*B	20
Median RRT calls death, recorded per month (IQR)		5 (3.5–8.25)	2.5 (2–3)

**ICU/HDU separate in 2017, then integrated in 2018.*
Results are based on two-sided tests. For each significant pair, the key of the category with the smaller column proportion appears in the category with the larger column proportion.
Significance level for upper case letters (*A, *B): .05
y. Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

Reason for RRT call

The most common reason for RRT call in both periods was SBP <90mmHg (25.8% in 2017 v 25% in 2018) with the other common reasons for RRT call remaining similar in proportions, as shown in **Table 6**. A comparison of column proportions was performed, where the most significant difference was that there were more RRT calls made by staff who were "worried" about their patient in 2018 (n=502 [14.4%]), compared to the previous year in 2017 (n=347 [10%], **Table 6**). Additionally, there was a significant difference recorded between 2017 and 2018 for the reasons: "cardiac arrest"; "O2 saturations <89%"; and "unexpected or uncontrolled seizure", as shown in **Table 6**.

Table 6. The distribution of reasons for RRT calls, with a comparison of column proportions [y].

Reason for RRT call	2017		2018	
	n	n %	n	n %
Respiratory Arrest	10	0.3	3	0.1
Cardiac Arrest	**47*[B]**	1.4	30	0.9
Threatened Airway	38	1.1	31	0.9
Significant Bleeding	20	0.6	29	0.8
Respiratory Rate <7	13	0.4	17	0.5
Respiratory Rate >30	375	10.8	339	9.7
O2 Saturation <89%	**486*[B]**	14.0	397	11.4
Pulse Rate <40	59	1.7	60	1.7
Pulse Rate >140	326	9.4	377	10.8
SBP >200mm/Hg	255	7.4	275	7.9
SBP <90mm/Hg	893	25.8	873	25.0
Level of Consciousness /Sedation	467	13.5	453	13.0
Unexpected or uncontrolled seizure	**105*[B]**	3.0	77	2.2
Worried	347	10.0	**502*[A]**	14.4
Unattended MDT Review	10	0.3	17	0.5
≥3 Observations in Red zone	15	0.4	9	0.3

Results are based on two-sided tests. For each significant pair, the key of the category with the smaller column proportion appears in the category with the larger column proportion.
Significance level for upper case letters (*[A], *[B]): .05
y. Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

RRT call duration and time of call

The data collected from the RRT database included the time of RRT call start and call end. There was a 9% increase in the average duration of RRT calls from a mean of 35.32 minutes (SD=25.824) in 2017, compared with a mean of 38.53 minutes (SD=30.006) in 2018. The median for both groups was 30 minutes. Refer to **Table 7**.

Table 7. Descriptive statistics of RRT scene time (minutes) in 2017 and 2018			
		2017	**2018**
Sum all RRT call time		122433	134438
Mean (Std. Error)		35.32 (.439)	38.53 (.508)
95% Confidence Interval for Mean	Lower Bound	34.46	37.54
	Upper Bound	36.18	39.53
Median		30	30
Standard Deviation		25.824	30.006
Interquartile Range		24	28
Range		265	278
Variance		666.885	900.38
Skewness (Std. Error)		2.308 (.042)	2.432 (.041)
Kurtosis (Std. Error)		8.771 (.083)	9.101 (.083)

The overall time spent at RRT calls was similar for dual ICU/RRT nurses (mean 36.42 minutes [SD 27.58]) and dedicated nurses (mean 37.15 minutes [SD 28.09]). The median and IQR for the dual and dedicated nurses' overall time at RRT calls were identical (median 30 minutes [IQR 20–45]).

Histograms were used to visualise the distribution of RRT call duration within the dataset. The first histogram showed the distribution of call duration in 2017 (**Figure 3**), the second histogram showed the distribution of call duration in 2018 (**Figure 4**). Both histograms were displayed with a distribution curve line and are skewed to the right/positively skewed. In 2017, the most frequent RRT call durations were 20 minutes (7.5%), 30 minutes (6.7%), 25 minutes (6.6%), and 15 minutes (6.5%). In 2018, the most frequent RRT call durations were 20 minutes (5.3%), 15 minutes (4.2%), 25 minutes (4.2%), and 30 minutes (4.0%). The histograms for 2017 (**Figure 3**) and 2018 (**Figure 4**) showed a difference in variance between the two groups.

Figure 3. Histogram of RRT scene time/ call duration in 2017.

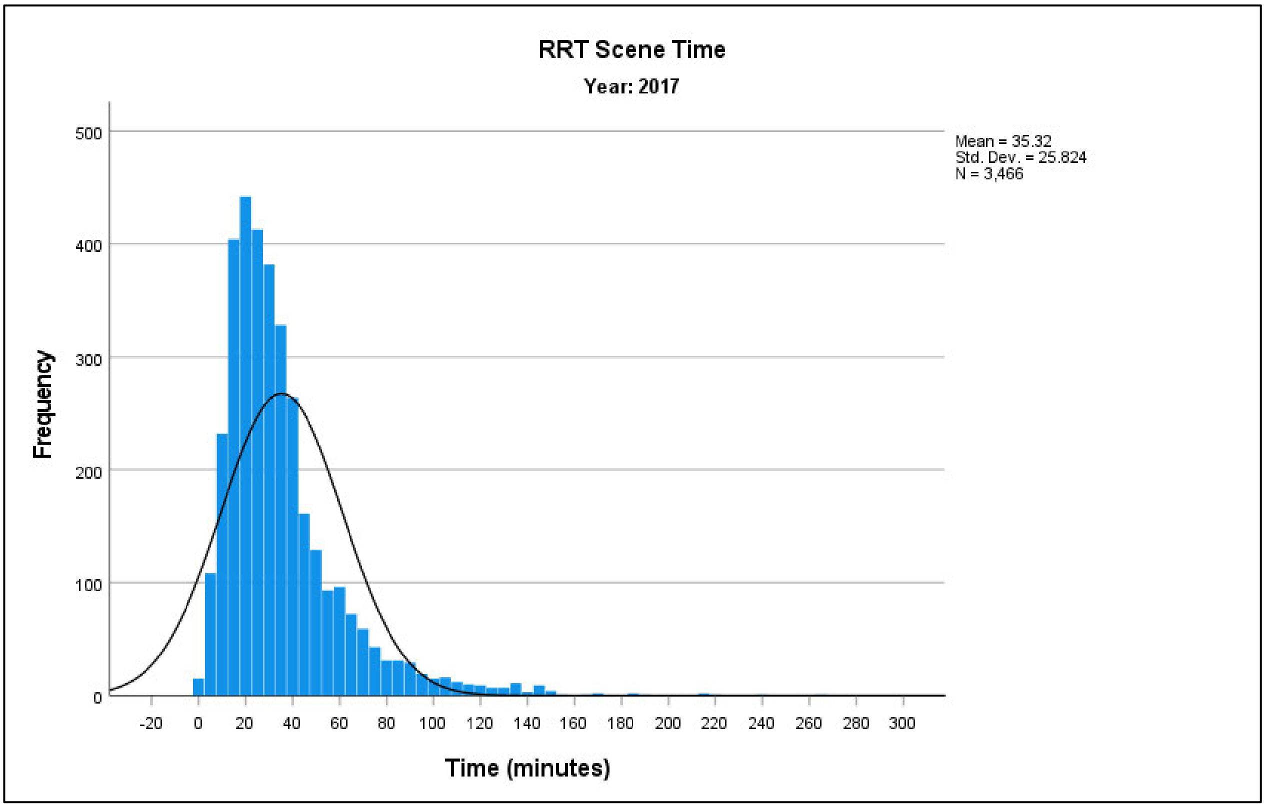
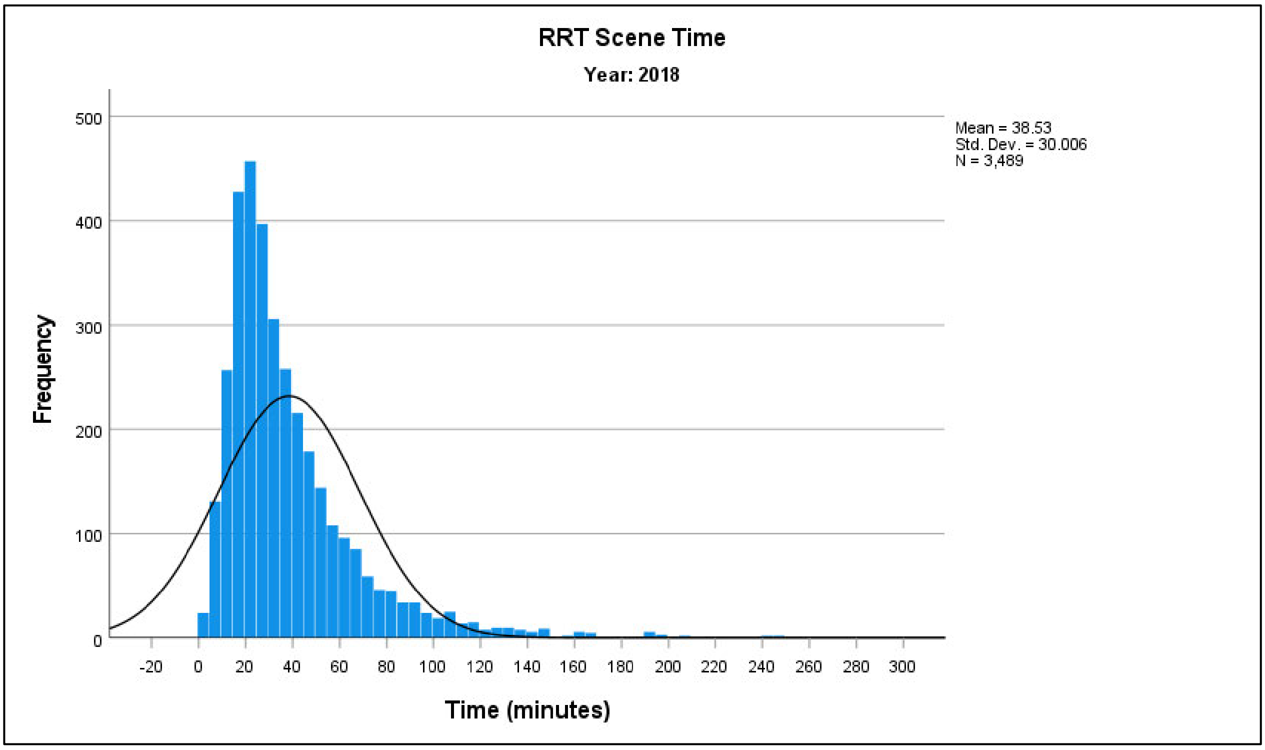


Figure 4. Histogram of RRT scene time/call duration in 2018.



Overall, the RRT calls occurred at different times of the day over a 24-hour time span. The time of day the RRT calls were made was examined and is visually represented for 2017 (**Figure 5**) and 2018 (**Figure 6**). In 2017, the two most frequent times RRT calls were made were around 08:00 and 20:00. In 2018, 08:00 remains a frequent time for RRT calls; additionally, 20:30, 22:30 and midnight were revealed as frequent times for RRT calls.

Figure 5. Histogram displaying the time of day RRT calls were made in 2017.

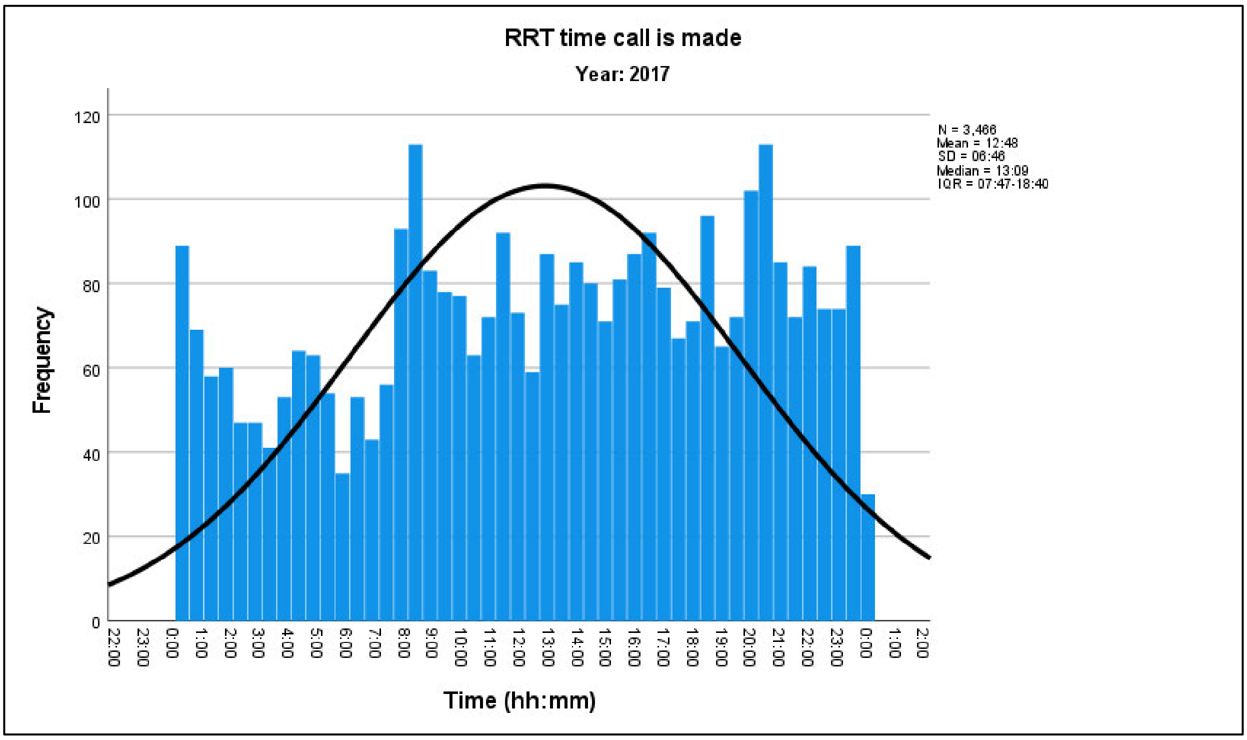
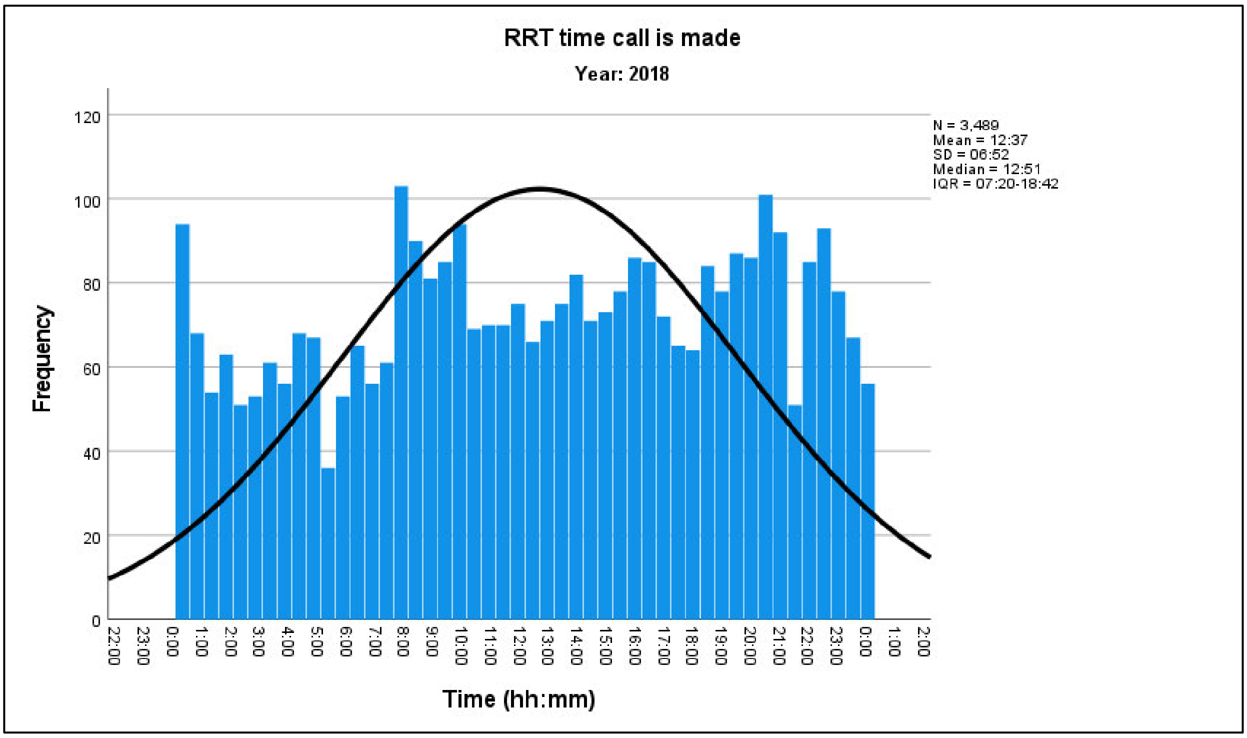
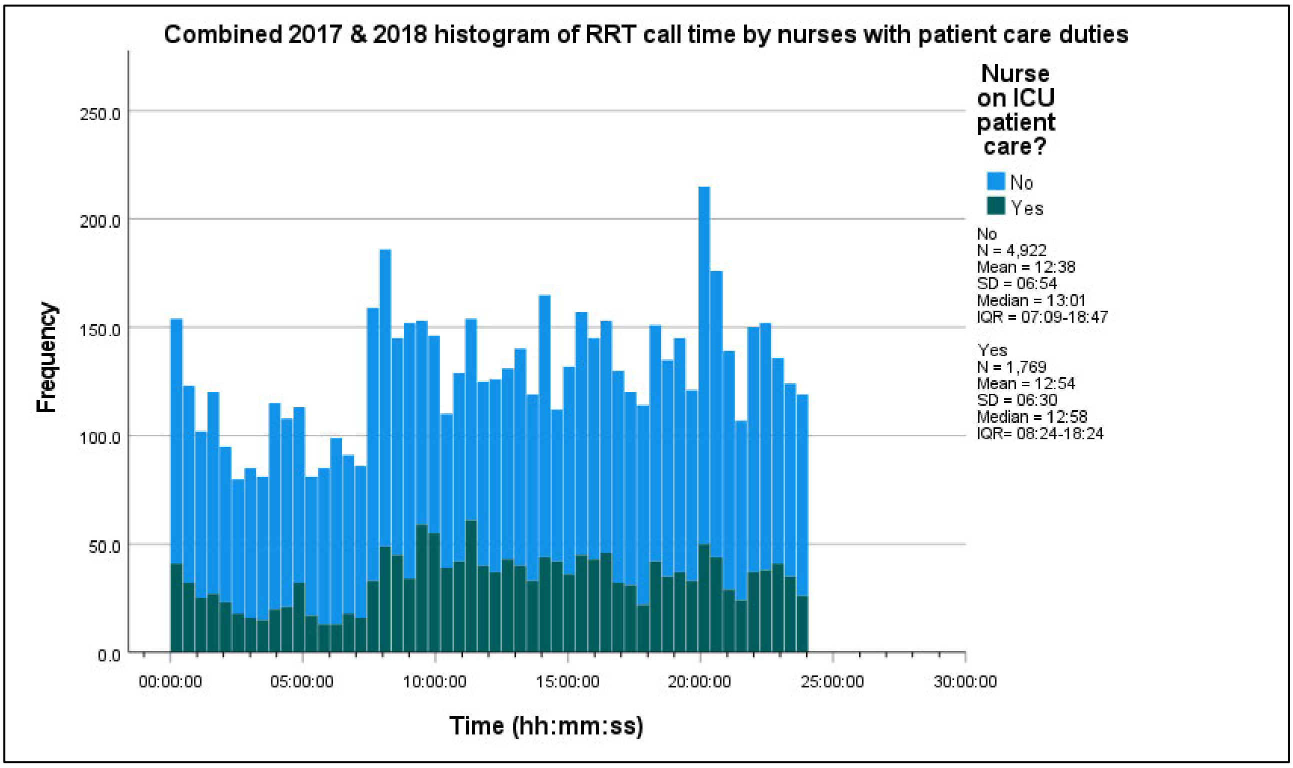


Figure 6. Histogram displaying the time of day RRT calls are made in 2018.



An additional histogram was included for all of the study data, filtered by the demographic dual ICU/RRT nurse (nurses with patient care duties), displayed in **Figure 7**. **Figure 7** visualises the time of day dual ICU/RRT nurses (with patient care responsibilities) attended RRT calls, compared with dedicated nurses (not on patient care). Dual ICU/RRT nurses attended calls at two main peak times of 09:30 and 11:00, with the dual ICU/RRT nurses being busiest in hours (between 08:00-20:00), as opposed to out of hours (20:00-08:00). The median time of RRT activation for dual ICU/RRT nurses (12:58) and dedicated nurses (13:01) remains similar. However, there was a shift in the variability of the data and the nurses' hours of peak activity with dedicated nurses having an IQR 07:09-18:47, compared with dual nurses having an IQR 08:24-18:24. Refer to **Figure 7**.

Figure 7. Histogram of overall RRT call time by nurses with or without patient care duties.



RRT call time as time series including nurse responder assignment

The time spent at RRT calls was displayed as time series data (monthly) by the nurse responder number and includes information for 2017 (**Table 8**) and 2018 (**Table 9**). The responder labelled 'other' reflects that an ICU patient care nurse who was not responder one, two, three, or four were required to attend that RRT call. In 2017 (**Table 8**), responder one does not have patient care duties, however, was not dedicated to RRT duties either. However, in 2017 responders two, three, and four were all on patient care in the ICU and were considered to be dual ICU/RRT nurses. In 2018 (**Table 9**), responders one and two were dedicated to RRT duties and responders three and four were on patient care in the ICU and were considered to be dual ICU/RRT nurses. In 2017 (**Table 8**), the amount of time dual ICU/RRT nurses spent at RRT calls each month varied between a low of 3390 minutes (29.4% of time spent at all calls that month) and a high of 9470 minutes (41.9% of all time spent at calls that month). By comparison, in 2018 (**Table 9**), nurses on patient care spent between a low of 992 minutes (4.2% of all time spent at calls that month) and a high of 3550 minutes (11.1% of all time spent at calls that month) at RRT calls each month.

Table 8. 2017, minutes spent at RRT calls by nurse responder no. and month.

	Jan min (min%)	Feb min (min%)	Mar min (min%)	Apr min (min%)	May min (min%)	Jun min (min%)	Jul min (min%)	Aug min (min%)
Responder 1	9610 (60.6)	11401 (59.9)	13141 (58.1)	11371 (60.5)	13185 (66.8)	12598 (63.8)	9982 (65.9)	8151 (70.6)
Responder 2	2978 (18.8)	3290 (17.3)	4666 (20.6)	3839 (20.4)	3168 (16.1)	3833 (19.4)	3430 (22.6)	1876 (16.3)
Responder 3	1162 (7.3)	1670 (8.8)	1663 (7.4)	1394 (7.4)	1070 (5.4)	1544 (7.8)	881 (5.8)	696 (6.0)
Responder 4	714 (4.5)	860 (4.5)	1260 (5.6)	783 (4.2)	745 (3.8)	855 (4.3)	420 (2.8)	113 (1.0)
Other	1396 (8.8)	1821 (9.6)	1881 (8.3)	1415 (7.5)	1568 (7.9)	913 (4.6)	442 (2.9)	705 (6.1)
Total min for dual ICU/RRT nurses	6250 (39.4)	7641 (40.1)	9470 (41.9)	7431 (39.5)	6551 (33.2)	7145 (36.2)	5173 (34.1)	3390 (29.4)
OVERALL TOTAL MINUTES AT RRT CALLS	15860	19042	22611	18802	19736	19743	15155	11541

The results have different shading, no shading represents a nurse responder without ICU patient care duties; light grey shading represents a dual ICU/RRT nurse who had ICU patient care duties; dark shading is used for the totals. The first total is the minutes completed by dual ICU/RRT nurses that month, the second total (in caps) is the total time spent that month by nurses at RRT calls.

min = minutes

Table 9. 2018, minutes spent at RRT calls by nurse responder no. and month.

	Jan min (min%)	Feb min (min%)	Mar min (min%)	Apr min (min%)	May min (min%)	Jun min (min%)	Jul min (min%)	Aug min (min%)
Responder 1	11201 (47.7)	11407 (48.1)	11854 (44.5)	11850 (44.6)	13034 (46.8)	12291 (46.8)	14220 (44.9)	14870 (46.4)
Responder 2	10675 (45.4)	11335 (47.8)	12271 (46.1)	13073 (49.2)	12707 (45.6)	11712 (44.6)	14440 (45.6)	13648 (42.6)
Responder 3	1194 (5.1)	706 (3.0)	1862 (7.0)	1366 (5.1)	1223 (4.4)	1844 (7.0)	1916 (6.1)	1979 (6.2)
Responder 4	340 (1.4)	266 (1.1)	552 (2.1)	238 (0.9)	566 (2.0)	385 (1.5)	860 (2.7)	944 (2.9)
Other	83 (0.4)	20(0.1)	105 (0.4)	25 (0.1)	326 (1.2)	35 (0.1)	206 (0.7)	627 (2.0)
Total min for dual ICU/RRT nurses	1617 (6.9)	992 (4.2)	2519 (9.5)	1629 (6.1)	2115 (7.6)	2264 (8.6)	2982 (9.4)	3550 (11.1)
OVERALL TOTAL MINUTES AT RRT CALLS	23493	23734	26644	26552	27856	26267	31642	32068

The results have different shading, no shading represents a nurse responder without ICU patient care duties; light grey shading represents a dual ICU/RRT nurse who had ICU patient care duties; dark shading is used for the totals. The first total is the minutes completed by dual ICU/RRT nurses that month, the second total (in caps) is the total time spent that month by nurses at RRT calls.

min = minutes

Star plots provide a visual representation of the month, the nurse responders' number and activity which is displayed for 2017 (**Figure 8**) and 2018 (**Figure 9**). The variables within the star plot are coloured to show which nurse responder attended to the RRT call and how long they spent at all RRT calls that month. The further away from the middle of the plot, the more time that responder spent at an RRT call. In 2017 (**Figure 8)**, responder 1 spent the most time at RRT calls, compared with 2018 (**Figure 9**) when responders 1 and 2 spent similar amounts of time at calls.

Figure 8. Star plot of minutes spent at RRT calls each month in 2017 and nurse responders

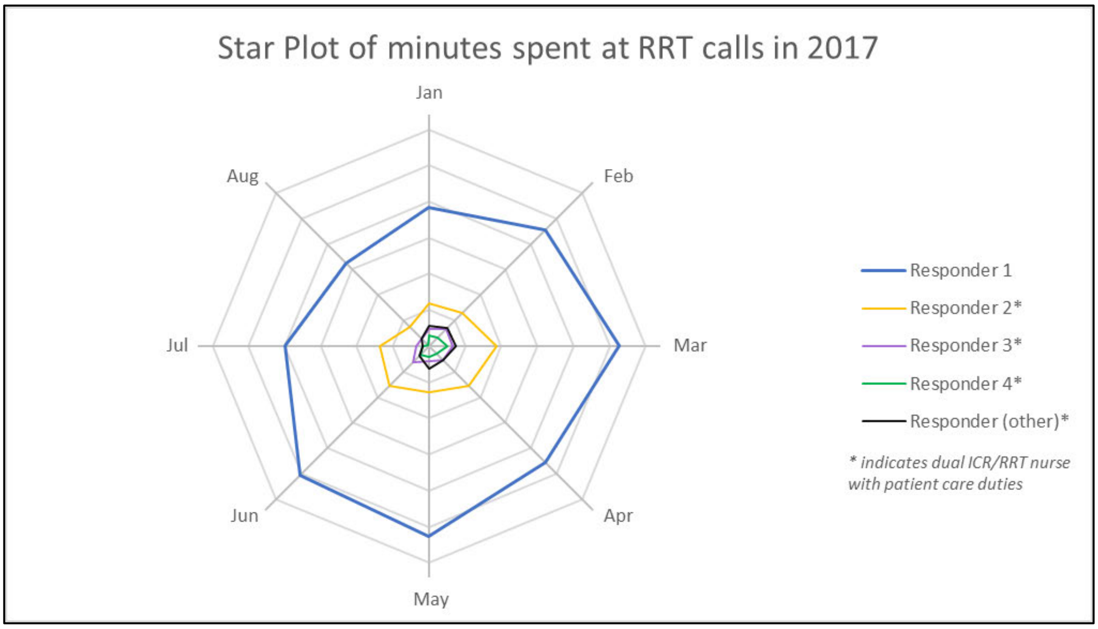
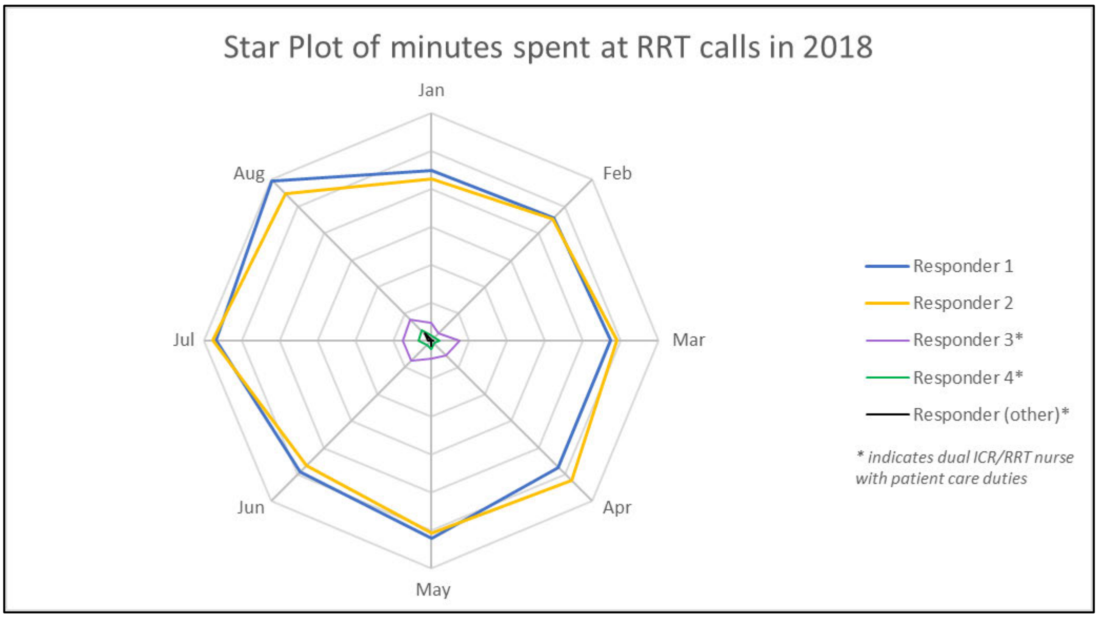


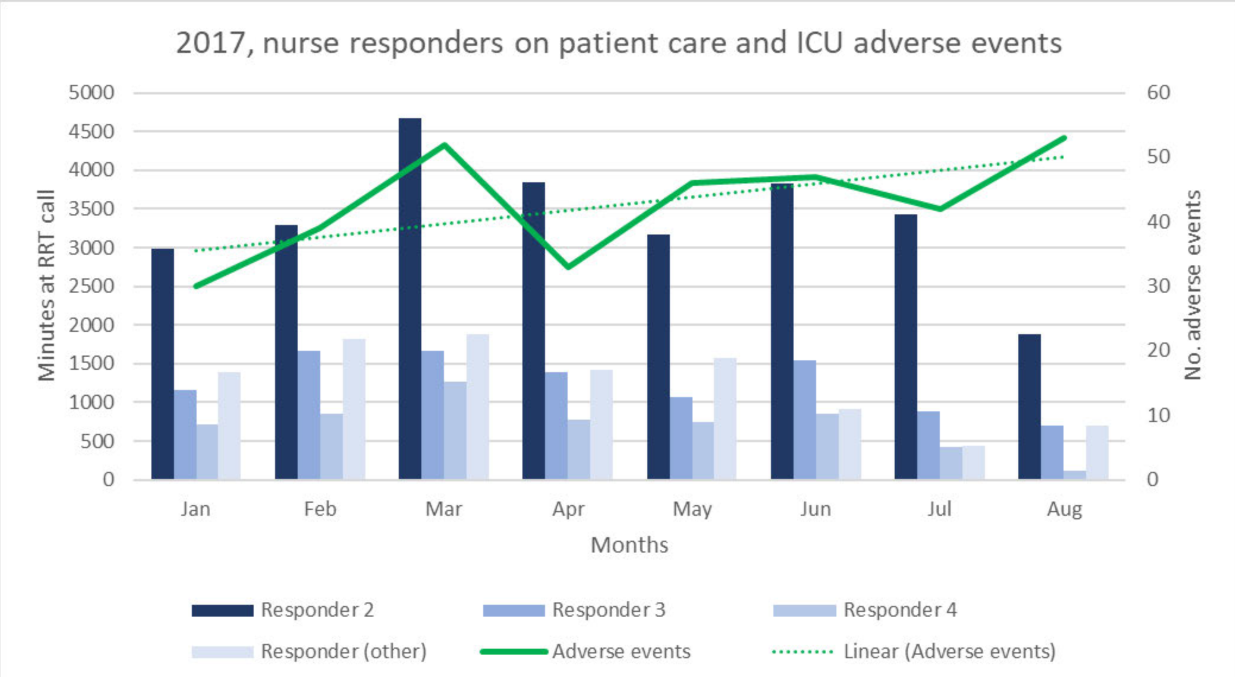
Figure 9. Star plot of minutes spent at RRT calls each month in 2018 and nurse responders



Adverse events

An adverse event/incident was defined at this institution as “any event or circumstance which could have (near miss) or did lead to unintended and/or unnecessary psychological or physical harm to a person and/or to a patient, that occurred during an episode of health care” (Government of South Australia, 2020, p. 4). The reporting of incidents or adverse events was not automatic and required the employee on duty who witnessed, or was part of, the incident to enter a report into the software program. In **Figure 10** and **Figure 11**, the nurse responders working as dual ICU/RRT nurses and their time spent at RRT calls were explored with adverse events. In both 2017 (**Figure 10**) and 2018 (**Figure 11**), there was a pattern between increasing dual ICU/RRT nurse activity and increasing adverse events for some months.

Figure 10. Combination chart of time (minutes) spent at RRT calls each month by nurses on patient care with the number of adverse events occurring in the ICU in 2017



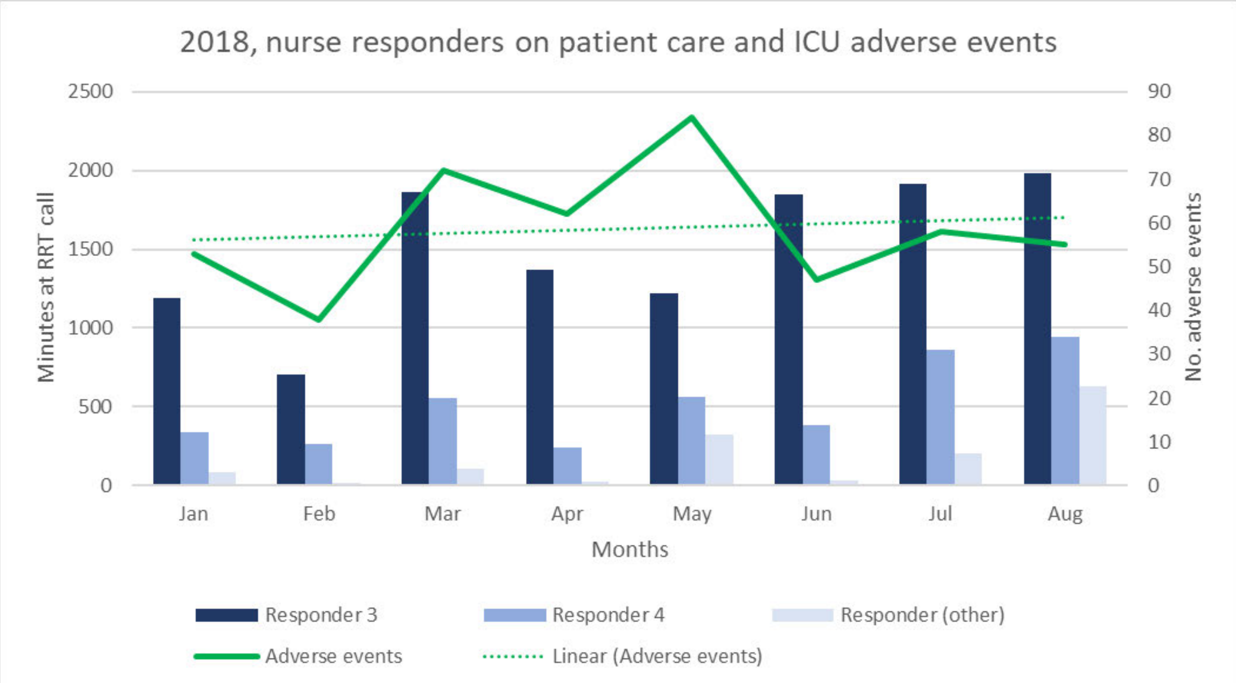
Combination chart: the visualisation combines the features of a bar chart, represented here as time series data by responder each month, and the line chart which shows the number of adverse events each month with a linear trend line.

The patterns or variations noted with 2017 data:

- January dual ICU/RRT workload (6250 minutes) and 30 adverse events were recorded.
- Dual ICU/RRT time at call increased in Feb (7641 minutes) and again in March (9470 minutes), both matched with increased adverse events (39, then 52).
- Dual ICU/RRT time at call decreased for the next two months in April (7431 minutes) and May (6551 minutes). In April adverse events decreased to 33, however, there is an atypical increase in May (46 events).

- In June dual ICU/RRT nurses spent 7145 minutes at RRT calls, but adverse events were almost static (47 events) when compared to May.
- Dual ICU/RRT time at RRT calls decreased in July (5173 minutes), matched with a decrease in adverse events (42).
- The adverse events are atypical in August when compared to other months and as dual ICU/RRT time at calls decreased (3390 minutes), the adverse events were high (53).

Figure 11. Combination chart of time (minutes) spent at RRT calls each month by nurses on patient care with the number of adverse events occurring in the ICU in 2018.



Combination chart: the visualisation combines the features of a bar chart, represented here as time series data by responder each month, and the line chart which shows the number of adverse events each month with a linear trend line.

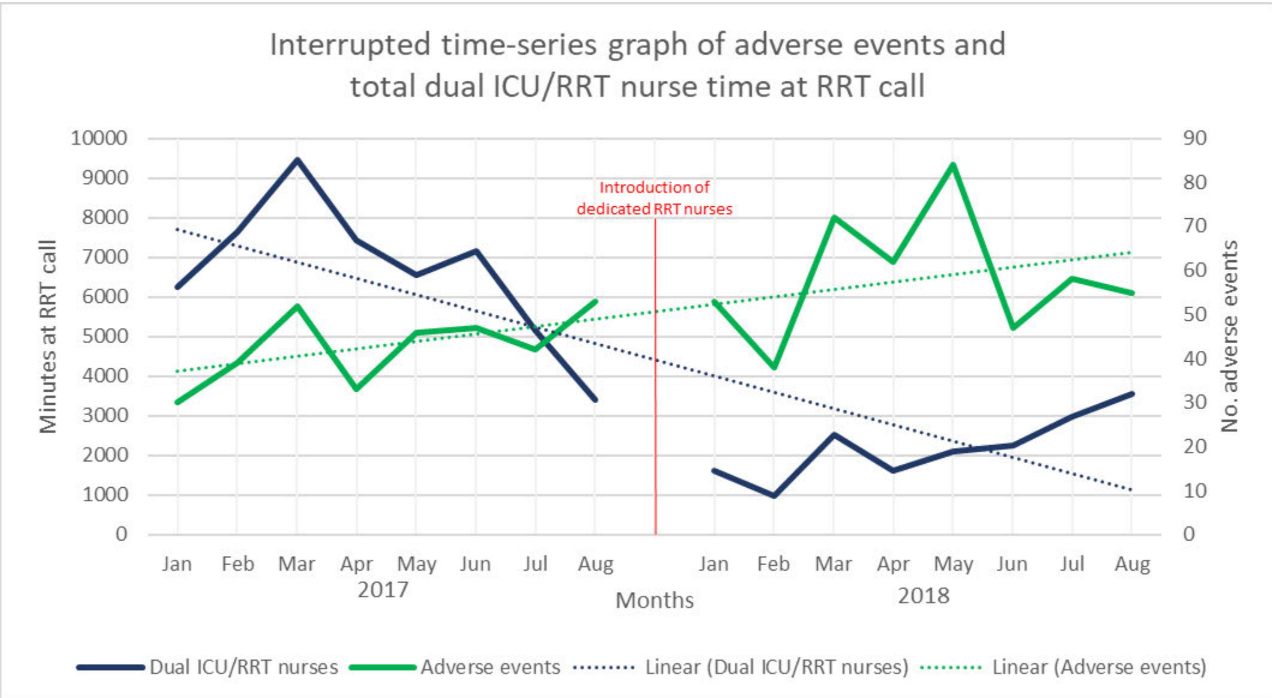
The patterns or variations noted with 2018 data:

- January sees dual ICU/RRT nurses spend 1617 minutes at RRT calls and 53 adverse events were recorded.
- In February, a downtrend in dual ICU/RRT time at RRT calls (992 minutes) coincides with fewer adverse events (38).
- In March, the dual ICU/RRT nurses spent more than double the time at RRT calls they did in February (2519 minutes), and adverse events increased proportionally to 72.
- In April the dual ICU/RRT nurses spent less time at RRT calls (1629 minutes), and adverse events reduced (62).
- In May dual ICU/RRT spent more time at RRT calls (2115 minutes), and adverse events increased (84).

- A higher than expected peak in adverse events during May (84 adverse events) meant the trends for June, July and August were atypical when compared to other months.

The interrupted time series graph (**Figure 12**) illustrates the trend (the overall long-term direction of the series) and reveals that adverse events are increasing and dual ICU/RRT nurse workload is decreasing over time. There is seasonal variation seen in both years, adverse events and dual ICU/RRT workload increased in March, then decreased in April. There is a data irregularity for August 2017, where the RRT workload was significantly less than what would normally be expected; likely owing to a deliberate downtrend in hospital activity, prior to the hospital relocating to a new site.

Figure 12. Interrupted time-series, with line graphs of dual ICU/RRT nurses total minutes at RRT calls and adverse events each month.



Univariate analysis

There were three main call outcomes recorded at the end of an RRT call: (1) left on the ward; (2) transferred out of the ward (transferred away from where the call originated); or (3) patient death. Cross-tabulation (crosstab) tables were used to explore the relationship between age groups and: the number of RRT calls dual ICU/RRT nurses' did, or did not attend (**Table 10**); calls that resulted in a transfer (**Table 11**); transfers to ICU (**Table 12**); and calls that resulted in a patient death (**Table 13**).

In **Table 10**, dual ICU/RRT nurses' responded to 31.4% of RRT calls for patients aged 40 years or less; overall dual ICU/RRT nurses responded to a similar percentage of RRT calls across all age groups (26.4%). This result is important and highlights that dual ICU/RRT nurses respond to a similar percentage of calls across all age groups, as displayed below with the overall percentage shown in bold.

Table 10. Crosstab exploring the relationship between age groups and calls attended or not attended by dual ICU/RRT nurses

Crosstab: age groups & dual ICU/RRT nurses			RRT call attended by dual ICU/RRT nurse?		
			No	Yes	Total
	Years				
Age group	<40	Count	490	224	714
		% within Age group	68.6%	31.4%	100.0%
	41-50	Count	378	122	500
		% within Age group	75.6%	24.4%	100.0%
	51-60	Count	652	205	857
		% within Age group	76.1%	23.9%	100.0%
	61-70	Count	934	327	1261
		% within Age group	74.1%	25.9%	100.0%
	71-80	Count	1048	397	1445
		% within Age group	72.5%	27.5%	100.0%
	81-90	Count	1109	394	1503
		% within Age group	73.8%	26.2%	100.0%
	91>	Count	311	100	411
		% within Age group	75.7%	24.3%	100.0%
Total		Count	4922	1769	6691
		% within Age group	73.6%	**26.4%**	100.0%

At the end of an RRT call, a patient may require a transfer from their current location. A transfer was usually required when the patient needed a higher level of care; or, a visitor or employee required assessment in the emergency department. Standardised transfer locations responses were obtained from the RRT database and include: “ICU”; “ED”; “OT”; “SDU/HDU”; or “other”. Total overall transfer numbers were examined with age groups on a crosstab. The age-adjusted cross-tab showed that a higher percentage of younger patients were transferred from their current location to another area (transfers for patients <40 years old were 26.5%, highlighted bold), with transfers decreasing to 4.2% (highlighted bold) for patients aged over 91 years. Refer to **Table 11**.

Table 11. Crosstab exploring the relationship between age groups and RRT calls that result in a patient transfer.

Crosstab: age groups & call outcome: transferred			Did the patient transfer to a new location?		
			No	Yes	Total
	Years				
Age group	<40	Count	547	197	744
		% within Age group	73.5%	**26.5%**	100.0%
	41-50	Count	428	94	522
		% within Age group	82.0%	18.0%	100.0%
	51-60	Count	735	164	899
		% within Age group	81.8%	18.2%	100.0%
	61-70	Count	1094	211	1305
		% within Age group	83.8%	16.2%	100.0%
	71-80	Count	1310	191	1501
		% within Age group	87.3%	12.7%	100.0%
	81-90	Count	1429	125	1554
		% within Age group	92.0%	8.0%	100.0%
	91>	Count	412	18	430
		% within Age group	95.8%	**4.2%**	100.0%
Total		Count	5955	1000	6955
		% within Age group	85.6%	14.4%	100.0%

Transfers specifically to ICU were examined and accounted for 41.8% of overall transfers, and 6% of overall call outcome results. Transfers to ICU decreased for patients aged 61-70 years to 7.6%. Transfer percentage to ICU decreased notably for the 71-80 year old patient group (5.9%), then decreased again for the 81-90 year old group (3.2%) and decreased again for patients aged over 91 (1.2%), refer to these results highlighted in bold in **Table 12**.

Table 12. Crosstab exploring the relationship between age groups and transfers to ICU.

Crosstab: age groups & transfer location ICU					
			Did patient transfer to ICU?		
			No	Yes	Total
	Years				
Age group	<40	Count	686	58	744
		% within Age group	92.2%	7.8%	100.0%
	41-50	Count	482	40	522
		% within Age group	92.3%	7.7%	100.0%
	51-60	Count	822	77	899
		% within Age group	91.4%	8.6%	100.0%
	61-70	Count	1206	99	1305
		% within Age group	92.4%	**7.6%**	100.0%
	71-80	Count	1412	89	1501
		% within Age group	94.1%	**5.9%**	100.0%
	81-90	Count	1504	50	1554
		% within Age group	96.8%	**3.2%**	100.0%
	91>	Count	425	5	430
		% within Age group	98.8%	**1.2%**	100.0%
Total		Count	6537	418	6955
		% within Age group	94.0%	**6.0%**	100.0%

There were 64 deaths (0.9%) recorded overall at an RRT call during the study. The rate of death differed for younger and older people (<40 years [0.3%] v >91 years [1.6%]), with the percentage of deaths increasing with each subsequent rise in age group, these discussed values are highlighted in bold, refer to **Table 13**.

The crude mortality rate of the RRT population in this study was 92 per 10^n population (n=4).

Table 13. Crosstab exploring the relationship between age groups and RRT calls that result in patient death.

Crosstab: age groups & call outcome: death			Does a patient's death occur during the RRT call?		
			No	Yes	Total
	Years				
Age group	<40	Count	742	**2**	744
		% within Age group	99.7%	**0.3%**	100.0%
	41-50	Count	520	2	522
		% within Age group	99.6%	0.4%	100.0%
	51-60	Count	892	7	899
		% within Age group	99.2%	0.8%	100.0%
	61-70	Count	1295	10	1305
		% within Age group	99.2%	0.8%	100.0%
	71-80	Count	1485	16	1501
		% within Age group	98.9%	1.1%	100.0%
	81-90	Count	1534	20	1554
		% within Age group	98.7%	1.3%	100.0%
	91>	Count	423	**7**	430
		% within Age group	98.4%	**1.6%**	100.0%
Total		Count	6891	**64**	6955
		% within Age group	99.1%	**0.9%**	100.0%

Multivariate analysis

RRT call outcomes analysis

The relationship between dual ICU/RRT nurses and RRT patient call outcomes was tested in logistic regression (**Table 14**). An RRT call outcome was routinely always recorded and there were three possible outcomes: (1) patient left in the ward; (2) patient transferred out of the ward; or (3) death of a patient during RRT call. During analysis, a fourth RRT call outcome was created from the transfer variable to highlight patient transfers to ICU/HDU. A summary table of comparative odds ratios, including confidence intervals, is displayed in **Table 15**.

Logistic regression analysis found an odds ratio greater than 1.0 for the dedicated RRT nurses' (only assigned to RRT duties) and for leaving patients on the ward at the end of the RRT call, being a dedicated RRT nurse increased the odds of leaving patients in their ward. This finding meant that the odds of dedicated RRT nurses leaving patients on the ward were 2.120 (95% CI 1.843-2.438) times greater compared with the odds of dual ICU/RRT nurses leaving patients on the ward at the end of the RRT call.

Dual ICU/RRT nurses had odds ratios greater than 1.0 for call outcomes: transfer (anywhere in the hospital); transfer to ICU; and patient death. The odds of dual ICU/RRT nurses transferring a patient were 2.027 (95% CI 1.756-2.340) times greater than the odds of dedicated RRT nurses transferring a patient at the end of RRT call, this included transferring a patient to ICU; however, the odds ratio was not as strong for ICU transfers (OR 1.428 with 95% CI 1.148-1.776). RRT calls that resulted in transfers were found to have an overall average call duration of 50 minutes (SD 39), compared to 35 minutes (SD 25) for calls where a patient was not transferred. Transfers to ICU resulted in the longest overall average call duration of 67 minutes (SD 37). Transfers to ICU were not affected by the time of day. In 2017, there were a total of 470 transfers and the most common location to transfer patients to was the ICU (35.3% of all transfers). In 2018, 530 transfers occurred and the most common transfer location was ED, this accounted for 40.8% of all transfers, compared with transfers to ICU at 38.7%. A comparison of column proportions was performed for transfer locations in 2017 and 2018 and found transfers to ED had increased significantly (significance level: .05. Tests were adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction).

Patient mortality

When examining the data for patient deaths as the dependent variable during an RRT call, the odds of the dual ICU/RRT nurses having patients die during an RRT call were 3.015 (95% CI 1.796-5.061) times greater compared with the dedicated RRT nurses. Dual ICU/RRT nurses attended to an even distribution of patients across all age groups (**Table 10**). Patient mortality during RRT call increased with increasing age (**Table 13**). RRT calls that resulted in patient death had an overall mean call duration of 30 minutes (SD 21), compared with a mean of 37 minutes (SD 28) for calls that did not result in death. Furthermore, RRT calls that resulted in death had a range of 102 minutes, with a median of 25 and IQR of 10–43 minutes. This was different for dual ICU/RRT nurses and dedicated nurses who responded to RRT calls when patients died (dual nurses: mean 34 minutes (SD 23), median 34 minutes [IQR 10–47]; dedicated nurses: mean 27 minutes (SD 21), median 23 minutes [IQR 16–31]). The majority (66%) of RRT calls that resulted in death occurred out of hours between 2000 and 0800 hours. A comparison of column proportions was performed for patient deaths during RRT calls in 2017 and 2018 and found significantly more deaths occurred in 2017, refer to **Table 5**.

Table 14. Logistic regression for dual ICU/RRT nurses (nurses on patient care) and RRT call outcomes.

RRT Patient Outcome (Variable)	Coef (B)	S.E.	Wald	df	*p*-value (Sig.)	Odds Ratio* [Exp(B)]	95% CI for Exp(B)	
							Lower	Upper
Left in ward	-0.751	0.071	110.745	1	<.001	0.472	0.41	0.543
Transferred out of ward	0.706	0.073	93.121	1	<.001	2.027	1.756	2.34
Transferred to ICU/HDU	0.356	0.111	10.255	1	0.001	1.428	1.148	1.776
Died during RRT call	1.104	0.264	17.445	1	<.001	3.015	1.796	5.061

**Odds ratios are unadjusted.*
CI = confidence interval

Table 15. Odds ratio (CI) for dual ICU/RRT nurses or dedicated nurses, and RRT call outcomes.

RRT Patient Outcome (Variable)	Dual ICU/RRT nurses (Nurses on patient care)	Dedicated RRT nurses (Nurses not on patient care)
	Odds Ratio* (95% Confidence Interval)	Odds Ratio* (95% Confidence Interval)
Left in ward	0.472 (0.410-0.543)	2.120 (1.843-2.438)
Transferred out of ward	2.027 (1.756-2.340)	0.493 (0.427-0.570)
Transferred to ICU/HDU	1.428 (1.148-1.776)	0.700 (0.563-0.871)
Died during RRT call	3.015 (1.796-5.061)	0.332 (0.198-0.557)

**Odds ratios are unadjusted.*
CI = confidence interval

Chapter summary

Chapter four has presented the results of the data analysis, which were primarily collected from the hospital's RRT database. The results have outlined the demographic information and reasons for RRT calls comparatively in each study period, and between key variables. In examining the data, this chapter has demonstrated associations, differences, or similarities between the two different nursing models. The findings will be discussed in chapter five.

CHAPTER FIVE: DISCUSSION

Chapter overview

Chapter five presents the key findings from the previous analysis of data. This chapter begins by restating the aims and objectives of the study. This is followed by a discussion of the key findings including, demographic data, time data, safety and quality data, and RRT call outcomes. Comparisons will be made with dedicated and non-dedicated RRT nursing models and associations or differences between data will be discussed. The discussion will refer to literature from the literature review in chapter two and other literature to deliberate this study's findings.

Research aim and objectives

The research aimed to explore the difference between two different RRT approaches at a single centre. The objectives of the study were to provide a detailed description of the time of day and amount of time nurses spent at RRT calls, to examine associations between the time spent at RRT call and adverse events in the ICU, and to compare RRT call outcomes between nursing models that use nurses with dual ICU/RRT responsibilities and nurses with dedicated duties.

Summary of key findings

Five key findings were established. First, this study found an increase in the age of patients experiencing RRT calls, compared with other studies. Second, the increase in the RRT caseload, comparable to ICU workload, was considerable. Third, nurses spend a considerable amount of time at RRT calls and this has financial implications for ICUs if staff are not dedicated to RRTs. Fourth, a real risk to patient safety exists within the ICU with the ongoing use of dual ICU/RRT nurse models. Finally, dispatching nurses who had dual ICU/RRT responsibilities to attend RRT calls significantly increased the odds of patient transfers and death.

Key findings

Older aged patients, high RRT caseload and reasons for RRT call

This retrospective cohort study of two different rapid response models yields several key findings. With regards to the overall characteristics of RRT calls, this patient cohort was older and the RRT caseload was high. The Australian Institute of Health and Welfare (2019, p. 29) reported on health outcomes for 2017 and 2018 and found that "…people aged 65 and over, who make up about 15% of the population, accounted for 42% of separations (hospitalisations)". This study found an overall mean age of 67 (SD 19), with an overall median age of 71 years (IQR 57–82, **Table 5**) for patients experiencing an RRT call. While this age is older than reported in other RRT studies, it is in keeping with Australian data that reports a high amount of older being are being hospitalised (Psirides, Hill, & Jones, 2016; White et al., 2016; Australian Institute of Health and Welfare, 2019).

The hospital's RRT has a high call-out rate with an overall average of 14 calls a day, which equates to approximately one RRT call every 1 hour and 40 minutes. The call rate is higher than an average of 10.5 hours between RRT calls reported by Psirides et al. (2016). One reason for the high call rate may be the older patient cohort or that this hospital empowers nurses to call RRTs based on their clinical judgement and expertise, which is a common attribute of top-performing hospitals (Dukes et al., 2019).

Low systolic blood pressure (<90 mmHg, **Table 6**) was the most common trigger for RRT calls and this is a common finding in the literature (White et al., 2016). Potentially, low systolic blood pressure was a common trigger for RRT calls because it can be easily measured and documented by automated machines. The number of RRT calls placed by general ward nurses who were "worried" about their patients was statistically significant between 2017 and 2018. This worry was likely due to the relocation of the hospital and all services to a new hospital site, bringing associated stressors.

There were 6955 (2017: 3466; 2018: 3489) RRT calls and 4792 (2017: 2398; 2018: 2394) ICU admissions during the study, refer **Table 5**. To provide an estimate of the RRT caseload, compared with the traditional ICU workload, a ratio of RRT calls to ICU admissions was calculated based on the work of Jones et al. (2016). The ratio was useful to express RRT calls/workload, relative to ICU admissions. The overall ratio of RRT calls to ICU admissions in this study for 2017 was 1.45 and in 2018 was 1.46. The ratios in this study are almost double that of an Australasia multi-centre study by Jones et al. (2016) that reported an overall ratio of 0.73, demonstrating that the RRT caseload was high in this study, relative to ICU admissions. In this study, RRT workload has grown more than ICU workload, and an older cohort of patients were requiring inpatient care than has been previously reported. It is paramount that future planning of RRTs ensures adequate RRT staffing and resourcing to meet hospital activity, patient acuity with the prospect of improving patient outcomes.

Nursing time and cost

Nurses spend a considerable amount of time at RRT calls, averaging 35 (2017) to 38 (2018) minutes per call with a range of 0-265 and 0-278 minutes respectively and the RRT was busiest in hours (0800-2000) (refer to **Table 7** and **Figure 7**). The time spent at RRT calls was similar for dual ICU/RRT nurses and dedicated nurses. Dual ICU/RRT nurses overall peak activity differed from dedicated nurses, the IQR was 08:24-18:24 compared with an IQR of 07:09-18:47 respectively. Dual ICU/RRT nurse peak activity is likely later due to the hospital's local process of dispatching nurse responders in sequential order and dedicated nurses were often the first responders to be dispatched. In practice, during 2018, the dedicated nurses were dispatched to the first and second RRT calls, with dual ICU/RRT nurses dispatched later if a third or greater RRT occurred within the same period.

Before the introduction of dedicated RRT nurses, nurses with dual ICU/RRT responsibilities had worked a peak of 9470 minutes (158 hours) a month, refer to **Table 8**. These number of minutes represent over one full-time equivalent (FTE) senior ICU nurse who was allocated to work in the ICU but doesn't because they are out at RRT calls. In Australia, a full-time employee would usually work an average of 38 hours each week, which would be 152 hours a month (Fair Work Ombudsman, n.d). The base cost of one full-time max level registered nurse (RN0109) base salary was $85,902 (2017) or $88,050 (2018) AUD per year (Government of South Australia, 2016). With the introduction of a dedicated RRT nursing model in 2018, a significant reduction (71% reduction) in the number of calls dual ICU/RRT nurses must attend was recorded. The nurses working in a dual ICU/RRT role were still required to support the RRT, and their activity peaked in August 2018 at 3550 minutes (59 hours) or 0.39 FTE, refer to **Table 9**. The ICU continued to pay the salary of the dual nurses, but they were attending RRT calls around the hospital without fiscal reimbursement to the ICU.

The continued practice of utilising dual ICU/RRT nurses that have other competing clinical responsibilities; is associated with non-top performing hospitals, causes significant disruption to normal hospital routines, inconveniences staff, may increase workload complexity, strain the ICU and risks the safety of patients within the ICU (Cheung et al., 2014; Jones et al., 2016; Flabouris & Mesecke, 2017; Dukes et al., 2019). The findings from this study showed that despite being based in ICU and assigned to ICU patient care, at times dual ICU/RRT nurses spent over 1.03 FTE a month out of the ICU to support RRTs at an estimated yearly cost of over $85,000 AUD to the ICU. Historically, the ICU was left to absorb the nursing staffing costs of running a hospital-wide RRT. Fortunately, the introduction of two dedicated RRT nurses saw a reduction in dual ICU/RRT nurse activity. However, this study does highlight that nurses in a dual ICU/RRT role were still required to regularly support the RRT and this may impact the safety and quality of care in the ICU.

Safety and quality

In regards to safety and quality, The Australian Commission on Safety and Quality in Health Care (2017) acknowledge the importance of "Recognising and Responding to Acute Deterioration" and has dedicated an entire National Standard to this area. However, much of the standard defers the responsibility of establishing, maintaining, and funding a rapid response service to the "health service organisation" (Australian Commission on Safety and Quality in Health Care, 2017, p. 72).

To understand how to establish a safe rapid response service and deliver quality care, refer to the "Joint Position Statement on Rapid Response System in Australia and New Zealand and The

Roles of Intensive Care" (Boots et al., 2016). That document provides greater detail about establishing and maintaining rapid response services and RRTs and includes the needs of both staff and patients. However, the document by Boots et al. (2016) was predominately written by and for medical staff and does not consider the unique needs of ICU/RRT nurses. Boots et al. (2016) defer exactly how the RRT should be run to the individual institution, but they acknowledge that inadequate resourcing of the RRT will lead to failings in the quality of care in the ICU. This inadequate resourcing is exactly what a dual ICU/RRT nurse model does to the nursing staff by removing them from direct care of critically ill ICU patients to attend RRT calls around the hospital.

The time has now come to cease vague suggestions and recommendations of what may be acceptable for RRTs and for nurses to make a stance that supports the nursing workforce of ICU and RRTs. In Australia, the peak body that represents critical care nurses is the Australian College of Critical Care Nurses. Whilst they have a comprehensive "Workforce Standards for Intensive Care Nursing" document, unfortunately, a similar document does not currently exist for RRT nursing workforce standards (Australian College of Critical Care Nurses, 2016). Ensuring that RRT nursing workforce standards are developed and made available to organisations and the nursing profession provides an opportunity to improve the safety and quality of RRT and ICU care delivery.

To further highlight the importance of ceasing dual ICU/RRT nurse models, this study found that there was a repeating pattern between the increasing activity of nurses in a dual ICU/RRT role and increased adverse events in the ICU (refer to **Figure 12**). As expected, the overall activity of nurses in a dual ICU/RRT role decreased with the introduction of a dedicated RRT nurse model. However, it was unexpected that adverse events continued to increase over time. Factors that may have influenced the continued occurrence of negative adverse events in the ICU could include: the ongoing use of nurses that work in a dual ICU/RRT role; ineffective replacement of dual ICU/RRT nurses where adequate coverage was unlikely because of their unique skill set and the specialised nature of their work; the strain using dual ICU/RRT nurses can create on ICU resources, which risks the safety of patients in the ICU; the covering nurse feeling overwhelmed and inadequate handover to the covering nurse; and dual ICU/RRT nurses attending to overlapping calls that are known to run for longer (Wang et al., 2013; Cheung et al., 2014; Jones et al., 2016; Flabouris & Mesecke, 2017). There were seasonal changes in activity with both the dedicated nurse model and dual ICU/RRT nurse model when adverse events increased in March and then decreased in April of each year. There was irregular RRT activity in August 2017 (lower than expected) which was likely due to the deliberate downtrend in hospital activity, before moving to a new location in September 2017. Despite activity decreasing, there was an increase in adverse events for August 2017. Whilst the data demonstrated a consistent pattern of increased adverse events in the ICU with increased activity of nurses in a dual ICU/RRT role, some months were atypical.

There was a statistically significant reduction in the number of RRT calls for in-hospital arrests (IHA) in 2018 (**Table 5**), specifically cardiac arrests (**Table 6**), potentially resulting from the nurses exclusively dedicated to RRT duties not having to leave their normal duties to attend RRT calls; and therefore, not having to juggle the competing demands of a dual ICU/RRT role. The reduction of IHAs possibly occurred because the nurses dedicated to RRT duties were responding to the bulk of calls in 2018 and were spending longer (9% rise in average call duration from 2017 to 2018) with their patients to investigate the reason more thoroughly for the deterioration, and were pro-actively re-reviewing the patients of concern later in-between calls. Importantly, these achievements occurred without any increase in the rate of ICU admissions, perhaps because the dedicated RRT nurses were able to provide a greater level of ward-based care than offered before. For example, dedicated RRT nurses started to provide advanced treatments such as non-invasive ventilation for short-term treatment of acute pulmonary oedema on the ward during RRT calls. Previously, dual ICU/RRT nurses were unable to provide such advanced treatments due to their self-imposed time constraints and desire to return to the ICU and care for their allocated patient(s).

This study's findings reinforce the notion that dedicated RRT nurses can reduce the disruption to normal hospital routines caused by dual ICU/RRT roles, whilst simultaneously reducing the number of RRT calls for IHA and avoiding admissions to ICU. Other organisations with similar RRT activity should consider financial investment into RRTs as one way to reduce the burden and bed pressures on the ICU; or, may find that the ongoing inadequate resourcing of RRTs will harm the quality and safety of patient care in the ICU (Boots et al., 2016).

Patient transfers

There were 1000 transfers (14.4%) at the time of RRT call (refer to **Table 11**). RRT calls that resulted in transfers had longer average scene times (50 minutes), compared with calls that did not result in a transfer (35 minutes). Longer scene times for RRT calls that result in a transfer remain consistent with the literature (Wang et al., 2013). The odds of nurses working in a dual ICU/RRT role was a significant factor for patient transfers, where the odds of being transferred was 2 times higher compared with having a dedicated RRT nurse responded to the call (p < 0.001; OR 2.027 (CI: 1.756–2.340), refer to **Table 14**). This is problematic. Dual ICU/RRT nurses have been removed from the direct care of an ICU patient to attend the RRT call, are at greater odds for having to transfer a patient, and transfers are known to have longer average scene times. If the nurse working in a dual ICU/RRT role was away for a long time transferring a patient, it creates a mismatch between workload and staffing ratios in the ICU, and if these types of absences are reoccurring it will cause chronic under-resourcing and impact the quality of care in the ICU (Boots et al., 2016; Lee et al., 2017). The high workload, in combination with low staffing ratios, has been associated with an increased risk of death in critically ill ICU patients (Lee et al., 2017). RRT calls resulting in transfers to ICU were not affected by the time of day, which is different to a finding by

Molloy et al. (2018) who found that RRT calls occurring after-hours were often more likely to result in ICU admission.

Patient mortality

In regards to patient deaths at the time of RRT call, this study found that having nurses working in a dual ICU/RRT role responding to the call was significant and there were 3 times the odds of patient death occurring for dual ICU/RRT nurses ($p < 0.001$; OR 3.015 (CI: 1.796–5.061), refer **Table 14**). Regarding this outcome, there are no directly comparable studies that could be located. When the data was distributed into age groups, the dual ICU/RRT nurses attended 26.4% of all RRT calls (lowest 23.9% and highest 31.4%, refer **Table 10**) across different age groups, therefore, the rise in deaths cannot be attributed to dual ICU/RRT nurses responding to an older patient cohort. As expected, deaths at this hospital increased with the increasing age group, refer **Table 13**. For the deaths recorded during an RRT call, nurses allocated to dual ICU/RRT roles experienced overall longer call times (mean 34 minutes (SD 23); median 34 minutes (IQR 10–47)), compared with dedicated RRT nurses (mean 27 minutes (SD 21); median 23 minutes (IQR 16–31)). Nurses working in a dual ICU/RRT role had longer RRT call times, highlighting concerns about prolonged absences, high workload/ low staffing ratios in the ICU, and the association this has with an increased risk of death in critically ill ICU patients (Lee et al., 2017). Having nurses working in a dual ICU/RRT role respond to an RRT call was a major factor related to patient death, with possible contributing factors being: the nurses' usual work routines being disrupted by having to attend to RRT calls; concern for their colleagues back in the ICU who were under-resourced and have an additional workload; the risk of adverse events occurring while they are absent; and an increase to personal stress levels due to the excessive workload and fatigue (Shapiro et al., 2010; Benin et al., 2012; Wang et al., 2013; Flabouris & Mesecke, 2017; Cheung et al., 2019).

A recent systematic review by Ramírez-Elvira et al. (2021) highlighted work overload, seniority and age as the main factors related to burnout in ICU nurses. As most nurses working in a dual ICU/RRT role are senior, thus usually older, and may be overworked in a dual role, there exists a real potential risk for burnout. Nurses who experience burnout have several associated negative outcomes, such as psychological strain, lower job satisfaction and heart disease; whereby work overload contributes to burnout and further depletes the available staff that can work due to higher rates of staff turnover (Chuang, Tseng, Lin, Lin, & Chen, 2016). To avoid ICU nurse burnout, Adams, Chamberlain, and Giles (2019) describe four strategies ICU Nurse Managers could implement: (1) knowing and understanding nurses; (2) creating a caring and supportive culture; (3) creating meaningfulness; and (4) involving others in the support of nurse well-being. If managers are ‘caring for the carers’ and supporting and assisting the ICU/RRT nursing workforce, it may help to reduce burnout and fatigue (Huggard, 2003; Adams et al., 2019). Huggard (2003, p. 164) stressed the need for organisations to support and assist their employees and identified that “…the challenge for health care organisations lies in developing respect and care for their employees in the same way that they require their employees to care for patients". Nearly 20 years later, this quote still holds relevance. The stopgap measure of organisations providing well-being measures to staff who rate high in burnout scores can end if organisations actively and truly prioritise staff well-being by investing and supporting their employees through the provision of a safe, manageable workload then the cycle of work-overload and burnout can be broken. Therefore, the allocation of nurses to dual ICU/RRT roles and the use of dual ICU/RRT models should cease.

Chapter summary

Chapter five discussed the key findings from the analysis of data and made comparisons between the nurses who undertake a dual ICU/RRT role and nurses who are dedicated to RRT duties. Literature has been included to further the discussion and provide a more enriched, detailed consideration of the problems encountered. The next chapter summarises the contributions this study has made and frames the overall conclusion.

CHAPTER SIX: CONCLUSION AND CONTRIBUTION

Chapter overview

This chapter will provide a detailed study conclusion, including revisiting the objectives, summarising key findings, detailing the strengths and limitations, listing the contributions this study makes to the existing body of RRT knowledge and concludes with future recommendations.

Research aim and objectives

This research aimed to explore the difference between two different RRT approaches at a single centre. The objectives of the study were to provide a detailed description of the time of day and amount of time nurses spent at RRT calls, to examine associations between the time nurses spent at RRT calls and adverse events, and to compare RRT call outcomes between nurses with dual ICU/RRT responsibilities and nurses dedicated to RRT duties.

Summary of key findings

Based on a quantitative analysis of data, it can be concluded that this hospital had a busy rapid response service with numerous RRT calls, a high RRT/ ICU work ratio and that dual ICU/RRT nurses spend a considerable amount of time out of ICU at RRT calls, which has fiscal implications. Furthermore, having dual ICU/RRT nurses respond to RRT calls significantly increased the odds of patient transfers and death. The introduction of nurses dedicated to RRT duties reduced the workload of nurses with a dual ICU/RRT role and was associated with decreased IHAs, without increased ICU admissions. In addition, as the workload and time at RRT call of nurses in a dual ICU/RRT role increased, there was a consistent pattern seen with increased adverse events in the ICU. Therefore, the use of dual ICU/RRT nursing models is an important contributing factor to consider when reviewing explanations for adverse events in the ICU.

Strengths and limitations

This was a retrospective, observational, study and it cannot demonstrate a causal relationship between dual ICU/RRT nurses and RRT call outcomes or adverse events. However, despite this being descriptive work the patterns in data regarding the concurrent increased dual ICU/RRT nurse workload and increased adverse events cannot be ignored and the findings were supported in other studies (Wang et al., 2013; Cheung et al., 2014; Cheung et al., 2019). Additionally, there were plausible reasons why overworked and overstretched nurses working in a dual ICU/RRT role may be associated with higher odds of patient transfers and death. Possible reasons include: the association of older patient cohorts; lengthy RRT calls and having to attend to RRT calls that overlap; high workload/ low staffing ratios; the subjective feelings of guilt nurses experience while they are absent from the ICU; and the real risk all of these factors pose to causing negative adverse events to ICU patients (Shapiro et al., 2010; Benin et al., 2012; Wang et al., 2013; Cheung et al., 2014; Flabouris & Mesecke, 2017; Lee et al., 2017; Cheung et al., 2019).

This study has several strengths, including a high number of RRT calls included in the data analysis over two different years. The data were reduced to a focused period of 16 months, where the first eight months were pre-RRT model change, and the second eight months were post-RRT nursing model change. The study periods were compared like to like (month to month) using an ITS design to assess whether effects were short-lived or sustained over time and in this way, reduced the potential for seasonal variation in acute hospital presentations and activity due to the monthly like-for-like comparisons.

This study has several limitations. Firstly, the data were collected from only one hospital. Secondly, the analysis was retrospective. This may reduce the generalisability and external validity of the findings to hospitals with different RRT structures, hospital acuity and activity. Thirdly, the data set included missing data, however, missing data were not extrapolated or estimated and were most likely present due to the manual way data were collected before being entered into the RRT database. Finally, RRT rates are often reported per 1000 admissions, however data on denominator admissions to calculate this was not readily available or collected; likewise, hospital length of stay and 30-day outcomes were not part of the data reported.

Contribution to knowledge

This study is believed to be the first to focus primarily on RRT nursing time and report on the differences between two different rapid response models within a single centre. This study provides detailed descriptive statistics accompanying visual exploratory data analysis of dual ICU/RRT and dedicated RRT nurse activity. Furthermore, this study reports on an older patient cohort and busy rapid response service, in comparison to other studies. In chapter two, there was a gap in the literature comparing RRT call outcomes between dual ICU/RRT and dedicated RRT nursing models. In this study, logistic regression was used to assess RRT call outcomes with calls attended by nurses working in a dual ICU/RRT role found to be associated with higher odds of patient transfers and death. This is a novel finding that requires further exploration to understand.

Data analysis from this study found that the introduction of nurses dedicated to RRT duties was associated with several significant results. Firstly, a reduction in the activation and time spent out of ICU by nurses working in a dual ICU/RRT role. Secondly, a reduction in RRT calls for IHA; and thirdly, a reduction in the number of patient deaths at the time of an RRT call.

However, the use of nurses dedicated to RRT duties was associated with an increased average RRT call time and the RRT caseload was high, relative to ICU admissions. The introduction of dedicated RRT nurses did not reduce the number of adverse events occurring in the ICU, despite decreasing the workload of nurses working in a dual ICU/RRT role; probably because dual nurses continue to be dispatched to RRT calls. When dual ICU/RRT nurses were dispatched to RRT calls frequently within a month there were generally an increased number of adverse events recorded in the ICU, this was also true for months of low dual nurse activity where comparably fewer adverse events were recorded. This pattern in the data was noted to repeat consistently, where high RRT activity and increased reliance on nurses in dual ICU/RRT roles generally led to subsequent rises in ICU adverse events. This means the ongoing use of dual ICU/RRT nurse models can be associated with increased adverse events in the ICU and there exists a real risk for patient harm.

Recommendations from the study

Clinical practice recommendations

Based on these conclusions, the dual ICU/RRT nursing model should not be used when it requires the nurse to leave critically unwell patients in the ICU whilst they attend to RRT calls around the hospital. Current practitioners operating within a dual ICU/RRT nurse role should advocate for, and be supported with, migration to a dedicated RRT nursing model. This study revealed that the introduction of dedicated nurses was associated with several benefits, including a reduction in the activity of dual ICU/RRT role nurses, a reduction in RRT calls for IHA, and a reduction in the number of patient deaths during an RRT call. These benefits were achieved without a concomitant increase in ICU admissions.

Policy recommendations

The discussion of this study highlighted several gaps in the current Australian National Standards regarding safe staffing to support deteriorating patient services. New additions to the National Standards should consider ‘caring for the carers’ by introducing provisions and standards that support the nursing workforce. Fortunately, Boots et al. (2016) have already undertaken a detailed joint position statement on safe rapid response service provision. There exists an opportunity for the ACCCN to lead the way in Australia and create an RRT nursing workforce standard, that supports both the patients and nurses, and could guide the future direction of nursing RRT models.

The findings of this study have important implications for hospital administrators and clinicians responsible for and working within the RRTs. Attempts to continue with high-risk models using dual ICU/RRT nurses should cease and transition to a dedicated RRT nursing model. Otherwise, as this study reports, a failure to do so could risk patient outcomes and lead to patient harm.

Future research

This research highlights that nurses who undertake a dual ICU/RRT role were associated with higher odds of patient transfer and death, compared with dedicated nurses, but raises the question of why.

To better understand the implications of these results, future studies could aim to investigate if a causal relationship between dual ICU/RRT nurses and patient mortality exists. The optimal design for such a study would be a multi-centre stepped-wedge trial that includes interrupted time series to compare the effect of dual nurses against dedicated nurses and patient outcomes. However, as this study raises significant concerns about safety and the risk of patient harm, ethical approval may be complex. Therefore, a multi-centre cohort study may be possible where the outcomes of institutions with an existing dedicated RRT are compared with institutions in which nurses have dual responsibilities. The subjective experiences of the nurses involved cannot be ignored either and therefore mixed methods or a qualitative study should be considered in combination with any quantitative study. However, the first action would be to confirm the findings of this study prospectively.

Concluding comments

This study demonstrates that nurses working in a dual ICU/RRT role spent a considerable amount of time out of ICU at RRT calls, which has financial implications for the ICU. It also confirmed that any use of nurses in a dual ICU/RRT role, especially when dual nurse activity was high, was associated with an increased rate of adverse events in the ICU. RRTs should adopt a dedicated RRT nursing model as soon as feasible, this would limit the dual-workload complexity and reduce the risk of patient harm in the ICU. In this study, the use of nurses dedicated to RRT duties was associated with several benefits, most of all, a decrease in IHAs, without an increase in ICU admissions. However, having nurses who work in a dual ICU/RRT role respond to RRT calls significantly increased the odds of patient transfers and death. Further research and expert consultation is urgently recommended to explore these findings and develop Australian RRT nursing workforce standards/guidelines. Developing these standards centered on evidence-based practice and implementing real change for the ICU/RRT nursing workforce is needed. Although this study was a single-centre, observational study, the findings from this research provide context and highlight an important issue, that was previously ignored. Furthermore, this study will contribute to the growth and development of the ICU/RRT nursing workforce as professionals and highlights the need for safe, manageable, workforce standards development to achieve quality patient care.

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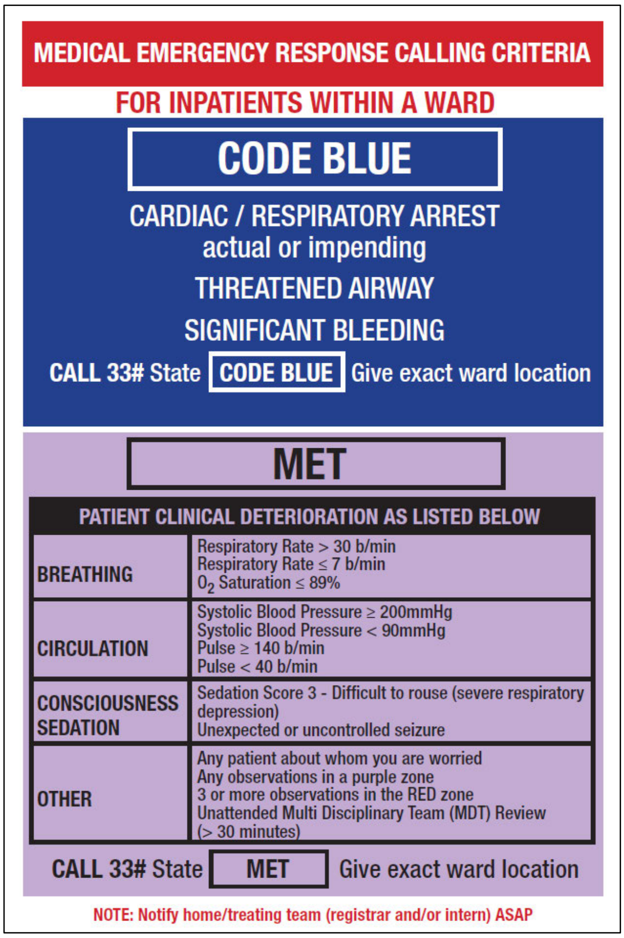
APPENDICES

Appendix 1: Rapid Response Service

The term Rapid Response Service (RRS) is the term used to describe the overall service. When discussing the team, the term Rapid Response Team (RRT) is used, and this describes the team that attends to the medical emergencies throughout the hospital to provide treatment and support. At this large metropolitan teaching hospital, there are two types of responses, a “MET” and a “CODE BLUE”. The calling criteria for each response and the difference in the staff that respond are shown below.



CODE BLUE Team:

x1 ICU Registrar

x2 ICU CCRN

x1 – 2 MER RMOs

x2 Medical RMO

x1 Surgical RMO

x2 Intern

x1 Orderly

MET Team:

x1 ICU CCRN

x1 – 2 MER RMOs

x2 Medical RMO

x1 Surgical RMO

x2 Intern

Terms

ICU CCRN: critical care registered nurse, a nurse from ICU who has post-graduate qualifications in critical care and/ or ICU.

ICU Registrar: a medical officer who has obtained specialist qualifications in ICU and/ or anaesthesia and has advanced airway skills.

RMO: registered medical officer, is a post-graduate year (PGY) 2 or greater.

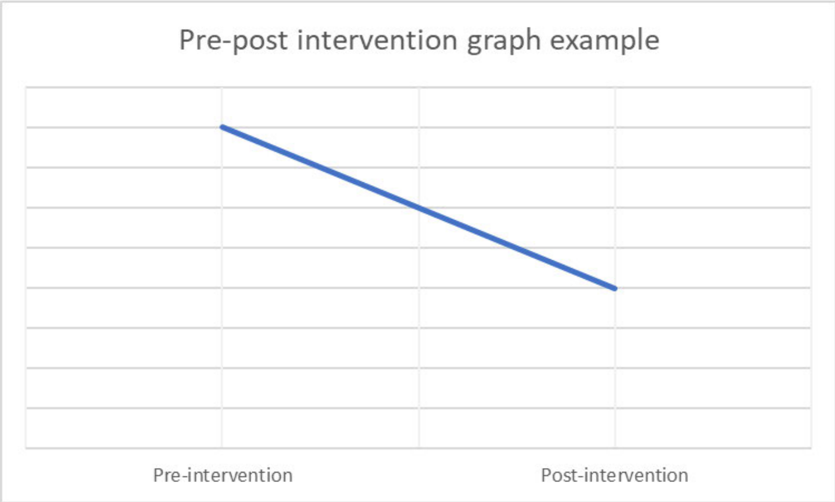
Intern: is an employee who has graduated from an accredited school of medicine and has been granted provisional registration, PGY 1.

Orderly: an attendant in a hospital responsible for the non-medical care of patients, attends on a CODE BLUE to assist with patient transport.

Appendix 2: Graph examples. Pre-post design v. time-series design

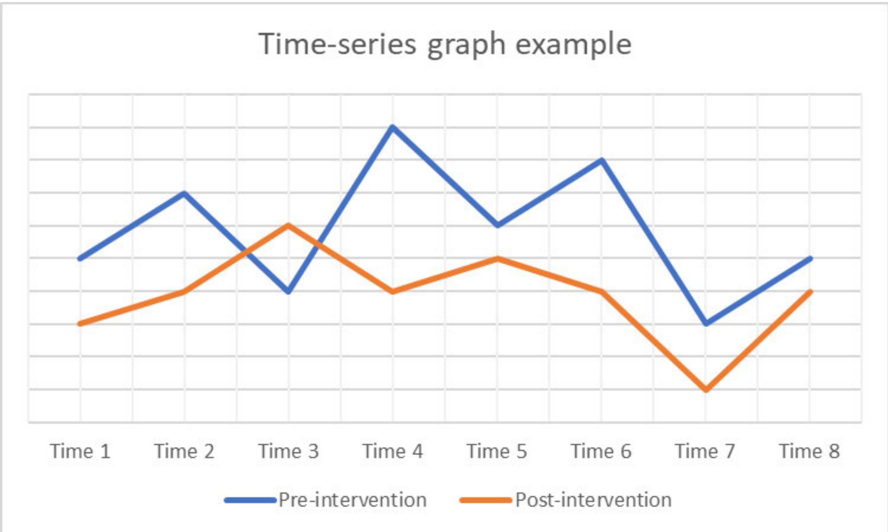
Example graph one shows a simple graph with data pre-intervention and post-intervention at two data points. The intervention has caused a reduction in the variable being measured post-intervention.

Example graph one: simple pre-post intervention graph



Example graph two shows a time-series graph of the same data pre and post intervention, but instead of being collapsed into one pre and post data point (as above) it's adjusted in time-series design, displaying multiple key time periods (as below). The intervention has caused a reduction in the variable being measured, however, there is some variation which you can observe more clearly, overall, the variable has generally been sustained over time by the intervention in this example. There are different ways to display time series data, this is one example.

Example graph two: time-series graph



Appendix 3: Ethics and governance acceptance

Health
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Local Health Network

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Research Services

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ABN: 96 269 526 412

Authorisation Date: 16 November 2020

Mr Clinton Fildes
Critical Care and Perioperative Services Department
[redacted]

Dear Mr Fildes

CALHN Reference Number: 13893

Project Title: Let's talk about a nurses' time. A cost-conscious, safety-focused value of a rapid response service.

Thank you for submitting the above proposal for review. The above submission was considered by the CALHN Human Research Ethics Committee (CALHN HREC) at its meeting held on 05 November 2020 and governance review has been conducted by CALHN Research Services.

The above application included the following waiver requests:

- Waiver of Consent to access participants' medical records for the duration of this project, for clinical data recorded up and until the approval date

The CALHN HREC determined that the waiver request meets the requirements of section 2.3.10 of the NHMRC National Statement. Waiver of consent has been granted for access to all electronic and hard medical records for the above project.

The project is **authorised** by CALHN Research Services for conduct at [redacted]

The CALHN HREC is constituted in accordance with the NHMRC *National Statement on the Ethical Conduct of Human Research* (2007).

Documents reviewed and approved:

Document	Version	Date
Ethics and Governance Application	-	16 October 2020
Protocol	2	12 November 2020

Sites covered by CALHN HREC approval:

Site	State	Principal Investigator
[redacted]	SA	Clinton Fildes

Project authorisation is valid for **one (1) year** from **16 November 2020 to 16 November 2021**. An annual progress report requesting an extension must be submitted if the duration of the project continues beyond this period.

GENERAL TERMS AND CONDITIONS OF PROJECT AUTHORISATION:

1. The CALHN HREC is the South Australian (SA) 'lead HREC' for the purpose of this ethics approval. Any study sites that are not listed on this letter are not covered by the CALHN HREC approval.
2. The study must be conducted in accordance with the standards outlined in the National Statement on Ethical Conduct in Human Research (2007), the Australian Code for the Responsible Conduct of Research (2018), and SA Health policies.
3. Adequate record keeping must be maintained in accordance with Good Clinical Practice, and the NHMRC, state, and national guidelines. The duration of record retention for all low risk research data is five years from the date of publication.
4. Proposed amendments to the research protocol or conduct of the research which may affect the ongoing