Title: Risk management of the deteriorating patient in the Acute Care Setting (RACS study): A single centre case study

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Certificate of original authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as part of the collaborative doctoral degree and/or fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

Contemporary acute care health facilities are increasingly recognized as dangerous places for patients due to the high risk of adverse events, many of which are preventable. These events include unplanned admissions to Intensive Care Units, unexpected cardiopulmonary arrests and deaths. The reasons for this are complex, diverse and multifaceted and attributable to patient, provider and health care system factors. Failure to recognise early warnings signs of clinical deterioration on our acute inpatient wards has been widely documented within the literature. This has led to the advent of Rapid Response Systems (RRS) designed for early recognition, escalation and management of the deteriorating general ward patient.

Measuring the success of these systems has been difficult, in part due to implementation issues and the underestimated complexity of model workings when placed within the context of the greater healthcare environment. Local resourcing, communication and team cohesion can influence implementation effectiveness, inhibiting RRS from achieving their full potential. Investigating models of health care interventions isolated from contextual factors will result in a failure to successfully implement and sustain interventions to improved health outcomes.

Deeper exploration into perspectives of how clinicians operate within these obligatory systems, as well as how the systems themselves impact on clinician work routines and activity is required. Factors influencing daily functioning and activity stability of RRS impact on demand and resourcing in environments that have been found to be resource poor.

Using a framework of organisational theory, this thesis examined how individuals perceive organisational structures, processes, relationships and practices, and how these influence

their clinical practice and function within the health care system. The study explored, utilising a mixed approach, factors influencing operation of a single centre rapid response system (RRS). The study aims were addressed through collection of data in three discrete phases, interpreting findings not only within the boundaries of the single site, but additionally in the broader interface between professional and regulatory bodies determining practice (the case).

This study found that ongoing education and clinical support is essential, especially for medical officers, often left to work independently, with insufficient mentoring and support in the clinical environment. The RRS is potentially unstable in process and easily falls out of control leaving resource poor clinicians struggling to work within the system. Several factors have been identified that are not routinely measured for their negative impact, including patient acuity and team models. Cultural, organisational and technical factors impact on RRS workings. Improvements in RRS should consider the complex interactions that occur within this system as well as workload and staffing issues.

Glossary of terms

Glossary term	Glossary definition
ACSQHC	Australian Commission on Safety and Quality in Healthcare
AE	Adverse events
Afferent limb or arm	The activation segment of the RRS
BTF	Between the flags: A NSW state wide rapid response system program
Calling criteria	Criteria used to activate the RRS when parameters are breached, consists of vital sign readings and subjective 'worried or concerned' criteria
Case	The healthcare environment, system and participants involved in the study
CEC	Clinical Excellence Commission: Quality pillar of NSW Ministry of Health
Clinical Review	A tier of the rapid response system with less sensitive parameters than the rapid response tier, requiring a Registered Nurse response
Code Blue	A medical emergency responded to by an ICU based critical care team
Consumer	Health system users, includes patients, families and carers
Efferent limb or arm	The response segment of the RRS
EWS	Early warning score: Rapid response system model design with an aggregated scoring system used to trigger the RRS
ICU	Intensive care unit
KPI	Key performance indicator
MET	Medical emergency team: A rapid response system model design using a team of clinicians usually dispatched from a critical care unit as the efferent (response) arm

MEWS	Modified early warning score: Rapid response system model design with an aggregated scoring system used to trigger the RRS
Out of control	Statistically 3 sigmas (3 standard deviations) above or below the mean
PACE	Patient with acute condition for escalation: A rapid response system model design using the patients admitting medical team as the efferent (response) arm
Provider	Healthcare facility administration or clinician proving care to patients
Quaternary	A hospital offering specialised care, care for particular medical conditions or systems of the body
Rapid Response tier	A tier of the rapid response system requiring a medical officer response
RRS	Rapid response system: System designed for early detection and escalated care of deteriorating patients
RRT	Rapid response team: A team of clinicians that responds to rapid response calls on wards
System	The overall healthcare system or smaller systems operating within the broader healthcare system
Unexpected cardiopulmonary arrest	A patient who has experienced a cardiopulmonary arrest without a 'not for resuscitation/do not resuscitate' order put in place prior to the event occurring
Unmonitored wards	Wards without continuous vital sign monitoring capabilities
Unplanned ICU admission	A patient admitted to the Intensive Care Unit as a result of undetected or delayed recognition of clinical deterioration

Chapter 1 Introduction

Contemporary acute care health facilities are increasingly recognised as dangerous places for patients due to the high risk of adverse events, many of which are preventable.(1-4) The reasons for this are complex, diverse and multifaceted and attributable to patient, provider and health care system factors.(5) In addition, the inpatient population on the general wards of acute hospitals is changing. Once the domain of relatively stable medical and surgical patients, this population has now not only become greater in number, but also presents with increasingly higher acuity requirements.(6) Coupled with this burdening healthcare dilemma is the rising incidence of states of chronic disease and associated co-morbidities,(7) further leading to patients now facing increasing instability. These changes have created environments where patients are now at higher risk of adverse clinical events than ever before. These events include, but are not limited to, unplanned admissions to the intensive care unit (ICU) or requiring other higher levels of care, severe patient harm, unexpected cardiopulmonary arrests and deaths. Unplanned ICU admissions does not by definition always equate to a failure of system performance. Early transfer of a patient to the ICU can often prevent the occurrence of a critical outcome and may also equate to a shorter length of stay with less invasive and aggressive treatment regimens.(8) Those transferred to the ICU as a result of delayed or unrecognised deterioration are considered adverse events. Unexpected cardiopulmonary arrests and deaths are those where the patient is for full active treatment and resuscitation (i.e. without treatment limitation orders). If either of these events occurs when a patient is not for resuscitation, then statistically this is registered as an 'expected or possible outcome'.

To avoid unexpected adverse events and improve health outcomes, there is an increasing emphasis placed on the early recognition and management of the deteriorating general ward patient, particularly with a focus on organisational factors that influence patient safety.(9) In addition, the literature has identified that a range of provider and system concerns have also contributed to unnecessary adverse events in hospitals, including: failure to recognise early deterioration of patient vital signs; delays in instituting interventions / therapies; inadequate resuscitation; delays in seeking appropriate senior assistance; staff shortages and skill mix and ineffective communication.(10, 11)

Rapid Response Systems (RRS) have been advocated as global best practice initiatives for early identification and intervention management of patients who exhibit the first signs of clinical deterioration on general hospital wards.(12, 13) Initial seminal studies of ward patient deterioration leading to RRS development began in the 1990s at Liverpool Hospital, Sydney Australia.(14) These studies explored both signs and symptoms of ward patients who experienced deterioration, then further, ways of possible prevention. It was found that clinical deterioration of patients on unmonitored wards (patients without technologies applied to continuously monitor vital sign parameters) could be a predicted event. It was therefore deemed possible that early detection and intervention may halt further decline, reducing the occurrence of related adverse events.(14, 15)

Potentially deteriorating patients were identified as being for rapid response by ward based clinicians using a developed set of 'calling criteria'. The criteria, derived from patient assessment outcome data, was primarily based on vital signs findings (respiratory rate, blood pressure and heart rate etc.). When established vital sign parameters were breached,

it indicated that the patient was at increased risk of deterioration, thereby activating the system.

In 2006, another Australian study (SOCCER) (15) was conducted to re-validate the initial MERIT criteria.(16) In addition, this study investigated if a differential could be found between early and late signs of deterioration using the existing calling criteria. This study not only resulted in the identification of an early and late differential, but also added other criteria for activating the RRS such as oxygen saturation levels and urine output.

Initially, to respond to these 'at risk' ward patients, models were developed consisting of groups of ICU clinicians termed the 'Medical Emergency Team' (MET).(14) Strategically now responding to this vulnerable patient population, the MET effectively transported ICU expertise in managing the 'sick' patient from the silo of the critical care environment to the potentially deteriorating ward patient. Team roles included review of medical management plans and diagnostic tests, initiation of new therapies and transfers of the patient to higher acuity environments, enabling more intensive and aggressive treatment regimens if required. Prior to MET/RRS development, teams were dispatched from the ICU, but commonly termed 'arrest teams', they were generally only initiated once the patient was immediately pre, or in an actual arrest state. The role mainly focused on resuscitation rather than prevention.

Despite variable outcomes surrounding these systems since initial inception, including within multiple major systematic reviews (Table 1.1), the appeal of the RRS as a preventative model of care has led to widespread global adoption taking place.(17, 18) This escalation in popularity has seen RRS become a part of safety and quality frameworks across many institutions.(19) In addition to scholarly articles, other contributing factors, including

findings and recommendations to implement from government commissions of enquiry and special inquests,(20, 21) as well as professional and government body endorsements, have all helped drive the progress of these systems into the contemporary acute healthcare setting.

Table 1.1 Systematic reviews of Rapid Response Systems

Year	Author/citation	Key Findings
2007	Gao et al.(22)	A wide variety of track and trigger systems were in use with little evidence of reliability, validity and utility. Sensitivity was poor, may be due in part to physiology monitored or choice of trigger threshold. Available data insufficient to identify best track and trigger.
2007	McGaughey et al.(23)	There is currently minimal evidence to recommend the adoption of outreach to support the identification and management of acutely ill patients. There is a need for further random control trials. The current studies showed two different RCT designs. Study heterogeneity requires for future studies to be standardized measures. There is a need to clarify similarities and differences between MET and CCOT models. The EWS and MET criteria systems in the practice setting needs to be evaluated, providing understanding of factors associated with poor documentation of EWS charts. Education around patient assessment and immediate management is imperative. To date there is no evidence of the impact programs have on practice. Further research needs to focus on barriers leading to suboptimal care. This is important to identify and explain the complex processes and mechanisms within a hospital that which support or hinder the change process in managing deteriorating patients.
2007	Winters et al.(24)	There is weak evidence that RRS are associated with reduction in mortality and cardiac arrest rates, however, there are limitations in quality of studies, wide confidence intervals and between study heterogeneity. These limit ability to conclude that RRS are effective interventions for preventing in hospital mortality, cardiac arrests or ICU admissions. Large randomized trials are needed to clarify efficacy of RRS before they become a standard of care
2010	Chan et al.(25)	Rapid response Teams have broad appeal but lack robustness to support effective reduction in hospital mortality.
2013	Winters et al.(26)	Although the beneficial effects of RRSs are becoming clearer as the intervention is more universally applied, not all RRS programs realize these benefits. Potentially related archaic monitoring practices (limiting the

		afferent limb to periodical vital signs in the absence of continuing electronic monitoring systems. Optimate team composition and structure are unknown. Staff and education themes mainly focus training. Barriers to effective recognition and response in- grained in the culture of medicine persist.
2015	Maharaj et al.(27)	RRS teams associate with a reduction in hospital mortality and cardiac arrest. The study was unable to show any benefit from the presence of a physician on the RRS team, the duration of implementation or the number of activations. Further work is needed to understand the specific factors that are likely to mitigate their effectiveness in given operational contexts.
2017	Tirkkonen et al.(28)	Patient outcome literature post rapid response attendance is highly variable and data quality modest. Following a RRS call, every 12th patient receives a 'limitations of medical treatment' order. Every 4th review results in an ICU transfer. The ICU mortality of admitted patients post rapid response is high with nearly 1/3 of patients dying in ICU. 75% of patients are discharged alive post RRS call but there is little or no data on long term outcomes or quality of life.

To date, data evaluation of RRS effectiveness has primarily focused on outcome measures for cardiopulmonary arrests and mortality. The evidence for such approaches after almost 25 years still remains inconclusive.(25) Study outcomes are however increasingly showing improvement in these measured variables.(27)

Although randomised controlled trials (RCTs) are widely accepted as the most reliable method of determining effectiveness of an intervention, implementing an RCT is more challenging in the context of complex interventions, that is, an intervention made up of various interconnecting parts.(29) This is particularly true for RRS where there are a number of interactions between levels of health providers and an accompanying set of required behaviours. An example is where a nurse is required to be adherent to recommendations for identifying risk as well as escalating systems. Investigation of team work in hospitals underscores significant complexity.(30) This is reflected in power relationships and competition between discrete organisational units. These factors are juxtaposed against a set of circumstances that reveal a system under significant stress in terms of workforce shortages, fiscal constraints, increased demands and increasing public accountability.(31) Additionally, local resourcing, communication and team cohesion can influence implementation effectiveness, often inhibiting RRS from achieving their full potential and are being increasingly recognised as salient in ensuring patient safety. Implementation processes are strongly impacted by these environmental workplace cultures and characteristics. Yet teams are not spontaneously created and are often organic and also based upon professional boundaries, relationships, culture and systems.(32) These factors are important considerations in developing effective health care systems. Therefore, investigating models of health care interventions isolated from contextual factors will result in a failure to successfully implement and sustain interventions to improved health

outcomes. Rapid Response System calling criteria, team structure and composition also still remain undefined as the struggle to identify the optimal model continues.(33)

While current literature supports the interaction of all of these aforementioned factors and their ability to inhibit effective RRS implementation and functioning, deeper exploration into perspectives of how clinicians operate within these obligatory systems, as well as how the systems themselves impact on clinician work routines and activity is required. Additionally, we do not fully know what factors influence the daily functioning and activity stability of RRS which can impact on demand and resourcing in environments that have been found to be resource poor.

Using a framework of organisational theory, this thesis will examine how individuals perceive organisational structures, processes, relationships and practices, and how these influence their clinical practice and function within the health care system.(34) Organisational theory also requires consideration of organisational behaviour. This relates to collective behaviour of individuals that are part of an organization. These behaviours are also shaped by the organisation's values, missions, culture and context. Mackintosh and colleagues have called for an increased focus on team response behaviours in further understanding the impact of RRS.(35) The work carried out in this dissertation adds to the theoretical body of knowledge in the field and the study's practical significance.

1.1 Aims of the study

Utilising mixed methods of both quantitative and qualitative methodologies and an integrative review process, this doctoral thesis will

1. Review the extant literature and evaluate methods for RRS and Rapid Response Teams (RRT);
2. Explore factors influencing deviation from optimal functioning of an RRS over a seven-year period. Particular focus will be placed on the effects of operational system changes to both afferent (activation) and efferent(response) limbs of RRS;
3. Develop an understanding of the ways in which acute care clinicians experience and negotiate care for deteriorating patients within the rapid response system environment

And

4. Summarise the system, provider and research factors that inhibit or enable risk management strategies for the deteriorating patient.

1.2 Objectives

The study seeks to answer the following specific research questions:

1. What are the optimal processes for assessing and managing the deteriorating patient in the acute care setting?
2. What are the optimal methods of process and outcome assessment of the RRS and RRT?
3. What is the impact on organisation, system users and patient outcomes of a systematic process of risk assessment and identification in a single setting?

And

4. What are the system, provider and patient factors that inhibit or enable risk management strategies for the deteriorating patient?

1.3 Thesis Outline

The chapters of this thesis are outlined below. For the ease of the reader references are provided at the end of the chapter. Chapters 4, 5 and 6 include submitted/ published papers as outlined in Appendices.

Chapter 1: Introduction and background

This chapter will outline the background and significance of this study

Chapter 2: Focused literature review

The purpose of this chapter is to examine the literature highlighting major historical trends in managing the deteriorating patient locally and internationally and identify areas for future focus. In particular this chapter will elucidate contextual factors in the Australian setting to aid interpretation of study data. The resulting paper is currently under consideration in the peer review journal Contemporary Nurse.

Rihari-Thomas J, Newton P, Sibbritt D, DiGiacomo M, Davidson PM. The rapid response system in an Australian context: an integrative review. 2018.(36)

Chapter 3: Methods

This chapter will outline the methodological considerations of the study, ethical considerations and data management considerations. Specifically, it will outline the case study method with an embedded concurrent triangulation design using qualitative and quantitative data to address the study questions. It will also provide an overview of organisational theory which has aided the study design and interpretation of findings.

Chapter 4: Quantitative results

This study aims to explore factors influencing RRS activity over a seven-year period. Particular focus will be placed on the effects of imposed operational changes to both afferent (activation) and efferent (response) limbs of the system. A peer review journal is currently being sort for publication of this manuscript.

Rihari-Thomas J, Newton P, Sibbritt D, Davidson PM. Effect of systematic changes to afferent and efferent limbs of a rapid response system over a seven year period: An observational study. 2016.(37)

Chapter 5: Qualitative Results

A qualitative design study will be used in this chapter to elicit perspectives of health professionals who had current knowledge and active participatory experience with RRS. A method that would facilitate discussion and narratives of experiences was required to understand clinicians' meanings and motivations that informed their actions. This manuscript has been published in International Journal of Health Policy and Management. (Appendix 7)

Rihari-Thomas J, DiGiacomo M, Phillips J, Newton P, Davidson PM. Clinician perspectives of barriers to effective implementation of a rapid response system in an academic health centre: A focus group study. International Journal of Health Policy Management. 2017;6(8):447-456.(31)

Chapter 6: Integrations, Synthesis and Discussion

This study will provide integration of the qualitative and quantitative findings of the study as part of the mixed method study design and provide a discussion of the study findings.

Chapter 7: Implications for policy, practice, education and research.

This chapter will outline the implications of the study findings for policy, practice, education and research. This chapter will also identify crucial areas for focus in advancing RRS. Key points outlined in this chapter have been published in the Journal of Nursing Management (Appendix 8).

Rihari-Thomas J, Newton P, Sibbritt D, Davidson PM. Rapid response systems: Where have we come from and where we need to go. Journal of Nursing Management. 2018;(26)1:1-2. Available from: **https://doi.org/10.1111/jonm.12533.**(38)

1.4 Conclusion

The discrete studies outlined in Chapter 3, seek to examine an important area of clinical management and advance the science of RRS. As the complexity of health care increases, implementing transparent and accountable systems for managing the deteriorating patient are critically important.

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Chapter 2 The Rapid Response System: an integrative review

2.1 Introduction

The previous chapter has provided an introduction to the RRS and the research questions posed by this thesis. To understand the construct of the contemporary environment in which the studies undertaken within this thesis took place, a search and analysis of the literature was essential to map the evolution of the RRS to the contemporary setting. The methodology, findings and conclusion sections of this chapter have been transposed with only minor editing from the primary manuscript submitted for publication and currently under consideration in Contemporary Nurse to facilitate chapter congruence.

Rihari-Thomas J, Newton P, Sibbritt D, DiGiacomo M, Davidson PM. The rapid response system in an Australian context: an integrative review. 2018.(1)

2.2 Aim

The purpose of this chapter is to examine the literature highlighting major historical trends in managing the deteriorating patient locally and internationally and identify areas for future research focus and system improvement. The guiding question of this review is to identify the state of the science, describe the socio-political context and identify drivers for model implementation within the Australian context. Elucidating contextual factors in the Australian setting, it aids interpretation of the data presented in Chapters 4 and 5.

2.3 Method

The method of integrative review was chosen to allow retrieval of data from a diverse range of sources. This approach has enabled synthesis and integration of a wide range of concepts and issues pertaining to the implementation of RRS. In addition to scholarly research studies, the inclusion of policy, statistics, government documents and commissioned

enquiries were essential in describing the development and evolution of the RRS and the strong political attention on adverse events in hospitals. Data searching, evaluation and analysis was guided by Whitmore and Knafls' integrative review construct to maintain integrative process rigor.(2)

The process of systematic review was not chosen as the review method of choice for this manuscript due to requirements of content primarily consisting of experimental research and also a strict adherence to methodological process. The inability to utilise other essential forms of evidence would have limited the scope of discussion of the paper and deriving data explaining contextual factors.(3)

2.3.1. Literature search

Both the grey literature and published, peer reviewed data sources were included. The electronic data bases Medline, Embase, Cochrane database of systematic reviews, CINAHL and Pubmed were searched using the terms 'medical emergency team', 'rapid response system', 'rapid response team', 'deteriorating patients', 'early warning score' and 'Australia'. The chosen search period 1996 to present allowed for inclusion of primary foundation studies. Searches of the World Wide Web were conducted using Google and Google Scholar search engines to obtain further information, including data from international, national and state government health sources.

2.3.2. Data evaluation and analysis

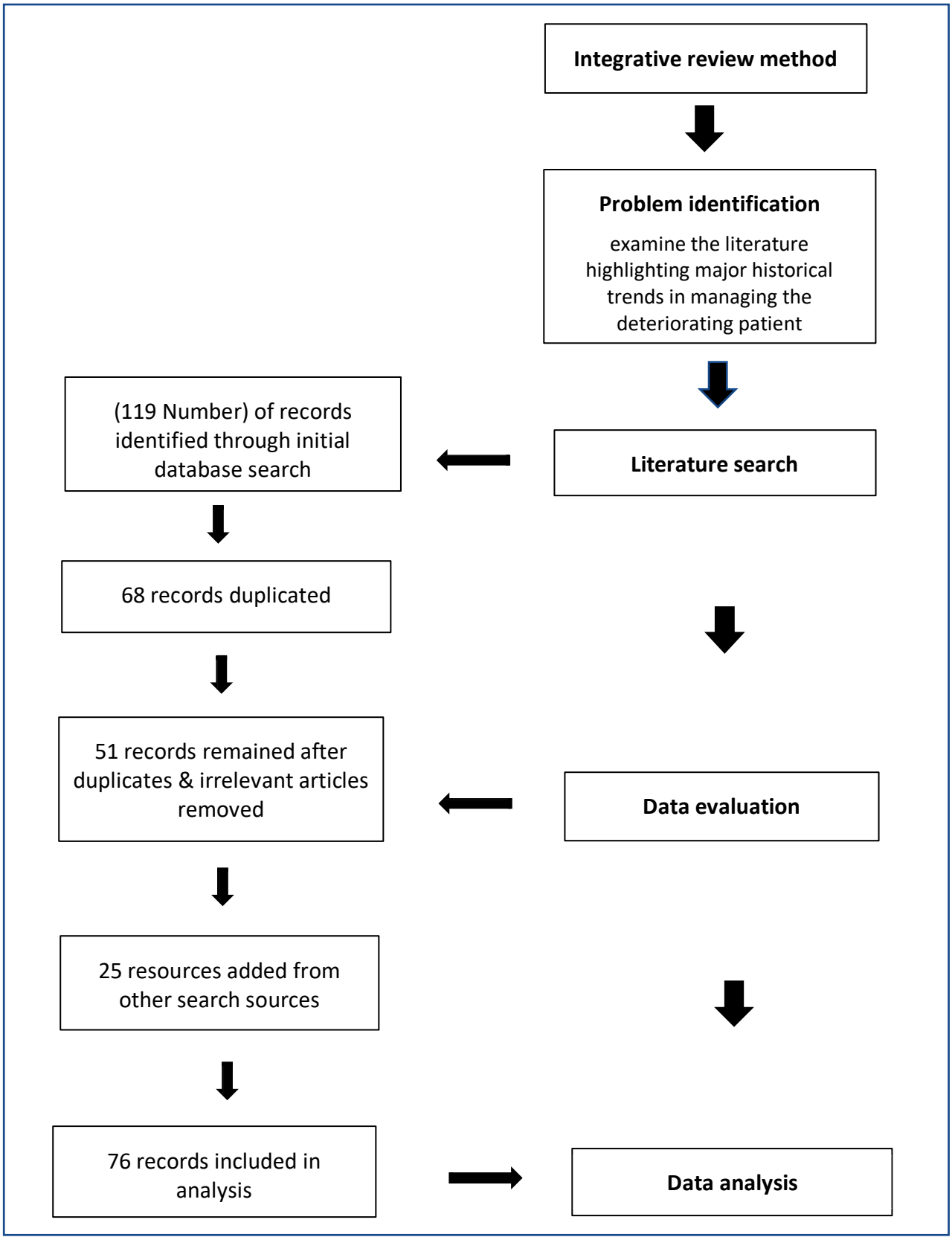
Definitive data for this integrative review included empirical and theoretical resources. Resources consisted of a wide range of methods included phenomenology, case-study, grounded theory and cross-sectional designs. The initial search returned 119 articles (Figure 2.1). Sixty-eight articles were rejected. Exclusion occurred if the search terms did not

produce materials discussing rapid response within the context of the Australian health system, had direct influence on the development of historical trends or where article duplication occurred. Inclusion of the remaining articles was based on the impact and importance of primary resources and research papers pertaining to patient deterioration in the Australian setting, relevance to the research questions and emerging themes and discussions presented in the paper. Hand searching of retrieved material was also undertaken. Articles were then reviewed and summarised according to model elements using the method of an integrative review.(2) Elements were categorised both chronologically and/or themed to allow narrative synthesis.

2.3.3. Presentation

The process of integration is represented in Figure 2.1 with a further description of resource characteristics described in section 2.4 Results.

Figure 2.1 Flow Chart of Integrative Review Method



2.4 Results

The search strategy generated 76 sources pertinent to the study aim and thesis questions. Fifty one journal articles were identified, seven of which were systematic reviews. In addition, 21 Australian government sources were also identified consisting of 17 federal and state resources and four state initiated commissions of inquiry into health system failures. International policy and works by professional organisations were also included, providing a contextual backdrop and assisting with the generation of evidence. Results were derived through integration and synthesis of data using a discursive method to provide a snapshot of contemporaneous issues allowing departure and exploration from the main topics in order to cover a varying range of subjects relating to RRS literature (4). Using this philosophical reasoning allowed the identification of the key themes providing attainment of the study aims. The changing patient population, systemic growth, evolution and standardisation of implementation methods, influence of hospital cultures and the emerging role of the consumer in RRS were all emergent themes used to analyse. Although international data have been considered as context, identifying trends in this manuscript focuses on implications for the Australian health care system.

2.4.1. Findings leading to contemporary settings

Australia has a strong history of pioneering ways to better manage patients at clinical risk in the acute care hospital setting.(5) During the mid-20th century high rates of morbidity due to cardiovascular disease focussed attention on critical care systems, providing monitoring and resuscitation expertise. Responding to this growing trend, Australian clinicians pioneered ways to more effectively detect and manage the deteriorating patient.(6) In 1961, Drs Malcolm White and Gaston Bauer established the worlds' first (although contested by Bethany Medical Centre, Kansas, USA) coronary care unit at Sydney Hospital where these

patients could be managed in a dedicated specialty area. With specialised staff and equipment, innovation in treatment modalities have continued to improve morbidity and mortality outcomes.(7) These specialised models of care demonstrate that conditions such as acute myocardial ischaemia for example, can be treated more successfully if clinical staff are trained in specific skills, in this case electrocardiographic monitoring and cardiopulmonary resuscitation.(8) Coronary care and cardiac intensive care units are now found in most major acute care centres throughout the world and showcase the importance of workforce skill mix and systems for detecting and managing specific populations of patients at clinical risk.(9)

Contemporary hospital wards are dangerous environments for patients.(10-12) This is particularly true as the population ages resulting in greater numbers of elderly patients, many presenting with multiple co-morbidities as lifespans continue to increase. These, along with other patient groups living with chronic illness, are by nature, of higher acuity than those found on wards in the past as conditions become more complex creating greater susceptibility to clinical deterioration.(13) This changing evolution of the general ward patient often occurs without an increase in nurse to patient ratios and a diverse nursing skill mix. Evidence demonstrates a strong correlation between the impact of nurse staff levels and patient outcomes.(14) An extension of the International Hospital Outcomes Study conducted in Swiss hospitals correlated the increase of nurse rationing with greater frequencies of nurse-reported adverse patient outcomes.(14) Adding to this, other explanations for high rates of adverse clinical events in hospitals are patient, provider and health care system factors. Ineffective communication, inefficient escalation models and workforce challenges are all recurring themes in the literature.(15-17) Interest in identifying patients at risk of adverse events has evolved around the need for reducing the occurrence

of such events.(18) Not solely clinician driven, this need is also strongly pursued by policy makers and consumers alike. System process failures leading to adverse clinical events have not only been identified in the research literature, but also in outcomes of numerous government commissions of enquiry. Together, this evidence has helped shape the development of contemporary RRS models. Emerging trends have also again highlighted the increasing role of consumers, their families and carers and examination of clinician behavior within these systems.(19, 20)

2.4.2. Contemporary acute settings

Increasing hospital acuity & the changing Australian patient population.

Population aging and the growing burden of chronic disease challenge contemporary health systems. Patients in the acute ward environment are now at higher risk of adverse clinical events than ever before as incidence of undetected deterioration and failure to escalate the deteriorating patient continue. From 2007–08 to 2011–12, Australian hospitalisations linked to adverse events increased from 4.8 to 5.3 per 100.(21) Today, as traditionally, intensive care, high dependency and coronary care units continue to house our sickest patients enabling more aggressive, invasive and extensive management regimens. What has changed over time is the acuity and complexity of the admitted general ward/unit patient in our acute care hospitals.(22) Historical trends in the reduction of length of stay over the past few decades suggest that patients admitted to acute health facilities are generally of higher acuity, as 'well' patients are now discharged earlier and may have ongoing care regimes and follow up in community and outpatient settings.(23) The number of separations for people aged 85 and over increased by 41% over the period 2006–07 to 2010–11, an average annual

increase of 8.6% and most of these separations were for acute care (87%) or rehabilitation care (8%).(23)

The number of separations for people aged 85 and over increased by 41% over the period 2006–07 to 2010–11, an average annual increase of 8.6% and most of these separations were for acute care (87%) or rehabilitation care (8%).(24) RRS use the principles of early detection through predefined indicators of clinical deterioration and response. The most common terms given to clinicians who respond to rapid response activations include medical emergency teams (MET), rapid response teams, and critical care outreach teams.(25) Within acute settings, these teams are outsourced in a variety of ways, most typically from critical care units such as intensive care, coronary care or other critical care areas and usually consist of a senior medical officer and critical care nurse/s. Historically, these teams were designated 'cardiac arrest teams' and were initiated when a patient was either in a pre or actual arrest state. These roles are now evolving to become de-centralised from their 'home' critical care units, increasingly focusing on involvement in ward patient clinical management when signs of deterioration are first evident.(5, 6)

Winters and colleagues undertook a systematic review and meta-analysis of articles reporting outcomes of rapid response systems.(26) Of the studies included in the review, 5 used historical controls, 1 concurrent controls, and 2 a cluster randomized design. The pooled relative risk for hospital mortality comparing rapid response teams to control was 0.76 (95% confidence interval, 0.39 –1.48) between the two randomized studies and 0.87 (95% confidence interval, 0.73–1.04) among the five observational studies. The pooled relative risk for cardiac arrest comparing rapid response systems to control was 0.94 (95% confidence interval, 0.79 –1.13) in the single randomized study and 0.70 (95% confidence

interval, 0.56–0.92) in four observational studies. The heterogeneity of study designs was an important consideration of this systematic review.

A further systematic review was undertaken by Chan.(27) This review incorporated data on nearly 1.3 million hospital admissions. Implementation of a rapid response team in adults was associated with a 33.8% reduction in rates of cardiopulmonary arrest outside the intensive care unit (relative risk [RR], 0.66; 95% confidence interval [CI], 0.54-0.80) but was not associated with lower hospital mortality rates (RR, 0.96; 95% CI, 0.84-1.09). In a paediatric population, the use of rapid response teams was associated with a 37.7% reduction in rates of cardiopulmonary arrest outside the ICU (RR, 0.62; 95% CI, 0.46-0.84) and a 21.4% reduction in hospital mortality rates (RR, 0.79; 95% CI, 0.63-0.98) (27). This review also found evidence that deaths were prevented out of proportion to reductions in cases of cardiopulmonary arrest, raising questions about mechanisms of improvement. In spite of this limited evidence for mortality reduction in many settings, rapid response systems became a standard of care throughout Australia**.** This expansion may have been led by the absence of conclusive evidence for mortality reduction being insufficient to discard the routine application of these systems.

Though reducing cardiac arrest rates is an extremely important indicator of rapid response system success, some argue that overall end point mortality rates may not be the most appropriate measure with which to analyse the effectiveness of RRS.(24) It has been suggested that mortality depends more upon the nature of the patients underlying clinical state and type of interventions they receive rather than being a measure of hospital safety and effectiveness of rapid response system.(24) Chen et al. (28) compared in-hospital cardiac arrest, in-hospital cardiac arrest related mortality and overall hospital mortality

rates between a hospital with a mature rapid response system against three other similar centres without an existing formal system. While the overall mortality rate did not change for the hospital with a long standing RRS in place, there was a significant reduction in in-hospital cardiac arrest rates (50% lower), in-hospital cardiac arrest related mortality (40% lower) and lower overall hospital mortality (6% lower) for the centres that previously did not have a rapid response system.(28)

Results of RRS studies to date are still diverse and contentious despite their widespread adoption.(29, 30) This can likely be explained by methodological variation within the clinical trials and the challenges of implementing complex interventions. However, in advancing the science of systems for RRS, it is also important to consider structural characteristics of various models and their adaptability to individual healthcare organisations. Poor resourcing, model design and implementation could impact on the uptake and long-term success of the rapid response system.

Australian government commissions of enquiry and inquests

The need to mandate RRS across all national health facilities stemmed from commissions of enquiry initiated by the prevalence of critical incidents occurring within the Australian health system (10, 19, 31). High rates of preventable adverse events have raised the attention of health professionals and policy makers alike. In the Australian state of New South Wales (NSW), a sequence of well-publicised adverse clinical events and growing public disquiet led to the Special Commissions of Inquiry into acute care services in the states' public hospitals.(19, 32) The Garling Report (19) made 139 recommendations, many addressing increased protection of patients, commentary on the nursing role and an increased emphasis on clinical cares including models of care utilised in our contemporary

acute care facilities. Many in- hospital failures documented in the extant literature also emerged as findings in the Garling Report. One major recommendation led to the mandated introduction of RRS for managing deteriorating patients including the addition of clinician education in all NSW public hospitals.(19) Despite widespread implementation, the continued occurrence of reportable critical incidents relating to adverse clinical events in ward patients suggests there are still process failures within these RRS systems.

Non-clinician escalation models for the deteriorating patient in Australia have not been a concept previously leading to mass appeal or widespread adoption. Recently however, a strong move to incorporate consumer and family activation into our rapid response models has occurred. In the Australian state of Queensland, the Office of the State Coroner's inquest findings into the death of Ryan Charles Saunders, (31) a child who died of toxic shock syndrome, was instrumental in mandating a state wide process within the Queensland health system allowing for consumer and family escalation of care.(20) The Clinical Excellence Commission in NSW is also working with acute public health facilities to integrate consumer and family activation into its 'Between the Flags' rapid response model through the 'REACH' program.(33) At national level, National Safety and Quality Health Standard (NSQHS) 'Standard 9: Recognising and Responding to Clinical Deterioration, element 9.9 Mechanisms in place for patient / family/carer to escalate care response' (34) will require all Australian acute care facilities to adopt this initiative into their rapid response programs in order to meet requirements for national accreditation. The foundation has now been set by the NSQHS to mandate processes for empowering patients, families and carers to enable escalation of care.

Consumers are now generally experiencing a more integrated clinician, patient and family centred approach to the acute inpatient journey within the Australian healthcare setting. Led by initiatives such as the NSW Clinical Excellence Commission's 'In Safe Hands' program, (35) local governance is being diverted to the grass roots ward level. This includes the involvement of the patient and family in the multi-disciplinary bedside clinical handover, inviting patients and their families to become more involved in medical management plans and decision making, with great relevance to deterioration and end of life discussions and care.(33)

R**apid response criteria**

Track and trigger systems are formalised processes that utilise periodic vital sign measures (track) with a predetermined action (trigger) when the measures are breached.(36) The Australian Capital Territory and Northern Territory use numerical scoring with a Modified Early Warning Score (MEWS) system (37) to track clinical deterioration. The majority of other Australian states however employ vital sign parameter calling criteria as a track for initiating rapid response such as that used by NSW 'Between the Flags' program.(38)

Hillman and colleagues (6) investigating the antecedents to hospital deaths and the role of a medical emergency team in the 'MERIT' study, began a series of primary research studies into acute inpatient deterioration that have led to Australia being a contemporary global leader in the field of model development in this area. Hillman's work around vital sign parameters for medical emergency team activation began in the 1990's originating at Sydney's Liverpool Hospital. It resulted in the creation of calling criteria that is still currently primarily used for activating many Australian RRS. In 2005 Jacques (39) conducted a follow on study, 'signs of critical conditions and emergency responses (SOCCER), testing the efficacy of vital sign parameters established in the MERIT study in an attempt to further distinguish early from late signs of deterioration. This cross-sectional survey looked at 3,046 adult patients in five hospitals over a two-week period. Of these patients, the existence of 26 early signs of deterioration (critical condition and adverse events) were found in n=12,384 instances and 21 late signs were identified in n=1,410 cases. Pulse oximetry was not part of the initial measures for calling criteria with early medical emergency team activation, but SOCCER found that decreasing saturations were evident in both early (SpO2 90-95%) and late (SpO2 <90%) signs with increased risk of death. Overall the study validated

the original criteria but also showed the occurrence, and importance of earlier signs of deterioration.

Subjective criterion

The worried or concerned criterion is an essential element of any rapid response system.(40, 41) For many years the nursing literature has discussed nurses as having an intuitive feeling that 'something is just not quite right' or patients 'have that look about them'.(42-44) The worried criterion taps into this subjective patient assessment, acknowledging that nurses also possess their own unique sets of assessment skills. This criterion also covers all assessment aspects and events not relating directly to objective vital sign parameter breaches. The criterion was designed to empower nurses to escalate a patient's care by requiring a medical response within a specified timeframe. The potential exists therefore, to also be a possible tool for inter professional manipulation if not utilised appropriately. The literature reports on barriers and facilitators to nurses utilising rapid response systems.(45, 46) This same literature however is scant when reporting on the possible existence of issues such as nurses manipulating their medical colleagues with 'threats' of initiating rapid response if they are not satisfied with current management plans. Future studies with a strong focus on the cultural use of these systems may help to determine the existence or absence of changing professional balance between medical officers and nurses as a result of working within these systems.

Progression to large scale Rapid Response Programs in Australia

For many years, the implementation of RRS was inconsistent with institutions across Australia designing and running their own programs. The late 2000's saw the development and implementation of large scale programs for the first time, encompassing multiple sites

over vast geographical areas. Two differing foundation models created the scene that set momentum for large government initiated schemes to follow around the nation.

Compass

Both the Australian Capital and Northern Territories adopted territory wide programs labelled 'Compass',(47) a modified version of the early warning score system (EWS) used in the United Kingdom.(48) The modified early warning score (MEWS) utilises numerical scores to calculate a patient's acuity based upon pre-determined vital sign parameters.(37, 49) Scores are allocated according to how far a patients vital signs are seen as being deranged from a pre-determined set of parameters. The Compass program is assisted by an online learning and a training manual.

Between the Flags (BTF) and Patient with Acute Condition for Escalation (PACE)

In 2009, NSW rolled out a state wide initiative developed by NSW Health's quality pillar (Clinical Excellence Commission), which saw the implementation of a major rapid response program labelled 'Between the Flags'.(38) The aim, to deliver standardisation of one rapid response program across the entire state incorporating all public healthcare centres within a diverse range of clinical settings. The red and yellow zones (tiers) of the program reflect surf life saver flags at the beach whereby a patient who's clinical parameters sit between the 'flags' (i.e. a non-coloured zone) is considered to be safe, those outside of this safe zone are considered at increased risk of deterioration. The BTF design was primarily suited to the medical emergency team concept in acute centres, but is capable of being interchangeable with other rapid response models and can be modified to meet lesser resourced centres such as those found in rural and remote areas.

Although there was intent of a 'one model state', NSW actually housed two of the largest programs in Australia at the time of BTF introduction. Former NSW Health's South East Sydney Illawarra Area Health Service' 'Patient with Acute Condition for Escalation' (PACE) program also co-existed.(50) These two programs differed in their approach to rapid response model design. Most large acute sites using the BTF model utilised a first line rapid response/medical emergency team outsourced from a critical care unit while PACE utilised the patient's admitting medical team as first line response. Over time, PACE adopted the BTF vital signs chart and calling criteria, though most PACE centres still use these tools within their admitting team model.

Heterogeneity of implementation models

Despite aiming for standardised RRS processes, model diversity still exists both between and within Australian states. Single and multi-tiered, aggregated scoring and vital sign parameter activation, critical care and non-critical care led first line response give rise to debate as to the effectiveness of one model over another.

Gao et al. conducted a systematic review of the reliability and validity of physiological track and trigger systems.(51) They examined 36 papers containing 25 different systems. Outcome measures for all studies were similar, death, admission to a critical care unit or not for resuscitation orders. The investigators however found low sensitivity in these outcomes (median quartile 43.3) along with low predictive values (median quartile 36.7). It was conclusive that there was little evidence of reliability, validity or utility within the studies they examined. The low sensitivity was explained as possibly being due in part to the nature of the physiology monitored, or perhaps the threshold value of the trigger itself. The study could not identify one type of track and trigger system to be better than another.

Another systematic review by Smith et al. looking at the performance of aggregate weighted track and trigger systems was also inconclusive, once again pointing out inconsistency around physiological components of the systems.(52)

Scrutiny around the use of early warning score systems such as the modified system (MEWS) utilised in the ACT/NT also leaves some doubt to their effectiveness as the ultimate design for rapid response. Although utilised widely in the United Kingdom, scoring systems can be more complicated than simple coloured vital sign chart parameter criteria with potential for inaccurate calculation.(37, 53) Comparative effectiveness of RRS and the impact each may have on patient clinical outcomes requires further exploration. Until it is determined which model, if any, is the most optimal in assisting with early recognition and prevention of further clinical deterioration, then it is left to government policy and personal preference to decide.

The primary aim of rapid response models that use a non-critical care unit based approach (such as the admitting medical team) is skill enhancement of both medical and nursing staff directly responsible for patients care. As first line, their responsibility is to not only detecting deterioration, but to assess and implement management plans themselves rather than handing this responsibility to an 'outside' medical emergency team in the first instance. Critical care unit based teams are generally unfamiliar with the ward patient and their history, nor do they routinely continue with direct care after the acute event has past. Evidence that these models do in fact increase the skills and knowledge of the patients own primary care clinicians does not however currently have enough weighted research to draw on a definitive conclusion to the argument. The possibility may exist that some clinicians do not acquire or increase their assessment skills within this type of model environment, which

may lead to a 'fall back' to, and in some cases a possible delay in rapid response activation or escalation to a critical care team assessment.

Advocates of the medical emergency team (critical care based) approach would argue that as core business, critical care teams deal with unstable patients on a daily basis and are therefore best equipped with both the knowledge and skills to manage those who are deteriorating in the ward environment.(54, 55) Identified as a disadvantage in the MERIT study in reference to the medical emergency team model, was the significant increase in the number of 'call outs' to the general wards/units that the team received as a consequence of ward patients breaching rapid response criteria. In today's landscape of tight clinical budgets, few critical care led teams would have the luxury of additional 'floating staff'. Significant logistical resource strain on their personnel most likely occurs when required to leave their own patients and units in order to attend those requiring assistance in the ward setting. Centres that use ICU liaison nurses or nurse led teams would face the same issues if not adequately resourced specifically for that purpose.(56) Jones et al. (57) led a team of investigators looking into the composition and resourcing of rapid response teams in Australian hospitals. Of the 39 sites studied, all had a 24hour service but only 25% of these teams were funded, meaning that resources had to be taken away from other areas in order to operate the teams. The investigators also found significant variation in team composition. An interesting point was very few rapid response teams were led by an Admitting/Consultant Medical Officer, the majority were intensive care fellows/registrars with the most senior nurses coming from both intensive and coronary care units. As the changing role of the old cardiac arrest team continues to evolve, resourcing requirements will also need to shift away from a focus on advanced life support and the resuscitation team to that of early intervention and rapid response teams. In order to function effectively

as early interceptors of clinical deterioration, they will need appropriate resourcing of staff, equipment and technology as well as tailored education and training.

Standardisation

Whilst the Australian Commission on Safety & Quality in Healthcare (ACSQHC) released standardised national guideline recommendations for RRS,(58) data collection and analysis around these systems remains inconsistent, both between and within our states and territories. Key performance indicators (KPI) in NSW for example are reported from all acute facilities to the Ministry of Health on both cardiac arrest and rapid response rates. These data do not necessarily accurately reflect or compare true clinical activity, especially where differing rapid response models are being measured against the same KPIs. Medical emergency team facilities report their rapid response figures based on critical care team call out rates. Those facilities utilising admitting care team responder models only utilise the critical care based teams in their facilities if higher level escalation is required. Therefore, these types of models appear to be under activating & reporting on their rapid response systems.

Cardiac arrest rates in Australian facilities are also a likely underestimation of actual figures, as areas such as emergency departments, operating theatres and intensive care units often manage their arrests 'in house'. Formal activation of a medical emergency team to these areas means arrest data may not be as accurately captured or reported in the entire hospital data.

Non-standardisation of definitions is also an issue of contention. Cardiac arrest for example is not standardised in facilities across Australia. Some report this by definition only as 'absence of cardiac output', reporting all other medical emergencies including respiratory

only arrests separately. Others may include cardiorespiratory arrests under the same data set for reporting purposes. In 2012, the Australian Resuscitation Council changed the definition to '…combination of unresponsiveness and absent or abnormal breathing'.(59) Regardless of the measures implemented, contextual issues, such as patient case mix, staffing levels and clinician skill mix are not considered or cross referenced during analysis of these events, which may offer more accurate insight into real world system process failures and successes.

Elements of national standardisation are progressively occurring. The ACSQHC national consensus statement on essential elements for recognising and responding to clinical deterioration (59) was released in 2011. Further, production of the Australian Council Healthcare Standards (ACHS) occurred in 2013. 'Standard 9: Recognising and Responding to Clinical Deterioration in the Acute Health Care Setting' (34) assists all Australian facilities to achieve accreditation relating to deteriorating patient systems. ACSQHC and Queensland Health also developed and endorsed a 'national' vital signs chart.(60) Using a combination of vital sign parameters and numerical scoring, it's human factor principles design is now being utilised in several Australian states.

2.4.3. Education

Implementation of educational strategies to increase clinician skills around deterioration and effectively support their roles within RRS has also occurred within the Australian healthcare setting (47, 61). Standard curriculum for most courses includes physical assessment concepts, detection, management and escalation of the deteriorating patient as well as communication and clinical handover strategies. A variety of media modalities are utilised in the delivery of these education programs. Hands on, high and low fidelity

simulation is perhaps regarded as one of the most useful forms of educational delivery, although it's effectiveness as a teaching tool still requires further study.(62) These practical programs are also often backed up with eLearning.(38, 47) Clinical handover initiatives are also developing around Australia creating models to improve clinician communication. We are seeing strategies such as the return of bedside clinical handover with multidisciplinary clinician, patient and carer input to help plan better care around the patient's hospital journey.(33)

Despite an increasing emphasis placed on education to increase RRS success, it does not necessarily ensure understanding, acceptance, compliance or clinical practice change, nor does current research provide overwhelming evidence of its ability to improve critical thinking ability of bedside clinicians, assisting them to make better decisions faster. Although education contained relevant content and addressed specific issues identified in needs analyses, Fuhrmann et al. (63) concluded it did not influence clinician awareness of ward patients at risk, nor influence the outcomes of this patient group. Further analysis needs to be undertaken to study the effect of these education programs on changing clinical behaviour and the application of learnt skills.

The development of education specifically designed to teach awareness and clinical intervention of the deteriorating patient is still at the forefront of most RRS implementation plans. The multidisciplinary nature of many of these programs may have the added benefit of helping to improve team collaboration.

Despite the availability of education programs to enhance clinical skills, very little has been published to date on curricula to support actual roles of responders to rapid response. Responders must also take leadership roles, effectively communicate with other clinicians,

and in many cases, alter the current management regimes set by the patient's own medical teams, crossing culturally instilled intra-professional boundaries.

2.4.4. Hospital Cultures

Hospital cultures are diverse and individual. The degree of success or failure of RRS depends very much on a facilities adaptability and acceptance to change. It is not enough to simply introduce a rapid response system and expect it to work effectively and with full compliance. Van Der Weyden (64) researched the attitudes of Australian clinicians to system change. Results showed that clinicians generally do value the implementation & use of evidence based systems for client centred care within the context of the Australian health care setting. Looking more closely at cultural attitudes and behaviours within RRS, Salamonson and colleagues (25) identified nurse years of experience as a major factor in system activation. Experienced nurses believed the greatest benefits were getting immediate help or attention, followed by their use in early recognition and management of deterioration. Rapid response also provided a backup system if they were worried about a patient, or were not satisfied with a current medical management plan. From 2004 to 2006, the Robert Wood Johnson Foundation funded demonstration projects in nine geographic locations to support RRS.(65) Focus group evaluation with key groups at one "robust" and one "late adopter" hospital in this evaluation provided important information about the characteristics of rapid response teams, and a view of these teams 'through the eyes of a nurse'. Their work provided new insight into what makes a rapid response team successful and underscores the importance of considering process issues as well as outcome issues in health system redesign. In 'robust' adopter centres where the teams were an accepted part of hospital system culture, nurses were confident they had a positive effect, and were activated without hesitation. The opposite seemed to be prevalent in more 'challenged

centres', with nurses hesitant and more inclined to exhaust all other avenues before reluctantly activating a rapid response. Nurses were also worried about the attitude and level of assistance they would receive from rapid response team members on arrival in these later centres. Cultural leaders also played a part in the success of these teams in robust hospitals with both clear leadership and a 'no option' attitude to activation.

Azzopardi et al. examined attitudes and barriers to the medical emergency team in an Australian tertiary paediatric hospital.(66) Eighty percent of nurses and 45% of medical staff still preferred to contact the covering medical officer first before initiating a MET call. Jones et al. also reported that a similar pathway was also followed by activators in an Australian adult setting where 72% of nurses would call the covering medical officer before initiating MET.(29, 45)

There is currently limited information pertaining to the preference or confidence levels of clinicians initiating one type of rapid response model over another. Traditional roles of cardiac arrest teams may still be firmly embedded in the minds of some clinicians, causing hesitation and anxiety with activation. Though unfounded, it's possible existence and extent should be explored. Comparing possible differences in levels of clinician comfort between activation of critical care versus admitting team models could be invaluable.

Workforce culture and flexibility in any clinical environment will determine acceptance and utilisation of new initiatives. RRS are clearly not a substitute for astute clinical judgement, monitoring and vigilance. It is also important that the views of a range of providers are considered when implementing these models. Cultural barriers need to be removed before effective system uptake can occur unimpeded. Contemporary acute health environments are extremely busy, often under staffed and under skilled, leaving clinicians at all levels

experiencing multiple pressures. Rethinking our moral obligations to patients requires the removal, or at least reduction in both systemic and personal barriers. Professional egos have little place in RRS success where team effort, equality and communication are paramount for optimal patient care.

Exploration of Inter-professional trust issues could further extract opinions of each profession by the other. Issues in communication are already present within the literature and exist between hierarchies within and between healthcare disciplines, significantly impacting on both intra and interdisciplinary communication in situations of patient deterioration, with possibilities of leading to delays in patient reviews and initiation of rapid response.(17)

Changes in RRS models and trends, clinician skill mix and healthcare cultures may all impact on policy adherence and practice within healthcare facilities, shaping future research enquiry. In most Australian states, RRS are now governed by government initiated clinical emergency response system policies.(34, 67) Despite policy development, evidence of non-adherence is underscoring the importance of examining implementation issues.(29, 45, 66) Lack of professional accountability may be a factor in non-enforcement of policy related practice.(68) The NSW Ministry of Health, along with many other local, national and global health authorities are slowly emerging from years of operating under cultures of 'no blame'. Initially well intentioned, it may have inadvertently to a point, generated a sub culture where deficits in professional accountability by many health care clinicians occurs.(68) Thinking around benefits in a degree of blame in medical culture and promoting reporting of non-complaint clinicians is supported by several authors.(58, 69, 70) Clinicians must take

professional accountability, ownership and support of the RRS as a contemporary tool for keeping patients under their care safe.

Acceptance and uptake at clinical level is essential for success, but executive buy- in could prove an essential ingredient for added drive and leadership from the top. Clinical governance support helps promote acceptance, providing organisational solutions to barriers or issues that arise.(69) At the ward level this same leadership should be driven by clinical champions/leaders. Utilisation of project / program coordinators may help in providing operational and educational support to clinicians, assisting with understanding, implementation, monitoring of compliance, collection and dissemination of data and reports and a valuable resource to escalate identified risks to executives. Loop closure, or feedback of rapid response activity and audit reports to clinicians at the local level is necessary for system engagement.(71) Presenting and discussing relevant local data enables clinicians to analyse performance and raise awareness of issues that may otherwise have gone relatively unnoticed or not recognised as repeat occurrences. Feedback should have integration with hospital and government performance indicators and benchmarks for consistency of practice and reporting at all levels.

Utilisation of clinician support programs through mentoring and clinical supervision by senior clinicians could assist with leading a culture of acceptance. Junior medical officers may benefit greatly by increased clinical supervision, mentoring and teaching by admitting medical officers and other staff specialists. Similarly, junior nurses by more direct supervision and role modeling by their senior colleagues and managers.(35)

2.4.5. Future directions

Today's acute care health facilities are high technology environments. These technologies are also becoming best practice in monitoring patient physiology for early signs of deterioration.(72, 73) Smart monitors have the capacity to continuously collect and store vital sign information, urine output and neurological status. They also have ability to automatically escalate a patient by initiating RRS.(72) Potential exists for this technology to bypass ward clinicians, making both cultural issues that impact on escalation, as well as missed opportunities to escalate due to poor clinical skill and decision making, inconsequential. Removing human elements of system obstruction is on one hand positive, it then completely removes important subjective clinical assessment of the patient prior to system activation occurring, leading to a possible waste of resources and clinician time. The impact of high rates of 'false positive' calls will need to be a focus of future studies as these automated systems become more widely accepted.

Trends are beginning to focus on reducing the frequency of unnecessary rapid response calls. Currently, high numbers of rapid response are seen as positive for the most part, demonstrating clinician engagement. Yet this same activation may suggest patients have already began their journey on the deterioration pathway, having been doing so for some time with haemodynamic compensation preventing early parameter breaches. The RRS could perhaps then no longer be utilised as the predictor of the deteriorating patient, but rather an indicator that the patient had not been identified early enough as a potential risk. There is beginning discussion around development of systems and screening tools able to predict, upon admission, those who are more likely to require rapid response.

Questioning a patient's likelihood of increased risk, as well as the likelihood of recovery, presents itself as an ideal time point to consider end-of-life issues more closely for certain

patient groups.(74) Admitting medical teams are still for the most part, reluctant to have these conversations with their patients.(35, 75) In many cases when a patient experiences an adverse clinical event or sudden irreversible deterioration, the role of delivering this conversation is often left up to the responders of rapid response. Too many patients and their families still experience the mental and physical trauma of a resuscitation, only for the patient to be documented 'not for cardiopulmonary resuscitation' in hindsight post event. In many cases this directive would have been appropriate prior to clinical adverse events, based on review and discussion of patient prognosis and co-morbidities. To date, there does not seem to be an educational model to train rapid response teams in dealing with end of life conversation,(76) despite being required to regularly take on this role. They suggest these programs should include core components of communication about benefits, risks, and alternatives, formulation of a rapid response plan and preferences for resuscitation, alleviation of symptoms, attention to immediate patient and family needs and the emotional needs of themselves and the clinicians responsible for patient care. Our hospitals are not equally staffed twenty four hours a day, it is therefore imperative that we develop and implement these types of curricula for rapid response teams to effectively manage the needs of those who are unlikely to recover from the deterioration trajectory.

In addition to education, clinicians can benefit from tools to assist and manage this patient group. Programs such as the 'AMBER Care Bundle' are being trialled in some NSW hospitals, providing guidance as to when and how to initiate conversations with patients and their families around choice of treatment deterioration occurs.(74) Having these conversations, leads to a more dignified and planned death process for both patients and clinicians. AMBER has shown to improve decision-making positively impacting on multi-disciplinary team communication. It has also shown increased nurse confidence in approaching medical

colleagues to initiate discussion of treatment plans with patients and families. Early conversations avoid unnecessary use of the RRS and have also shown a remarkable reduction in emergency department readmission rates.

In summary, evidence leads to several areas of focus for future investigation if RRSs are to evolve and reach their full potential. Organisational culture, resourcing, the impact of technology on both clinicians and patient care and complimentary systems to reduce RRS activation will all impact on rapid response evolution and need to be analysed for their impact and improvement if our current systems are to surpass their current limitations. This includes designing models that clinicians are comfortable in activating.

The RRS, along with many other imposed systems, require clinicians to be prepared and supported, not just with initial implementation, but for ongoing sustainability. Positive cultures of change are paramount if these systems are to be accepted.

For clinicians utilising rapid response, resourcing also needs to be addressed. Evidence shows the ever growing trend into RRS for early intervention, yet resourcing still remains funnelled into resuscitation training and equipment. Resourcing of RRS Teams needs greater analysis in order to provide appropriate staffing/team mix and equipment. Further, the organisational cost savings that early intervention teams could bring through prevention of further deterioration of patients who, would otherwise, require either extensive resuscitation and / or transfers to expensive critical care units needs to be brought to the forefront of discussion.

The growth of technology is helping to identify patient vital sign parameter breaches, yet many systems exclude human assessment and interaction variables. Inquiry into the impact these systems are generating on clinicians with consequent changes in interaction with

other health workers as well as job satisfaction and culture should be studied for effect. In addition, there is a possibility clinicians may over time give up their assessment skills in favour of 'automated assessment' as a way of easing their workload.

The impact of both end of life and improvement in the ability clinicians to have general resuscitation discussions as part of all patient's care planning, are approaches that could reduce the use of RRS, their resourcing, costs and inappropriate activation. Lastly, what is the real impact of the immense time and money currently being injected into clinician education around deterioration producing at the patient bedside? Studies need to examine if they are actually making any significant difference to early detection and management, or could this resource be better utilised and directed elsewhere?

2.5 Conclusion

This review has highlighted contemporaneous trends in the implementation of RRS, focussing on the Australian setting within a context of international evidence. A strength of this review has been the integration of a range of policy issues and the grey literature with published data. The strengths and limitations of RRS have been identified as well as the implications for future research.

To quote Dr Dana Edelson: *"The answer to why rapid response teams haven't been more successful is a combination of two things. We don't call them often or early enough, and when we get there we don't always do the right thing*".(77)

Future rapid response direction must include the elimination of negative human factors that impede their effectiveness, while promoting technology to help capture patients who might otherwise 'slip through the net'. Rapid response systems are complex interventions requiring consideration of contextual factors at local levels, appropriate resources, a skilled

workforce and positive workplace culture before effective uptake and utilisation can reach their full potential. The following chapter outlines the methodological and conceptual considerations for this study.

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Chapter 3 Methodology

3.1 Introduction

In Chapter 2, examination of the published literature set the contemporary healthcare scene, highlighting major historical trends and contextual factors in managing the deteriorating patient in the acute Australian tertiary hospital setting. This chapter describes the methodological process of the study, ethical considerations and data management. Specifically, it outlines the case study method with an embedded concurrent triangulation (1, 2) design using qualitative and quantitative data to address the study questions. It also provides an overview of organisational theory which has aided the study design and interpretation of findings. Data analysis methods are described under each methodological approach and more detail is provided in individual Chapters 4-6.

3.2 Aims

The study aims were addressed through the collection of data in three discrete phases and interpreting these findings, not only within the boundaries of the single site, but additionally in the broader interface between professional and regulatory bodies determining practice (the case).

3.3 Study design

Using a mixed method approach, integration and synthesis of key findings to address the aims of the study have been undertaken. Employing the approach of a case study method with an embedded concurrent triangulation design using qualitative and quantitative data,(3) has allowed explication of study questions.(4) The confines of a case have enabled the consideration of contextual issues such as workforce characteristics and the policy context.(5) Rapid response systems operate within greater macro healthcare systems and

environments, but also rely on meso and micro components to function as a whole. The empirical inquiry of case study design allows for 'disassembly' at a systems level, it is through this regression that real life context of it's true performance can be examined. Consisting of two main components, a quantitative approach will be used to examine the system itself and aspects of it's daily functioning within the contemporary healthcare environment and qualitative methodology to extract clinicians perceptions and daily work rituals performed within it's procedural expectations. The concept of triangulation allows for a retrogression and synthesis of these two methodologies that in turn are placed within the case and contextual concepts of organisational theory underpinning the thesis. It is then the understanding of these contextual findings, deriving meanings and potential solutions from the perspective of this complexity that will enable reflection of contemporary clinical environments that have driven enquiry for this study.

Data sources comprised of retrospective clinical record review, rapid response system case mix data and qualitative data derived from focus groups. The capability to adopt a mixed methods design was invaluable in examining the relationship between the RRS and the consequential development of in-depth knowledge pertaining to the interaction between this system over time and clinicians working within system boundaries.

3.4 Conceptual framework

Organisational theory provides a framework to define the patterns, structures and interactions that are used to address productivity and meet the expectations of stakeholders.(6) Contemporary healthcare settings are constructs of, and operate within collections of other complex and interwoven systems. System components are understood not solely by looking at the structure of the system itself, but through observation of how

interactions occur between all of it's components. Unpredictable behaviour is a common outcome and largely results from sensitivity of these components from either external influences, or internally as parts of these components, such as workforce, continually change and evolve.(7) Applying organisational theory to the construct of this thesis will allow deep exploration of the RRS environment. It will assist with the unpacking, validation and identification of both enabling and disabling influences on the RRS. It will also facilitate and unfold the extent to which satellite systems sitting within and interacting with RRS on a daily basis effect functioning. Dissection of the RRS own components will permit study of intended performance ability when placed within organisational and cultural workings, largely the unpredictable interaction between the system and the independent thinking and actions of clinicians.

Organisational behaviour (6, 8) describes how individuals interact in groups and is important to consider within a contextual framework. Understanding both process and outcomes within this context is important. The implementation of RRS occurs within a complex environment of health care within an intersection of micro, meso and macro factors. All large systems have a degree of errors associated primarily from both human and system causes.(8) This is particularly true within high reliability organisations such as acute care health centres, where the systems themselves, especially at times of increased demand and pressure, can result in influencing behaviours of individuals operating within its boundaries.(8)

Applying the theory of systems science, RRS complexity can be said to contain a multitude of variables that cause feedback loops, that then interact back into the system. These

"systemic interrelationships between feedback loops constitute the structure of the system, and it is this structure that is the prime determinant of system behaviour".(9)

3.5 The Case

The case study method involved collection, analysis and interpretation of detailed information (10) about the RRS at the study site to understand contextual phenomena. The study setting was an Australian academic health centre within a jurisdictional based model of clinical governance. A metropolitan quaternary facility with a bed base of 320, it provides most major speciality services including heart and lung transplantation. The RRS had been in place for five years at the time the study took place, receiving between 250-400 activations per month. The RRS design consisted of an admitting team model with primary response attended by the patients admitting medical team. After 'normal business hours' and on weekends, the responsibility for responding to RRS calls was given to the Medical Registrar (Senior ward clinician) on duty.

3.6 Quantitative Study

Title: Effect of systematic changes to afferent and efferent limbs of a rapid response system (RRS) over a seven-year period; an observational study

A quantitative observational study was undertaken to determine and understand cause and effect of factors influencing RRS call rates. Findings from the integrative review identified RRS resourcing as a major concern nationally in Australia. Times of greater system demand equates to greater strain on allocated resourcing, thereby affecting system performance. This study explored factors influencing deviation from optimal functioning of the RRS. Emphasis was placed on the effects operational system changes had to both afferent (activation) and efferent (response) limbs of rapid response.

3.6.1. Sample

Rapid Response System call rate data were collected over a seven-year period between April 2009 and March 2016. The study included 20,078 RRS call activations.

3.6.2. Instrument

The facility switch board initially recorded call activations manually, then electronically as systems developed. An Excel derived RRS database was developed to record data for analysis. The dataset consisted of date, ward, RRS tier level, cardiopulmonary arrest rate and the number of ward separations (including deaths) per month. When additional information was required surrounding clarification of call details, the principal investigator then perused medical records of patients who received a rapid response call to obtain the additional data.

3.6.3. Procedure and data analysis

Data cleaning took place to ensure variables were prepared for further analysis, data was then uploaded into statistical analysis software. The primary statistical analysis of the data was undertaken using control (Shewhart) charts(11), with the u-chart chosen as the most suitable for the study. The main functionality of control charts is to monitor the stability of processes;(11) allowing comparison between actual variance occurring within the RRS, to that which is expected of 'normal' operation. The u-chart was specifically chosen as it allows for a variation in sample numbers for each sample period.(11) As the number of ward separations is variable from month-to-month, the u-chart allowed for this variation when calculating control limits.**(11, 12)** Analysis focused on points that fell 'out of control', meaning ≥3 sigma limits (standard deviations from the mean).

Control chart generation procedure

The following process was used to generate the u-charts using SPSS software for system variation analysis:

The data set was chosen from the raw data (excel spreadsheet n=14 wards). Data was cleaned then de-identified and coded, then imported into SPSS for and analysed for control chart generation. The u-chart was selected and variable sample size chosen. Date was used as the sub group and the following test criteria were employed to test for out of control process:

1. One or more points are outside of the upper and lower control limits;
2. At least seven consecutive points are on the same side of the mean;
3. Two out of three consecutive points are outside a 2-sigma limit;
4. Four out of five consecutive points are outside of a 1-sigma limit;
5. Any pattern that is non-random or systematic in anyway;
6. One or more points are close to the upper or lower control limits.

From the generated data, the file was split and organised by output groups (Wards). Data was the run again selecting cases (specific Wards chosen for analysis) and the u-charts generated. (Appendix 3)

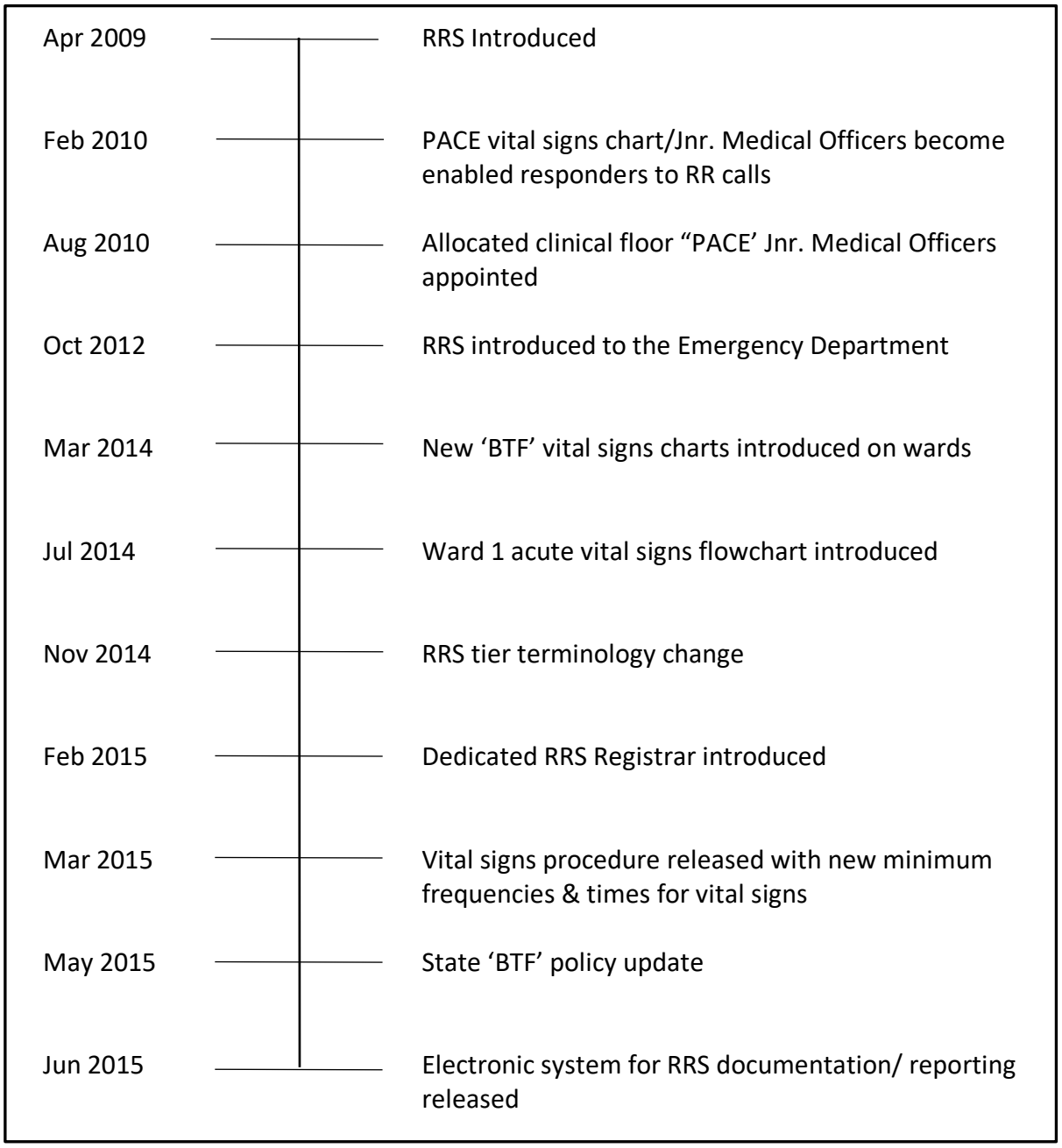
Tests were run on all 14 areas (wards and relevant procedural/treatment units) where all three tiers of the RRS were in place. Areas were de-identified and renamed 'Wards 1 through 14'. The top three (Wards 1, 4 & 7) were then chosen for investigative analysis, each exhibiting both significantly higher rapid response call rates, along with greater rates of

correlation than other studied wards for points outside of control when mapped against RRS operational changes.

Within the operational parameters of the RRS was documentation of administrative events such as major system changes introduced to the both afferent and efferent limbs over the seven-year study period. From these events, a timeline (Figure 3.1) was developed and mapped against chronologically corresponding out-of-control points (i.e. ≥3 standard deviations above or below the mean), on u-charts. The study data also included one clinical pandemic correlating to a significant impact on the system for a continuous four-month period.

Additional analyses included examining total inpatient ward cardiopulmonary arrest rates, calculated using combined totals for all wards (1-14) and also a combined separations score including deaths per 1000 separations as the denominator value. Total ward figures were chosen for reporting arrest rates as they best represented overall facility RRS performance, enabling more accurate assessment of the systems' ability to prevent these adverse events at this level. Results were then measured against the NSW Health performance indicator '(SSQ102) Deteriorating patients-unexpected cardiopulmonary arrest rate' (13) to ensure they were below the indicator target figure of >3 per 1000 separations for in-hospital arrests. If a score fell above this indicator, for the purpose of this study, the RRS could be considered ineffective or showing non-performance for that month. The findings are provided in Chapter 4 and a peer review journal is currently being sort for publication of this manuscript.

Figure 3.1 Timeline of rapid response system administrative events



Dates of significant administrative changes to the RRS over the seven-year study period appear to the left of the baseline, the corresponding changes that occurred at these times appear to the right of the baseline.

3.7 Qualitative Study

Title: Clinician perspectives of barriers to effective implementation of a Rapid Response System in an academic health centre: a focus group study

A qualitative design was used to elicit perspectives of health professionals who had current knowledge and active participatory experience with RRS.

3.7.1. Participants

The two eligible criteria for participation required both nurse and physician participants to be employed at the study site and currently work in clinical environments where the RRS operated. A total of thirty-four participants took part in the focus groups with recruitment consisting of a total of twenty-one physicians and thirteen nurses.

3.7.2. Design

The design and reporting of the qualitative study was guided by the consolidated criteria for reporting qualitative research (**COREQ**): a 32-item checklist for interviews and focus groups.(14) To specifically target this group of clinicians, purposive sampling (15) was employed to recruit participants.

Qualitative method allowed for facilitated discussion and narratives of experiences, required to understand clinicians' meanings and motivations that informed their actions.

3.7.3. Procedure

Invitations to attend focus groups were distributed via administrative email distribution lists. In addition, advertisements posted on hospital notice boards sought clinician volunteers. Although this method enabled significant reach, it precluded our ability to establish a response rate. Recruitment ceased upon data saturation. Interested potential participants contacted the principal researcher who provided additional oral and written

study information. Prior to focus group commencement, all participants provided written informed consent (Appendix 1) including permission to audio record proceedings.

Given the centrality of inter-professional perspectives of teams in our study, six discipline-specific and multi-disciplinary focus groups were undertaken during April and May 2014 to identify registered nurses' (RNs) and physicians' perceptions and experiences of the RRS.(16) Focus groups were chosen over individual interviews in order to generate dynamic discussion and responses to participants' comments, prompt memories, and refine opinions already expressed. As nurses and physicians have their own distinct culture, history, and approach to teamwork, conducting several discipline-specific focus groups allowed investigation of roles and practice and for open dialogue and disclosure of potentially diverse perspectives (17). Owing to time constraints, some clinicians were unable to attend discipline-specific groups and chose to attend a multidisciplinary group comprising both physicians and nurses. This choice allowed for individual narratives as well as responses and elaborative comments from others within each type of group. A literature review and preliminary discussions with key stakeholders informed development of the semi-structured topic guide (Figure 3.2).(18-20) Topics included barriers and facilitators to caring for deteriorating patients, RRS experiences, operating within and outside of the RRS protocol, and perceived need for protocol changes.

The one-hour focus groups took place on weekdays at the designated health facility in a private meeting room to enable attendance of target groups. Throughout the focus groups, the moderator noted newly emerging topics and points in need of clarification that were re-visited prior to concluding the sessions along with a summary of main points. This step enabled participants to verify the moderator's understanding and interpretation of reports,

thus acting as one method to verify findings. Within the context of the qualitative design it is important to outline the role of the researcher in the research. As the principal researcher was a senior nurse within the facility and had a working relationship with many of the potential participants and a significant role within the RRS, an external experienced clinician and researcher conducted the focus groups to minimise researcher and response bias. This individual, also a senior nurse, was neither known to participants, nor was a usual collaborator of the principal researcher, but had an understanding of and previous affiliation with the facility. Another experienced researcher moderated one group due to schedule conflict of the principal moderator; this person also performed the role of scribe in the other groups to record observational notes. Participants were informed that the principal researcher would not be attending the focus groups, but would have access to the recordings and conduct analysis. They were assured that names and identifying information would be removed from transcripts and demographic information would only be reported in aggregate form. They were also assured that the principal researcher would take steps to ensure confidentiality of participants including secure storage of data and act in accordance with established ethical frameworks.

Figure 3.2 Semi-structure focus group topic guide

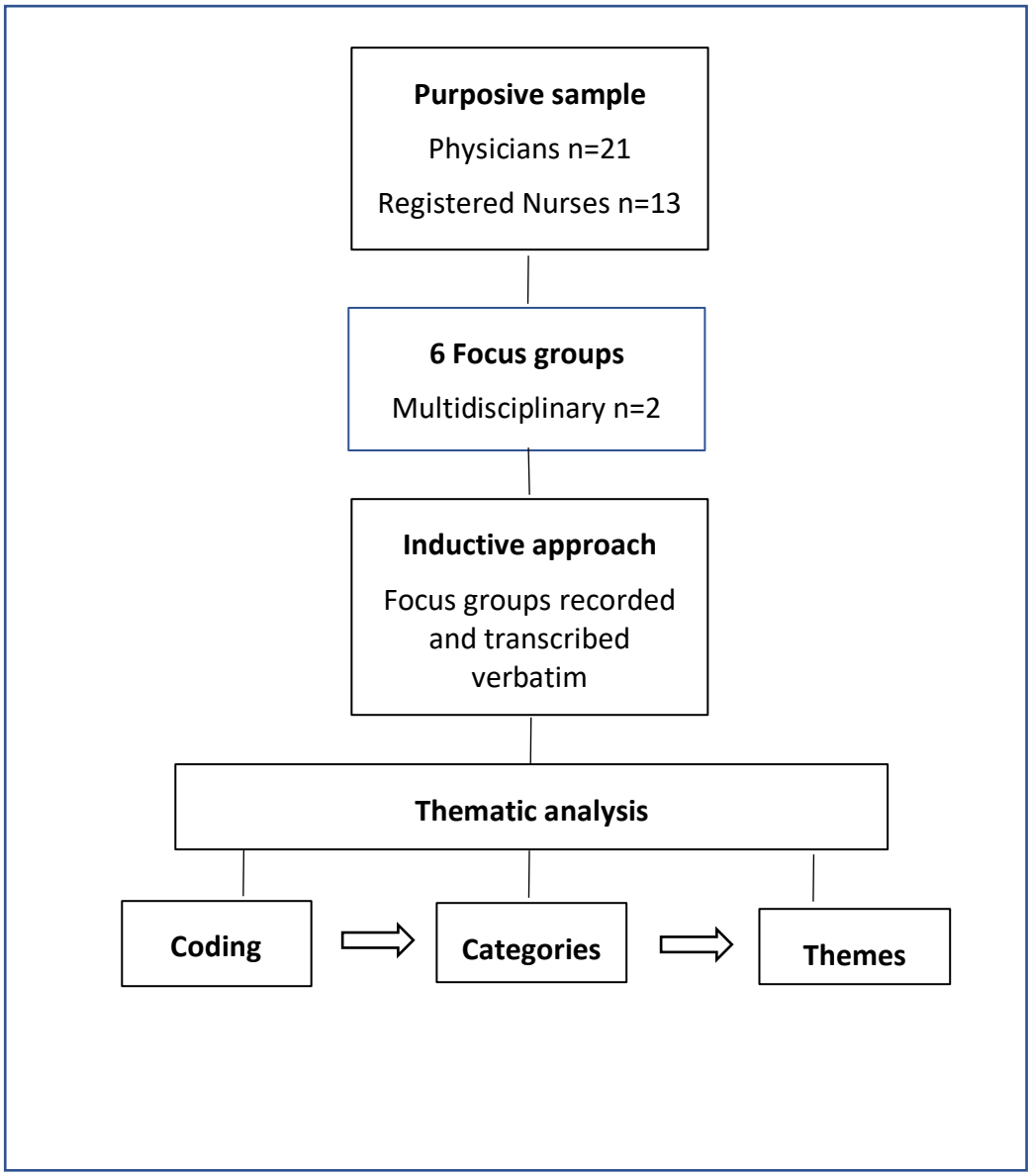
- What factors in your ward make it easy/difficult to care for 'sick' patients whose condition deteriorates?
- Can you tell me how the Rapid Response System (RRS) works on your ward?
- What has been your experience with the RRS?
- Do you follow the Clinical Emergency Response System Protocol?
  - If NO - how do you negotiate to operate outside of the Clinical Emergency Response System Protocol?
  - If YES – what enables you to operate within the Clinical Emergency Response System Protocol?
- In your experience, what makes the RRS work effectively/ineffectively?
- What, if any, changes are needed to enhance the existing RRS?

3.7.4. Data analysis

All focus groups were audio recorded and transcribed verbatim to facilitate thematic content analysis.(21) Analysis began with the principal researcher closely reading each transcript and listening to the audio recordings to get a sense of the proceedings and context.(22) Transcripts were analysed using the general inductive approach (22) (Figure 3.3). Inductive coding began with line-by-line reading and coding of raw data without a pre-specified framework to remain open to emergent topics and multiple meanings within the text. Coded text was grouped into categories of material reflecting similar topics. Categories were then synthesised into themes and independently reviewed by two additional researchers (XX & XX). To facilitate analytical rigour, the three analysts (1) principal researcher (experienced clinician perspective and context/topic expert), 2) principal

moderator (experienced, yet detached clinician perspective and witness to focus group processes), and 3) external qualitative researcher (methodological expertise) posed contradictory viewpoints and new insights and contributed to consolidation of themes. This analytical triangulation facilitated capture of key aspects of the themes assessed to be most important and useful in answering the research questions.

Figure 3.3 Inductive approach flowchart



Process of focus group analysis resulting development of study themes.

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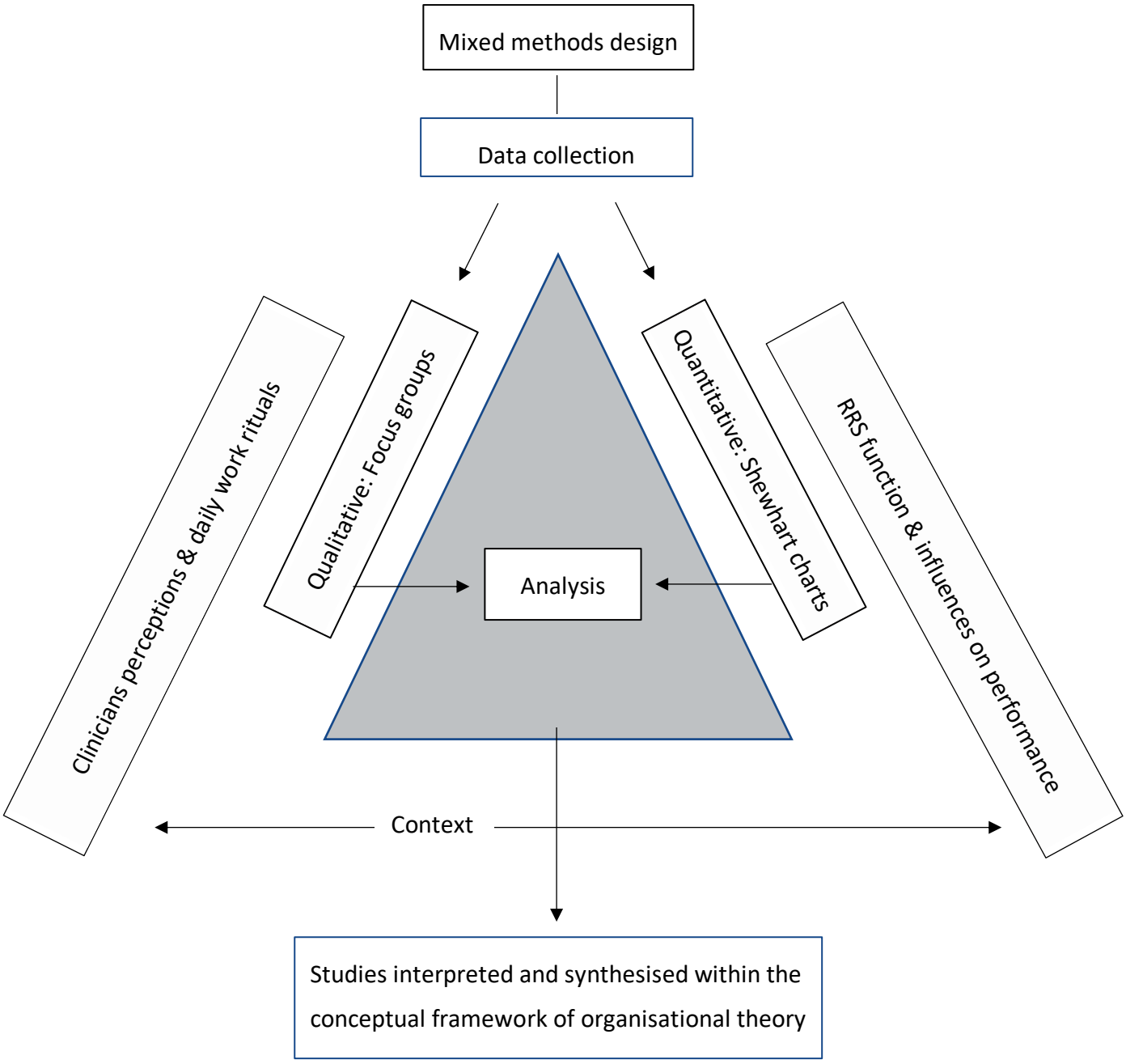
Rihari-Thomas J, DiGiacomo M, Phillips J, Newton P, Davidson PM. Clinician perspectives of barriers to effective implementation of a rapid response system in an academic health centre: A focus group study. International Journal of Health Policy Management. 2017;6(8):447-456.(23)

3.8 Process 4: Mixed method; Integration

A mixed method approach was employed to synthesise data from all three studies. Mixed method involves collecting data from both quantitative and qualitative research and integrating the two designs, produces a greater comprehension of the research problem than either method can approach alone.(24) Mixed method allows multiple perspectives and views of the case.(25) It contextualises findings through analysis of events from these studies. Placed in the contextualisation of systems theory, it enabled synthesis of data firstly exploring possible demand influences on both the RRS and related resources, then examine how clinicians negotiate care for patients within this environment.

This process was facilitated through the use of triangulation (1, 2) (Figure 3.4). Triangulation allowed for the combining of this dissertations' research methods to ascertain an overall view of RRS functioning in a contemporary healthcare setting. Triangulation was an important aspect of the case study research as different methods reveal aspects of a case, clarifying meaning through diversity and enhancing validity.(26)

Figure 3.4 Triangulation of methodologies model



Process of synthesis of review, quantitative and qualitative studies using triangulation

3.9 Data analysis

Analysed findings from the three studies were placed within the context of the conceptual framework. Organisational theory allowed for the deconstruction of individual components of the RRS from the influencing factors identified on a macro level within the quantitative study, to organisational behaviour and clinician influence on the system derived from quantitative work. Through the merging of this evidence, organisational systems science theories assisted in understanding RRS patterns, structures and interactions. This was then assimilated within the bounds of current literature to develop an overall understanding of the RRS in the Australian context.

Integration and synthesis of the study data are interpreted in Chapter 6.

3.10 Ethical approval

Ethical approval (Appendix 2) to conduct these studies was granted by both the University of Technology, Sydney and the site-specific ethics committees.

The studies within this dissertation were classified as 'low and negligible risk' and given HREC approval (reference **LNR/12/SVH/262**) after completion and submission of both 'Low and Negligible Risk Research Site Specific Assessment' (LNR SSA) and 'NEAF' ('National Ethics Application Form) applications.

Data was stored in locked facilities at the study site in the principle researcher's office of employment. Data was stored in both digital and hard copy media. Access to data was restricted to the researcher, focus group moderators and the students PhD supervisors. All data was de-identified for reporting purposes. All electronic data was password protected and all hard copy data was stored in a locked filing cabinet within a locked office within the study site. Data will be stored for 7 years, after this time electronic data will be deleted

from all hard drive sources and hard copy data will be placed in locked secure document containers for destruction.

3.11 Conclusion

This chapter has described the methodological process of the study, ethical considerations and data management considerations. Outlining the use of case study method, this chapter has demonstrated how the process of triangulation allowed for synthesis of both qualitative and quantitative study findings data in order to answer the study questions. Application of organisational theory was then explained, demonstrating the application in the interpretation of findings and role in generating implications for policy, practice, education and research. The following chapter introduces the quantitative study looking at factors possibly influencing on RRS function over a seven-year period.

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Chapter 4 Effect of systematic changes to afferent and efferent limbs of a rapid response system over a seven-year period: an observational study

4.1 Introduction

The previous chapter has outlined the methodological processes of this dissertation and how mixed method has been used to synthesize data findings from both qualitative and quantitative studies. This chapter reports on the outcomes of the quantitative study. The aim of this study was to describe factors influencing deviation from the optimal functioning of a RRS over a seven-year period. Emphasis was placed on the effects of operational system changes to both afferent (activation) and efferent (response) limbs of rapid response. It demonstrates that RRS exist within a complex and dynamic health care ecosystem, providing evidence that workforce characteristics influence the functioning of RRS. It was also able to demonstrate that factors external to the health care system need to be considered in the design, implementation and evaluation of RRS. Although there is some duplication with Chapter 3, methodological considerations are repeated to add in description of the study design and interpretation of study findings.

The content of this chapter with the exception of the conclusion, has been transposed from a completed manuscript for which a peer review journal is currently being sort for publication consideration. The conclusion has been edited and differs from the manuscript to allow for dissertation flow and synthesis.

Rihari-Thomas J, Newton P, Sibbritt D, Davidson PM. Effect of systematic changes to afferent and efferent limbs of a rapid response system over a seven year period: An observational study. 2016.(1)

4.2 Background

Rapid Response Systems focus on the detection, management and escalation of physiological deterioration in patients.(2, 3) In spite of best practice recommendations, results of the implementation of RRS are inconsistent.(4) Patient, provider and healthcare system factors influence the efficacy and effectiveness of RRS.(5) Unnecessary and preventable adverse events in the acute care setting are increasingly of a concern internationally.(6, 7) Rapid Response Systems have been globally implemented as best practice models for early detection, management and escalation of physiological deterioration experienced by patients on general hospital wards.(8, 9) These systems target prevention of adverse clinical events, including unplanned intensive care unit (ICU) admissions, unexpected cardiopulmonary arrests and deaths (10). While the literature reports on the success of RRS in reducing in-hospital cardiopulmonary arrest rates, and more recently, improving mortality rates,(11) adverse events persist in the acute care setting and implementation of models beyond research settings is challenging.(12) Optimal RRS functionalities are influenced by many factors including workplace processes and culture.(13) There is heterogeneity found in RRS as they continue evolution to meet both system and consumer demands demonstrated by extensive variation in models, team composition and resourcing.(14, 15)

Contemporary rapid response teams range from critical care based 'medical emergency teams' (MET), local admitting specialty ward physicians, to nurse led critical care outreach initiatives.(15, 16) Despite the model or composition of the RRS, resourcing for the most part remains suboptimal, impacting on peak functional performance.(15) Many influencing factors including patient acuity, and clinician shortages and skill-mix cannot be fully controlled in dynamic clinical settings. Some influencing factors are imposed on RRS through

operational and systemic changes to the health care organization intentionally made over time. It is imperative to identify the impact of these changes in order to reduce system dysfunction and ultimately, patient harm. Exploring factors influencing operationalisation of the RRS and identification of causal variance can be useful in planning risk reduction.

4.3 Setting

The study site was a metropolitan acute tertiary referral centre within a jurisdictional state based governance model. Classified as a 'Schedule 3 Facility', the site was privately owned, but was additionally affiliated with both the state of New South Wales' Ministry of Health and multiple universities, receiving both privately and publicly funded patients. State based health facilities are generally clustered into groups for ease of funding and governance termed Local Health Districts.

4.4 Rapid response model

An admitting medical team responder model was the RRS design implemented in the study setting. The system was designed around track and trigger system principles using vital sign parameters to 'track' a patients physiological variables, which then 'triggered' various levels of clinician response when a breach in calling criteria occurred.(17) In addition, subjective criterion of 'concerned' allowed the RRS to be activated for any other reason based upon a clinician's clinical concern.

During the first seven years of operation, the RRS underwent multiple changes to both afferent and efferent limbs. Originally designated 'Patient with Acute Condition for Escalation' (PACE),(18) it consisted of two tiers, 'PACE' and 'Code Blue'. PACE allowed for a 30-minute response window where the patient was attended by a ward based Registrar level physician (19) as the primary responder (or general 'medical registrar' who covered

the hospital out of normal business hours). Code Blue level initiated an immediate response to the patient bedside from an intensive care unit (ICU) based critical care team. Team makeup included an intensive care unit (ICU) registrar, two ICU registered nurses (RN) and an anesthetics registrar.

In 2014 PACE transitioned to a three-tiered model, integrated into a state government based program labelled 'Between the Flags' (BTF).(20) The program effectively created a single, geographically large RRS, incorporating standardised calling criteria in all government acute care facilities across the entire state of New South Wales (NSW), Australia. Servicing a population of 7.7 million, NSW Ministry of Health currently operates 230 hospitals managing 1.9 million inpatient episodes per year.(21) Post transition, the second and third RRS tiers remained unchanged in the study facility (the term 'PACE' was originally retained post transition despite the official BTF tier designation of 'Rapid Response'). The first tier (previously non-existent) was labelled 'Clinical Review'. Consisting of more sensitive calling criteria than the PACE tier, this became a registered nurse response and assessment tier, escalated to a second or third tier activation if the assessment outcome suggested possible deterioration. All three tiers of the BTF program were initially employed in the inpatient wards in the study setting as well as select inpatient/outpatient treatment areas of the study centre, areas outside of these defaulted directly to the Code Blue Tier. Critical care areas such as ICU, operating theatres, recovery units and the emergency department (ED) managed deterioration and cardiopulmonary arrests 'in house' and as such were not included within the study analysis.

4.5 Method

Within the overall embedded case study design, an empirical analytical approach was used to analyse and interpret a quantitative observational study of RRS call rate data collected over a seven-year period between April 2009 and March 2016. Data were analysed with the use of the Shewhart (control) charts, a statistical process that allows identification of systems when they perform out of statistical control. For the purposes of this study, the definition of 'out of control' occurred when RRS call rates fell outside of three standard deviations from the mean. Mapping out of control occurrences with a timeline of institutional operational processes was then undertaken to identify possible relative causes of system divergence from expected (normal) operation.

4.6 Procedure

The facility switch board initially recorded call activations manually, then electronically as systems developed. The principal investigator then perused medical records of patients who received a rapid response call to obtain additional data. The dataset consisted of date, ward, RRS tier level, cardiopulmonary arrest rate and the number of ward separations (including deaths) per month.

Control charts, specifically u-charts, were run for primary analysis of the dataset (Appendix 3). The main functionality of control charts is to monitor the stability of processes;(22) allowing comparison between actual variance occurring within the RRS, to that which is expected of 'normal' operation. As the number of ward separations is variable from month-to-month, the u-chart was chosen for the ability to allow for this variation when calculating control limits.(22, 23) Analysis focused on points that fell 'out of control' meaning $\geq$3 sigma limits (standard deviations from the mean).

The following test criteria were employed to test for out of control process:

1. One or more points are outside of the upper and lower control limits;
2. At least seven consecutive points are on the same side of the mean;
3. Two out of three consecutive points are outside a 2-sigma limit;
4. Four out of five consecutive points are outside of a 1-sigma limit;
5. Any pattern that is non-random or systematic in anyway;
6. One or more points are close to the upper or lower control limits.

Tests were run on all 14 areas (wards and relevant procedural/treatment units) where all three tiers of the RRS were in place. Areas were de-identified and renamed 'Wards 1 through 14'. The top three (Wards 1,4 & 7) were then chosen for investigative analysis, each exhibiting both significantly higher rapid response call rates, along with greater rates of correlation than other studied wards for points outside of control when mapped against RRS operational changes.

Within the operational parameters of the RRS was documentation of administrative events, such as major system changes, introduced to the both afferent and efferent limbs over the seven-year study period. From these, a timeline (Chapter 3, Figure 3.1) was developed and mapped against chronologically corresponding out of control points (i.e. 3 standard deviations above or below the mean), on u-charts. An outbreak of H1N1 occurred in the observation period correlating to a significant impact on the system for a continuous four-month period. Total inpatient ward cardiopulmonary arrest rates were calculated using combined totals for all wards (1-14) and also a combined separations score Including deaths per 1000 separations as the denominator value. Total ward figures were chosen for

reporting arrest rates as they best represented overall facility RRS performance, enabling more accurate assessment of the systems' ability to prevent these adverse events at this level. Results were then measured against the NSW Health performance indicator '(SSQ102) Deteriorating patients-unexpected cardiopulmonary arrest rate' (24) to ensure they were below the indicator target figure of >3 per 1000 separations for in-hospital arrests. If a score fell above this indicator, for the purpose of this study, the RRS could be considered ineffective or showing non-performance for that month.

This study was undertaken with approval from both the affiliated University and study Hospital Human Research Ethics Committees.

4.7 Results

During the observation period, 20,078 system activations were recorded. Wards 1, 4 and 7 fell outside of control on a total of 59 occasions as shown in Appendix 3. Ten operational or systematic changes were made to the RRS during this time period, eight of which correlated with ward variance from control at corresponding time points. One clinical pandemic also transpired during the period of study and correlated to out of control for a four-month period in 2009.

2009

Between June and September 2009 there were no changes to the RRS, however wards 1 and 7 fell out of control in June, 1 and 4 in July and August and 1 and 7 in September. These consecutive months correspond to the peak of the H1N1 pandemic in Australia. The general ward cardiopulmonary arrest rates per 1000 separations for June and September were zero and 0.008 respectively.

2010

In February 2010 wards 1 and 4 were out of control at the time a new colour coded vital signs chart was being introduced across the facility. Operationally, there was also a change in the skill level of medical responders permitted to respond to rapid response calls. Policy was changed to allow Junior (resident medical officers or 'RMO') (19) belonging to the patients admitting team to respond to a rapid response call. Clinical handover with a registrar level physician around the outcome of the rapid response was then required after the consultation. Out of control continued into March.

During August, the RRS had another operational change with additional 'floor allocated' resident medical officers added to the existing medical response team. Implemented as a 'back up' initiative, it covered instances where admitting team medical officers were delayed in attending a rapid response due to simultaneously being required elsewhere, such as assisting in operating theatres or performing procedural tasks. This change again correlated with RRS performance variation for wards 1 and 4, with ward 1 being out of control for both August and September and ward 4 solely in September. Cardiopulmonary arrest rates were February 0.005, March 0.006 and August 0.004/1000 separations.

2012

The Emergency Department implemented a new colour coded vital sign/observation chart as part of the NSWHealth Between the Flags (BTF) program in October. This did not correlate with any system variance and inpatient wards remained in control throughout this, as well as the following month of November. Cardiopulmonary arrest rate for this month was 0.002 / 1000 separations.

2014

In March 2014, the RRS underwent major change as BTF expanded into inpatient areas with general ward specific colour coded vital sign/observation charts. This operational change also brought the addition of the new third tier to the RRS at the study site. Ward 7 fell out of control during the month of implementation, with wards 4 and 1 continuing this trend for the following two months of April and May respectively.

During July, a vital signs/observation flowchart was designed for an acute high dependency area of ward 1 as the general ward chart was not specific or detailed enough to adequately monitor these higher acuity/higher risk patients. This corresponded to out of control for the following 2 months of August and September post implementation. November saw an official change in the rapid response tier name from 'PACE' (originally maintained from the original model despite changing to between the flags) to 'Rapid Response'. Ward 4 experienced out of control in correlation with this tier labelling change.

2015

Operational changes occurred again in February 2015. Between 0800 – 1700hrs week days, the responding RRS registrar was now sourced from the ICU. Team registrars/RMO's continued to be both informed of rapid response calls on their admitted patients and required to attend, though the formal responder was acknowledged as the ICU registrar. Ward 4 fell outside of control during this month. Cardiopulmonary arrests rates/1000 separations for March, July and November were 0.002, zero and 0.009 respectively. In March2015, a new vital signs procedure was introduced modifying vital sign frequencies and times on inpatient wards. Wards 4 and 7 corresponded with out of control results upon introduction.

During May, the RRS policy was updated to formally reflect the latest system changes. Ward 4 fell out of control during this time. The facility went live with new software slaved to the patient management system for electronic initiation and documentation of RRS activity in June. Upon initial introduction, wards 4 and 7 correlated to out of control, then continued to show this trend for the following six months with wards 1 and 7 in July, wards 4 & 7 in August and September, and ward 4 again in October.

Study results also showed a large out of control variation during times of medical officer rotations to new specialty areas. Though not an operational change to the RRS itself, it did correlate with a significant impact on the system with out of control occurring on 18 separate occasions. Cardiopulmonary arrest rates for this period were zero for March and 0.002 for May.

4.8 Discussion

There are reports of system failures of RRS from both afferent and efferent limb perspectives. Accuracy of activation (trigger) tools and clinician knowledge in being able to detect and escalate the deteriorating patient have been identified as potential inhibitors from an afferent perspective.(25) Hospital cultures, systems implementation (26) and resourcing (15) dominate findings associated with efferent failures. Cultural concerns included clinician perceptions of the RRS efficacy as an effective tool for detecting and managing patient deterioration (27) and responder negativity influencing clinician decisions to activate.(28) A systematic review by Winters and colleagues (29) reported that although these factors have been identified within the extant literature, the context in which they present and attempts to account for secular trends over time is lacking in many studies.

Chronological data analysis within this study over seven years demonstrates that RRS exist within a complex and dynamic ecosystem and are influenced by both internal and external factors. While only eight of the 10 formal operational changes occurring to the RRS over the study period appeared to have caused any significant impact on expected RRS process, the interconnection between the RRS and other general hospital operational functionalities such as clinical rotations, appeared to have related to most (n=59) 'out of control' events.

4.8.1. Clinical rotations

Medical staff rotations across specialties correlated to RRS deviation outside of control limits on a total of 18 occasions facility wide (all Wards). Rotations for Interns and RMO's occurred four times per year in February, May, August and November. This also coincided twice a year with registrar-level medical officers rotating specialties simultaneously with their more junior colleagues in February and August. For the three specific wards analysed, RMO/Intern rotations corresponded to a fall outside of control on 17 out of 28 rotations (61% of the time), with at least 1 ward experiencing deviation each time. Registrar rotations correlated to 9 out of 14 (64%) occasions, also affecting at least 1 ward each time, similarly correlating with every control violation where more than 1 ward was involved. Ward 1 showed the greatest out of control points with 12, six of which occurred during rotations where both registrars and RMO/Interns occurred together. While there is ample literature supporting the learning experiences of junior medical officers on ward rotations, including suggestions that the level of supervision and patient case-mix play important roles in effective learning,(30) there is little focus on the impact of patient care and management when medical officers begin practicing in new environments or medical specialties.

4.8.2. H1N1 pandemic

Another non-operational incident correlating to significant change in RRS activity was during the H1N1 pandemic. Control violation occurred for four consecutive months between June and September 2009 at the peak of the pandemics in Australia.(31)

Predominantly, the eight control violations correlating to formal RRS operational changes can be grouped into two main categories, those relating to vital sign/observation charts and those corresponding to operational policy & procedure changes.

4.8.3. Documentation

Out of control violations were detected simultaneously to ward vital sign charts either changing or being redesigned. These changes occurred twice during the study period, with significance being that they set trigger parameters for rapid response activation. The 'PACE' chart was introduced in February 2010, with a further change when the BTF chart was introduced in March 2014. The Emergency Department also introduced a unit specific BTF chart, however this chart did not lead to any noticeable out of control at ward level. In July 2014, a specialty specific vital sign / observation flowchart was introduced into the six-bed high acuity area of Ward 1. Patients in this area required a nurse to patient ratio of 1:2. While this did not correlate with control violations during that month, the ward was outside of control the following month. This however also coincided with Resident/Intern and Registrar rotations which may possibly also lead to an association of the variance.

The introduction of a software program for the electronic assessment and documentation of RRS events appeared to have created one of the largest impacts on system performance. Out of control violations continued to show in wards six months post program release. User compliance remained an issue relating in part to a hybrid medical records environment,

with some systems electronic, while others remained paper based. This left clinician's with an option to continue utilisation of hand written notes in the absence of fully electronic systems being in place.

4.8.4. Policy and procedure

Six operational, policy or procedural changes occurred during the study. Deviation from control limits occurred each time policy or procedure was introduced or updated, with clinician activation of the system falling either less/greater than 3 sigma.

Both operational changes and one clinical pandemic affected RRS activity during the seven years. These changes however accounted for only 15% of total identified out of control limit violations. This suggests that although formal changes to the system may contribute to out of control, other factors not identified within this study also heavily impact on deteriorating patient systems. This is an important consideration requiring further inquiry. Principally so when resources may be stretched or in short supply, placing further demands on the RRS and clinician workloads, both heavily influencing the ability of the system to perform effectively.

Current results highlight a RRS that could be considered unstable in system process based solely on studied variables, exhibiting special cause variation with non-random variation from external factors.(22) The RRS could therefore be said to be in a state of 'brink of chaos',(22) where the process is unpredictable but the system is still meeting customer (patient) demand. This stands true as cardiopulmonary arrest rates, a principal rationality for RRS, remained generally low and constant across the facility throughout the study period. Although the three study ward arrest rates exceeded the KPI target of <3/1000 separations (21) on five time point occasions negatively impacting on total facility KPI

targets, consideration should be given to these numbers in respect to the seven year timeframe and total facility numbers of ward arrests. These KPI 'failures' also need to be placed in context of individual events. The experience of one patient exhibiting multiple episodes of ventricular tachycardia despite optimal treatment regimens for example, contributed to an inability of the whole facilities monthly arrest statistics to meet target. Not only exhibiting the highest cardiopulmonary arrest rates, the three study wards also demonstrated the greatest variations to out of control RRS call rates. This is not only an indication that they housed the facilities sickest, most at risk patient groups, but more importantly, that the RRS was well engaged by clinicians in these areas.

Further studies are required to identify the additional factors causing system variance at specific time points. These could include analysis of patient acuity, staffing shortages and skill mix, as well as periods of sub-optimal patient flow /bed block. Additionally, further enquiry into these factors may also explain why some wards are more sensitive to change or remain effected for longer periods of time, while others remain in control during these periods of change.

4.9 Limitations

The study did not report on other factors that may have influenced out of control variance at certain time points, such as overall hospital patient acuity, staffing shortages and skill mix or bed allocation issues such as 'bed block', preventing a patient's ability to be placed in the most suitable environment for optimal care.

4.10 Conclusion

This study described factors influencing deviation from the optimal functioning of a RRS over a seven-year period. Demonstrating that RRS exist within a complex and dynamic

health care ecosystem, it was able to provide evidence that workforce characteristics influence the functioning of RRS. Factors external to the health care system need to be considered in the design, implementation and evaluation of RRS. Despite a RRS found to be currently 'out of control', it continued to generally remain effective in keeping cardiopulmonary arrest rates under performance targets. Identification of imposed actions and changes on system performance will allow better planning and risk reduction. Bringing these additional influencing factors to light may also identify a system that is potentially more predictable than current analysis dictates, allowing for further evolution to enable performance enhancement by reducing the volume of time points where the system falls outside of control. These aspects are further elucidated in Chapters 5 and 6.

The following chapter presents a qualitative study undertaken to elicit clinicians' perceptions of performing daily works within the boundaries of these vulnerable and unstable RRS environments.

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Chapter 5 Clinician perspectives of barriers to effective implementation of a Rapid Response System in an academic health centre: a focus group study

5.1 Introduction

The previous chapter described factors influencing deviation from the optimal functioning of a Rapid Response Systems (RRS) over a seven-year period. The results provided evidence that workforce characteristics influence the functioning of RRS and also that factors external to the health care system need to be considered in the design.

This chapter presents a qualitative study undertaken to elicit clinicians' perceptions of performing daily works within the boundaries of unstable and vulnerable RRS environments. Physicians and nurses discuss their experiences with rapid response and how they negotiate care for deteriorating patients in the acute health care sector.

The content of this chapter has been transposed from a peer reviewed and published manuscript which can be found in the *International Journal of Health Policy and Management* (Appendix 7).

Rihari-Thomas J, DiGiacomo M, Phillips J, Newton P, Davidson PM. Clinician perspectives of barriers to effective implementation of a rapid response system in an academic health centre: A focus group study. International Journal of Health Policy Management. 2017;6(8):447-456.(1)

5.2 Background

Hospitals are facing increasing patient demand and complexity whilst also being more accountable for improving care, decreasing costs, optimising access to evidence based treatments and minimising adverse events.(2) An increased emphasis on clinician accountability to improve health care quality and safety is challenging in an environment with significant workforce shortages and variations in skill mix.(3) As part of the global

patient quality and safety agenda, the past two decades have seen a growing focus on implementing Rapid Response Systems (RRS) to facilitate early detection, management and escalation of deteriorating inpatients.(4) The RRS is designed around early 'rescue' of patients showing abnormal physiological signs and symptoms, preventing adverse clinical events (i.e. unplanned intensive care unit (ICU) admissions, unexpected cardiopulmonary arrests and/or deaths).(5, 6) Despite the progressive uptake of RRSs, various provider and systems factors have limited optimisation.(7) The lack of translation of key principles highlights the need to consider interpersonal, intra-organisational, and systemic factors including: workforce distribution, skills and shortages, culture, teamwork, power relationships, fiscal constraints, increasing public accountability(8) and competition between discrete organisational units.(9) Teamwork and communication are essential in ensuring patient safety.(10) Team building is complex and influenced by professional boundaries, power relations and systems.(11) As with any healthcare initiative, human factors and the understanding of interactions among individuals and elements of a system, may influence the level of acceptance, utilisation and ultimately, the effectiveness of RRSs within the acute care setting.(12) The ways in which clinicians operate within the RRS depend partly on the extent to which they value its use as a tool for patient safety, as well as ways in which they engage and effectively communicate within and between professional disciplines. Despite the no blame feature of all safety and quality agendas, clinician fear of retribution often shapes reluctance to activate RRSs.(13-15) Clarifying interactions and experiences that occur between clinicians operating within these mandated clinical systems is required to address known gaps. Frameworks in health care and institutional structures are still largely shaped by historical, medically dominated hierarchies(16-18) challenging

communication and innovation. Failing to acknowledge these human factors is detrimental to success when implementing any model of care.(8)

Current literature reports on barriers to effective RRS activation, including RRS knowledge, attitude of responders and workloads.(19) This study further aimed to explore and understand how doctors and nurses experience this system and negotiate care for deteriorating patients within the RRS environment. Our objectives were to ascertain 1) factors that influence implementation and ongoing effective use of RRS and 2) clinicians' perceptions of its efficacy and utility when the initial tier of medical response is led by the patient's admitting team.

5.3 Methods

Purposive sampling was used to recruit nurse and physician participants who had been involved with RRSs.(20) The study setting was an Australian academic health centre within a jurisdictional based model of clinical governance. The RRS had been in place for 5 years at the time the study took place and received between 250-400 activations per month.

A qualitative design was used to elicit perspectives of health professionals who had current knowledge and active participatory experience with RRSs. A method that would facilitate discussion and narratives of experiences was required to understand clinicians' meanings and motivations that informed their actions. Given the centrality of inter-professional perspectives of teams in our study, six discipline-specific and multi-disciplinary focus groups were undertaken during April and May 2014 to identify registered nurses' (RNs) and physicians' perceptions and experiences of the RRS.(21) Focus groups were used to generate dynamic discussion and responses to participants' comments, prompt memories, and refine opinions already expressed. As nurses and physicians have their own distinct

culture, history, and approach to teamwork, conducting several discipline-specific focus groups allowed investigation of roles and practice and for open dialogue and disclosure of potentially diverse perspectives.(16) Owing to time constraints, some clinicians were unable to attend discipline-specific groups and chose to attend a multidisciplinary group comprising both physicians and nurses. This choice allowed for individual narratives as well as responses and elaborative comments from others within each type of group. A literature review and preliminary discussions with key stakeholders informed development of the semi-structured topic guide (Chapter 3, Figure 3.2).(3, 22, 23) Topics included barriers and facilitators to caring for deteriorating patients, RRS experiences, operating within and outside of the RRS protocol, and perceived need for protocol changes.

5.3.1. The Rapid Response Model

Track and trigger systems are recognised both nationally and internationally as best practice models. They take many forms with triggers typically incorporating numerical (aggregate weighted) scoring, vital sign parameters or combinations of both.(24, 25) The rapid response model utilised in the study is a state-based multi-tiered vital sign parameter track and trigger system.(24) Individual tiers are activated when a pre-determined set of clinical observation and vital sign variables are breached (track), which then 'triggers' the response of the appropriate level of Rapid Response Team (RRT). (26) The two tiers, 'Clinical Review' (Tier 1) consist of more sensitive trigger indicators (early warning signs), while 'Rapid Response' (Tier 2) contains less sensitive indicators indicative of late warning signs. Indicators are derived from research outcomes of the 'SOCCER' study,(27) each attracting differing levels of clinician response (Appendix 4). This allows a degree of individual facility autonomy based on RRS structure, resourcing and geographic location. Tier parameter

criteria can be modified to create individual patient customisation, affectively making indicators more or less sensitive to system activation over the standardised criteria. The response processes are primarily based around initial medical response (in the Rapid Response tier) coming from admitting medical teams, or dedicated facility physicians out of normal business operating hours. Although not alone in adopting this type of response model, the majority of peer facilities more popularly initiate this level of medical response in the first (Clinical Review) tier, dispatching a critical care lead medical emergency team (MET)(14) when Rapid Response criteria are breached.(28) The Clinical Review tier is generally responded to and managed by unit RNs in the study facility who perform a thorough A-G (airway, breathing, circulation, disability, exposure, fluids, glucose) patient assessment within 30 minutes, initiate required interventions within their scope of practice, and escalate to the second tier if their assessment reveals possible or actual clinical deterioration. The admitting team model was chosen by this facility as it allows admitting physicians to initially manage the patient's deterioration, thus decreasing workload demands on individuals as the RRS response load is spread across many speciality teams, rather than just a single MET. This model was also intended to allow admitting teams opportunity to develop skills in identifying and managing clinical deterioration themselves through experience rather than relying on the MET for 'rescue' in every RRS situation. The admitting, or after-hours team registrar (a physician who has obtained full registration with the Medical Board of Australia with at least 3 years' experience working in public hospital service),(29) is required to respond to all second tier calls within 30 minutes of activation. A junior resident medical officer (physician who has obtained full registration with the Medical Board of Australia)(29) is allocated to each clinical floor and is also required to attend. A third tier (Code Blue) is embedded within the Rapid Response tier and activates the MET

from ICU if clinicians feel that immediate critical care assessment is required, there has been no physician response from a rapid response activation, or the patient is not showing sign of stabilisation or improvement 1 hour after rapid response intervention.

5.3.2. Recruitment

Invitations to attend focus groups were distributed via administrative email distribution lists. In addition, advertisements posted on hospital notice boards sought clinician volunteers. Although this method enabled significant reach, it precluded our ability to establish a response rate. Recruitment ceased upon data saturation. The two eligible criteria for participation required both nurse and physician participants to be employed at the study site and currently work in clinical environments where the RRS operated. Interested potential participants contacted the principal researcher who provided additional oral and written study information. As the principal researcher was a senior nurse within the facility and had a working relationship with many of the potential participants and a significant role within the RRS, an external experienced clinician and researcher conducted the focus groups to minimise researcher and response bias. This individual, also a senior nurse, was neither known to participants, nor was a usual collaborator of the principal researcher, but had an understanding of and previous affiliation with the facility. Another experienced researcher moderated one group due to schedule conflict of the principal moderator; this person also performed the role of scribe in the other groups to record observational notes. Participants were informed that the principal researcher would not be attending the focus groups, but would have access to the recordings and conduct analysis. They were assured that names and identifying information would be removed from transcripts and demographic information would only be reported in aggregate form. They were also assured that the

principal researcher would take steps to ensure confidentiality of participants including secure storage of data and act in accordance with established ethical frameworks. Prior to focus group commencement, all participants provided written informed consent including permission to audio record proceedings. The affiliated University and Hospital Human Research Ethics Committees granted approval to undertake this study (HREC: XXXXX).

5.3.3. Procedure

One-hour focus groups took place on weekdays at the designated health facility in a private meeting room to enable attendance of target groups. Throughout the focus groups, the moderator noted newly emerging topics and points in need of clarification that were re-visited prior to concluding the sessions along with a summary of main points. This step enabled participants to verify the moderator's understanding and interpretation of reports, thus acting as one method to verify findings.

5.3.4. Analysis

All focus groups were audio recorded and transcribed verbatim to facilitate thematic content analysis.(30) Analysis began with the principal researcher closely reading each transcript and listening to the audio recordings to get a sense of the proceedings and context. Transcripts were analysed using the general inductive approach.(31) Inductive coding began with line-by-line reading and coding of raw data without a pre-specified framework to remain open to emergent topics and multiple meanings within the text. Coded text was grouped into categories of material reflecting similar topics. Categories were then synthesised into themes and independently reviewed by two additional researchers (XX & XX). To facilitate analytical rigour, the three analysts (1) principal researcher (experienced clinician perspective and context/topic expert), 2) principal

moderator (experienced, yet detached clinician perspective and witness to focus group processes), and 3) external qualitative researcher (methodological expertise) posed contradictory viewpoints and new insights and contributed to consolidation of themes. This analytical triangulation facilitated capture of key aspects of the themes assessed to be most important and useful in answering the research questions.

5.4 Results

Thirty-four health professionals (21 physicians, 13 RNs) took part in six focus groups over a five-week period. Each group was comprised of two to five participants with the exception of the registrar group, which included 15 participants. Four groups were discipline-specific and two groups were multi-disciplinary**.** Participants included both junior and senior registered nurses (RN) and physicians. Participants held differing skill levels and clinical experience ranging from less than one year to greater than 10 years (Table 4)**.** Physicians had worked in both admitting specialty teams and facility-wide 'after hours' roles. The majority of participants were under 30 years old and had worked at the study facility for less than five years.

Analyses of focus group data yielded a range of organisational and systems-level factors shaping the ways in which health professionals experienced and negotiated care for deteriorating patients within the RRS environment. The themes that reflect systems or organisational-level barriers to an effective RRS include: 1) responsibility is inversely proportional to clinical experience, 2) actions around system flexibility contribute to deviation from protocol, 3) misdistribution of resources leads to perceptions of inadequate staffing levels inhibiting full optimisation of the RRS, and 4) poor communication and documentation of RRS increases clinician workload.

Responsibility is inversely proportional to clinical experience

Interns and resident medical officers (hereafter, junior physicians) reported feeling unprepared and out of their depth when they entered clinical settings. They were confused about the logistics of the RRS process, particularly around who should attend RRS calls and where (allocated areas). Despite the RRS protocol and process included as part of facility orientation, some junior physician participants remained unaware. This lack of understanding contributed to doctors developing their own unique way of making the system work and/or introducing the RRS processes from previous employment sites. This resulted in doctors frequently deviating from standardised RRS protocol and perpetuating confusion for other team members.

Operation of medical response tier left to most junior physicians

Tier 2 of the local RRS requires senior physicians (registrar level and above) to be primary responders, with junior physicians attending as additional support and to gain learning opportunities. Junior participants reported often being first at the bedside, and on occasion, the only responder. Despite study site protocol dictating activation of a MET call in such instances, they were often unsure of their options if they were the only responder. These participants reported feeling anxious, isolated and uncertain, out of their depth, and fearful of being unsupported, as depicted in the following excerpt:

> **Junior physician:** *"There are times that I felt quite out of depth….I'm still getting anxious when my pager goes off and says 'it's time to go and do a [rapid response] and it's like oooooh"[nervous]*

Similarly, RN participants expressed concern around variability of junior physicians' skill levels in managing the complexity of some deteriorating patients. Nurses' concerns about clinical capabilities was amplified if they perceived the junior physicians as not always having the prerequisite specialist knowledge of particular medical conditions or circumstances around deterioration, considering this as possibly detrimental to patient safety:

> ***RN:*** *"…I say 'do you know anything about VADs (ventricular assist devices), and they (junior physicians) turn around to me and say 'no', I'm really concerned, and I'll guarantee the majority of the Junior Reg's (Registrars) know nothing about VAD patients either…If you're running a hospital with VADs and (heart) transplants and lung transplants and haematology patients you shouldn't have a junior doctor looking after them at night, it can be quite scary."*

Amidst these circumstances, nurses often perceived that their medical colleagues were reluctant to escalate the rapid response to a higher tier when they were 'out of their depth' for fear of being viewed as clinically inept. Medical reluctance to seek expert support was particularly apparent at night where junior physicians feared incurring the wrath of more senior specialist staff if they perceived to have disturbed them unnecessarily.

RN: *"…but if you push and push (for escalation) they (junior physicians) will call them (Senior Specialists) eventually because we stand our ground… but if, as you say, we have a lot of junior staff (nurses) on, and you haven't got experienced shift leaders on, it's very difficult to get beyond that".*

Nurses also empathised with the anxiety and complexity that physicians must face when they are required to attend an RRS call.

RN: "*I'm sure it must be very hard for them too, going from unit to unit…If you were doing it all the time then I would have thought you would end up with good skills, but just doing it for a short period or as a fill in, it sounds as if it could be quite tricky".*

Concerns about junior nursing staff's abilities to perform critical roles in the RRS if they lacked the experience required to distinguish important and sometimes subtle clinical cues in the first (non-medical) Tier of the RRS.

RN: *"When you consider nurses' experience now [new graduates], they might have six months in palliative care and six months in rehab. and suddenly they are in another [acute]unit, that's no experience [to deal with some acute situations]. So, they don't feel confident with their decision making…experienced nurses have more confidence to call, a new nurse that has spent one rotation in Rehab. with knowledge of the system is one thing, but confidence in activating it is another.*"

Actions around system flexibility contribute to deviation from protocol

There was varied understanding amongst participants around altering RRS calling criteria, enabling individual patient's parameters to become more or less sensitive to RRS activation. Participants viewed that physicians were either inappropriately altering the criteria to prevent further RRS activation or were in contrast, reluctant to alter the criteria, thus contributing to unnecessary and excessive activation. Nurses dissatisfied with medical responses often repeatedly activated the RRS as a way of initiating further medical review. This behaviour invariably forced physicians to alter the RSS criteria to prevent ongoing calls.

> *RN: "We keep calling a [rapid response] until it resolves, or until the criteria gets changed ….keep calling it until they change it"*

Nurse participants shared their experiences in challenging physicians' decisions to alter RRS calling criteria to unsafe levels without appropriate patient assessment, particularly for those patients already attracting multiple calls. They labelled this a 'band-aid' approach, omitting appropriate escalation and further investigation into why the breaches were occurring.

> **RN:** *"There should be a criteria if there's multiple [RRS] calls that they are reviewed properly, not just continue on for 48 hours sitting at those [altered] levels".*

Patient safety was a concern for nurse participants, especially in relationship to junior physicians altering the RRS calling criteria. Despite protocol mandating changes can only be made by senior physicians (registrar level and above), junior physicians altered criteria at times; a strategy perceived to avoid registrar attention.

> **RN:** *"The only one who should change the RRS criteria is the Registrar, and that should be done in consultation with the team anyway. They [junior physicians] shouldn't just be doing that…."*

Also concerning to nurses was the enactment of alterations by physicians who were not medically familiar with patients with complex medical care needs. In many speciality areas, nurses perceived that the RRS physicians were operating outside their area of expertise and were therefore not cognisant of the specific care needs of some complex specialty patients. Not having time to review the patients' medical record before initiating changes to their treatment amplified these concerns. It was also perceived that medical records frequently lacked adequate detail, context and clarity to enable full, detailed assessments and management paths.

> **RN: "***I think it's unfair for clinicians who aren't familiar with the patient to have to make that decision in such a short period of time, and I think it's a lot of pressure".*

Misdistribution of resources leads to perceptions of inadequate staffing levels inhibiting full optimisation of the RRS

Introducing the RRS increased participant awareness of patient deterioration, but also generated a perception of further workload burden. Both nurses and physicians expressed concern that the RRS generated an increase in workloads, often without any additional resources to assist. Fewer staff working 'after-hours' meant that clinicians on these shifts may be less willing to enact the RRS or to deviate from established care plans.

Confusion over logistical response and over-attendance at RRS calls was reported. Such redundancies, perhaps relating to a knowledge deficit in protocol, reflect a waste of resources and frustration for some.

> **Junior physician:** *"…you don't need all of the medical staff at every [rapid response] a lot of the time the units are so busy, you spend a lot of time trying to get through them [tasks], then to put down what you are doing, then you go upstairs [to attend the call])…".*

Preference to avoid 'crying wolf' contributes to complacency in RRS

A portion of RRS calls are 'false positives', whereby the objective criteria are breached, but the patient is not actually deteriorating. This phenomenon has contributed to a level of complacency and doubt amongst some clinicians, as depicted in the excerpts below:

> **Junior physician:** *"…and you get to the next one and you think, oh I shouldn't rush this, you know, and I think it's a bit 'boy who cried wolf.' It's sort of [rapid response]*

after [rapid response] where you're not necessarily [needed] and you have another couple of flights of stairs, only to be sent away again"

Resource deprivation and nurse empathy undermine system

Nurse and physician participants attributed strained resources to senior physicians' inability to attend some Tier 2 RRS calls 'after-hours.'

RN: *"There is one [Registrar] in the whole hospital and there could be six [rapid response] calls at once, and how can they possibly get to six?...It worries me that they're so stretched, that they can't physically get there."*

As a result, nurses attempted to delay or avoid adding additional workload to already busy physicians.

RN: *"Often it's sort of 'well we need to stop having to call the doctor', 'cause the Dr looks like he's frustrated and annoyed, and the nurse doesn't want to call him, and that kind of undermines the system at times".*

This perceived pressure on human resources led to RNs feeling torn between protocol-mandated escalation and feeling responsible for creating extra workload for colleagues.

Poor communication and documentation increases clinician workloads

Participants suggested that inadequate communication, unclear or lack of documented nursing or medical management plans, and/or no record or clinical handover of a RRS impacted adversely on patient's subsequent care. Several participants reported that overnight RRS events were not discussed during handover/rounds because either RRS documentation was not prominently displayed in the medical records, or senior members of the patients admitting team were not aware that an RRS call had been initiated.

> **Junior physician:** *"They [night shift physicians] are generally meant to find the home teams in the morning and give them a rundown of what's happened...if that patient has been handed-over, you should probably prioritize them first, um but I don't see that always happening"*

Participants attributed the omission of these vital details to the limited time available to physicians to convey a large volume of information.

> **Moderator: "***so do you raise it? [the fact that the patient has had a rapid response call]*

> **Junior physician:** *"That would be fantastic for 1 in 30 patients, but it's hard on 4 hour rounds to keep saying 'what about this, what about this' when like you're flat out ordering, doing this, doing that. It's a gap…not much time to say what about this [rapid response] call here?"*

When it worked well, clinical handover involved routine team discussions of events, including RRS activations, and involved meetings between shifts, ensuring each team member had an understanding of relevant events and plans.

> **Junior physician:** "*The other really good thing is that the [rapid response] calls are handed over in the medical handover at five o'clock when we meet before the after-hours shift. That brings attention to the patients that are unwell, everyone's got it written down on a piece of paper, everyone kind of knows a little bit about the history of the patient which makes it easier."*

In some units, integrating RRS call details into unit rounds prioritised patient management for the day.

> **Junior physician:** "*…When you see them on the unit round in the morning, you look at their overnight events…like it's the first thing you do when you're assessing your patient… it's just your normal practice"*

This variability highlights diversity in practice despite working within the same systems.

Participants discussed how inadequate technological tools, such as information management systems, were contributing factors to communication barriers and variation in handover practices. They believed that establishing better ways of identifying patients who

received RRS calls or had calling criteria modified, would lead to better clinical handover and prioritisation of sicker patients on rounds. The following excerpt depicts one participant's description of sharing information as being reliant on clinician memory and note taking in the absence of appropriate electronic tools.

> **Junior Physician:** *"As far as I am aware, there is no formal list or computer-based system, [rather] it's a matter of people noting it down and taking a sticker [containing patient details] and presenting it at the handover. I think that works relatively well, it's not very formal."*

Although described as adequate by participants, this manual system of RRS had the potential to miss identifying priority patients and those needing monitoring more closely. Completion of documentation of altered criteria was on single, loose paper forms placed in the front of patient's bedside medical records alongside vital sign observation charts. Clinicians discussed how these forms have at times become misplaced or difficult to locate if not in the correct location every time, potentially resulting in unnecessary RRS due to poorly documented changes.

> **RN:** *"The altered [rapid response] calling criteria forms can get lost. If there was a better way of identifying patients who had an altered [rapid response call criteria]"*

RRS entries in the patient's medical record were sometimes overlooked as they 'blended' with other entries. Participants discussed using 'flags' in patients' medical records to ensure high visibility of RRS entries. The effect of poor, incomplete, misplaced or out-dated documentation around RRS deterioration and altered calling criteria disabled management plans, ultimately influencing other clinicians' workloads. These issues created greater obstacles for after-hours RNs and physicians who sought guidance from admitting medical team documentation. Responding to after-hours RRS calls for patients who had already breached criteria during the day was reportedly frustrating for physicians when appropriate alterations had not been undertaken in a timely manner.

> **Junior physician**: *"I'd just like to reiterate about getting the [admitting] team to actually make more management plans for the patient…I see the frustration on the regular night nurses' faces because we had to [rapid response] this patient again, oh and … again, and it's like why can't we do something about that?...I think it would be great for the team[s] to have a very clear [documented] plan about what they want for their patients during out-of-hours."*

The above excerpt reflects the need for routine review and detailed documentation of management plans. Failure to do so creates frustration and increased work for other clinicians with the potential to jeopardise patient safety. Both nurses and physicians commented on their regular workloads and responsibilities being sidelined to attend RRS calls.

> **Junior physician:** *"I have had situations when working a very busy shift where you have [rapid response] calls going off …where you are supposed to attend, where you don't get any of your work done that night, and then you hand over to the next people this huge list of which, really, you could have done because you really weren't needed at those things [rapid response]."*

The above excerpt illustrates the impact of poor documentation of patient management plans on the ability of subsequent clinicians to meet their workload demands.

5.5 Discussion

This study highlighted multiple factors influencing clinician's abilities to operate effectively within the RRS environment, from their own perspectives. Protocol deviation was evident to varying degrees by both disciplines, though as reported in the literature, it is not a unique observation that nurses are more likely to adhere to protocols than physicians,(32) perhaps a manifestation of their professional training and views of role and scope of practice. This reflected consistently with nurses seemingly having greater understanding of the RRS process than their medical colleagues.

The study, however, revealed potential reasons for the occurrence of some protocol deviation. The initial information given at commencement of employment pertaining to the RRSs structure and process was less likely to be retained by physicians than nurses. Though both disciplines received identical education, senior nurses and clinical nurse educators in the clinical setting were essential in ensuring embedment of RRS knowledge and operation within the nurse culture. In contrast, an absence of ongoing support, training and evaluation of physician's roles in the RRS was a key finding and influenced functioning within the RRS.

While a primary aim to involve and up-skill the patients' admitting teams, barriers pertaining to the study sites' model type were evident. Relying solely on admitting medical teams (and over-extended after-hours physicians) for primary tier medical response, at times, translated to an inconsistent and desultory RRS. Physicians, still in various stages of training, participate in these response roles for short periods, limiting both development into the role and establishing peer relationships with nurses from other clinical units. This inconsistent exposure was further complicated by a need to orientate large numbers of physicians into the responder role without support of a targeted, formal curriculum.

Existing literature discusses failures of RRS, (14, 33, 34) yet studies seem scarce on examining the direct effectiveness between a variety of efferent (response) limbs models, tending to generically conclude suitability should be based on individual healthcare facilities goals and resources.(14) While many options exist around composition and resourcing of rapid response teams, pros and cons are evident regardless of choice. ICU without walls(35, 36) is one concept that utilises the expertise of a trained critical care physician or team. Its small, targeted group make-up would enable easier training into rapid response roles. It would also lend to more consistent exposure to other acute areas of the hospital, theoretically supporting more effective peer relationship development outside the ICU. Similarly, MET's and ICU Nurse Liaison models(37) would have correlative benefits. While perhaps not encouraging the 'enabled' up skilling of non-critical care clinicians to the same degree as admitting team models, they do afford greater opportunity for consolidation of RRS skill and role development.

The admitting team model was not unsuccessful in identifying and managing deterioration, the study participants engaged the system, though model design did cause discord around

understanding and the perceived availability, functionality and efficiency of appropriately positioned resources. It was apparent the deployment of resources used in any RRS is a major factor when determining implementation and ongoing system success. Investigation into RRS team composition and resourcing(7) found that teams operated 24 hours a day, yet only 25% were funded, meaning resources were stripped from one area to service another. This no doubt causes extra burden on clinicians left to cover redundant positions during that time and can result in multiple forms of deviation of protocol as evidenced in this study.

There was discussion amongst participants around METs being a better option for the facility, who cited physician training, knowledge and workload as the main reasons for efficient processes. Rapid response team makeup is still contentious within the literature with some studies showing the importance of physician inclusion,(38) while others show beneficial results of nurse led ICU Liaison / critical care outreach.(37, 39)

The nursing unit team environment played an important role in support and ongoing re-enforcement of RRS utilisation. Additionally, two nurses noted the system's ability to provide statistical evidence of workload and patient acuity so as to potentially identify discrepancies between workforce supply and demand.

Physicians' experiences reflected managing multiple competing demands, learning at various institutions with differing systems, and accelerated advancement to team member roles within the RRS. These topics were of greater concern in the junior physician groups where most agreed. Unlike nurses, these physicians do not have large support teams with senior colleague (consultant level) and educator guidance. This appears to be repeated nationally(7) and is accentuated in situations of patient deterioration where consultant physician level guidance and support would be of most benefit. As many of these individuals

are training for specialties there are anxieties about competencies and further opportunities.(40, 41) This may have lent to situations of escalation avoidance witnessed by nurses, who believed physicians needed to be seen as being able to manage and were not comfortable with patients deteriorating 'under their watch'.

Efferent limb response demands more than just high-level skills in clinical assessment and management. Effective RRS implementation requires stronger development in responder role clarity and effective teamwork, yet there is often limited attention to this critical dynamic, both within the team and between peer relationships.(42) The rapid response physician is required to enter unknown situations, while often unfamiliar with the patient or specialty, communicate with colleagues from different disciplines, make clinical decisions, frequently change the management of what is seen as 'another team's patient' and take responsibility for the change. This responsibility imposes significant burden on physicians, many of who are relatively inexperienced. The study provides strong support for responder development of the non-technical clinical skills required to effectively perform within RRS roles; in particular, advanced communication, leadership, and teamwork being primary assets.

Future research should focus on investigating the impact and efficacy of differing RRS model types. Of particular interest, a focus on the impact of differing responders, their professional composition, level of seniority and area of origin on influencing optimal rescue of deteriorating patients. The impact each has on existing staffing and resources would also be invaluable in helping already overloaded clinicians cope with further demands of these and other imposed systems.

Ongoing development and evaluation of RRS team training is also required to ensure responding clinicians are confident and capable, not only with clinical skills, but also with ability to work in teams and effectively lead in what are, quite commonly, difficult circumstances for patients, families and fellow clinicians. Literature is still scant on the development of training specifically aimed at rapid response teams. Initial evidence from investigators such as Theilen et al.(43) show promising advantages in weekly multi-disciplinary simulation training, citing responder supportiveness and clinical, teamwork and communication skills as essential elements within the curricula. Large multi-centre studies to help support this evidence are required to ensure both simulation and training content are the most effective ways to train our rapid response teams.

Within the study site, improvements in technology are developing to aid clinicians with patient management. Electronic activation and documentation of RRS calls will prompt clinicians to better document patient clinical events and management plans while also allowing for integration of this information to other systems. Production of clinical handover alerts of these patients to proceeding shifts of clinicians for example, enables identification of patients most at risk, allowing for prioritization of rounding and closer observation. The advancement and increasing use of technologies such as these, continuous smart vital sign monitors with automated RRS activation, and technologies allowing patient bedside point of care recording, will all add to future tools for clinicians, assisting in patient deterioration prevention through swifter, more accessible and adaptable information. Add to this, increasing advancements in integrated health records allowing continuation of patient information between primary and acute health facilities.

5.6 Limitations

Generalisability of this study is limited due to the single site. Some participant demographics are absent as a result of participants not supplying all information. The self-report and recall nature of this study is a limitation, but the qualitative approach has allowed elucidation of critical, nuanced factors influencing system implementation and ongoing optimisation.

5.7 Conclusions

Study participants viewed the use of the RRS overall as an enabling tool for keeping patients safe, but also highlighted discrepancies and weaknesses exist in the system, particularly around choice and distribution of resourcing. The ways in which clinicians operated within this system was complex, multifactorial and non-standardised, sometimes with unintended consequences.

This study adds to an emerging body of data emphasising the importance of considering local, contextual factors, as well as model elements. (44) Workplace processes, cultural and professional factors and systems are important considerations in implementation of RRSs. Failing to consider teamwork, communication and inter-professional dynamics impede activation of critical elements of the RRS. The next chapter will discuss the significance of the findings from previous chapters to discuss existing knowledge with new insights found as part of this dissertation.

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Chapter 6 Data integration, synthesis and discussion

6.1 Introduction

As discussed in previous chapters, Rapid Response Systems (RRS) have been advocated as global best practice models, evolving to become the gold standard of care for early recognition and management of the deteriorating ward patient.(1, 2) More recent studies highlight the role of RRS in decreasing levels of cardiopulmonary arrest and in hospital mortality.(3, 4) Measuring the success of these systems has been difficult, in part due to implementation issues and the underestimated complexity of model workings when placed within the context of the greater healthcare environment.(5, 6)

This chapter discusses these complexities, synthesising information from the existing literature (Chapter 1 and 2), along with the building of additional knowledge gained through studies undertaken as part of this dissertation work (Chapters 4 and 5).

This chapter described the true contemporary state of the rapid response scene in the acute healthcare facility. Following commentary on key findings, it then elucidates further discussion through analysis of RRS processes, applying systems science and complexity theories to assist with explanations of RRS phenomena and behaviour findings within the study environment. This has allowed for the identification of both inhibitors and enablers of effective risk management strategies for the deteriorating acute ward patient. Optimal processes, used both historically and contemporaneously for assessing and managing these vulnerable patients in the acute care setting, were able to be identified and de-constructed for further exploration.

6.2 Summary of study findings

6.2.1. What are the optimal processes for assessing and managing the deteriorating patient in the acute care setting?

Though rapid response model and team make-up designs have undergone a process of evolution and diversity since inception,(2, 7-9) the absence of an overall consensus, or large collection of indisputable evidence demonstrating the superiority of one design over another is still non-existent. This study identified three commonly used model designs implemented across global healthcare settings for tracking patient's clinical status and initiation of rapid response. These three designs appear to have a 'monopoly' on rapid response global design culture, partly due to their widespread adoption by both state and national large-scale deteriorating patient programs. Early Warning Scores (EWS) have proven popular,(2, 10) requiring the addition of numerical scoring against both a set of patient vital sign criteria and, in addition, a list of early interventions required and applied to the patient such as the need for oxygen therapy. Recent studies have however shown that numerical calculation errors and scores attached to specific patient variables in EWS systems, may in fact be inaccurate when placed against a patients' acuity and clinical status.(11) Perhaps a less complicated strategy for some in prompting rapid response activation, lies with simple 'track and trigger' systems using colour coded zones on vital signs charts which highlight activation parameters.(7) These types of system designs do not require the numerical adding of scores. As with EWS, their popularity also sees this design utilised in large-scale systems such as the Between the Flags (BTF) program employed across the state of NSW, Australia. (7) The third type, one identified as being widely used in the Australian healthcare setting (12), is of a hybrid nature. Using concepts adopted from both aforementioned models, coloured vital sign chart zones are coupled with the addition of

numerical scores to activate specific tiers of the RRS.

All identified contemporary models regardless of design also incorporated subjective criteria.(2, 7, 10, 13) Subjective criteria enables RRS activation whenever clinicians, and more recently patients, families and careers, are concerned or worried about ongoing deterioration. This may be activated regardless of objective vital sign data readings. The current contention over the most effective efferent or responder limb of rapid response is also in a similar situation of disagreement, though much of the decision by providers around this seems to be heavily influenced by the availability of resources over that of ideology.(9) Regardless of model design, all are susceptible to external influence as systems operating in, and dependant upon other operationally linked systems within the healthcare environment. When placed within the contextual framework of this thesis, quantitative analysis demonstrated the inability of these systems in their current form to demonstrate sufficient flexibility to perform effectively at times of greater demand. The RRS was unstable in process and it's efficiency in able to perform it's intended function compromised when external factors occurred in parallel.

6.2.2. What are the optimal methods of process and outcome assessment of Rapid Response Systems (RRS) and Rapid Response Teams (RRT)?

Decision around measuring optimal RRS process and outcome assessment has managed relative success, with agreement on most elements of system requirements becoming structurally ingrained in the healthcare setting. This is in contrast to the still fluid nature of model and responder design elements of RRS themselves. Essential structural and operational components identified as necessary to ensure successful and holistic RRS implementation have been found in both scholarly literature and government documents.(14-16) The Australian Commission on Safety and Quality in Healthcare have

structured these essential elements in National Standard 9; Recognising and Responding to Clinical Deterioration in Acute Health Care.(16) Among best practice criteria within the standards are: good governance structures for implementation and maintenance of RRS; policy development; mechanisms for effective data collection and feedback; tools for monitoring and escalating; a system for responding to the patient; RRS awareness for both clinicians and patients, their families and carers and facilitation processes for advanced care planning. Development of the national standards framework has allowed RRS environments the assurance of encompassing essential domains for best practice implementation regardless of individual settings and resources. Placed again within the conceptual framework of systems science, missing elements continue to allow for the existence of insufficiencies around the larger systemic factors influencing the day to day operation of RRS, including its micro impact on each domain element. Analysis and reporting elements of the national standard for deteriorating patients also need to incorporate the operational effectiveness of rapid response in light of identified influencing system factors and aim toward addressing greater strategic action and planning to promote optimal functioning as a measure. While some components of this standard were previously not mandated, the standards are currently being updated and due for implementation in 2018, whereby all elements will become mandatory in order to achieve facility accreditation to practice.

Outcomes success of rapid response has heavily focused on the reduction of three main key performance measures: unplanned intensive care unit (ICU) admissions and rates of both in-hospital cardiopulmonary arrests and mortality.(4, 14) More in-depth discussion around both success and contention of these indicators is discussed within the patient section of this chapter.

6.2.3. What is the impact on organisation, system users and patient outcomes of a systematic process of risk assessment and identification in a single setting?

In contrast to contentious literature surrounding RRS, there is sufficient clinical evidence supporting positive outcomes of these strategies for early rescue to not dismiss their potential, or ongoing implementation.(3) Cardiopulmonary arrest and in-hospital mortality rates are now beginning to decrease in relation to early intervention through rapid response activation.(3, 4, 14) These results equate to obvious beneficial health outcomes for patients and their families. The cost savings of preventing cardiopulmonary arrests and associated post event care, including transfers to critical care environments and sequential increased length of stays (17) and/or re-admission rates are extremely substantial given contemporary financial stresses placed on our health institutions.(18) Preventing further clinical deterioration reduces the need for critical care transfers and the use of intensive and expensive 'reversal therapies'. Less demand on our critical care beds reduces impact on 'bed blockage', in itself is a costly barrier in high demand acute centres. The availability of these beds also assists with another healthcare crisis,(17) that of surgical wait list reduction. RRS have also empowered nurses to attract immediate medical assistance for patients in their care. With the advent of consumer activation, patients and their loved ones also now have greater consumer control over seeking medical escalation and increased input into directions of care through inclusion in medical management decision making.(19, 20) The fact to fill a void in care, that is the ability to effectively monitor patients to prevent deterioration developing. Rapid response systems, although effective to a degree, do not address causal systems issues at the foundation level. They do not for example allow for a change in clinician daily works that will bring greater nurse surveillance, increased assessment or time spent with patients to prevent the need for rescue and intervention

programs such RRS.

The impact of RRS on clinicians is reported as twofold. Clinicians were found to value the worth of RRS in being able to detect and escalate the care of potentially deteriorating patient.(21-23) However, they often struggled to perform daily works within the rapid response environment.(24, 25) Inadequate or ineffective implementation strategies played a major role in how effectively clinicians perceived they could operate within these systems. System design, education, provider support and perceptions of inadequate staffing and other resources,(24) especially 'out of hours' when these essential elements were even more restricted, were among the identified and reported causal factors. Conceptualising these findings within the confines of organisational theory, it becomes apparent that the misalignment of clinicians work environments, availability of resources both real and perceived and the inflexibility of RRS to adapt to times of greater demand lends to deviation from RRS policy structures.

6.2.4. What are the system, provider and patient factors that inhibit or enable risk management strategies for the deteriorating patient?

The origins of rapid response complexities presented themselves in many ways throughout the study. Elements of system inflexibility assisted in facilitating deviation from protocol, with clinicians developing their own way of making the system work within the confines of daily workloads and resourcing.(24) This inflexibility extended into the organisational structure as a whole. Already established, this study highlighted the ability of other external systems to influence RRS remaining in or out of intended functional control. Without a more flexible RRS that is able to adapt and change during periods where other systems are known to have most influence over it, or alternatively, allowing for change within these external system forces to ensure RRS can remain in control at times of influencing activity, RRS will

continue to fall short of optimal function. Poor communication of RRS events increased clinician workloads as medical management plans for patients were said to be frequently unclear, or ineffectively communicated by either verbal or documented means. Established cultures of calling were enablers to RRS utilisation.(24) Nurses often pushed activation on behalf of patients, with advocacy and concern for physical deterioration being reported facilitators.(24) Patients (consumers) have the greatest vested interest in ensuring these safety systems work effectively. As previously mentioned, the introduction of patient/family/carer activation has empowered these consumers by allowing them to have an active role within the RRS itself, enabling escalation of care past first line ward level clinicians. Inhibitors of consumer activation also need to be considered. Consumer awareness of the system, it's ease of activation and other associated barriers of language, illiteracy and satisfaction of responder interventions all need to be approached before successful implementation can take place. Although still at rudimentary stages, consumer activation has potential to increase further demand on existing RRS resources causing more strain on the system. Again, if the RRS is not considered within the overall organisational context it's continued expansion and use will see an inability to perform and negative feedback loops will occur whereby use of the system will ultimately result in its failing to effectively function. Working within this context, clinicians will continue to deviate from intended procedural roles in order to ensure a way of making patients safe, bypassing formal RRS channels.

Failing to activate the RRS can risk patient safety and lead to adverse health outcomes. Factors required to enable effective and optimal RRS function from a provider perspective include ongoing training and evaluation of roles, prioritisation of inter-professional

education and teams to increase understanding of the unique role and contribution of professional groups to the clinical encounters.

6.3 Clinical Environment

The contemporary healthcare environment is one of evolving change and constant contradiction, where both the RRS and clinicians working within this context are expected to operate efficiently. Some workplace characteristics such as technologies, treatments and medicines can progress at exceedingly rapid rates, while other larger systemic aspects such as operational and infrastructure components, may at times struggle to maintain pace and equilibrium. Adding to these turbulent settings, clinicians face increasing patient populations requiring cares and treatments, more acute and unwell than ever before, they are now living longer with accompanying greater incidence of co-morbidities and acute care requirements.(26) In the past, many of these patients would have been placed in critical care environments, enabling both greater access to medical officers, increased nurse-to-patient ratios and ongoing assessment. It has become contemporary practice to now accommodate many of these patients within the environments of the general wards, creating issues around clinician ability to maintain adequate monitoring and vigilance. Evidence demonstrates a strong correlation between the impact of nurse staff levels and patient outcomes.(27) It has been reported in the literature that there is a strong correlation between an increase of nurse rationing with greater frequencies of nurse-reported adverse patient outcomes.(27)

Modern healthcare settings also operate within ever constricting budgetary controls, often leaving clinicians short of optimal resourcing required to meet these intensifying demands.(28) Increasing legal and consumer accountability of healthcare institutions, has

also led to substantiated clinician focus away from direct bedside care. To further elucidate, formal demonstration of many skills, patient care duties and clinical knowledge are now increasingly required, most often with additional imposed systems of assessment that are not always delivered in the most conducive way for adult learning, or workplace efficiencies for those working in pressure driven, busy clinical environments.(29) To illustrate, on any given shift in a NSW public hospital, a ward nurse with a clinical loading of four to five patients, is not only required to perform traditional bedside care, but to also record for evidence, many facets of this care either manually or electronically. This can include, but not limited to: admission and discharge work; hourly rounding; transferring and escorting to theatres; diagnostics; clinics and other wards; falls risk and pressure/wound assessments; allied health referrals; multiple clinical handovers/ward rounds; and rapid response assessments when breaches in vital sign parameters occur. If these systems developed for recording and monitoring these events are not designed with human factors in mind, or ergonomically sound, valuable time is re-directed away from the patient. In the state of NSW, there is additionally a minimum of 28 mandatory requirements nurses must fulfil for practice.(30) These factors, inclusive of 'proof of care' and general routine happenings takes time away from the bedside, reducing vigilance and ability to detect deterioration.

RRS implementation has been applied to these turbulent settings, a reactionary measure, that in part, has only become necessary as a result of failings in the healthcare system as a whole to maintain stride with adequate resourcing and efficiencies at the grass roots level in line with changing patient and financial demands. Despite this, it would be dismissive and perhaps short-sighted to underplay RRS programs as just a 'band aid' to the real issues that plague contemporary acute care settings. The state of rapid healthcare change has meant that these initiatives have actually been life-saving for many.

This current state of play has however meant RRS have been placed in a vulnerable position, with daily struggles in attempting success. In addition to the identified demands placed upon modern day clinicians working within the rapid response environment, the Chapter 4 study found that administrative changes such as medical officer rotations, beginning clinicians and changes to policy all impact on RRS stability.(31) This also supports in part, evidence from the literature finding it difficult to demonstrate optimal levels of RRS performance. Root cause incident analysis, along with government reports have all identified to varying degrees, failures in the healthcare system to detect early deterioration of ward patients under their direct care in acute care health settings.(32-34) RRS were created to fill this void in care, their sole purpose to provide a niche system, tools and conduit with which to enable early rescue of this vulnerable patient group.(33, 35)

6.4 System

Rapid response systems as a model of care have an historical evolutionary timeframe of over 25 years since first inception.(36) Their proliferation and dominating transition into the acute care health setting has occurred despite contentious research findings.(35, 37) The very foundation study of medical emergency teams itself found no improvement in any of its aims, reducing unplanned intensive care unit admissions, unexpected cardiopulmonary arrests and deaths.(35) In 2007, a systematic review was in support of these findings, with study evidence unable to conclude RRS were effective interventions for preventing any of the aforementioned measures.(38) Implementing large scale systems regardless of best practice evidence is unique in the context of healthcare where uptake and acceptance, especially with such a widespread model of care, is not usual without a robust and definitive evidence base. Much of the criticism within the literature has been attributed to large

variation in study design methods and analysis.(38) Increased collaboration is needed to bring greater levels of standardisation to research for better comparative analysis and results.

Rapid response systems have nonetheless been adopted and supported for their capability to save lives,(3) with recognition and implementation driven from government and professional bodies alike.(2, 7, 39) At study commencement, it was anticipated that strong robust systems would be found to be in place across healthcare settings. Initially aware that some discrepancies existed around several components of RRS process, the level to which these system 'vulnerabilities' presented was unexpected. Their complexity is a woven system that is both intricate and delicate and one easily agitated and vulnerable to outside systems influence. The RRS was found to often function in an environment where planned resourcing was not always adequately supportive (17, 24) and with the degree to which it could achieve successful daily operation largely influenced by many forces.(40) These forces were both internal and external, most competing with, and impacting the stability of the RRS itself.(40)

Some findings from the single case study can also be said to be representative of the larger healthcare scene, suggesting that despite RRS design differences, many of the same issues present themselves within the overall healthcare environment. Similar themes found in other studies with commonality to the case study include the distribution of system resources, both perceived and real,(9) as well as cultural and communication barriers. Overall, these imperative systems, at the very foundation of patient care and safety, continue to have both initial and ongoing implementation and support issues.(14, 24) As with all imposed systems, rapid response requires compliance in order to be effective. This

is often an expectation within the acute healthcare environment without fully addressing implementation process concerns, consideration of strong local governance, infrastructure support, workplace culture and resourcing. Many of these concerns have been demonstrated as being present within this study. While the majority of RRS analysis work has focused on both afferent and efferent system limbs,(41) insufficient in-depth examination around daily influences impacting both system use and application appear to still exist.(4, 14) This need has been identified as far back as 2007 when recommendations from a systematic review by McGaughey et al. (37) pointed to the need to more closely examine, identify and explain the complex processes and mechanisms within a hospital that support or hinder the change process in managing deteriorating patients. Despite this, RRS research continues to heavily weigh on patient outcome data.

Demonstrated evidence of effective RRS performance is now a component in acquiring accreditation to practice in all Australian acute healthcare facilities.(16) As demonstrated throughout this study, RRS have not yet been able to reach full operational potential, by this, it is meant that patients are still 'slipping through the net', evidenced by continuing episodes of adverse clinical events related to deterioration.(32) This ongoing 'failure to rescue' has left stakeholders and administrators in need of a greater understanding of rapid response workings.

The quantitative work undertaken in Chapter 4 aimed to determine factors that are capable of impacting on the normal day to day function of the RRS. When mapped against a timeline of known administrative changes to the RRS, correlation with deviation from normal system operation occurred. Results showed vulnerability in the system when these changes to system dynamics were made. Not only observed to become out of control on eight

occasions when mapped against ten known operational changes within the study (changes in policy/procedure, RRS operational changes and increased system use during a pandemic), but more alarmingly, to a large number of influences of unknown nature not identified within the study's variable set. These unknown influences caused the RRS to deviate from normal control on 59 occasions for just the three study wards alone over the seven-year data period. This finding further suggests that the RRS is an extremely vulnerable system, requiring little influence to push it into a 'brink of chaos'.

Based on these observations, it could be concluded that under general everyday circumstances, times where higher patient acuity exists on individual wards requiring greater system activation, RRS resources would be routinely stretched to maximum. Typically, occurrences of out of control may not be recognised unless specific mapping of hospital acuity to incidence of deteriorating patients on a shift to shift basis can occur. These are not considerations within the literature with any study reporting an RRS model allowing for 'flexing' up or down of resourcing at times of higher or lower patient demand. Looking further into why systems overload and find it difficult to maintain control, study findings were matched against systems science to assist with possible deviation rationale. The work of systems scientist Michael Jackson (42) explains theory dynamics within systems. Within complex systems such as rapid response, there are a multitude of variables that cause feedback loops that interact back into the system. These "systemic interrelationships between feedback loops constitute the structure of the system, and it is this structure that is the prime determinant of system behaviour".(42)

Since initial RRS inception at the study site, the number of calls had increased over time as clinicians became accustomed to the system and also recognised it's worth in early

prevention of deterioration.(24) Relative to systems theory, this trust and use in the system could also be the likely cause of loss of control, especially when resources are not adequate to meet peak demands. It is possible that increasing use of the RRS without appropriate planning can therefore itself be detrimental to the system. This relates well to the study, where periods of increased RRS demand and reduced resources (after hours staffing) occurred and contributed to system failure. It appears that if systems can work well, as it appears most RRS do, (initial start-up, resourcing and cultural issues aside) then the uptake, acceptance and use by clinicians (a positive feedback loop) also places greater demand and pressure on the system. Jackson explains that "at this point, this pressure may become too great and quality suffer … A linked negative feedback loop has come into being, which counteracts the original growth loops".(42)

The interaction between these feedback loops brings about system structure, this then leads to a systems inability to sustain itself. Not only was this seen in the quantitative study in Chapter 5, but also relates to clinicians experiences with struggling to operate within the 'formal' system of the Chapter 4 study.(24)

6.5 Resources

RRS, for the most part, are reported as being under-funded and under resourced,(9) yet highly regarded as important 'must haves' by administrators and recommended in clinical practice guidelines.(2, 16, 33) This under-resourcing was both perceived (24) and real,(9) impacting on clinicians abilities to function effectively in RRS environments. Not only limited to the study site, it has been reported as being widespread both nationally and internationally.(9) Lack of resourcing has a clear link to the availability of funding in costly healthcare environments. In a study conducted over both Australia and New Zealand (9)

only 25.7% of the 39 healthcare sites studied had been able to secure additional funding to run their RRS, yet all were expected to operate 24 hours a day, seven days a week. This meant clinicians were generally required to fulfil more than one role if also allocated responsibilities to a rapid response role.

If RRS are to truly be given the credit they are said to be able to provide by identifying the deteriorating patient early and preventing adverse events, administrators need to re-direct attention and funding away from vast amounts invested in both the training of staff and equipment for cardiopulmonary arrest management and cypher this into resourcing of preventative models such as RRS. Conclusive evidence demonstrates the impact of reduced resourcing has on RRS effectiveness including deviation form policy by clinicians as a result of 'bypassing' a system that is often seen as containing barriers to attract help. Reduced staff and resources after hours, cultures of calling and miscommunication appear repeatedly in the literature. These will be discussed further in the provider section of this chapter.

Increasing resourcing for RRS is the only avenue for easing pressure on the system and reducing incidence of 'out of control'. Resource conservation is a way of reducing the need for system use through unnecessary activation of rapid response calls. Clinicians themselves play the most important role in processes already available, but not necessarily well utilised.

Modifying rapid response calling criteria when possible, better patient end of life engagement and more effective communication between clinicians around clinical handovers and medical management plans will all reduce the need for system activation. These factors are also discussed further in both provider and patient sections of this Chapter.

Without a more rigorous understanding of how these processes and specific variables influence systemic, operational and cultural aspects of rapid response, they will continue to perform outside of ideal efficiency. Knowledge of analogous considerations will reduce facilitated continuation of enablers impacting patient safety and an ongoing production of contentious literature trends. In turn, reduction of continuing and conflicting findings for researchers attempting RRS analysis, model and implementation indecision for administrators and inefficiencies in work practices for clinicians may be possible.

6.6 Provider

System instability flows further on to the clinical floor, impacting clinicians and how they orchestrate provided care for patients within this volatile system. The qualitative study undertaken in Chapter 5 identified how clinicians implemented rapid response within daily practice. A process of informal communication and negotiation was used in spite of standardised protocols being in place. Several system and organisational-level barriers, such as heavy workload and again, perceived misdistribution of resourcing were discussed by participants as pretext to decisions to deviate from protocol. The line between system and provider issues was blurred on many occasions throughout the study. Described under the clinical environment section of this chapter, clinicians reported struggling to maintain clinical cares within the environments they now work in.

6.7 Reducing RRS demand

Perceived system inflexibility presented as a theme across the study spectrum. Already highlighted, RRS do not currently support a capability of increasing additional resourcing during times of greater demand. The impact of this shortfall gains weight as clinicians begin to deviate from normal practice in an attempt to work around the formalised system in a

manner than enables it to work for them. However, connecting clinician demand on resources and time, unveiled vexing issues around full comprehension of the use of alteration/modification of RRS calling criteria and associated practices, often leading to the creation of greater stress on the system. Although literature is scarce on analysis of clinical decision making of physicians in modifying set RRS calling criteria, the study undertaken in chapter 5 elucidates several reasons this is not done effectively. Time limitations when undertaking daytime specialty team rounding often meant rapid response breaches were not always discussed, or thought priority at this important and opportune time of information dissemination and exchange. Without attention to rapid response activity and subsequent management plans to address patient issues, criteria breaches often reoccurred, frequently at times when resourcing was less able to cope with demand such as 'after hours' when reduced staffing levels are implemented. Not only did this create unnecessary activation of the system from modifications to calling criteria not already made, or medical management plans not instituted to correct these parameters, but it also led a trail to two further issues, both stemming from workplace cultures. Firstly, modifications were not always made by after-hours physicians either for fear of 'treading on the toes' of their colleagues by what was sometimes seen as intruding on the management of another teams' patient, often not always within the boundaries of their own specialty knowledge. Consequently, this led to continued system activation. Opposing this, there were reported occasions during the study when calling criteria was changed too hastily. This was perceived to have occurred because physicians (especially those with more junior skills and knowledge), were not seen to be always completely aware of the significance of deterioration in some specialty patient groups. Another reason identified around inappropriate modification was to avoid attracting attention. Physicians felt that when their

patients attracted rapid response calls, they were then personally perceived as providing inappropriate care by allowing patients to deteriorate ‘under their watch’. Large scale multi-site studies are required to obtain further enquiry into this important aspect of the RRS, designed to lessen the frequency of calls required, but overtly underutilised and affected by historical medical culture idealisms.

Poor or miscommunication has been widely documented as a cause of adverse clinical events.(43) Chapter 5 highlights the effect of poor, incomplete, misplaced or out-dated documentation around RRS, medical management plans, deterioration and altered calling criteria, all ultimately influencing other clinicians’ workloads. These issues created greater obstacles for after-hours RNs and physicians who sought guidance from admitting medical team documentation. Responding to after-hours RRS calls for patients who had already breached criteria during the day was reportedly frustrating for physicians when appropriate alterations had not been undertaken in a timely manner. These same study participants also commented on the benefits of when handover and communication went well, they had a better awareness of who the most ‘at risk’ patients were and more informative direction if further deterioration occurred.

Providing better planning of advance care directives and end of life care is perhaps the most expeditious, significant and cost and resource effective intervention that could be employed to ease burden on the RRS.(44, 45) Trends are beginning to focus on reducing the frequency of unnecessary rapid response calls. Generally, physicians are not yet comfortable in initiating these discussions with healthcare consumers.(20, 46) When a patient experiences an adverse clinical event or sudden irreversible deterioration, the role of delivering this conversation is often left up to the responders of rapid response. Initiation of these plans by

admitting medical teams as a routine in prospective care, will again reduce rapid response initiation through poor medical planning and ease system burden.

6.8 Education and mentoring

The outcomes of educating clinicians on RRS varied by profession.(24) The importance of mentoring played a major role in clinicians ability to both retain and implement knowledge of rapid response. In the qualitative study undertaken in Chapter 5, nurses were found to be both able to retain knowledge on RRS workings and better supported to enact the system. Once arriving on the clinical floor for the first time, they were supported by educators and mentors and placed with team environments where support to call raid response came from senior nurse leaders. In contrast, junior medical officers were often left alone on the clinical floor without the retention of initial RRS knowledge reported to be influenced by excessive information upon facility orientation and the absence of constant mentoring of senior medics. Feeling vulnerable and out of depth, they often found deviation from RRS protocol more appealing to achieve patient outcome goals. This deficiency in strong mentoring and team dynamics for junior medical officers on the clinical floor needs focus.

As mentioned, to date there is no 'best practice model' identified for RRS and teams. Shortfalls in the admitting/ward sourced team model chosen for in depth study were however evident, assisting clinician decisions to operate outside of formal practice guidelines. Due to the nature of rotating shift work, primary responders to rapid response (registrars) in the chosen model were sporadically placed into these roles for short periods of time and at irregular intervals meaning expectations for ability and continuity to gain and maintain skills were impractical. The existence of a dedicated rapid response team model alleviates this issue, maintaining that it could be the best solution at present, providing

skilled clinicians that have opportunity to build and maintain constant skills in this area. This continued experience would also allow for growth and evolutionary change as they experience and encounter systematic inhibitors to effectiveness.

6.9 Patient

Though initial RRS research found it difficult to demonstrate any real success with patient outcomes study data,(35, 38) more favourable results in all key performance areas, including cardiopulmonary arrest and mortality data,(4) are becoming more frequent. The Clinical Excellence Commission has reported a demonstrated 35% reduction in cardiac arrest rates across the state of NSW, Australia (3) within acute public health facilities since inception of the BTF program in 2010. This report (3) also indicated a consistent rise in the number of rapid response activations over the same time period, indicating that early recognition and intervention from RRS activation is a successful strategy.

Many studies have chosen to report rapid response performance through reductions in mortality rates.(14) The results of in-hospital mortality data is still however surrounded by contention. Trial methodologies and data analysis have been profuse amongst studies making comparisons difficult and leaving systematic reviews without absolute outcomes. This is a result of the identity of two prominent factors. The first is heterogeneity of mortality study designs. Winters et al.'s (38) systematic review undertaken in 2007 were the first to report on this weakness, concluding that it greatly limits the quality of studies. Wide confidence intervals between the heterogeneity of studies limited ability of their effectiveness in identifying mortality reduction. This was reported again in 2010 with another systematic review by Chan et al. (47) identifying that robustness of these studies was still lacking. For mortality data to be useful as a preferred rapid response outcome

indicator, an agreed standard of methodological rigor for trials allowing sufficient comparison of performance data are required to be put in place.

The second factor surrounding mortality contention may need even greater consideration. This argument puts forward that mortality is perhaps not the most appropriate measure with which to analyse the effectiveness of RRS.(48) Mortality has the tendency to depend more upon the nature of the patients underlying clinical state at the time, the existence of co-morbidities and type of interventions they receive, rather than being a measure of hospital safety and effectiveness of rapid response systems. Received interventions are of paramount consideration, for instance, taking into account that not all facilities have access to the same treatments, gold standard and critical care resources, this may impact on patient outcomes. These factors should be taken into consideration in mortality data analysis in order to determine its appropriateness for use, rather than being solely reported as a 'raw' reflection of rapid response outcomes.

As demonstrated, RRS do however now have a proven track record of showing reductions the incidence of in hospital cardiopulmonary arrests.(3, 4) This may be the most appropriate indicator to use to highlight their success and importance. Measuring RRS outcomes success should perhaps then look firstly at the immediate impact of rescuing early, thereby averting cardiopulmonary arrest situations. From there, more extensive regimens need to be examined separately for longer term outcomes.

6.10 Consumer empowerment

Perhaps one of the biggest revolutionary change made to the RRS since its inception is the advent of consumer empowerment.(16, 20) Over recent years there has been a definitive push for patient, relatives or carers ability to be able to self-escalate care if they are

experiencing increased or continued clinical deterioration. Stemming from coronial and commissioned enquires,(49) unrecognised or untreated deterioration by clinicians occurred despite communicated concerns from patients and relatives. Resulting from these events, consumer avenues of escalation are now mandated across Australia as part of healthcare facility accreditation standards.(16) Too early in the adoption phase for large analytical data supporting this transition to consumer empowerment, international literature reports appropriate use of these avenues by patients and relatives for escalating deterioration.(50, 51)

Rapid response systems have also seen a greater awareness of the need for more focused attention on improving patient advanced care directives and end of life decision making. As mentioned previously, not only does this empower consumers to have a voice and control of their direction and limitations of medical management, but it also reduces the need for unnecessary rapid response initiation and burden on the system. Advanced assessment of patients entering the acute healthcare environment, including overall prognosis and the likelihood of recovery, presents itself as an ideal time point to consider end-of-life issues more closely for certain patient groups.(52) The screening of all admitted patients and discussions initiated around their wishes and treatment expectations is not routinely done as the medical model is still concerned with ‘cure over care’, clinicians simply do not like to see their patients experience adverse events or death. Admitting medical teams are still for the most part, reluctant to have these conversations with their patients.(20, 46)

This is an important aspect of healthcare that requires priority and action, not only would it ease the use of many systems, preserving resources and costs, but more importantly, it

would create precedence consumer satisfaction through patients full control over wishes and expectations should deterioration occur.

Overall, RRS have provided patients with early detection and treatment of deterioration, less risk of experiencing a cardiopulmonary arrest and greater engagement and empowerment to both escalate care and more readily engage clinicians in discussions around advance care and end of life planning.

6.11 Strengths and Limitations

The strengths of this study are that it provided new insight into the operability of an RRS and the ways in which clinician's daily work is impacted by systems designed to detect and manage early deterioration. This study has demonstrated that clinicians value the RRS as a tool to avoid adverse events but also training and resourcing to help make these systems workable is often lacking. Despite this resource shortfall, clinicians often practice outside of formal protocol in order to support each other and maintain the system in a way that it works for them. Although a limitation of the study that it is single centre, wider literature suggests that many of the issues identified are ubiquitous.(33) Another strength of this study has been the application of a mixed method approach where qualitative and quantitative data have been used in a complimentary manner to address study questions. Moreover, this study has illustrated that RRS exist within the complex health care ecosystem with multiple competing priorities.(53)

6.12 Conclusion

This study has demonstrated the importance workplace processes, cultural and professional factors and systems in RRS implementation. Teamwork, communication and inter-professional dynamics are paramount and when not present, impede activation of critical

elements of the RRS. Ongoing education and clinical support is essential, especially for medical officers who are often left to work independently, with insufficient mentoring and support in the clinical environment. The RRS is potentially unstable in process and easily falls out of control leaving resource poor clinicians struggling to work within the system. Several factors have been identified that are not routinely measured for their negative impact, including patient acuity and team model and make-up. Moreover, this study has clearly demonstrated that cultural, organisational and technical factors Improvements in RRS should consider the complex interactions that occur within this system as well as workload and staffing issues. The following chapter summarises key findings and addresses the implications for policy, practice, education and research.

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Chapter 7 Implications for development of Rapid Response Systems

7.1 Introduction

Internationally, health care systems are being held accountable for the outcomes of hospitalized patients. Lavoie and colleagues define a deteriorating patient as "*an evolving, predictable and symptomatic process of worsening physiology towards critical illness*".(1) Rapid Response Systems (RRS) have evolved over the past 25 years to enable early detection and management of the deteriorating patient in non-critical care units. The premise of these models is that patient deterioration in the hospital ward is generally preceded by several hours of altered physiological processes, as measured by the patient's vital signs. Rapid response systems are built around trigger or calling criteria, which are typically significant deviations in vital signs and other measurements made in all patients. These triggers, such as hypotension and tachycardia, are common antecedents to adverse events. Breaches of patient parameters set to these criteria lead to activation of a team with specified skills, knowledge and experience. Despite the wide spread adoption of RRS there is a vast heterogeneity in models including workforce composition, initiation criteria as well as variability in patient outcomes.(2) Some studies are now beginning to show the benefits of RRS in helping to prevent unplanned intensive care unit admissions, with major reductions in unexpected cardiopulmonary arrests and deaths.(3-5) There is also some evidence to suggest that the improvement in team work can have organizational effects beyond the RRS. The previous chapter discussed the complexities of Rapid Response Systems (RRS), synthesising information from the extant literature, along with the building of additional knowledge gained through studies undertaken as part of this dissertation work. This chapter summarises the implications for policy, practice, education and research. Some of this

content has been published in an editorial in the *Journal of Nursing Management* (Appendix 8

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7.2 Rapid Response Systems exist with a complex health environment and health ecosystem

The International Society of Rapid Response Systems identifies that optimally a RRS has the following components: an *afferent component* to ensure timely escalation of the deteriorating patient involving agreed physiological values as triggers; an *efferent component* with an individual or team of clinicians who can promptly respond to trigger; *governance and administrative structures* to oversee and organise the RRS; and *analytic mechanisms* to undertake quality improvement activities to improve processes of care and monitor patient outcomes.(6)

The variability in outcomes across clinical studies and implementation issues in the clinical environment are likely attributable to the failure to recognize that RRS exist within a complex environment and are multidimensional, involving patient, provider and healthcare system elements.(7) RRS models involve a complex interplay of reliable and valid initiation criteria, system activation and action, all occurring within complex organizational structures and inter-professional practice models. Considering patient and provider issues within the RRS environment as below is becoming increasingly important.

7.3 Patients

Patients in acute care organizations are commonly older and presenting with multiple and more complex conditions.(8) Increasing the role of patients and families in shared decision making can increase clarity of treatment goals.(9) This decision making is now extending to

their ability to engage the RRS through the power to activate calls themselves.(10, 11) Though recognized as an essential component of any contemporary RRS, again, implementation issues unless considered thoroughly, can plague the system. Patient and family awareness campaigns of the system must be widespread and diverse in nature. Presenting patients solely with information brochures or pamphlets when they may be physiologically and/or mentally distressed is not an optimal process of delivery. Patient information is often disseminated via this media, yet studies show that not all patients read, or understand this type of presented information.(12, 13) Information delivered via this method has additional obstacles including language barriers and lack consideration that some patients may be illiterate or vision impaired. Patients and families would better benefit from more varied and large-scale awareness campaigns utilizing multiple media modalities. In addition to diverse language pamphlets and posters, the use of hospital television channels and verbal information given by clinicians (14) to both patients and their families/carers upon ward arrival would allow more diverse knowledge dissemination. The importance of regular patient and relative/carer feedback surveys eliciting knowledge of self-initiated rapid response is also paramount to ensure information processes are appropriate and viable.

The continuation, development and implementation of multidisciplinary bedside ward rounds involving patients and their families/carers in planning of care discussions will also facilitate this process.(9) Involving consumers in the decision making process has reported benefits in detecting early deterioration where signs/symptoms may not be recognized by clinicians, but identified by consumers knowledge of 'the norm' of either themselves or their relatives.(15) Joosten et al. (16)also reported benefits of reaching agreeance with and

better adherence to treatments, along with increased patient satisfaction, well-being, and quality of life.

In addition, other factors impacting on RRS usage such as initiation of discussions around, and implementation of advanced care plan directives and resuscitation status can also be improved.

7.4 Providers

Communication barriers between healthcare professionals can lead to ambiguity in care, particularly around factors identified within this study including the quantity, and more importantly extensiveness of information disseminated via documentation of medical management plans. This often leaves clinicians unsure of escalation and intervention options for the patient at risk of deterioration. Again, without reference to strong management guidelines, the RRS is susceptible to misuse through factors such as the continuation of unnecessary calls, or opposingly, failures in initiating the system.

Failure to escalate was attributable to multiple reasons including lack of clinical knowledge and recognition of trends, hierarchical communication patterns, fear of retribution and an absence of defined systems.(17, 18) RRS are also susceptible to outside influence such as other operational functionalities including rotations of medical officers into new specialties(19) where unfamiliarity with certain patient groups may hinder identification of early detection of deterioration. Evolutionary changes to RRS policy, procedure and the model itself may also generate clinician confusion and uncertainty.(17) Education of clinicians, and again, patients and relatives/carers around speaking up, with easy options and avenues for clinical escalation essential for engagement. Importantly, ensuring role

clarity among health care professionals (20) and engagement in continuous quality improvement is critical in the development of the RRS.(21, 22)

7.5 System

Increasingly, the importance of culture and organizational systems are being recognized as crucial for promoting both the safety and quality of health care.(23) Implementation science is the study of how evidence based practices are adopted into clinical practice and policy.(24) Application of identified requirements for optimal RRS (17, 19, 25, 26) are now coming to light and clinical application is essential in ensuring quality improvement and effective ongoing implementation strategies for these systems. Understanding the barriers and facilitators to implementing RRS is crucial.(27, 28) Ensuring role clarification,(29) education (30) and support for clinicians working within RRS can improve patient outcomes.(29) Increasing capacity to provide more supportive mentoring of junior medical staff while working clinically on wards is required help to build skill levels, knowledge and support of patient deterioration, management and escalation.(17, 31) This may require a greater presence in our hospital wards of senior consulting medical officers. Patients admitted to general wards of contemporary Australian public hospitals are predominantly attended shift long by registrar level medical officers as the most senior medics. The emergence of newly appointed roles such as hospitalists may fill this essential gap in junior medical officer mentoring whilst on the clinical floor.(31, 32)

The RRS while flexible to some degree within the afferent arm of system design, where activation parameters are able to be modified to suit individual patients and circumstances, the systems efferent arm is more uncompromising. While promotion and quality are drawn to RRS as gold standard preventative models, most are inadequately resourced. Siphoning

of resources continues to focus on advanced life support training and equipment in contrast to literary evidence that cardiopulmonary arrests are reduced with effective RRS implementation. Efferent (responder) arms do not currently have the ability to 'flex up' with increased resourcing during periods of higher demand. Without this capacity, this leaves administrators and providers with the current strategies identified within this study employable to reduce RRS usage; reducing cultural barriers to use of modifying calling criteria parameters, improved administrative awareness of factors than increase RRS call rates such as mass medical rotations and times of increased patient acuity, better communication around medical management plans and advanced care planning and end of life decision making.

7.6 Conclusion

The complexity of health care is growing and the need to implement systems to safeguard patients is increasing. Many local practice and cultural factors likely influence the efficacy of the RRS. The nurses role is crucial in any model of RRS in both the afferent and efferent limb. Instituting more robust strategies for data collection and exploring person –centered models are important strategies for future development. The studies in this thesis underscore the importance of taking a broader socio-ecological approach to health care system design considering the influence of patient, provider and system issues. Embracing theoretical perspectives related to systems theory are likely as important as recognising pathophysiological processes in the care of the deteriorating patient and promotion of the RRS. Engaging theoretical and conceptual elements of implementation science have the capacity to take the principles of the RRS and tailor and target them to organizational characteristics.

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Appendix 1 Participant information and consent forms

St. Vincent's Hospital

Participant Information Sheet and Consent Form
Non-interventional Research

Title	**Risk Management of the Deteriorating patient in the Acute Care Setting**
Short Title	**RACS Study**
Principal Investigator	**John Rihari-Thomas**
Site	**St. Vincent's Hospital, Sydney**
Protocol	**RACS study Version 1. 2012**

Part I – What does my participation in the study involve?

1 Introduction[1]

You are invited to take part in a research study looking into risk management of the deteriorating patient in the acute care setting which will assist with deeper enquiry into, and the identification of systematic failures in the Patient with Acute Condition for Escalation (PACE) rapid response system. You have been invited to participate in this study because you are a St. Vincent's Hospital clinician directly responsible for patient care including utilisation of the clinical emergency response system when patients show signs of possible clinical deterioration. As a direct system user, you are aware of facilitators and barriers to the system working effectively.

This Participant Information Sheet and Consent Form tells you about the study. It explains what is involved to help you decide if you want to take part in the study. Please read this information carefully. Ask questions about anything that you do not understand or want to know more about. Before deciding whether or not to take part you might want to talk about it with a relative, friend or local health worker.

2 What is the purpose of this research?

The study aims to increase understanding into the reasons why failure to rescue deteriorating patients occurs despite the successful introduction of the PACE program designed to increase early recognition and management of deterioration. Specifically, it will help to identify processes that enable the PACE system to work more effectively, and provide greater insight into barriers that inhibit a rapid response systems effectiveness which result in deterioration related adverse clinical events.

3 Why have I been chosen?

You have been chosen because your daily work requires you to be directly responsible for patient care including utilisation of the clinical emergency response system. As a direct system user, you are aware of facilitators and barriers to the system working effectively.

4 Do I have to take part in the research?

It is up to you to decide whether or not to take part in this study. Participation in this study is voluntary. It is completely up to you whether or not you participate. If you do decide to take part you will be given this Participant Information Sheet and Consent Form to sign and you will be given a copy to keep. If you decide to take part you can change your mind later and withdraw from the study at any stage, for any reason.

5 Other relevant information
The study will include groups containing multiple healthcare professions in order to identify potential issues that may relate to specific disciplines. The study is single centred so will only take place at St. Vincent's Hospital, Sydney. The groups will continue to be conducted until data saturation has been reached. It is anticipated that this may take between 20-40 clinicians to achieve.

6 What will happen to me if I take part?
The study will require your participation in either a focus group or one to one interview if you cannot attend a group session, or we would like to further explore a theme or topic you discussed in a group. During the session you will be asked to discuss your thoughts and feelings regarding the PACE deteriorating patient program at St. Vincent's Hospital. If you agree to participate in this research, you will then be asked to meet either individually or as a group participant at a mutually agreeable time to discuss PACE and answer specific questions relating to the program. Disciplines will be separated into Medicine, Nursing and Allied Health for the focus groups, It is envisaged that all sessions will last around 60 mins in duration, this may vary however depending on the length of discussions taking place. Most participants will only be required to attend one 60min session. If a subsequent one on one interview is thought to be beneficial, it will be completely voluntary and at a mutually agreeable time. Refreshments will be provided during the sessions.
You will be advised of the venue closer to the time of your session, these sessions will be held within the St. Vincent's Hospital Campus. Your comments will be recorded via digital audio recording equipment to ensure all your comments are captured and to also assist with future analysis and reporting. You will be de-identified in any reports or publications resulting from the study. The data will be analyzed using the method of qualitative thematic analysis guided by theoretical perspectives of organizational theory that identify relationships and interactions between key personnel. There are no costs associated with participating in this study, nor will you be paid. Participation may however cause some minor inconvenience as it will require some time set aside for the focus groups or an interview, this may restrict your work or free time during this/these session/s depending on when an agreeable time to meet is set.

7 What are the possible benefits of taking part?
The data collected may be used to make the PACE more clinician friendly and improve early detection and management of deteriorating patients in your care, however it may not directly benefit you in other areas of your day to day work.

8 What are the risks of taking part?
There are no foreseeable risks involved in participating in the study. Participating may however cause some minor inconvenience as it will require some time set aside, this may restrict your clinical work time or free time during this/these session/s depending on when an agreeable time to meet is set. You may feel that some of the questions we ask are stressful or upsetting. If you do not wish to answer a question you may skip it and go to the next question, or you may stop immediately. If you become upset or distressed as a result of your participation in the study, the study coordinator is able to arrange for counselling or other appropriate support. Any counselling or support will be provided by staff who are not members of the study team.
Whilst all care will be taken you may experience embarrassment if one of the group members were to repeat things said in a confidential group meeting. Your confidentiality will be maintained by the researchers through de-identification and coding of your answers. Some identifying data may be discussed exclusively amongst the researchers in order to sort and analyse data. Your individual identity will not be able to be traced through any report or publication resulting from the project. The researchers are professionals and will maintain your confidentiality at all times.

9 What do I do if I wish to withdraw from the research?

Participation in any research project is voluntary. If you do not wish to take part you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at a later stage. If you wish to withdraw from this study please advise the study team. If you do withdraw you will be asked to complete and sign a "Withdrawal of Consent' form. This will be provided to you by the study team.

If you decide to leave the project, the researchers would like to keep the personal information about you that has been collected. This is to help them make sure that the results of the research can be measured properly. If you do not want them to do this, you must tell them before you withdraw from the research project

Part II – How is the study being conducted?

10 What will happen to information about me?
By signing the consent form you consent to the study coordinator and relevant research staff collecting and using personal information about you for the study project. Any information obtained in connection with this study project that can identify you will remain confidential. All data collected in the study will be stored in a locked cupboard in the CERS CNC office at St. Vincent's hospital, Sydney for a period of five years. This includes both hard copy and electronic format which will also be stored in an archived disk and placed in a locked cupboard in the CERS CNC office. Any data stored on a St. Vincent's Hospital hard drive will be password protected. Transcripts will be destroyed by placing them in a secure document destruction bin for disposal. Data stored on hard drive/s will be permanently deleted. Your information will only be used for the purpose of this study project and it will only be disclosed with your permission, except as required by law.

The personal information we will collect and use for this study is your professional discipline and position title, age, gender, years of service and any other information you choose to disclose during the focus groups/interviews.

It is anticipated that the results of this study will be published and or presented in a variety of forums. In any publication and/or presentation, information will be provided in such a way that you cannot be identified, except with your express permission.

Once the results have been collated and analysed, you will be given information as to how to access the report/published article containing the outcomes of the session/s.
The outcomes of the information you supply during the sessions may also be utilised to change and improve policy and practice around rapid response systems and the early detection and management of the deteriorating patient.

In accordance with relevant Australian and/or New South Wales privacy and other relevant laws, you have the right to request access the information collected and stored by the study team about you. You also have the right to request that any information with which you disagree be corrected. Please contact the study team member named at the end of this document if you would like to access your information.

11 Who has reviewed the study?
All research in Australia involving humans is reviewed by an independent group of people, called a Human Research Ethics Committee (HREC). This study has been reviewed and given approval by St. Vincent's Hospital (Sydney) Human Research Ethics Committee.
The conduct of this study at St. Vincent's Hospital, Sydney has been authorised by St. Vincent's Hospital, Sydney.

12 **Further information and who to contact**
If you would like any further information on this study you may contact
John Rihari-Thomas
Clinical Nurse Consultant
Clinical Emergency response System (CERS), St Vincent's Hospital, Sydney
Phone +61(2) 8382 2484 +61(2) 8382 1111 page 6556
jriharithomas@stvincents.com.au

If you would like to talk to someone not directly involved with the study for any further information regarding your rights as a study participant or should you wish to make a complaint to people independent of the study team, you may contact the St Vincent's Hospital (Sydney) Research Office on (02) 8382 2075 and quote the HREC reference number: LNR/12/SVH/262.

Question	Who to contact	Phone / Facsimile
General questions or concerns during the study	John Rihari-Thomas CERS CNC	Phone 02 8382 1111 page 6556 Facsimile 02 8382 3688
Questions about the way the research is being conducted	Institutional Research Governance Officer	Phone 02 8382 2075

St. Vincent's Hospital

PARTICIPANT CONSENT FORM

Title.	**Risk Management of the Deteriorating patient in the Acute Care Setting**
Short Title	**RACS Study**
Principal Investigator	**John Rihari-Thomas**
Site	**St. Vincent's Hospital, Sydney**
Protocol.	**RACS study Version 1. 2012**

1. I have read the attached Participant Information Sheet outlining the nature and purpose of the research study and I understand what I am being asked to do.

2. I have discussed my participation in this study with the member of the study team named below. I have had the opportunity to ask questions and I am satisfied with the answers I have received.

3. I have been informed about the possible risks of taking part in this study.

4. I freely consent to participate in the research project as described in the attached Participant Information Sheet.

5. I understand that my participation is voluntary and that I am free to withdraw at any time during the study.

_____	_____	_____
Name of Participant	Signature of Participant	Date

_____	_____	_____
Name of Witness to.	Participant's Signature	Date
Signature of Witness		

*Witness is not to be the Investigator or member of the study team nor their delegate
* Please note that in the event that an Interpreter is used, the Interpreter is not a witness to the consent process

Participant will be provided with a copy of the Participant Information Sheet and this Consent Form All parties signing the Consent Form must date their own signature

St. Vincent's Hospital
WITHDRAWAL OF PARTICIPATION

Title	**Risk Management of the Deteriorating patient in the Acute Care Setting**
Short Title	**RACS Study**
Principal Investigator	**John Rihari-Thomas**
Site	**St. Vincent's Hospital, Sydney**
Protocol	**RACS Study version:1 2012**

I hereby wish to WITHDRAW my intent to participate further in the above research project and understand that such withdrawal will not jeopardise my future health care.

Participant's Name (printed) .....

Signature .....

Date .....

In the event the participant decided to withdraw verbally, please give a description of the circumstances. Coordinating Investigator to provide further information here:

Coordinating Investigator to sign the withdrawal of consent form on behalf of a participant if verbal withdrawal has been given:

Participant's Name (printed) .....

Signature of Investigator .....

Date .....

Appendix 2 Ethics approval letters

St Vincent's Hospital

A facility of St Vincents
& Mater Health Sydney

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7 December 2012

Mr John Rihari-Thomas
Clinical Emergency Response System CNC
Nurse Education and Development Centre
Level 5 DeLacy
St Vincent's Hospital

Dear John

SVH File Number: 12/184
Project Title: Risk management of the deteriorating patient in the acute care setting.
(HREC Reference Number: LNR/12/SVH/262)

Thank you for submitting a Low and Negligible Risk Research Site Specific Assessment (LNR SSA) form for site authorisation of this project. I am pleased to advise that the Research Governance Officer on 7 December 2012 has granted authorisation for the above Low and Negligible Risk Research Project to be conducted at **St Vincent's Hospital**.

The version of the LNR SSA reviewed by SVH RGO was: AU/7/9AFE06.

Please Note: Site authorisation will cease on the date of HREC expiry (22 November 2017).

The following conditions apply to this research project. These are additional to those conditions imposed by the Human Research Ethics Committee that granted ethical approval:

1. Proposed amendments to the research protocol or conduct of the research which may affect the ethical acceptability of the project, and are submitted to the lead HREC for review, are copied to the Research Governance Officer.

2. Proposed amendments to the research protocol or conduct of the research which may affect the ongoing site acceptability of the project are to be submitted to the Research Governance Officer.

3. Projects that are undertaken by Investigators holding an academic appointment (including conjoint appointments) or by students as part of a University course are also required to notify the relevant University HREC.

Should you have any queries about your project please contact the Research Office, Tel: 8382-2075, email research@stvincents.com.au. The HREC Terms of Reference, Standard Operating Procedures, *National Statement on Ethical Conduct in Human Research* (2007) and the *CPMP/ICH Note for Guidance on Good Clinical Practice* and standard forms are available on the Research Office website: www.stvincents.com.au/researchoffice or internal at http://exwwwsvh.stvincents.com.au/researchoffice

Yours sincerely

Production Note:

Signature removed prior to publication.

Julie Charlton
Research Governance Officer
Research Office

cc: Mr John Rihari-Thomas
TRIM Record Number: D/2012/53990

From:Research.Ethics@uts.edu.au[SMTP:Research.Ethics@uts.edu.au] Subject:HREC Approval 2013000045

Dear Patricia and John

[External Ratification: St Vincent's Hospital, Sydney Human Research Ethics Committee HREC approval - 12/184 ¿ 07/12/12 to 07/12/17]

The UTS Human Research Ethics Expedited Review Committee reviewed your application titled, "Risk management of the deteriorating patient in the acute care setting (RACS study)", and agreed that the application meets the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that your external ethics approval has been ratified. Any conditions of approval as stipulated in the Committee's comments will be noted on our files.

Your approval number is UTS HREC REF NO. 2013000045

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Research Involving Humans requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

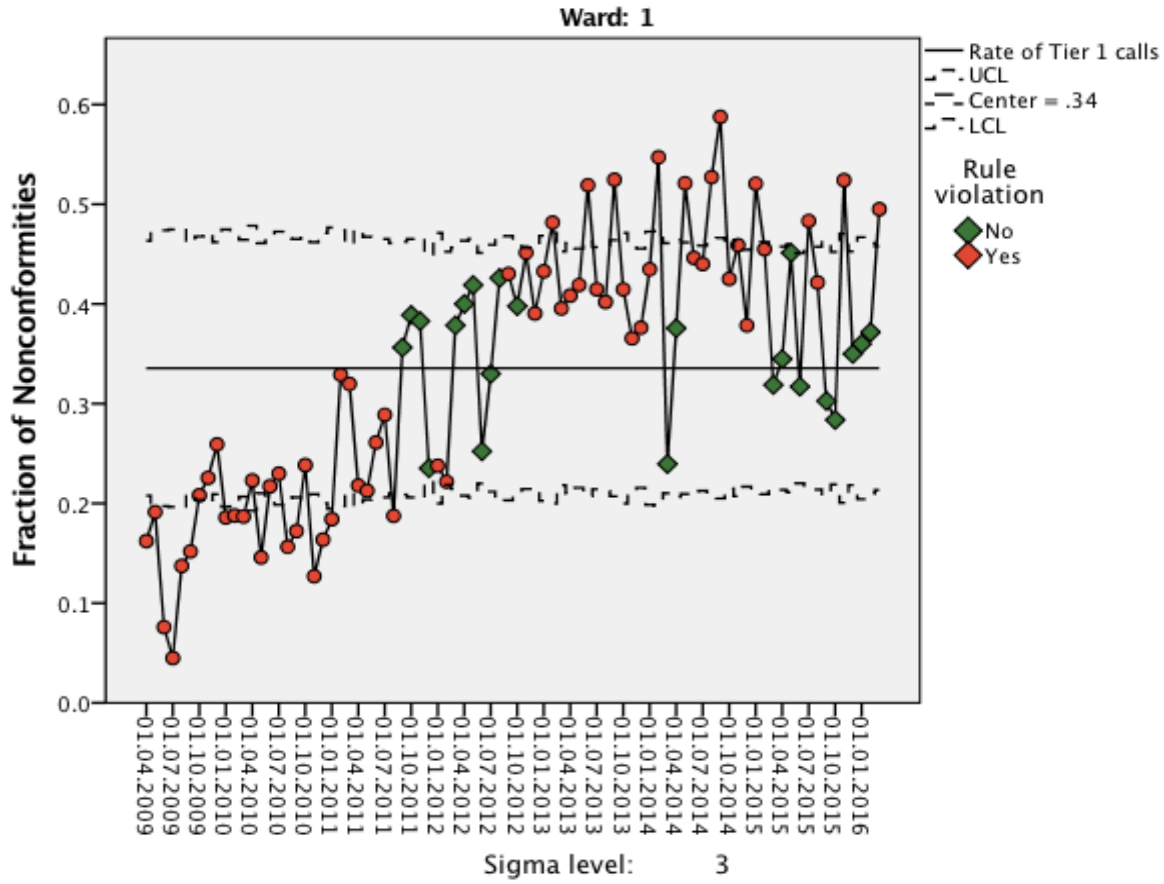
You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee C/- Research & Innovation Office University of Technology, Sydney
T: (02) 9514 9645
F: (02) 9514 1244
E: Research.Ethics@uts.edu.au

Appendix 3 Control charts

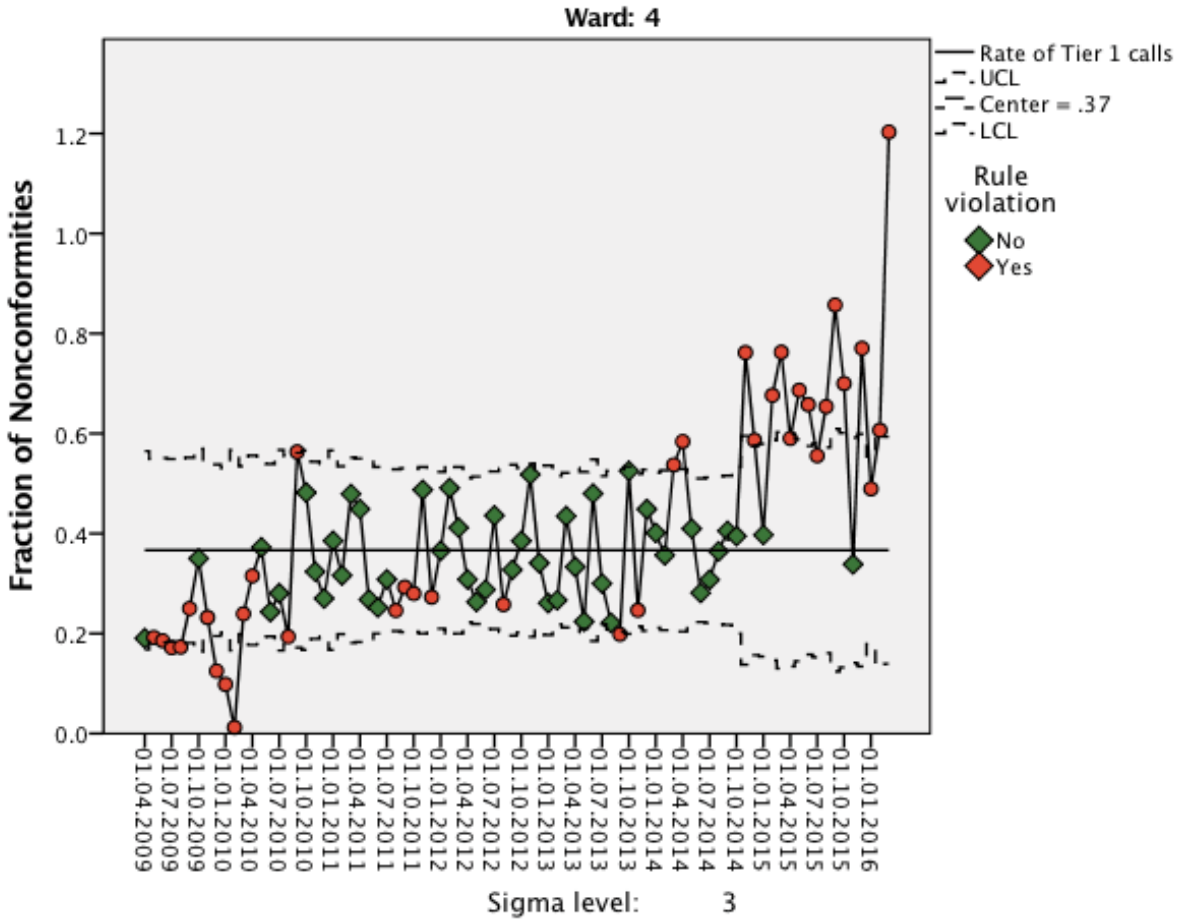
Figure 1: Ward 1 rate of rapid response calls per month



UCL = upper control limit

LCL = lower control limit

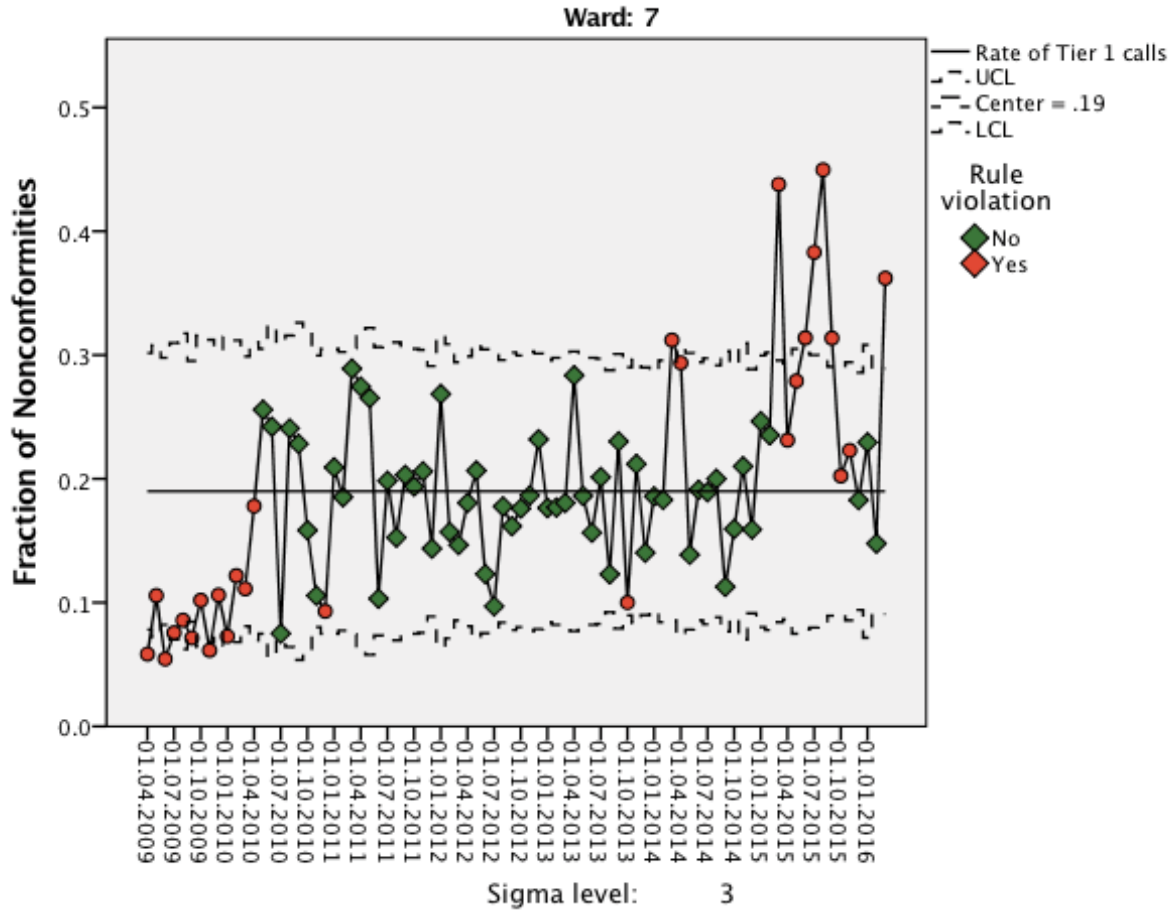
Figure 2: Ward 4 rate of rapid response calls per month



UCL = upper control limit

LCL = lower control limit

Figure 3: Ward 7 rate of rapid response calls per month



UCL = upper control limit

LCL = lower control limit

Appendix 4 Rapid response system tiers

Tier	Responder	Actions
Clinical Review (yellow zone)	2 RN's (one of which must be considered a Senior RN)	• Complete a full A-G (*airway, breathing, circulation, disability, exposure, fluids, glucose*) physical assessment on the patient within a **30 minute** timeframe. • If clinically stable and not at risk of deterioration, then increase vital sign frequency and monitor for trends to unit Rapid Response (red zone) criteria. • If possible clinical deterioration or you are concerned/worried, then escalation is required to either Rapid Response or Code Blue levels (depending on the patient's clinical status). • Nurses are also required to perform any nursing intervention they feel is warranted within their scope of practice. If the nurse's assessment indicates
Rapid Response (red zone)	• Patient's admitting or primary care medical team (during business hours or Medical Registrar at all other times) plus allocated PACE Resident Medical Officer	• Complete a full A-G physical assessment on the patient within a **30 minute** timeframe. • Institute therapies / interventions • Document a medical management plan including altering any calling criteria if necessary and an escalation plan if continued / further deterioration occurs • Escalate to Code Blue tier if: - Patient if at clinical risk of any life threatening condition and requires immediate intervention - Allocated Medical Officer has not arrived within 30 minutes of call activation - Patient continues to breach rapid response calling criteria 1 hour post intervention - You are concerned/worried
Code Blue	• ICU led team of ICU/ Anaesthetics Registrars and Critical Care Nurses	• **Immediate response** to the patient • Institute any management required including advanced treatments and/or resuscitation

Appendix 5 Focus group composition

Focus group	Physicians	Nurses
1	0	5
2	3	0
3	0	4
4	2	3
5	1	1
6	15	0

Appendix 6 Participant demographics

Element	Professional Designation						
	Registrar (n=15)	Resident (n=5)	Intern (n=1)	Nurse Manager (n=1)	Clinical Nurse Consultant (n=1)	Clinical Nurse Educator (n=6)	Regist-ered Nurse (n=5)
Total study participants (n=34)	**Total Medical (n=21)**			**Total Nursing (n=13)**			
Years working at the study facility							
<5	14	5	1	1	1	3	3
>5						3	2
Years working in profession							
0 to 5	12	5	1				3
6 to10	2					2	1
>10				1	1	3	2
Type of employment							
Full time	13	5	1	1	1	3	6
Part time	1					2	
Age							
20 to29	10	4					3

30 to 49	4	1	1			4	2
>49				1	1	1	1
Male	6	2					
Female	9	3	1	1	1	5	6

Note: Not all participants provided all demographic data requested.

Appendix 7 Published manuscript

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Original Article

Clinician Perspectives of Barriers to Effective Implementation of a Rapid Response System in an Academic Health Centre: A Focus Group Study

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Abstract

Background: Systemic and structural issues of rapid response system (RRS) models can hinder implementation. This study sought to understand the ways in which acute care clinicians (physicians and nurses) experience and negotiate care for deteriorating patients within the RRS.

Methods: Physicians and nurses working within an Australian academic health centre within a jurisdictional-based model of clinical governance participated in focus group interviews. Verbatim transcripts were analysed using thematic content analysis.

Results: Thirty-four participants (21 physicians and 13 registered nurses [RNs]) participated in six focus groups over five weeks in 2014. Implementing the RRS in daily practice was a process of informal communication and negotiation in spite of standardised protocols. Themes highlighted several systems or organisational-level barriers to an effective RRS, including (1) responsibility is inversely proportional to clinical experience; (2) actions around system flexibility contribute to deviation from protocol; (3) misdistribution of resources leads to perceptions of inadequate staffing levels inhibiting full optimisation of the RRS; and (4) poor communication and documentation of RRS increases clinician workloads.

Conclusion: Implementing a RRS is complex and multifactorial, influenced by various inter- and intra-professional factors, staffing models and organisational culture. The RRS is not a static model; it is both reflexive and iterative, perpetually transforming to meet healthcare consumer and provider demands and local unit contexts and needs. Requiring more than just a strong initial implementation phase, new models of care such as a RRS demand good governance processes, ongoing support and regular evaluation and refinement. Cultural, organizational and professional factors, as well as systems-based processes, require consideration if RRSs are to achieve their intended outcomes in dynamic healthcare settings.

Keywords: Medical Emergency Team (MET), Qualitative Research, Healthcare Quality Improvement

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Key Messages

Implications for policy makers

- Appreciate the importance of local, contextual factors, and model elements in implementing rapid response systems (RRSs).
- Organisational policy should ensure communication and negotiation via ongoing monitoring, evaluation, and coaching of health professionals.
- Ongoing training and evaluation of physicians' roles in RRSs is critical to ensuring patient safety.
- Creation of smaller dedicated RRS teams that inhabit these roles for a longer period will enable ongoing training and support for the physician role and consolidation of skills.
- Prioritise inter-professional education and teams to increase understanding of the unique role and contribution of professional groups to the clinical encounters.

Implications for the public

The rapid response system (RRS) concept focuses on the 'rescue' of patients showing abnormal signs and symptoms, preventing adverse clinical events. The way in which clinicians operate within such a system depends partly on their perception of its value as a tool for patient safety, as well as ways in which they engage and effectively communicate within and between professional disciplines. Failing to activate a RRS can risk patient safety and lead to adverse health outcomes. This study has identified an absence of ongoing training and evaluation of physicians' roles in the RRS and the importance of teamwork and communication in ensuring patient safety.

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Background

Hospitals are facing increasing patient demand and complexity whilst also being more accountable for improving care, decreasing costs, optimising access to evidence-based treatments and minimising adverse events.[1] An increased emphasis on clinician accountability to improve healthcare quality and safety is challenging in an environment with significant workforce shortages and variations in skill mix.[2] As part of the global patient quality and safety agenda, the past two decades have seen a growing focus on implementing rapid response systems (RRSs) to facilitate early detection, management and escalation of deteriorating inpatients.[3] The RRS is designed around early 'rescue' of patients showing abnormal physiological signs and symptoms, preventing adverse clinical events (ie, unplanned intensive care unit (ICU) admissions, unexpected cardiopulmonary arrests and/or deaths).[4,5] Despite the progressive uptake of RRSs, various provider and systems factors have limited optimisation.[6] The lack of translation of key principles highlights the need to consider interpersonal, intra-organisational, and systemic factors including workforce distribution, skills and shortages, culture, teamwork, power relationships, fiscal constraints, increasing public accountability[7] and competition between discrete organisational units.[8] Teamwork and communication are essential in ensuring patient safety.[9] Team building is complex and influenced by professional boundaries, power relations and systems.[10] As with any healthcare initiative, human factors and the understanding of interactions among individuals and elements of a system, may influence the level of acceptance, utilisation and ultimately, the effectiveness of RRSs within the acute care setting.[11] The ways in which clinicians operate within the RRS depend partly on the extent to which they value its use as a tool for patient safety, as well as ways in which they engage and effectively communicate within and between professional disciplines. Despite the no blame feature of all safety and quality agendas, clinician fear of retribution often shapes reluctance to activate RRSs.[12-14] Clarifying interactions and experiences that occur between clinicians operating within these mandated clinical systems is required to address known gaps. Frameworks in healthcare and institutional structures are still largely shaped by historical, medically dominated hierarchies[15-17] challenging communication and innovation. Failing to acknowledge these human factors is detrimental to success when implementing any model of care.[7]

Current literature reports on barriers to effective RRS activation, including RRS knowledge, attitude of responders and workloads.[18] This study further aimed to explore and understand how doctors and nurses experience this system and negotiate care for deteriorating patients within the RRS environment. Our objectives were to ascertain (1) factors that influence implementation and ongoing effective use of RRS and (2) clinicians' perceptions of its efficacy and utility when the initial tier of medical response is led by the patient's admitting team.

Methods

The study setting was an Australian academic health centre within a jurisdictional-based model of clinical governance. The RRS had been in place for 5 years at the time the study took place and received between 250-400 activations per month. Purposive sampling was used to recruit nurse and physician participants who were employed at this site and had current knowledge of and actively participated in RRSs.[19]

A qualitative design was used to elicit perspectives of participants. We intended to facilitate discussion and narratives of experiences to understand clinicians' meanings and motivations that informed their actions. Given the centrality of inter-professional perspectives of teams in our study, six discipline-specific and multi-disciplinary focus groups were undertaken during April and May 2014 to identify registered nurses' (RNs) and physicians' perceptions and experiences of the RRS.[20] Focus groups were used to generate dynamic discussion and responses to participants' comments, prompt memories, and refine opinions already expressed. As nurses and physicians have their own distinct cultures, histories, and approaches to teamwork, conducting several discipline-specific focus groups allowed investigation of roles and practice and for open dialogue and disclosure of potentially diverse perspectives.[15] Owing to time constraints, some clinicians were unable to attend discipline-specific groups and chose to attend a multi-disciplinary group comprising both physicians and nurses. This choice allowed for individual narratives as well as responses and elaborative comments from others within each type of group. A literature review and preliminary discussions with key stakeholders informed development of the semi-structured topic guide (Box 1).[2,21,22] Topics included barriers and facilitators to caring for deteriorating patients, RRS experiences, operating within and outside of the RRS protocol, and perceived need for protocol changes.

The Rapid Response Model

Track and trigger systems are recognised both nationally and internationally as best practice models. They take many forms with triggers typically incorporating numerical (aggregate weighted) scoring, vital sign parameters or combinations of both.[23,24] The rapid response model utilised in the study is a state-based multi-tiered vital sign parameter track and trigger system.[23] Individual tiers are activated when a pre-determined set of clinical observation and vital sign variables are breached

Box 1. Semi-structured Focus Group Topic Guide

- What factors in your ward make it easy/difficult to care for 'sick' patients whose condition deteriorates?
- Can you tell me how the rapid response system (RRS) works on your ward?
- What has been your experience with the RRS?
- Do you follow the Clinical Emergency Response System Protocol?
  - If NO - how do you negotiate to operate outside of the Clinical Emergency Response System Protocol?
  - If YES – what enables you to operate within the Clinical Emergency Response System Protocol?
- In your experience, what makes the RRS work effectively/ineffectively?
- What, if any, changes are needed to enhance the existing RRS?

(track), which then 'triggers' the response of the appropriate level of rapid response team (RRT).[25] The two tiers, 'Clinical Review' (Tier 1) consist of more sensitive trigger indicators (early warning signs), while 'Rapid Response' (Tier 2) contains less sensitive indicators indicative of late warning signs. Indicators are derived from research outcomes of the 'SOCCER' study,[26] each attracting differing levels of clinician response (Table 1). This allows a degree of individual facility autonomy based on RRS structure, resourcing, and geographic location. Tier parameter criteria can be modified to create individual patient customisation, affectively making indicators more or less sensitive to system activation over the standardised criteria. The response processes are primarily based around initial medical response (in the Rapid Response tier) coming from admitting medical teams, or dedicated facility physicians out of normal business operating hours. Although not alone in adopting this type of response model, the majority of peer facilities more popularly initiate this level of medical response in the first (Clinical Review) tier, dispatching a critical care lead medical emergency team (MET)[13] when Rapid Response criteria are breached.[27] The Clinical Review tier is generally responded to and managed by unit RNs in the study facility who perform a thorough A-G (airway, breathing, circulation, disability, exposure, fluids, glucose) patient assessment within 30 minutes, initiate required interventions within their scope of practice, and escalate to the second tier if their assessment reveals possible or actual clinical deterioration. The admitting team model was chosen by this facility as it allows admitting physicians to initially manage the patient's deterioration, thus, decreasing workload demands on individuals as the RRS response load is spread across many speciality teams, rather than just a single MET. This model was also intended to allow admitting teams opportunity to develop skills in identifying and managing clinical deterioration themselves through experience rather than relying on the MET for 'rescue' in every RRS situation. The admitting, or after-hours team registrar (a physician who has obtained full registration with the Medical Board of Australia with at least 3 years' experience working in public hospital service),[28] is required to respond to all second tier calls within 30 minutes of activation. A junior resident medical officer (physician who has obtained full registration with the Medical Board of Australia)[28] is allocated to each clinical floor and is also required to attend. A third tier (Code Blue) is embedded within the Rapid Response tier and activates the MET from ICU if clinicians feel that immediate critical care assessment is required, there has been no physician response from a rapid response activation, or the patient is not showing sign of stabilisation or improvement 1 hour after rapid response intervention.

Recruitment

We sent invitations to attend focus groups to all nurses and physicians employed at the site via administrative email distribution lists. In addition, advertisements posted on hospital notice boards sought clinician volunteers. Although this method enabled significant reach, it precluded our ability to establish a response rate. Individuals were included if they were a nurse or physician employed at the study site and currently worked in clinical environments where the RRS operated. Interested potential participants contacted the principal researcher who provided additional oral and written study information. Recruitment ceased upon data saturation. As the principal researcher was a senior nurse within the facility and had a working relationship with many of the potential participants and a significant role within the RRS, an external experienced clinician and researcher (JLP) conducted the focus groups to minimise researcher

Table 1. RRS Tiers[23]

Tier	Responder	Actions
Clinical Review (yellow zone)	2 RNs (one of which must be considered a Senior RN) *Senior RN is subjective and not formally agreed upon in facility protocol. In the situation of responding to Clinical Review, it pertains to the nurse in charge of the unit or the most senior RN in years of experience rostered on shift	• Complete a full A-G (*airway, breathing, circulation, disability, exposure, fluids, glucose*) physical assessment on the patient within a 30-minute timeframe. • If clinically stable and not at risk of deterioration, then increase vital sign frequency and monitor for trends to unit Rapid Response (red zone) criteria. • If possible clinical deterioration or you are concerned/worried, then escalation is required to either RRS or Code Blue levels (depending on the patient's clinical status). • Nurses are also required to perform any nursing intervention they feel is warranted within their scope of practice. If the nurse's assessment indicates.
Rapid Response (red zone)	Patient's admitting or primary care medical team (during business hours or Medical Registrar at all other times) plus allocated RRS Resident Medical Officer	• Complete a full A-G physical assessment on the patient within a 30-minute timeframe. • Institute therapies/interventions. • Document a medical management plan including altering any calling criteria if necessary and an escalation plan if continued/further deterioration occurs. • Escalate to Code Blue tier if: - Patient if at clinical risk of any life threatening condition and requires immediate intervention. - Allocated Medical Officer has not arrived within 30 minutes of call activation. - Patient continues to breach rapid response calling criteria 1 hour post intervention. - You are concerned/worried.
Code Blue	ICU led team of ICU/Anaesthetics Registrars and Critical Care Nurses	• Immediate response to the patient. • Institute any management required including advanced treatments and/or resuscitation.

Abbreviations: RN, registered nurse; RRS, rapid response eystem; ICU, intensive care unit.

and response bias. This individual, also a senior nurse, was neither known to participants, nor was a usual collaborator of the principal researcher, but had an understanding of and previous affiliation with the facility. Another experienced researcher moderated one group due to schedule conflict of the principal moderator; this person also performed the role of scribe in the other groups to record observational notes. Participants were informed that the principal researcher would not be attending the focus groups, but would have access to the recordings and conduct analysis. They were assured that names and identifying information would be removed from transcripts and demographic information would only be reported in aggregate form. They were also assured that the principal researcher would take steps to ensure confidentiality of participants including secure storage of data and act in accordance with established ethical frameworks. Prior to focus group commencement, all participants provided written informed consent including permission to audio record proceedings.

Procedure

One-hour focus groups took place on weekdays at the designated health facility in a private meeting room to enable attendance of target groups. Throughout the focus groups, the moderator noted newly emerging topics and points in need of clarification that were re-visited prior to concluding the sessions along with a summary of main points. This step enabled participants to verify the moderator's understanding and interpretation of reports, thus, acting as one method to verify findings.

Analysis

All focus groups were audio recorded and transcribed verbatim to facilitate thematic content analysis.[29] Analysis began with the principal researcher closely reading each transcript and listening to the audio recordings to get a sense of the proceedings and context. Transcripts were analysed using the general inductive approach.[30] Inductive coding began with line-by-line reading and coding of raw data without a pre-specified framework to remain open to emergent topics and multiple meanings within the text. Coded text was grouped into categories of material reflecting similar topics. Categories were then synthesised into themes and independently reviewed by two additional researchers (JRT and MD). To facilitate analytical rigour, three analysts (1) principal researcher (experienced clinician perspective and context/topic expert), (2) principal moderator (experienced, yet detached clinician perspective and witness to focus group processes), and (3) external qualitative researcher (methodological expertise) posed contradictory viewpoints and new insights and contributed to consolidation of themes. This analytical triangulation facilitated capture of key aspects of the themes assessed to be most important and useful in answering the research questions.

Results

Thirty-four health professionals (21 physicians, 13 RNs) took part in six focus groups over a five-week period (Table 2). Each group was comprised of two to five participants with the exception of the registrar group, which included 15 participants. Four groups were discipline-specific and two groups were multi-disciplinary. Participants included both junior and senior RNs and physicians. Participants held differing skill levels and clinical experience ranging from less than one year to greater than 10 years (Table 3). Physicians had worked in both admitting specialty teams and facility-wide 'after hours' roles. The majority of participants were under 30 years old and had worked at the study facility for less than five years.

Analyses of focus group data yielded a range of organisational and systems-level factors shaping the ways in which health professionals experienced and negotiated care for deteriorating patients within the RRS environment. The themes that reflect systems or organisational-level barriers to an effective RRS include (1) responsibility is inversely proportional to clinical experience; (2) actions around system flexibility contribute to deviation from protocol; (3) misdistribution of resources leads to perceptions of inadequate staffing levels inhibiting full optimisation of the RRS; and (4) poor communication and documentation of RRS increases clinician workload.

Responsibility Is Inversely Proportional to Clinical Experience

Interns and resident medical officers (hereafter, junior physicians) reported feeling unprepared and out of their

Table 2. Focus Group Composition

Focus Group	Physician Participants	Nurse Participants
1	0	5
2	3	0
3	0	4
4	2	2
5	2	1
6	15	0

Table 3. Participant Demographics[a]

	Medical[b]	Nursing[c]
Years Working at the Study Facility		
<5	21	8
>5	0	5
Years Working in Profession *Participants not responded (n = 2)		
0 to 5	17	3
>5	2	10
Type of Employment *Participants not responded (n = 1)		
Full time	19	11
Part time	1	2
Age *Participants not responded (n = 1)		
>30	14	3
>30	6	10
Male	8	0
Female	13	13

[a] Total participants (n = 34).
[b] Medical participants (n = 21): registrars (n = 15), residents (n = 5), and Interns (n = 1).
[c] Nursing participants (n = 13): managers (n = 1), consultants (n = 1), educators (n=6), and registered nurses (RNs) (n = 5).
*Note: Figures based on available data, some participants did not provide all demographic information requested.

depth when they entered clinical settings. They were confused about the logistics of the RRS process, particularly around who should attend RRS calls and where (allocated areas). Despite the RRS protocol and process included as part of facility orientation, some junior physician participants remained unaware. This lack of understanding contributed to doctors developing their own unique way of making the system work and/or introducing the RRS processes from previous employment sites. This resulted in doctors frequently deviating from standardised RRS protocol and perpetuating confusion for other team members.

Operation of Medical Response Tier Left to Most Junior Physicians

Tier 2 of the local RRS requires senior physicians (registrar level and above) to be primary responders, with junior physicians attending as additional support and to gain learning opportunities. Junior participants reported often being first at the bedside, and on occasion, the only responder. Despite study site protocol dictating activation of a MET call in such instances, they were often unsure of their options if they were the only responder. These participants reported feeling anxious, isolated and uncertain, out of their depth, and fearful of being unsupported, as depicted in the following excerpt:

"There are times that I felt quite out of depth….I'm still getting anxious when my pager goes off and says 'it's time to go and do a [rapid response] and it's like oooooh [nervous]" [Junior physician].

Similarly, RN participants expressed concern around variability of junior physicians' skill levels in managing the complexity of some deteriorating patients. Nurses' concerns about clinical capabilities was amplified if they perceived the junior physicians as not always having the prerequisite specialist knowledge of particular medical conditions or circumstances around deterioration, considering this as possibly detrimental to patient safety:

"…I say 'do you know anything about VADs (ventricular assist devices)?,' and they (junior physicians) turn around to me and say 'no', I'm really concerned, and I'll guarantee the majority of the Junior Reg's (Registrars) know nothing about VAD patients either…If you're running a hospital with VADs and (heart) transplants and lung transplants and haematology patients you shouldn't have a junior doctor looking after them at night, it can be quite scary" [RN].

Amidst these circumstances, nurses often perceived that their medical colleagues were reluctant to escalate the rapid response to a higher tier when they were 'out of their depth' for fear of being viewed as clinically inept. Medical reluctance to seek expert support was particularly apparent at night where junior physicians feared incurring the wrath of more senior specialist staff if they perceived to have disturbed them unnecessarily.

"…but if you push and push (for escalation) they (junior physicians) will call them (Senior Specialists) eventually because we stand our ground… but if, as you say, we have a lot of junior staff (nurses) on, and you haven't got experienced shift leaders on, it's very difficult to get beyond that" [RN].

Nurses also empathised with the anxiety and complexity that physicians must face when they are required to attend a RRS call.

"I'm sure it must be very hard for them too, going from unit to unit…If you were doing it all the time then I would have thought you would end up with good skills, but just doing it for a short period or as a fill in, it sounds as if it could be quite tricky" [RN].

Concerns about junior nursing staff's abilities to perform critical roles in the RRS if they lacked the experience required to distinguish important and sometimes subtle clinical cues in the first (non-medical) Tier of the RRS.

"When you consider nurses' experience now [new graduates], they might have six months in palliative care and six months in rehab. and suddenly they are in another [acute]unit, that's no experience [to deal with some acute situations]. So, they don't feel confident with their decision-making…experienced nurses have more confidence to call, a new nurse that has spent one rotation in Rehab. with knowledge of the system is one thing, but confidence in activating it is another" [RN].

Actions Around System Flexibility Contribute to Deviation From Protocol

There was varied understanding amongst participants around altering RRS calling criteria, enabling individual patient's parameters to become more or less sensitive to RRS activation. Participants viewed that physicians were either inappropriately altering the criteria to prevent further RRS activation or were in contrast, reluctant to alter the criteria, thus, contributing to unnecessary and excessive activation. Nurses dissatisfied with medical responses often repeatedly activated the RRS as a way of initiating further medical review. This behaviour invariably forced physicians to alter the RSS criteria to prevent ongoing calls.

"We keep calling a [rapid response] until it resolves, or until the criteria gets changed… keep calling it until they change it" [RN].

Nurse participants shared their experiences in challenging physicians' decisions to alter RRS calling criteria to unsafe levels without appropriate patient assessment, particularly for those patients already attracting multiple calls. They labelled this a 'band-aid' approach, omitting appropriate escalation and further investigation into why the breaches were occurring.

"There should be a criteria if there's multiple [RRS] calls that they are reviewed properly, not just continue on for 48 hours sitting at those [altered] levels" [RN].

Patient safety was a concern for nurse participants, especially in relationship to junior physicians altering the RRS calling criteria. Despite protocol mandating changes can only be made by senior physicians (registrar level and above), junior physicians altered criteria at times; a strategy perceived to avoid registrar attention.

"The only one who should change the RRS criteria is the Registrar, and that should be done in consultation with the team anyway. They [junior physicians] shouldn't just be doing that…" [RN].

Also concerning to nurses was the enactment of alterations by physicians who were not medically familiar with patients with complex medical care needs. In many speciality areas, nurses perceived that the RRS physicians were operating outside their area of expertise and were, therefore, not cognisant of

the specific care needs of some complex specialty patients. Not having time to review the patients' medical records before initiating changes to their treatment amplified these concerns. It was also perceived that medical records frequently lacked adequate detail, context and clarity to enable full, detailed assessments and management paths.

"I think it's unfair for clinicians who aren't familiar with the patient to have to make that decision in such a short period of time, and I think it's a lot of pressure" [RN].

Misdistribution of Resources Leads to Perceptions of Inadequate Staffing Levels Inhibiting Full Optimisation of the Rapid Response System

Introducing the RRS increased participant awareness of patient deterioration, but also generated a perception of further workload burden. Both nurses and physicians expressed concern that the RRS generated an increase in workloads, often without any additional resources to assist. Fewer staff working 'after-hours' meant that clinicians on these shifts may be less willing to enact the RRS or to deviate from established care plans.

Confusion over logistical response and over-attendance at RRS calls was reported. Such redundancies, perhaps relating to a knowledge deficit in protocol, reflect a waste of resources and frustration for some.

"…you don't need all of the medical staff at every [rapid response] a lot of the time the units are so busy, you spend a lot of time trying to get through them [tasks], then to put down what you are doing, then you go upstairs [to attend the call])…" [Junior physician].

Preference to Avoid 'Crying Wolf' Contributes to Complacency in Rapid Response System

A portion of RRS calls are 'false positives', whereby the objective criteria are breached, but the patient is not actually deteriorating. This phenomenon has contributed to a level of complacency and doubt amongst some clinicians, as depicted in the excerpts below:

"…and you get to the next one and you think, oh I shouldn't rush this, you know, and I think it's a bit 'boy who cried wolf'. It's sort of [rapid response] after [rapid response] where you're not necessarily [needed] and you have another couple of flights of stairs, only to be sent away again" [Junior physician].

Resource Deprivation and Nurse Empathy Undermine System

Nurse and physician participants attributed strained resources to senior physicians' inability to attend some Tier 2 RRS calls 'after-hours.'

"There is one [Registrar] in the whole hospital and there could be six [rapid response] calls at once, and how can they possibly get to six?...It worries me that they're so stretched, that they can't physically get there" [RN].

As a result, nurses attempted to delay or avoid adding additional workload to already busy physicians.

"Often it's sort of 'well we need to stop having to call the doctor,' 'cause the Dr looks like he's frustrated and annoyed, and the nurse doesn't want to call him,' and that kind of undermines the system at times" [RN].

This perceived pressure on human resources led to RNs feeling torn between protocol-mandated escalation and feeling responsible for creating extra workload for colleagues.

Poor Communication and Documentation Increases Clinician Workloads

Participants suggested that inadequate communication, unclear or lack of documented nursing or medical management plans, and/or no record or clinical handover of a RRS impacted adversely on patient's subsequent care. Several participants reported that overnight RRS events were not discussed during handover/rounds because either RRS documentation was not prominently displayed in the medical records, or senior members of the patients admitting team were not aware that a RRS call had been initiated.

"They [night shift physicians] are generally meant to find the home teams in the morning and give them a rundown of what's happened...if that patient has been handed-over, you should probably prioritize them first, um but I don't see that always happening" [Junior physician].

Participants attributed the omission of these vital details to the limited time available to physicians to convey a large volume of information.

"*So do you raise it? [the fact that the patient has had a rapid response call]* [Moderator].

"That would be fantastic for 1 in 30 patients, but it's hard on 4 hour rounds to keep saying 'what about this, what about this' when like you're flat out ordering, doing this, doing that. It's a gap…not much time to say what about this [rapid response] call here?" [Junior physician].

When it worked well, clinical handover involved routine team discussions of events, including RRS activations, and involved meetings between shifts, ensuring each team member had an understanding of relevant events and plans.

"*The other really good thing is that the [rapid response] calls are handed over in the medical handover at five o'clock when we meet before the after-hours shift. That brings attention to the patients that are unwell, everyone's got it written down on a piece of paper, everyone kind of knows a little bit about the history of the patient which makes it easier"* [Junior physician].

In some units, integrating RRS call details into unit rounds prioritised patient management for the day.

"*…When you see them on the unit round in the morning, you look at their overnight events…like it's the first thing you do when you're assessing your patient… it's just your normal practice*" [Junior physician].

This variability highlights diversity in practice despite working within the same systems.

Participants discussed how inadequate technological tools, such as information management systems, were contributing factors to communication barriers and variation in handover practices. They believed that establishing better ways of identifying patients who received RRS calls or had calling criteria modified, would lead to better clinical handover and prioritisation of sicker patients on rounds. The following excerpt depicts one participant's description of sharing information as being reliant on clinician memory and note taking in the absence of appropriate electronic tools.

"As far as I am aware, there is no formal list or computer-based system, [rather] it's a matter of people noting it down and taking a sticker [containing patient details] and presenting it at the handover. I think that works relatively well, it's not very formal." [Junior physician].

Although described as adequate by participants, this manual system of RRS had the potential to miss identifying priority patients and those needing monitoring more closely. Completion of documentation of altered criteria was on single, loose paper forms placed in the front of patient's bedside medical records alongside vital sign observation charts. Clinicians discussed how these forms have at times become misplaced or difficult to locate if not in the correct location every time, potentially resulting in unnecessary RRS due to poorly documented changes.

"The altered [rapid response] calling criteria forms can get lost. If there was a better way of identifying patients who had an altered [rapid response call criteria]" [RN].

RRS entries in the patient's medical record were sometimes overlooked as they 'blended' with other entries. Participants discussed using 'flags' in patients' medical records to ensure high visibility of RRS entries. The effect of poor, incomplete, misplaced or out-dated documentation around RRS deterioration and altered calling criteria disabled management plans, ultimately influencing other clinicians' workloads. These issues created greater obstacles for after-hours RNs and physicians who sought guidance from admitting medical team documentation. Responding to after-hours RRS calls for patients who had already breached criteria during the day was reportedly frustrating for physicians when appropriate alterations had not been undertaken in a timely manner.

"I'd just like to reiterate about getting the [admitting] team to actually make more management plans for the patient…I see the frustration on the regular night nurses' faces because we had to [rapid response] this patient again, oh and … again, and it's like why can't we do something about that?...I think it would be great for the team[s] to have a very clear [documented] plan about what they want for their patients during out-of-hours" [Junior physician].

The above excerpt reflects the need for routine review and detailed documentation of management plans. Failure to do so creates frustration and increased work for other clinicians with the potential to jeopardise patient safety. Both nurses and physicians commented on their regular workloads and responsibilities being sidelined to attend RRS calls.

"I have had situations when working a very busy shift where you have [rapid response] calls going off …where you are supposed to attend, where you don't get any of your work done that night, and then you hand over to the next people this huge list of which, really, you could have done because you really weren't needed at those things [rapid response]" [Junior physician].

The above excerpt illustrates the impact of poor documentation of patient management plans on the ability of subsequent clinicians to meet their workload demands.

Discussion

This study highlighted multiple factors influencing clinician's abilities to operate effectively within the RRS environment. Protocol deviation was evident to varying degrees by both disciplines, though as reported in the literature, it is not a unique observation that nurses are more likely to adhere to protocols than physicians,[31] perhaps a manifestation of their professional training and views of role and scope of practice. This reflected consistently with nurses seemingly having greater understanding of the RRS process than their medical colleagues.

The study, however, revealed potential reasons for the occurrence of some protocol deviation. The initial information given at commencement of employment pertaining to the RRSs structure and process was less likely to be retained by physicians than nurses. Though both disciplines received identical education, senior nurses and clinical nurse educators in the clinical setting were essential in ensuring embedment of RRS knowledge and operation within the nurse culture. In contrast, an absence of ongoing support, training and evaluation of physician's roles in the RRS was a key finding and influenced functioning within the RRS.

While a primary aim to involve and up-skill the patients' admitting teams, barriers pertaining to the study sites' model type were evident. Relying solely on admitting medical teams (and over-extended after-hours physicians) for primary tier medical response, at times, translated to an inconsistent and desultory RRS. Physicians, still in various stages of training, participate in these response roles for short periods, limiting both development into the role and establishing peer relationships with nurses from other clinical units. This inconsistent exposure was further complicated by a need to orientate large numbers of physicians into the responder role without support of a targeted, formal curriculum.

Existing literature discusses failures of RRS,[13,32,33] yet studies seem scarce on examining the direct effectiveness between a variety of efferent (response) limbs models, tending to generically conclude suitability should be based on individual healthcare facilities goals and resources.[13] While many options exist around composition and resourcing of RRTs, pros and cons are evident regardless of choice. ICU without walls[34,35] is one concept that utilises the expertise of a trained critical care physician or team. Its small, targeted group make-up would enable easier training into rapid response roles. It would also lend to more consistent exposure to other acute areas of the hospital, theoretically supporting more effective peer relationship development outside the ICU. Similarly, MET's and ICU Nurse Liaison models[36] would have correlative benefits. While perhaps not encouraging the 'enabled' up skilling of non-critical care clinicians to the same degree as admitting team models, they do afford greater opportunity for consolidation of RRS skill and role development.

The admitting team model was not unsuccessful in identifying and managing deterioration, the study participants engaged the system, though model design did cause discord around understanding and the perceived availability, functionality and efficiency of appropriately positioned resources. It was apparent the deployment of resources used in any RRS is a major factor when determining implementation and ongoing system success. Investigation into RRS team composition and resourcing[6] found that teams operated 24 hours a day, yet only 25% were funded, meaning resources were stripped from one

area to service another. This no doubt causes extra burden on clinicians left to cover redundant positions during that time and can result in multiple forms of deviation of protocol as evidenced in this study.

There was discussion amongst participants around METs being a better option for the facility, who cited physician training, knowledge and workload as the main reasons for efficient processes. RRT makeup is still contentious within the literature with some studies showing the importance of physician inclusion,[37] while others show beneficial results of nurse led ICU liaison/critical care outreach.[36,38]

The nursing unit team environment played an important role in support and ongoing re-enforcement of RRS utilisation. Additionally, two nurses noted the system's ability to provide statistical evidence of workload and patient acuity. This evidence can help to highlight discrepancies between workforce supply and demand.

Physicians' experiences reflected managing multiple competing demands, learning at various institutions with differing systems, and accelerated advancement to team member roles within the RRS. These topics were of greater concern in the junior physician groups where most agreed. Unlike nurses, these physicians do not have large support teams with senior colleague (consultant level) and educator guidance. This appears to be repeated nationally[6] and is accentuated in situations of patient deterioration where consultant physician level guidance and support would be of most benefit. As many of these individuals are training for specialties there are anxieties about competencies and further opportunities.[39,40] This may have lent to situations of escalation avoidance witnessed by nurses, who believed physicians needed to be seen as being able to manage and were not comfortable with patients deteriorating 'under their watch.'

Efferent limb response demands more than just high-level skills in clinical assessment and management. Effective RRS implementation requires stronger development in responder role clarity and effective teamwork, yet there is often limited attention to this critical dynamic, both within the team and between peer relationships.[41] The rapid response physician is required to enter unknown situations, while often unfamiliar with the patient or specialty, communicate with colleagues from different disciplines, make clinical decisions, frequently change the management of what is seen as 'another team's patient' and take responsibility for the change. This responsibility imposes significant burden on physicians, many of who are relatively inexperienced. The study provides strong support for responder development of the non-technical clinical skills required to effectively perform within RRS roles; in particular, advanced communication, leadership, and teamwork being primary assets.

Future research should focus on investigating the impact and efficacy of differing RRS model types. Of particular interest, a focus on the impact of differing responders, their professional composition, level of seniority and area of origin on influencing optimal rescue of deteriorating patients. The impact each has on existing staffing and resources would also be invaluable in helping already overloaded clinicians cope with further demands of these and other imposed systems.

Ongoing development and evaluation of RRS team training is also required to ensure responding clinicians are confident and capable, not only with clinical skills, but also with ability to work in teams and effectively lead in what are, quite commonly, difficult circumstances for patients, families and fellow clinicians. Literature is still scant on the development of training specifically aimed at RRTs. Initial evidence from investigators such as Theilen et al[42] show promising advantages in weekly multi-disciplinary simulation training, citing responder supportiveness and clinical, teamwork and communication skills as essential elements within the curricula. Large multi-centre studies to help support this evidence are required to ensure both simulation and training content are the most effective ways to train our RRTs.

Within the study site, improvements in technology are developing to aid clinicians with patient management. Electronic activation and documentation of RRS calls will prompt clinicians to better document patient clinical events and management plans while also allowing for integration of this information to other systems. Production of clinical handover alerts of these patients to proceeding shifts of clinicians for example, enables identification of patients most at risk, allowing for prioritization of rounding and closer observation. The advancement and increasing use of technologies such as these, continuous smart vital sign monitors with automated RRS activation, and technologies allowing patient bedside point of care recording, will all add to future tools for clinicians, assisting in patient deterioration prevention through swifter, more accessible and adaptable information. Add to this, increasing advancements in integrated health records allowing continuation of patient information between primary and acute health facilities.

Limitations

Generalisability of this study is limited due to the single site. Some participant demographics are absent as a result of participants not supplying all information. The self-report and recall nature of this study is a limitation, but the qualitative approach has allowed elucidation of critical, nuanced factors influencing system implementation and ongoing optimisation.

Conclusion

Study participants viewed the use of the RRS overall as an enabling tool for keeping patients safe, but also highlighted discrepancies and weaknesses exist in the system, particularly around choice and distribution of resourcing. The ways in which clinicians operated within this system was complex, multifactorial and non-standardised, sometimes with unintended consequences.

This study adds to an emerging body of data emphasising the importance of considering local, contextual factors, as well as model elements.[43] Workplace processes, cultural and professional factors and systems are important considerations in implementation of RRSs. Failing to consider teamwork, communication and inter-professional dynamics impede activation of critical elements of the RRS.

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Ethical issues

The affiliated University and Hospital Human Research Ethics Committees granted approval to undertake this study (Ethics approval number LNR/12/SVH/262).

Competing interests

Authors declare that they have no competing interests.

Authors' contributions

Study conception and design (JRT, PN, PMD). Acquisition, analysis, and interpretation of data (JRT, MD, JP, PMD). Critical revision of the manuscript (JRT, MD, JP, PMD). Supervision (PMD, PN, DS).

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Appendix 8 Published manuscript

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EDITORIAL

WILEY

Rapid response systems: where we have come from and where we need to go?

Internationally, health care systems are being held accountable for the outcomes of hospitalized patients. Lavoie and colleagues define a deteriorating patient as 'an evolving, predictable and symptomatic process of worsening physiology towards critical illness' (Lavoie, Pepin, & Alderson, 2016). Rapid response systems (RRS) have evolved over the past 25 years to enable the early detection and management of the deteriorating patient in non-critical care units. The premise of these models is that patient deterioration in the hospital ward is generally preceded by several hours of altered physiological processes, as measured by the patient's vital signs. Rapid response systems are built around trigger or calling criteria, which are typically significant deviations in vital signs and other measurements made in all patients. These triggers, such as hypotension and tachycardia, are common antecedents to adverse events. Breaches of patient parameters set to these criteria lead to activation of a team with specified skills, knowledge and experience. Despite the widespread adoption of RRS there is a vast heterogeneity in models including workforce composition, initiation criteria as well as variability in patient outcomes (Tirkkonen, Tamminen, & Skrifvars, 2017). Some studies are now beginning to show the benefits of rapid response systems in helping to prevent unplanned intensive care unit admissions, with some studies showing reductions in unexpected cardiopulmonary arrests and deaths (Chan, Jain, Nallmothu, Berg, & Sasson, 2010; Ludikhuize et al., 2015). There is also some evidence to suggest that the improvement in teamwork can have organisational effects beyond the rapid response systems in improving patient care.

The International Society of Rapid Response Systems identifies that optimally a rapid response system has the following components: an afferent component to ensure timely escalation of the deteriorating patient involving agreed physiological values as triggers; an efferent component with an individual or team of clinicians who can promptly respond to trigger; governance and administrative structures to oversee and organise the rapid response system; and analytic mechanisms to undertake quality improvement activities to improve processes of care and monitor patient outcomes (International Society of Rapid Response Systems, 2017).

The variability in outcomes across clinical studies and issues in implementation are likely attributable to the failure to recognize that RRS exist within a complex ecosystem and are multidimensional involving patient, provider and health care system elements (Massey, Aitken, & Chaboyer, 2010). Rapid response system models involve a complex interplay of reliable and valid initiation criteria, system activation and action, all occurring within complex organisational structures and inter-professional practice models. Considering patient and provider issues as below is increasingly important.

1 | PATIENTS

Patients in acute care organisations are commonly older and presenting with multiple and more complex conditions. Increasing the role of patients and families in shared decision making can increase the clarity of treatment goals. This decision making is now extending to their ability to engage the rapid response system through the power to activate calls themselves (Albutt, O'Hara, Conner, Fletcher, & Lawton, 2016).

2 | PROVIDERS

Communication barriers between health care professionals can lead to ambiguity in leading to the documentation of medical management plans. Failure to escalate is attributable to multiple reasons including lack of clinical knowledge and recognition of trends, hierarchical communication patterns, fear of retribution and an absence of defined systems (Johnston et al., 2015).

Rapid response systems are also susceptible to outside influences such as other operational functionalities including rotations of medical officers into new specialties where unfamiliarity with certain patient groups may hinder the identification of early detection of deterioration. Evolutionary changes to RRS policy, procedure and the model itself may also generate clinician confusion and uncertainty (Rihari-Thomas, DiGiacomo, Phillips, Newton, & Davidson, 2017). Education of clinicians, patients and family about speaking up and the existence of clinical escalation options is essential for engagement.

3 | SYSTEM

Increasing the importance of culture and organisational systems are being recognized as crucial for promoting both the safety and quality of health care (Smith & McSweeney, 2017). Understanding the barriers and facilitators to implementing RRS is crucial. Ensuring role clarification, education and support for clinicians working within RRS can improve patient outcomes.

4 | CONCLUSION

The complexity of health care is growing and the need to implement systems to safeguard patients is increasing. Many local practice and cultural factors likely influence the efficacy of the RRS. The nurse's

role is crucial in any model of RRS in both the afferent and efferent limbs and should be an important focus of nursing managers. The RRS is a conceptually compelling model but the devil is in the detail of implementation to ensure intervention fidelity and robust patient outcomes. More attention to model implementation, attention to the nurses' role, robust strategies for quality improvement and exploring person –centered models are important strategies for future development.

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