Document type: Position Statement
Category: Professional
Date last reviewed: 2016

College of Intensive Care Medicine of Australia and New Zealand
ABN: 16 134 292 103

Australian and New Zealand Intensive Care Society
ABN 81 057 619 986

JOINT POSITION STATEMENT ON RAPID RESPONSE SYSTEMS IN AUSTRALIA AND NEW ZEALAND AND THE ROLES OF INTENSIVE CARE

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Abstract

Rapid Response Systems (RRS) have become a standard element in the day-to-day care of patients in hospital and their establishment has coincided with an undeniable increase in acuity in hospitalised patients over the past several decades. With this increase in acuity comes the inevitable increased risk of deterioration in the hospital patient's clinical state. As such, the specialty of Intensive Care Medicine is placed to play a pivotal role in the culture change required to address this emerging healthcare issue.

The treatment, and ideally, the prevention of reversible deteriorating clinical status, underpins not only RRS, but is part of a broader medical philosophy governing daily practice. Healthcare practitioners strive to achieve best practice and excellence in outcomes. However, some patients will deteriorate even with appropriate and timely care. Deterioration after the commencement of treatment is often wrongly ascribed as "iatrogenic" due to delayed or incomplete treatment. Whilst this does occur, deterioration is commonly due to complications of the primary illness such as arrhythmias, progression of an acute illness such as renal failure from sepsis, or the complications of correct treatment despite best practice preventive measures including wound infection and venous thrombosis. This acute deterioration is often time-critical, arising over minutes or hours rather than days or weeks. The time dependence of a response to prevent and treat acute deterioration underlies many types of acute care including Code Blue Teams, Major Trauma Teams, Post-Operative Recovery Areas, CCU, ICU, HDU and Acute Stroke Teams. All of these focus on patients needing special expertise in a time-critical situation.

From its inception, the primary aim of the RRS has been to bring the most appropriate level of expertise to the deteriorating patient in the shortest possible time. Rather than being instigated by healthcare policy makers and implemented strategically in a top-down manner, RRS are one of the few healthcare initiatives that have been built from the ground up by clinicians in response to perceived patient needs not being met in any other way. Individual institutions have developed their own systems to meet their particular needs, which has led to practice variability, minimal standardisation and considerable debate as to models of best practice.

It is acknowledged that with evolving evidence, practice criteria and standards will become clearer. Despite Intensive Care historically initiating the RRS without a clear mandate that such a service should be an integral part of the Intensive Care Unit, pragmatically, the RRS in some form has been adopted as a hospital accreditation standard and requires an unambiguous, reliable process to meet the needs of deteriorating patients. As Intensive Care is predominantly called to review such patients as part of an RRS, an active participation by intensive care specialists and intensive care staff is desirable to ensure service delivery and integration. In the face of RRS practice variation across institutions and the increasing resource requirements to support the service falling largely to the specialty of Intensive Care Medicine, the College of Intensive Care Medicine of Australia and New Zealand (CICM) and the Australian and New Zealand Intensive Care Society (ANZICS) developed this position statement. The primary aims are to provide some clarity for the intensive care community in the current and future practice of RRS for the deteriorating patient and to include an executive summary of key areas of RRS with best supporting evidence provided in the detailed document.

Executive Summary: Joint CICM and ANZICS Position Statement on Rapid Response Systems

1. A Rapid Response System (RRS) describes a hospital wide structure providing a safety net for patients potentially becoming critically ill who have a mismatch between their clinical needs and the local resources to manage them within the patient's current location.

2. RRS have been adopted as a means to ensure patient safety around the clock irrespective of organisational philosophies and operational approaches. Hospital accreditation standards now require evidence of a reliable emergency response to the deteriorating patient by staff trained to deal with the range of potential clinical problems encountered. The structure of the team needs to be tailored to organisational patient case-mix and acuity being mindful of efficient resource allocation.

3. Meta-analyses and systematic reviews report that a RRS decreases the incidence of in-hospital cardiac arrests and hospital mortality while increasing the number of patients prescribed treatment limitations with no clear effect on ICU admission numbers.

4. RRS have evolved from cardiac arrest teams to address the need for earlier identification and intervention in the management of the clinically deteriorating patient. Generally, RRS are multidisciplinary and comprised of four limbs: 1) an afferent limb, which is the calling criteria and the method of activation, 2) an efferent limb, which is the Rapid Response Team (RRT) itself, 3) an administrative limb, which is responsible for the day-to-day running of the RRS and 4) the quality improvement and governance limb which addresses system and clinical factors contributing to deterioration.

5. There is no clear evidence for the best model for a RRS. The model employed by individual institutions must consider the resources available and the complexity and acuity of the patient mix. A RRS may use variable combinations of ward and non-ward based responders that best meet patient needs and ensure a continuum of patient care. A RRS must enhance the ability of all hospital staff to anticipate, identify, and manage patients at risk of deterioration. A combination of formalised, timely primary team review and an escalating response to deterioration may be efficient in the use of resources but may risk delays to definitive review and care. Some hospitals have implemented a staged response commensurate with degree of clinical deterioration. Within a multi-tiered response system for the detection and response to the deteriorating patient, the triggers, trigger modifications and failure to call are significant risks, particularly with lower tiers of escalation and potentially delays timely and appropriate intervention. Multiple triggers and their modifications potentially create confusion in the operations of the RRS with loss of predictability of response and efficacy of outcome. Collaborative decision-making between the ICU and primary teams minimise potential clinical inefficiencies, sub-optimal handover and follow-up and fragmented patient care. Reliance on a medically led ICU RRS working in isolation from the primary team may "conceal" hospital issues contributed to a patient's deterioration including staffing levels, inadequate training of ward staff,

access to senior medical staff, availability of clinical services and premature transfer of patients from the emergency department or the operating recovery room.

6. The development of RRS represents a cultural change for many organisations whereby there is planning and early referral for the patients at risk of or clinically deteriorating beyond the primary clinical team. Success of the RRS requires clinical teams from the RRS and the primary team to work in partnership to ensure timely review and continuity of clinical care. Such an approach has the greatest potential to enhance the skill set of members of each team and ensures that the RRS does not mask organisational problems in the patient journey.

6. The specialty of intensive care medicine has significantly driven the development and implementation of RRS in many parts of the world and has a clear role in RRS service delivery and governance. Intensive care medicine training provides the skill set needed for the early recognition and management of clinical deterioration and resuscitation as required. Nursing lead teams have not been shown to be inferior to medical led teams, although they have not been thoroughly tested in large teaching hospitals.

7. Inadequate resourcing of the RRS may in itself have an adverse effect on the quality of care in ICU by preventing clinical handover of patients or by removing required staff from the direct care of ICU patients.

8. Despite the composition of the team being variable, a high proportion of cases require involvement of ICU medical staff. The required skill set for ICU staff should focus on knowledge, technical and non-technical skills, and leadership skills should be taught, ideally in the context of immersive team training.

9. There is no conclusive data to define the optimal set of calling criteria for RRS. As a result, there is significant variability in practice as individual institutions design systems to suit their patient populations. However, some triggers for RRS callouts are extreme and potentially unsafe for the deteriorating patient. Patient or family activation of the RRS may provide an additional safeguard. Modification of calling criteria, to account for chronic disease and individual patient needs, has not been validated for safety and therefore must involve senior clinicians.

10. A hospital needs to define the particular equipment and consumables required by the RRS to bring to the location of the call. The RRS must be able to provide services including acute resuscitation, recommendations on appropriate further management including the recognition of the need for end-of-life care and ensure follow-up arrangements are of an appropriate time frame. There is limited evidence to describe which resuscitative interventions should be provided by a RRS.

11. The governance of an RRS in acute care facilities must have delegated responsibility to ensure the system is adequately clinically resourced with timely and data driven evaluation of performance aiming to improve the response and outcomes for deteriorating patients. A safety and governance committee requires representation from clinicians including intensive care, hospital administration,

quality and safety and consumers. In addition there is a need to benchmark and compare processes, resources and outcomes between hospitals though mechanisms such as a clinical quality registry.

12. Reliable provision of an RRS requires consistent identified resources for staffing, training and policy development and clearly identified within operating budgets.

Introduction:

Rapid response systems (RRS) have been implemented to identify acutely deteriorating hospitalised patients. The RRS aims to provide additional clinical review and interventions by more senior staff when patients have objective markers of instability. Such systems were initially established in response to a perceived need to better support the deteriorating patient using clinical criteria expanded beyond that of cardiorespiratory arrest. The team would be summoned to assist in the management of a wider range of emergencies before clinical deterioration was irretrievable. [2] With accumulating evidence of a positive patient benefit of RRS, [3] many organisations face increased service demands and "practice creep" without commensurate allocation of resources.[1]

The College of Intensive Care Medicine (CICM) of Australia and New Zealand and the Australian and New Zealand Intensive Care Society (ANZICS) developed a peer-reviewed, evidence-based Position Statement on RRS for the deteriorating hospital patient. The rationale for the statement related to RRS becoming mainstream clinical practice, promoted by national recommendations on patient health and safety without a clear definition for the role of intensive care specialists.[4]

The scope of the review included:

1. Defining RRS terms and elements
2. The history and description of current practice of RRS
3. Review of evidence base for the effect of RRS on patient outcomes
4. Description of RRS models in current practice
5. Training requirements for members of Rapid Response Systems (RRS)
6. RRS calling criteria
7. Patient care services provided by the RRS
8. Resource requirements for RRS

Methodology:

At the direction of the ANZICS and CICM Boards, the Education Officer from CICM and the Quality and Safety Officer of ANZICS were appointed as co-chairs to develop a steering committee to guide the process of the development of the Position Statement. The remainder of the steering committee was comprised of five recommended clinicians from each organisation with identified expertise in the field of RRS. Recommended clinicians were required to have contributed to the RRS literature or have extensive experience with developing, managing or teaching within the sphere of RRS. The Steering Committee defined the context of RRS in line with current definitions developed within New Zealand and Australia. A series of questions primarily based on the outcomes of the ANZICS Safety and Quality Conference: The Role of Intensive Care Rapid Response Teams, Melbourne 2014 defined the scope and content of the Position Statement [5]

The Steering Committee assembled a Working Party whose collective expert opinion would cover the broad spectrum of views on RRS evident in the intensive care medicine community within Australia and New Zealand. Letters of invitation were sent to the Chairs of CICM and ANZICS Regional and National

Committees including Rural and Remote focus groups to identify potential contributors. The Steering Committee reviewed the inclusion of nominations for the Working Party. For each question, members of the Working Party were assigned into Writing Groups chaired by a member of the Steering Committee.

The overarching methodology for the production of the Position Statement followed the recommendations of the NHMRC[6] with the aim to produce a practical narrative review given the diversity of information sources and breadth of questions. The Writing Groups conducted the literature search, defined criteria for study inclusion and presented the evidence for content area of the assigned questions. Searches were not restricted by language but only full texts of English-language articles were retrieved for the study selection process. Bibliographies of included articles and grey literature sources were also searched. Databases searched included Pubmed, MEDLINE, CINHAL, EMBASE, The Cochrane Library, EconLit EBSCO, UK Clinical Research Network (UKCRN), Current Controlled Trials, WHO International Clinical Trials Registry Platform (ICTRP) and the Australian New Zealand Clinical Trials Registry (ANZCTR).

Guidance given to the Writing Groups was to consider randomised controlled trials (RCTs), controlled clinical trials (CCTs), cohort studies with controls and case–control studies describing “criterion called” team response to the assessment and management of a clinically deteriorating patient. In addition, government recommendations, consensus statements, systematic reviews and meta-analyses were eligible for inclusion. Case reports, case series and editorial opinions were not considered except to highlight areas where the literature did not provide a sufficient answer to the questions assigned. The patient population included both children and adults but neonates in a neonatal care unit were excluded.

Outcome measures included but were not confined to hospital mortality, ICU admission rates, cardiac and respiratory arrest rates, RRS calls within 72 hours following ICU discharge, frequency of multiple medical emergency response as multiples to one patient and per 1000 inpatient admissions, institution of palliative care and acute resuscitation plans, rates of unplanned ICU admissions. The included studies were reviewed by the Steering Committee for quality and relevance to the specific questions.

Data synthesis methods were determined by the nature of the studies included with the formulation of a summary statement and a discussion of the supportive evidence. Answers for each question were reviewed for relevance and consistency of opinion within Australia and New Zealand by the Steering Committee, Regional Committees and the Boards of CICM and ANZICS. This Statement is for guidance only with disclaimers detailed in the Appendix.

Position Statement:

1. What is a Rapid Response System (RRS)?

A Rapid Response System (RRS) describes a hospital wide *system* composed of interacting elements for detecting, responding to and managing patients who are at risk of clinical deterioration, or who have clinically deteriorated. The RRS provides a safety net for patients whose clinical needs cannot be met through use of resources available from their primary team or the patient's current location. The precise nature of a Rapid Response System is defined by the needs of an institution to effectively manage deteriorating patients. As such a broad definition is required in order to effectively classify the variety of possible structures.

1.1 Common Terms and RRS elements

A RRS generally is described as comprising four components:

1. Afferent limb – detects deterioration and activates team
2. Efferent limb – the team and equipment that are summoned to the deteriorating patient
3. Patient safety/process improvement
4. Governance/administrative structure [1, 7]

Typically, the **afferent** limb is a protocolised process where a call for assistance is based on the detection of physiological abnormality from the routine patient vital signs taken by ward nursing staff. It may also include other clinical information such as urine output, laboratory results, pain, seizures, bleeding or qualitative criteria such as staff or family concern.[8] The latter may be of particular importance in the paediatric setting with parents detecting subtle change in a child's condition. Single parameter call triggers only require one mandated abnormal observation or concern to initiate system activation. A composite score such as the early warning score (EWS) aggregate assigns weighting for call criteria to provide a graded response to the deteriorating patient.[9] Although most early detection systems are vital sign based, the addition of other parameters such as admitting diagnosis and laboratory data may enhance the ability to detect at-risk patients.[10]

The **efferent** limb describes the responding clinician team and is often determined by the expertise immediately available. In larger hospitals with Intensive Care Units (ICUs), it is common for ICU clinical staff to be members of the responding team. In centres without an ICU, the team may be led by either senior nurses, senior medical or junior medical staff. Typically the responding team is referred to as a 'Medical Emergency Team' (MET) or 'Medical Emergency Response Team' (MERT) if medically led. However the term Rapid Response System (RRS) may be used to refer to either a MET/MERT or a nurse-led team.[1] In many organisations, an escalating, tiered response aims to match patient need to the skills of the called clinical staff.[4] Any system process where the detection and call protocol leads to a defined and appropriate clinical response is commonly known as a 'track & trigger' system, tracking deterioration to a defined point where a response is triggered.

A RRS also requires patient **safety and quality improvement** components which at a most basic level is an audit of RRS calls and adverse events. Insights gained are fed back to bedside clinicians and help guide changes in processes of care.

Finally, a RRS requires a **governance and administrative** limb to oversee the day to running of the RRS, update relevant policies, resourcing and RRS team member training.

Many hospitals also utilise nursing staff to review 'at risk' patients. Typically, such teams are referred to as 'Critical Care Outreach Teams' (CCOT), 'Outreach/ICU liaison' nurses or 'Patient At Risk' (PAR) teams. This approach aims to be more pre-emptive and pro-active than an RRS. Patients at-risk may be identified through the use of 'track & trigger' systems or defined consultation review criteria. Often but not exclusively, members of these teams are also members of the RRS. 'Outreach' is not synonymous with an RRS, although there is often overlap between the two systems.[11]

2. The history and description of practice of RRSs within Australia and New Zealand

RRS were conceived based upon the underlying principle that early recognition of acute patient deterioration, and subsequent activation and intervention by a suitably trained team would prevent serious patient adverse events and improves patient outcome. RRS were the first organisation-wide, patient-centred, pre-emptive safety system. Prior to the development of RRS, patient safety research had focused on the capture of hospital adverse events rather than patient safety care models.[12,13] There was little evidence to demonstrate that policy-driven, top-down, patient safety interventions had significant impacts on serious adverse events such as mortality and cardiac arrest.[5]

RRS initially evolved from cardiac arrest teams with their development largely overseen by intensive care medicine specialists. The concept of critical care clinicians leading a RRS emerged at the Liverpool Hospital, New South Wales, Australia in 1990, the "Medical Emergency Team" (MET).[14] At that time, the hospital was small and soon to become a teaching hospital. Despite the common barriers to change management of geographical and professional silos, there was interest and support from both nursing and medical intensive care colleagues to develop a RRS. The initial service was developed with no additional infrastructure.

The subsequent uptake of RRS into Australia and New Zealand occurred prior to studies showing a beneficial effect on patient outcomes.[7,15] In 2010, the Australian Commission on Safety and Quality in Healthcare (ACSQHC) published a consensus statement on deteriorating patients requiring acute care facilities to have a RRS.[4] Such recommendations subsequently became incorporated into national standards linked to hospital accreditation. The ANZICS-CORE 2014 survey records that more than 90% of ICU-equipped hospitals have used a RRS.[16]

The specialty of intensive care medicine has driven the development and implementation of RRS in many parts of the world. In Australia and New Zealand there have been landmark trials and ongoing research into the application and training required to support an RRS.[17] Over the last 20 years, different models of RRS have evolved across a range of adult and paediatric health care settings. RRS utilisation has increased over time as hospital staff becomes more familiar through education campaigns and direct exposure. [18,19]

3. The effect of RRS on patient outcomes

The effect of introducing a RRS on a variety of outcomes including cardiac arrest, in-hospital mortality, admission to ICU, not for resuscitation orders, complications after surgery has been studied in many countries using different methodologies.[20,21,22] Such studies present a variety of methodological limitations, largely derived from the nature of the RRS itself. These include an inability to randomise at an individual patient level, lack of equipoise, difficulty in reproducing human behaviour and variability in baseline performance, triggers for activation, call rates between centres and the training and expertise of RRS team members.[20,21,22] These features of RRS preclude a traditional individual randomisation trial and blinding.

Increasingly, meta-analyses and systematic reviews report that implementation of a RRS decreases the incidence of in-hospital cardiac arrests and hospital mortality, increases the documentation of patients with a treatment limitation but has no clear effects on ICU admission rates.[3,23-28,29,30] In paediatric facilities, cardiac arrest rates are low. Nevertheless, introduction of a RRS has been shown to reverse an increasing trend of critical deterioration [31] and a relationship between RRS dose and patient outcome has been described.[32]

Three meta-analyses suggesting that RRSs decrease the incidence of in-hospital cardiac arrests.[3,24,28] These studies consistently show that the relative risk for cardiac arrests in the context of the RRS is approximately 0.66 (CI 95% 0.46-0.84) and is similar for both adults and children. This association has been observed for both adult and paediatric populations.

The association between implementation of a RRS and reduction in hospital cardiac arrests has biological plausibility. Thus, several studies have suggested up to 80% of in-hospital cardiac arrests are associated with preceding arrangements for vital signs and suboptimal care.[33-36] In addition, the frequency of cardiac arrests is approximately tenfold lower than that of rates of RRS review. Hence, it is feasible that the RRS could potentially review the majority of patients at risk of in-hospital cardiac arrest. Furthermore, at least two studies have revealed a dose response association between increasing RRS calls and reducing frequency of in-hospital cardiac arrest.[37,38] An additional mechanism by which the RRS could reduce in hospital cardiac arrests is by the implementation of new limitations of medical therapy.[39]

Meta-analysis suggests that implementation of RRS is associated with a reduction in all-cause hospital mortality with odds ratios near 0.9 and unexpected mortality near 0.5.[23,40] Only a single centre study provides evidence for reduction in post-operative complications, following the implementation of RRS. [41,42] Finally, implementation of a rapid response system may also enhance end-of-life care processes.[43]

4. RRS Response Models described in Australia and New Zealand

The ACSQHC mandate all Australian hospitals to have a RRS.[4] However, the ideal composition of the response component remains uncertain. The range of RRS models primarily differ on whether the initial response is led by ICU medical staff, ICU nursing staff or ward-based medical staff. Most calls are to review patients “at-risk” of deterioration or require simple ward based managements with 75-90% of patients

remaining on the ward.[44] However, this does not diminish the need for detailed assessment and the formulation of a clinical plan aimed to minimise further deterioration.

4.1 Primary Response from ICU Medical Staff

The ICU medical staff can provide assessment skills and resuscitation expertise to a critically ill or potentially deteriorating patient.[45] Additionally, ICU staff can expedite patient transfer to a more appropriately resourced healthcare environment including inter-hospital transfer. [45]

ICU trainees and hospitalists reported the utility of the clinical experience of being part of a RRS.[18,46] However, the potential for routine attendance at RRS events to decrease learning opportunities of junior ward staff [47] but is not a uniformly held opinion.[48,49] Implementation of a successful RRS can increase morale and empower ward nurses[49,50] but may increase the reluctance of ward staff to manage patients with abnormal vital signs despite reassurance from ICU medical staff.[51]

Collaborative decision-making between the ICU and primary teams minimise potential clinical inefficiencies, fragmented patient care and sub-optimal handover and reviews.[46] Reliance on a medically led ICU RRS working in isolation from the primary team may 'conceal' hospital issues that possibly contribute to patient deterioration such as staffing levels, inadequate training of ward staff, access to senior medical staff, availability of clinical services and premature patient transfer from the emergency department.[52]

An often-raised concern with an ICU-led RRS model is that medical staff can be called away from known critically ill patients, regardless of clinical demands, time of day or staffing levels. Disruption of ICU ward rounds, patient reviews, clinical handover, procedures and family meetings can jeopardise patient safety and care of the critically ill [18,46,47,53,54] especially where there is a high call rate[44] and the RRS is not specifically resourced.[54]

Primary response from the intensive care unit with concurrent attendance and joint management planning with the ward team has the potential advantage of better integrated care of the most at risk patients at a hospital level.[47] Additional advantages of an ICU led RRS may include education of ward staff,[55] triage of unstable patients who may require ICU transfer, provision of a second opinion regarding goals of care and limitations of treatment[39] and reduce delays in definitive management of clinically important deterioration. It has previously been argued that any hospital wide approach with services which extend beyond the physical boundaries of intensive care and high dependency units, has the greatest chance of making optimum use of available resources including beds.[56]

4.2 Primary Response from Ward Medical Staff

In one centre, an initial RRS response from a ward-led team for medical patients was equally safe as an ICU-led RRS.[57] Primary team medical staff are familiar with the patient, their disease, management plan and have rapport with the family. One-third of RRS activations occur in patients with end-of-life issues,[44] and limitations of medical treatment are mostly documented prior to the arrival of the RRS.[58,59] Engaging the ward-based medical team emphasises the importance of anticipating deterioration of their patients,

considering treatment goals and maintaining clinical skills. Incorporating clinical leadership from ward senior medical staff is likely to have a positive impact on ward staff, patients and families.

However, some treating teams may have limited ability to attend to the needs of a deteriorating patient due to a lack of critical care skills or coinciding clinical obligations such as surgical teams in the operating theatre. These factors may equate to delayed RRS activation, which is associated with increased mortality.[60] In addition, there may be theoretical advantages of providing an acute second opinion from an external team, independent of the usual carers of the patient.

There is little information on the utility of a tiered or stepped response for a RRS activation. As an example, the initial RRS response is from a ward-based team, with an ICU-led team becoming involved if the patient's physiological derangement is more profound. Such a mandated response is often reflected in the charting of clinical observations. Such tier response systems may increase the failure to call rate[61] with an increase in calls for both ward-led and ICU-led teams.[62,63] Despite the increasing rate of RRS calls and lower severity of illness of patients admitted to ICU, rates of cardiac arrests and in-hospital mortality may not be affected.[60] Within a multi-tiered response system for the detection and response to the deteriorating patient, the triggers, trigger modifications and failure to call are significant risks, particularly with lower tiers of escalation and delays to timely and appropriate intervention. Multiple triggers and their modifications potentially create confusion in the operations of the RRS with loss of predictability of response and efficacy of outcome.

4.3 Primary Response from an Intensive Care Unit Nurse

A range of nurse-led (critical care trained) RRS models have been adopted in some Australian and New Zealand hospitals.[11,64-67] Trials do not support nurse-led over doctor-led teams.[24,68] Patients referred to a nursing review service may be different to patients referred to a medical emergency team.[13] In Australian hospitals, most nurse led-RRS are located in rural or smaller metropolitan hospitals.

While nurses have a defined scope of practice, the vast majority of RRS calls do not require complex therapies. Alternative models which utilise nurse practitioners, with an increased scope of practice are now described. These roles have the potential advantage of allowing the development of a group of expert responders. However, training requirements are ill defined.[69] Ward nurses are more likely to call for help from another nurse[46,49] and are more receptive to feedback and education from nursing colleagues.[11,67,68,70]

5. How should advanced trainees in intensive care medicine be trained to participate in RRSs, and what should the competencies of a Fellow of the CICM be in relation to the assessment and management of deteriorating ward patients?

5.1 RRS – Learning Objectives and Expected Skill Set

Many of the learning objectives and required skill sets required to complete a RRS review are similar to that outlined in in the CICM document *Competencies, Learning Opportunities, Teaching and Assessments for Training in General Intensive Care Medicine*.[71] There are several important differences between deterioration in the ICU and on the ward in the context of a RRS (Appendix Table 1).[5] The ICU doctor will often be the

team leader[65] and will need to work with potentially distressed ward staff and manage the intra-team dynamics of the RRS. Additionally, patients often have an undifferentiated diagnosis with a greater need to perform simultaneous assessment and management.[72] The RRS may also need to transport and monitor an unstable critically ill patient and also need to triage which patients require ICU admission.[44]

Despite the wide range of potential calls, it is possible to characterise RRS calls according to the main theme of the review and the major management aims (Appendix Table 2).[44] Common causes of RRS calls include pulmonary oedema, arrhythmias (in particular atrial fibrillation), seizures and sepsis.[73]

5.2 Important Principles in the Management of a RRS Review

The RRS members are often unfamiliar with the ward environment they are called to attend.[72] The team is often formed ad-hoc with unacquainted team members. Call goals should include the following, with the team leader coordinating all such elements of care: [72,73]

1. Simultaneous assessment and management to ensure an adequate airway, breathing and circulation.
2. Establishing or confirming a provisional diagnosis.
3. Ensuring that the events surrounding the RRS review are clearly documented including the:
    a. provisional diagnosis.
    b. management plan.
    c. proposed interventions and investigations.
    d. plan for subsequent frequency of vital signs and other observations.
    e. follow-up plans specifying time frames and rationales.
4. Communicating the cause of the deterioration, management plan and the ongoing personnel responsibilities for follow-up with the:
    a. patient and their next of kin.
    b. parent unit medical and nursing team.
5. Support for the ward staff and avoidance of criticism.
6. Ensuring clinical stability and appropriate patient monitoring during transport during transitions of care.
7. Triaging the patient and determining where the patient should be managed at the conclusion of the RRS call.

5.3 Domains for Addressing Learning Objectives for a Rotation to the RRS

The learning objectives and skill set required for proficient management of a RRS call can be divided into the several domains:

1. Knowledge base:
    a. Principles of the RRS.
    b. Differential diagnosis of conditions causing RRS calls / RRS syndromes.
    c. Detailed knowledge of clinical conditions causing RRS calls.
    d. Theoretical knowledge of how to manage deteriorating or critically unwell patients.

2. Procedural skills and application of interventions used during RRS review (Appendix Table 3).

3. Teamwork and crisis management during the simultaneous assessment and management of deteriorating ward patients:
    a. Ensure problems with the airway breathing and circulation are identified and corrected in a timely and efficient manner.
    b. Develop a structured and systematic approach to the assessment and management of a RRS review patient.
    c. Prioritise problems related to physiology, clinical conditions, and resources.
    d. Establish team dynamics and coordinate roles/responsibilities of all team members to optimise the performance of the team.
    e. Triage the patient throughout the call to determine where the patient is best managed at the conclusion of the call.

4. Leadership, Team-working and non-technical skills:
    a. Team leadership and control of RRS call.
    b. Team coordination and delegation to manage roles and goals.
    c. Situation monitoring and maintaining awareness.
    d. Communication skills – with family and ward staff and members of the RRS, and during hand over and referrals.
    e. Decision-making and planning.

5.4 Defining the Roles of Each of the Team Members

The members of the RRS from the ICU will need to interact and work with staff from the ward, the usual caring team, allied health and support staff, and other clinicians that become important in the patient's immediate and ongoing care. In many instances, the ICU doctor will function as the team leader. In such cases, it is important that non-technical and leadership skills of crisis resource management are used (Appendix Table 4). In cases where ICU nurses are involved in the RRS, it will be important to also define the knowledge and skill set of these staff (Appendix Table 5).

5.5 How To Train The RRS[72]

Because of the wide variety of skills, knowledge and behaviour required to train a registrar in the elements of RRS assessment, management and team leadership, there is a need to use a variety of training techniques (Appendix Table 6). The structure of teaching should include both theoretical and practical components. As outlined above, the content should include knowledge, skills and behaviours. This content could be delivered either online or via distributed media. Online resources permit version control and prompt updates and modifications. In contrast, distributed material permit offline access and sharing.

In house practical training is cheaper, easier to set up and may have a higher take up. External courses potentially achieve better standardisation and consistency, but require considerable infrastructure and coordination. Either option requires the need for credentialing of the facilitator. In theory external courses are more amenable to establishing a core faculty.

6. RRS Calling Criteria

There is much variability across institutions with regards to RRS calling criteria, both in chosen variables and the threshold at which the RRS is called (Appendix Table 7).[65] In addition the extremes of physiological derangement vary greatly with the range of call parameters from the most extreme measure being 50% for bradypnoea, 25% for tachypnea and bradycardia, 15% for tachycardia and 20% for hypotension.[9]

Additional cardiovascular criteria have been described such as chest pain and abnormal ECG changes. Neurological criteria also reported include *uncontrolled pain*, *possible stroke*, *agitation, delirium* and *decreased sensation or limb strength*. Subjective criteria are common and include such triggers as *concerned*, *unresolved concern*, and *seriously concerned* or *worried*. Patient or family activation have also been incorporated into calling criteria as have biochemical parameters such as pH, base excess, haemoglobin and electrolyte abnormalities. Lastly, dynamic beside variables such as *greater than expected drain fluid loss* and *uncontrolled bleeding* have been used.

Optimal thresholds for calling criteria theoretically represent an ideal balance between sensitivity and specificity and vary depending on the call criteria or the system of criteria used including single parameter, early warning scores or combination call systems.

6.1 What are the Advantages and Disadvantages of the Different RRS Calling Criteria?

Calling criteria for RRS should be easily measured, readily interpretable, able to show trends over time, familiar to staff [74], easily incorporated into student and staff education and most importantly, highly sensitive to identify patients in need of RRS review while specific enough to minimise calls to patients who do not need RRS review. The sensitivity and specificity of any calling criterion depends on the RRS model, the patient case-mix, the skill-set of the responders and the threshold of specific call criteria.

Vital signs, traditionally including respiratory rate, oxygen saturation, heart rate, blood pressure, temperature and level of consciousness, have the advantage that they are routinely measured by bedside staff and are embedded in the culture of patient monitoring. Such signs are recommended by the ACSQHC[4] and the standardised United Kingdom National Early Warning Score.[75] Abnormal vital signs are independently associated with mortality.[76] In addition, increasing mortality is associated with the number of simultaneous physiological abnormalities detected[77] and the extent to which the individual vital sign is deranged.[78] Vital signs as calling criteria include the element of human measurement and recording error. This may in part be mitigated by electronic point of care patient monitoring and recording.[79,80]

Non-vital sign clinical variables are less frequently used as calling criteria have also been shown to be associated with clinical deterioration. Common early signs predicting serious adverse events such as death, cardiac arrest, severe respiratory problems or transfer to a critical care area are the base deficit, partial airway obstruction, poor peripheral circulation, greater than expected drain fluid loss and oliguria or anuria.[81,82]

Most RRS will include "*subjective*" triggers or "*worried*" criteria. These criteria have the advantages of providing a sense of empowerment and independence to nurses and junior doctors, are well utilised and may be associated with earlier detection of clinical deterioration compared with standard objective calling criteria.[83]

Electronic data such as patient demographics and laboratory results may be included within calling criteria. Use of electronic data has shown improved accuracy to detect early clinical deterioration compared with the Modified Early Warning Score (MEWS) using bedside variables alone. [84] A real time system using vital signs and electronic data has been associated with reductions in hospital mortality.[79] A potential disadvantage of laboratory data is the questionable relevance of a blood result many hours preceding the patient's clinical deterioration.

6.2 What are the Optimal or Acceptable Thresholds for Call Criteria?

The optimal and/or acceptable thresholds for RRS calling criteria are yet to be defined. Studies examining different calling criteria thresholds have demonstrated changes in sensitivity and specificity but have not been able to establish ideal standards.[85,86,87]

Single Parameter Systems initially used temperature (T) <35.5^{o}C or >39.5^{o}C, systolic blood pressure (SBP) <100 mmHg or >200 mmHg, respiratory rate (RR) <10 or >30 breaths per minute, heart rate (HR) <40 or >120 beats per minute, 24 hour urine output (UO) <500mls. [14] In the absence of data supporting the use of any particular threshold, organisations have applied local modifications to various calling criteria thresholds with minimal standardisation across institutions. [5]

A strong association exists between vital sign abnormalities and mortality.[78] Critical vital signs, defined as associated with ≥ 5% chance of mortality included SBP <85 mmHg, HR >120 beats per minute, T <35^{o}C or >38.9^{o}C, oxygen saturation by pulse oximetry (SpO_2)<91%, RR ≤12 or ≥24 breaths/minute and level of consciousness as anything less than alert. There is a stepwise relationship between vital sign derangement and mortality. Systolic blood pressure of 80-84 mmHg, 65-69 mmHg and 55-59 mmHg are associated with mortality rates of 5%, 10% and 20% respectively. Similarly, respiratory rates of 24-28 breaths per minute, 28-32 breaths per minute and 36-39 breaths per minute are associated with mortality rates of 5%, 10% and 20% respectively. The presence of a single critical vital sign confers a mortality rate of 0.92% while three simultaneous critical vital signs are associated with a mortality rate of 23.6%.

Early warning scores and aggregate scoring systems use individual parameters added to generate a score to trigger an RRS call. The optimal call threshold for such systems was assessed for the National Early Warning Score (NEWS) in the United Kingdom.[75] Using the combined outcome of cardiac arrest, un-anticipated ICU admission or death within 24hrs of a NEWS value, the NEWS was found to have a greater ability to discriminate patients at risk than 33 other early warning scores. [88]

There are no definitive data to enable recommendation for RRS calling criteria which would be applicable across all RRSs. However, findings from the 2014 ANZICS RRS conference included the recommendation

that some RRS activation criteria are extreme and potentially unsafe and that there is a need to agree on safe thresholds.[5] In an effort to provide clinical guidance, consensus amongst the authors of this document is that with regard to commonly used calling criteria the activation thresholds should not exceed the values outlined in Table 8 (Appendix).

6.3 What is the Role of Patient or Family Escalation?

The capacity for patients or families to activate a RRS call has been incorporated into some RRS. These calls may be instigated for a variety of reasons including an unavailable healthcare provider at the time of clinical deterioration or reluctance on the part of the ward team to activate the RRS.

There is a paucity of published literature on family or patient activated RRS, with mainly paediatric hospitals describing such systems. 'Condition HELP' described for the Children's Hospital of Pittsburgh has reported that over the first two years of the programme, there were 42 calls largely the result of communication breakdowns between the family and the health professional.[89] A family or patient activated RRS in a level 1 trauma centre noted a mortality reduction of 8 deaths per 1000 admissions with a positive response in patient and family satisfaction surveys. [90]

In Australia, the New South Wales Clinical Excellence Commission (CEC) developed a patient and family activated escalation process called 'REACH: *Recognise, Engage, Act, Call, Help is on its way'*. [91] The Canberra Hospital also developed a patient and family escalation process 'CARE: *Call and Respond Early* for patient safety'.[92] Concerned patients or relatives use traditional escalation pathways such as the bedside nurse and the lead nurse but if these are unsuccessful, they can call a dedicated telephone number. The telephone will be answered by a critical care nurse or senior nurse in the hospital. There were 41 patient or family escalations in 2013-14, and 45 calls in 2014-15. The majority of the calls were in relation to communication problems or complaints. Only 12% of the calls in 2013-14 and 9% of the calls in 2014-15 were related to clinical deterioration.[93]

In response to the death of two year old Ryan Saunders in 2007 and subsequent coroner's findings that his death was "in all likelihood preventable", Queensland Health developed a consumer and family escalation process called "Ryan's Rule". [94] This is a three-step process: initially the patient or family talks to the ward nurse or doctor. If the issue remains unresolved, discussion then takes place with the nurse in charge of the shift. Finally, escalation to a single state-wide phone number requesting a "Ryan's Rule Clinical Review" occurs, which may include involvement of the Director of Medical Services, Director of Nursing, bed manager, RRS, or ICU liaison team. A nominated Ryan's Rule doctor or nurse will then review the patient. Between December 2013 and August 2015, there were 427 Ryan's Rule calls within Queensland Health facilities, resulted in clinical intervention with the patient remaining on the ward (23%), transfer to another facility (3.9%) and transfer to another ward (2.6%). No Ryan's Rule call resulted in transfer to a high acuity monitored area such as ICU, HDU or CCU.[95] However, information in the adult patient case mix is limited and may increase general complaint calls to hospital administration.

6.4 What are Appropriate Calling Criteria Modifications and what are the Implications of Modifying Calling Criteria for Patient Safety?

Calling criteria modifications are a necessary component of a working RRS. Without modifications taking individual physiology and chronic disease into account, the RRS may become too sensitive, leading to a potential overwhelming increase in calls.[96-99] At this time, no study has investigated the potential deleterious effects of modifying calling criteria. It is possible that modification of RRS criteria may lead to delays in definitive patient management and transfer to the ICU.

Modified criteria stem from a the lack of uniformity between early warning scores, the low specificity and sensitivity demonstrated for many of the current scoring systems and the inability of scores to adapt to individual variation and chronic disease.[100-103] In Australia and New Zealand the approach to making modifications is highly variable.[9] A review of RRS activation parameters in New Zealand noted that of the 21 policies and vital sign charts reviewed, 16 could be altered by medical staff, two only by consultants and two allowed modification by nurses on the 'Patient At Risk' team.

In general, modifications beyond limits where a mortality increase has been clearly demonstrated should be avoided.[78,86] The National Institute for Clinical Excellence (NICE) states that observation charts should be designed to display information with the potential to document the normal physiological range for an individual patient.[75] In addition, an international consensus conference on the afferent limb of RRS recommended that each patient should have an individual monitoring plan taking into account specific patient factors like severity of illness, co-morbidities, age and therapies to deliver with decisions to alter the plan made by a senior clinician with appropriate documentation and communication to staff.[8] The ACSQHC recommend that observation charts should include the facility to document the normal physiological range for an individual patient and that individualised protocols should be made by members of the healthcare team, in consultation with the consultant medical officer, the patient (where possible) or the family.[4,104]

A number of Australian States and local health organisations have published guidelines regarding the addition of modifications to observation charts. These guidelines incorporate the principles of making modifications to RRS calling criteria only in exceptional circumstances with sound justification[105], by a medical officer in consultation with a consultant, with documented rationale plus time frames for review.[106]

7. Patient Care Services Provided by the RRS

Services provided will vary between organisations according to the variability in structure and role of an RRS according to institutional resources and need.

7.1 What Acute Resuscitation Services do RRS Currently Provide?

RRS provide early treatment to ward patients at risk or who have deteriorated including cardiopulmonary resuscitation[15,19,107-113] It is not known how many interventions are performed by the RRS and how many occur as a result of handover to ward or ICU staff. [114-119] It remains unclear which services are optimally provided by the RRS but in general they will be determined by the service organisation of the hospital.

Acute resuscitative interventions performed by RRS include the insertion or replacement of airway devices, airway suctioning, the administration of oxygen, non-invasive and invasive ventilation, pleural catheter insertion or decompression, the insertion of vascular access devices, defibrillation and cardioversion, and the administration of fluids, blood products and vasoactive agents. Other interventions include the administration of medications, such as bronchodilators, diuretics and antiarrhythmic, and the creation of management plans including end-of-life plans and treatment limitation orders. [114-119] The types of acute resuscitation used by RRS depend on the characteristics of the patients and hospital system.[120-122]

Specialist RRS are described for children, trauma and obstetric emergencies [19,120,121,123-126], [127-132] Small numbers of studies describe RRS specific to mental illness, difficult airways, burns, pulmonary embolus, leukaemia, patients in the radiology department, emergency department and non-hospitalised patients.[122,133-139] There are no studies specifically describing the use of RRS in the ICU or operating theatre.

7.2 What Acute Resuscitation Services Should RRS Provide?

The precise nature of services provided by the RRS will vary between organisations depending on the team leader skills set, other expertise available, and whether the response is tiered. Ideally, the RRS should be able to escalate care to the point that intensive care therapies can be commenced at the patient's bedside, pending transfer to the in-house ICU or transfer out to more definitive care

7.3 End-of-Life Assessments

The elderly, frail and many on dying pathways are commonly admitted to hospital. Often advanced health directives are not available or do not reflect the patient's current circumstances.[140] Activation of the RRS may not be appropriate in circumstances where resuscitation measures cannot achieve an acceptable patient outcome or fails to preserve patient dignity and respect. However, this does not mean that a timely clinical review is not required.[141] Despite the RRS not perhaps being the most appropriate resource for patients in a palliative care pathway, a guaranteed response to a patient in need is required. In reality, the RRS is commonly called to such situations and may provide some clarity around the appropriate goals of clinical care, however there is no guarantee that the RRS call results in an improvement in the clarity of complex and palliative care plans.[43,142 143]

Patients with life limiting illness where the RRS is called are more likely to be elderly, have higher numbers of comorbidities, have higher symptom scores especially for pain and dyspnoea, have an oncology, chronic obstructive pulmonary disease or congestive cardiac failure or be admitted from a residential care institution.[144,145]

In 5-22% of RRS calls, a treatment limitation order is considered appropriate and generally the primary team agrees, but only 4% -10% of new DNR orders are instituted.[39, 142, 146, 147, 148] Repeated RRS activations can be an indicator of death in up to 30% and should trigger a consideration for end-of-life management strategies. [149,150,151]

There are some circumstances where involvement of the RRS in patients with end-of-life care may be appropriate. The RRS may assist in the determination of appropriateness for a trial of limited ICU. Importantly, not all patients reviewed by the RRS who have limitations of medical treatment will subsequently die in hospital.[152,153] Additional advantages may include limiting the incidence and duration of ICU admissions, and supporting junior staff in complex end-of-life care discussions out of hours.[39,154] Implementation of a RRS has been associated with improvements in administration of comfort care, initiation of family discussions and pastoral care referrals.

7.4 Management and Disposition Following RRS Intervention

Patient management following RRS activation is important for continuity of care but there is little published evidence to guide decision-making.[44] Patient disposition and ongoing care are largely determined by the clinical judgment of the Rapid Response and Treating Teams. Clinical judgment regarding disposition and ongoing care depends on numerous dynamic factors.[39,145,155,156]

1. Likelihood of response to escalated intervention such as transfer to ICU, in turn depend upon the presence of:
    a. reversible pathology or clinical conditions.
    b. irreversible pathology or clinical conditions such that further advanced support will not result in an improved length or quality of life.
    c. a moribund state or continued organ failure where there has not been a response to an adequate trial of appropriate therapy.
    d. the patient's physiological reserve.
2. Patient advanced health directions in relation to resuscitation and life supportive measures.

There is consistent evidence that patients subjected to RRS intervention have a high in-hospital mortality of 20-35%, approximately 10-20 times higher than patients not requiring an RRS intervention.[29,157,158] Following a RRS call, transfer to ICU may vary from 9% to 45%, another monitored bed in 1-10% while between 75-90% of patients remain on the ward.[44] Direct operating theatre transfers occur in <1% and inter-hospital transfers in <3%. [29,83,157-163] Services required following RRS intervention are highly variable and largely determined by diagnostic and therapeutic interventions required by each patient. A list of suggested post-RRS services is provided in (Appendix Table 9).

7.5 Follow-up and Referral of Patients who remain in the Ward after a RRS Call

Management and ongoing review of patients who remain on a ward is an important issue, and affects the majority of patients receiving a RRS review. A maturing RRS may result in an increased numbers of patients stabilised without transfer to the ICU/HDU.[164]

Those remaining on a ward may continue to trigger or experience recurrent RRS calls, although few (1%) die if there is active treatment intent.[165] RRS team referral to ICU does not always result in immediate ICU admission, with a delay of one or more days affecting 20% of ICU admissions following a medical emergency team encounter.[166]

Critical Care Outreach Teams (CCOT) have an established role in reviewing patients following discharge from ICU to a general ward.[25,167] A Nurse Practitioner in a CCOT service reviewed patients who remained on a general ward after an ICU medical review,[168] and planned follow up by the RRS following medical emergency encounter is described.[116] Although some hospitals utilise CCOT to review patients remaining on a ward following a RRS encounter,[169] there is no clear documentation of improved patient outcome.[11,64,70,168]

In the absence of a strong evidence base relating to the care of patients who remain on a ward following a RRS encounter, the following general recommendations are made:

1. ICU staffing and resources should be sufficient to accommodate increasing workload as more unstable patients are managed outside the ICU, who may require repeated clinical review.
2. Appropriate follow up will be determined by the goals of care set after the RRS encounter.
3. Those patients where limitations of medical therapy are implemented would be more appropriately managed by ward based teams or specialist palliative care services, than by ongoing critical care review.
4. Processes should be in place for further review of patients for whom ICU admission would be considered if their condition changes.
5. Nurse-led CCOT would be well placed to provide ongoing review of patients remaining of ward after a RRS review.
6. Following the RRS encounter there should be clear communication between the RRS team and ward medical and nursing staff regarding responsibility for ongoing review and management of the patient.
7. Further study is required to develop an evidence base regarding appropriate management of patients who will remain on a ward following a RRS review.

8. What Resources are required for the Maintenance of Both the Services and Standards of the RRS?

Although the majority of RRSs have grown from existing resources, often allocated from within critical care units or emergency departments, maintaining their ability to function effectively may be limited without additional organisational support. RRSs in Australia and New Zealand review more than 100,000 patients annually, intensive care units (ICUs) provide staff for virtually all RRSs and oversight in more than 80 percent. [65] Additional funding for RRSs in Australia and New Zealand is provided in only 25% of hospitals.[65]

Resource provision can be considered across all the domains of the RRS with the last two (quality improvement and governance) discussed together. These are, namely:

1) The afferent limb: detection systems including monitoring practices and associated education,
2) The efferent limb: team structure and equipment, training and education of team and ward staff,
3) Quality improvement: data collection and interpretation, administrative and governance processes.

Resources required will vary between organisations according to the variability in structure and role of the RRS according to institutional resources and need.

8.1 Resourcing the Afferent Limb

Consensus opinion recommends monitoring "the ongoing assessment of a patient with the intention of detecting abnormalities and triggering a response if an abnormality is detected" as a routine part of inpatient care.[8] Monitoring also assists with triaging the patient to an appropriate level of care.

Monitoring can be manual or automatic, dependent on available resources. Policies and guidelines outlining core set of vital signs and the frequency of monitoring them should be developed in each health care setting.[170] Monitoring equipment must function consistently with regular appropriate biomedical checks and support. Staff must be trained in its use. The number of monitoring devices should be appropriate for the number of patients, staff and expected acuity. A 2011 survey across ten hospitals observed inadequate labour resources were the most often cited reason for missed care (93.1% across the 10 hospitals), followed by material resources (89.6%) and communication issues (81.7%).[171] Adequate staffing along with appropriate clinical supervision and effective communication during day and night can improve monitoring compliance.

Standardisation of vital sign observation charts used for monitoring, documenting and triggering a system response may improve compliance and education across health care settings in addition to facilitating RRS research. Human factor studies have identified that charts with better design in terms of font size, colour coding and legibility yield fewer errors.[172] Resources allocated to planning paper-based detection and escalation systems should include experts in graphic design principles.

Many hospitals in Australia and all in New Zealand have some form of track and trigger system in place based around routine clinical observations.[104,173] Resource provision should include education on how to obtain and record the relevant parameters, the rationale behind an EWS system and how to calculate and escalate appropriately for the local setting. Education on a local EWS system should be a mandatory provision for new staff as part of hospital orientation.

Education resources are also recommended for training staff to use standardised communication tools such as 'SBAR' (Situation, Background, Assessment, Recommendation).[174] These have been shown to improve communication between health professionals and may contribute to a reduction in serious adverse event.

Continuous electronic monitoring systems with the ability to detect and alert for deterioration have been developed and studied in single centre studies.[175,176] Such technology may help empower the bedside nurse to escalate to a system response.[177] Wider acceptance of these systems will depend on ease of use, perceived utility, adaptability of the system into workflow, and a proven cost-benefit. Such systems may be considerably more expensive than their paper alternative and may require significant investment in technology as well as staff training.

Resources for promoting the engagement of patient, families and carers in the escalation of care are recommended. Such systems have been shown to improve outcome without significantly increasing false

alarm in a single centre study.[90] For this to work effectively, information about the process of escalation of care should be provided to the patient on admission to hospital as well as public advertisement throughout the hospital Expertise in health literacy is recommended for developing these processes. Health professionals also need to be educated about the purpose and existence of this system.

Resources should also be allocated to simulation based training where possible. The recognition and response to clinical deterioration, communication skills and the non-technical skills of team dynamics can all be taught using inexpensive low-fidelity simulation.[178] Initiatives such as the 'Between the Flags' program in New South Wales, Australia [179] and COMPASS[180] in Australian Capital Territory, Australia provide resources for education, implementation and governance, are freely available, and should be encouraged.

8.2 Resourcing the Efferent Limb

The RRT itself however is probably the most costly component of a RRS.[181] The presence of a physician on the team, such as an ICU registrar or specialist, will further increase the cost. With increasing scrutiny on RRS infrastructure costs in the current financial climate, inclusion of more senior critical care personnel on the RRS is constrained by evidence of cost effectiveness. Unfortunately, compelling evidence for the optimal team composition is not yet available.

There is evidence, particularly in RRS equipped hospitals, that ICU staff provide oversight for more than 80% of calls. This service however utilises existing ICU staff and additional funding for RRS is provided in less than one-third of hospitals[44,65] which may lead to major adverse events, and places significant disruptions to ICU services which are not captured by the usual hospital reporting systems.[47]

The training and competencies required for responding to clinical deterioration will depend on the particular acute care setting. Clinical staff as part of a team that responds to clinical deterioration should be trained in Advanced Life Support (ALS). Competence should be assessed every 3 -4 years for the practical skills component. This could be supported with annual updates using an e-learning package.

What are the equipment needs of an RRS?

During a clinical crisis, ensuring a safe and efficient emergency response requires the timely availability of standardised drug supplies plus operational and well-maintained equipment appropriate to likely circumstances as well as a logistic support program. Institutional, government and non-government guidelines are based on consensus and expert opinions.[182,183, 184, 185,186 187,188] Variation is often found throughout a hospital in equipment and drug supply.[189] Standardisation across an organisation is associated with a reduction in restock errors, crisis response times, and the probability of clinical error.[108] Specific requirements for portable transport bags, trolleys and specific access to support services including making use of ambulance services for patient transport will need to be customised to the health care facility and its function. Tables 10-12 in the Appendix summarise general principles for the logistics of outfitting a RRS.

8.3. Resourcing Quality Improvement: Data Collection and Interpretation, Administration and Governance Processes of the RRS.

Central to quality improvement is the collecting and reviewing of data to identify opportunities to improve the operations of the organisation with the end result of delivering better services resulting in better patient outcomes. The management of the RRS is no exception to this. Acute health care facilities range from large tertiary health care facilities to small community hospitals and the composition of the RRS will be reflective of that. Regardless of the complexity of the RRS as with any hospital system it must be subject to stringent data collection, analysis and review.

The Australian Commission on Safety and Quality in Healthcare recommends a governance structure for RRS to provide evaluation of the hospital wide performance of the teams.[4] There should be representation from clinicians, hospital administration, quality and safety and consumers. They are responsible to ensure appropriate resources and administrative support is available to run an effective RRS. The Commission specifically recommends that acute care facilities:

i. Assign responsibility, personnel and resources for the evaluation of recognition and response systems.
ii. Provide systems to support evaluation, audit and feedback of recognition and response system performance.
iii. Receive and analyse data results and implement solutions to address variations in data to improve recognition and response systems.
iv. Support the development and collection of data measures for each component of recognition and response systems.

In addition there is a need to benchmark and compare processes, resources and outcomes between hospitals though mechanisms such as a clinical quality registry.

9. Conclusions

Rapid response systems have become an accepted approach to keep hospitalised patients safe within a 24 hour care environment. They potentially form a component of an ICU outreach program. The specific operating characteristics of the RRS will vary with the organisation care structure for deteriorating patients. Key elements of the RRS are a dependable, well trained and resourced multidisciplinary clinical team responding appropriately to a call system which identifies patients who are deteriorating and at risk of becoming critically unwell without timely intervention. In addition, an ongoing educational program to maintain clinical competence needs to be maintained with a governance structure which ensures the maintenance of standards and quality improvement.

Appendix

Statement Disclaimer

This Statement is for guidance. It is not a substitute for proper clinical decision-making having regard to the particular circumstances of any case. It is not a substitute for proper clinical decision-making having regard to the particular circumstances of any case.

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Table 1: Comparison of training models for ICU and RRS medicine[5]

Variable	**Typical ICU training model**	**Typical RRS training model**
Nature of environment	-Closed and controlled -Equipment immediately to hand -Likely to be electrically isolated	-Open and uncontrolled -Equipment randomly distributed and may not be available -May not be electrically isolated
Availability of senior medical advice	Immediate	Primarily during working hours
Senior nursing staff on site	24hrs/day and 7 days/wee k	Primarily during working hours
Skill mix of nursing staff	Registered nurses	Registered and enrolled nurses
Patient to nurse ratio	1:1 or 1:2	1:4 -1:9
Experience of staff	Typically critically care educated	Typically not critically care qualified. This may be reflected in their skill set, knowledge and coping strategies in dealing with an acutely unwell patient.
Nature of patient deterioration	-Usually predictable -Immediately detected due to monitoring	-May be unpredictable and heterogeneous -Detection variable and potentially delayed due to intermittent nature of vital signs, diluted skill mix and limited scope of practice
Trainee supervision	Heavily supervised	Often unsupervised
Trainee familiarity with patient	Very familiar	Often unfamiliar

Table 2: Summary of major themes and objectives of RRS calls. [44]

Type of call	Features	Main objectives
Escalation of care (10-20%)	Patient admitted to ICU after the call	-Triage call -Communicate with ICU about need for and timing of admission -Commence ICU level care on ward
End-of-life care (≅ 30%)	The patient has issues around end-of-life care and has treatment limitations	-Clarify current limitations of medical therapy -Explore whether additional limitations of medical therapy are appropriate -Ensure appropriate comfort care has been prescribed
Expeditious care (> 50%)	Patient well enough to initially stay on the ward	Ensure that a clear management plan and follow-up is in place and to provide education for junior ward staff when time permits.

Table 3: Suggested knowledge and technical skill requirements for clinical staff participating in RRS calls

System	Knowledge	Technical Skill / task
Airway	Airway assessment and anatomy Signs of obstruction Intubation / securing airway Safe use of different airway devices Management of Tracheostomy tubes	Jaw thrust / chin lift Oral suction using Yankeur sucker Insertion of oro-pharyngeal airway Insertion of naso-pharyngeal airway Changing of tracheostomy tube Insertion of ETT
Breathing	Assessment of patient with hypoxia, hypercarbia or respiratory distress. Knowledge of different oxygen delivery systems.	Examination of respiratory system Bag-valve mask ventilation Insertion of Inter-costal catheter Prescribing Non-Invasive ventilation
Circulation	Management algorithms for basic and advanced life support. Assessment and management of: • Hypotension • Arrhythmias • Volume status • Peripheral perfusion • Hypertension	Examination of cardiovascular system Insertion of venous cannulae Insertion of arterial cannula Taking of ABG (single stab) Appropriate CVC insertion Perform CPR Perform safe defibrillation Fluid administration

System	Knowledge	Technical Skill or Task
Neuromuscular	Assessment of: • Consciousness • Delirium • Focal neurology • Pain • Dermatomes/myotomes	Examination of nervous system Lumbar puncture Assess epidural blockade Assess spinal sensory and motor level Joint examination
Gastrointestinal	Assessment of acute abdominal pain	Examination of abdomen Insertion of NGT
Renal	Assessment of patient with: • Oliguria • Acute renal failure • Chronic renal failure	Insertion of urinary catheter
Investigations	-Universal precautions for sample collection -Risks and benefits of transporting unstable patient for imaging (e.g. CT and MRI) -MRI safety principles -Differential diagnoses for laboratory abnormalities	Bedside interpretation of test results: • Blood tests • Other pathology tests • Imaging Preparing and monitoring unstable patient for safe transport
Prescribing	-Indications, contraindications and potential side effects of a broad range of medications. -Altered pharmacology in the acutely unwell patient.	-Titration of vasoactive medications. -Safe preparation and administration of intravenous medications. -Blood product administration.

ETT = endo-tracheal tube; ABG = arterial blood gas; CVC = central venous catheter; CPR = cardio-pulmonary resuscitation; NGT = nasogastric tube; CT = computerised tomogram; MRI = magnetic resonance imaging

Table 4: The ANTS taxonomy for non-technical skills used in crisis resource management[190]

Categories	Elements
Task Management	• Planning and preparing • Prioritising • Providing and maintaining standards • Identifying and utilising resources
Team Working	• Coordinating activities with team members • Exchanging information • Using authority and assertiveness • Assessing capabilities • Supporting others
Situation Awareness	• Gathering information • Recognising and understanding • Anticipating
Decision Making	• Identifying options • Balancing risk and selecting options • Re-evaluating

Table 5: Summary of expected skill set of ICU RRS nurse.[191]

Clinical performance and technical skills: a. Accredited in basic and advanced cardiac life support. b. Able to assist with endo-tracheal intubation and insertion of invasive lines. c. Application of haemodynamic monitoring. d. Preparation and administration of medications required for resuscitation. e. Setting up, commencing and trouble-shooting of non-invasive ventilation. f. Advanced knowledge and skills in the assessment and management of deteriorating patients.
Professional behaviour and non-technical skills: a. Effective communication with all staff in a respectful, supportive, constructive and non-critical manner. b. Display accurate written and/or electronic documentation relating to the emergency call. c. Display a professional manner that promotes collegiality amongst multiple care providers. d. Maintain a continuous professional development approach and be reflective of one's practice. e. To ensure timely review of patients when referred by ICU medical or nursing staff. f. Educate and train ward staff on recognition and response to patient deterioration.
ICU = intensive care unit; RRS = rapid response system.

Table 6: Suggested outline of the structure and method of content delivery for RRS training for ICU registrars.

Structure

Theory

Didactic materials

- 'Manual' in long prose
- Powerpoint presentations
- Videos with commentary

Interactives

- Moodle / Blackboard modules
- Webinars
- Forum based case reviews / discussion

Practical

- Stock scenarios with facilitator guidance notes
  - Micro-sims
  - Immersive 'long cases'
- Facilitator resources for locally generated scenarios

Materials

Knowledge

- Introduction / concept of RRS
- Roles, goals, responsibilities – running a RRS call
- Generic approach to patient deterioration
- Specific approach to common RRS syndromes
  - Hypotension
  - Hypoxia / desaturation
  - Decreased consciousness
- Logistics / scene management / disposition

Skills

- Technical
  - Airway management
    - Simple
    - Advanced
  - Respiratory support
  - Vascular/IO access
  - CPR
- Non-technical
  - Leadership
  - Communication
  - Situational awareness
  - Decision-making

Table 7: Variability of Calling Criteria and Threshold for Activation Amongst 36 Adult Australian Hospital RRS (reproduced with permission from authors ANZICS CORE MET-dose investigators) [65]

Calling Criteria	Number	Percentage of Total
Airway criteria	27	75
Threatened airway	19	52.8
Obstructed airway	9	25
Stridor or noisy breathing	6	16.7
Problems with tracheostomy	2	5.6
Respiratory arrest	13	36.1
Lower limit for pulse oximetry saturation (SpO_2)	30	83.3
Problems with breathing	14	38.9
Respiratory distress	6	16.7
Difficulty breathing	3	8.3
Severe respiratory distress	3	8.3
Difficulty speaking	2	5.6
Rapidly changing respiratory rate	1	2.8
Cardiac arrest	15	41.7
Low systolic blood pressure	36	100
SBP<90 mmHg	35	97.2
SBP<80 mmHg	1	2.8
Low heart rate	33	91.7
< 40 bpm	33	91.7
< 50 bpm	1	2.8
High heart rate	36	100
HR>120 bpm	3	91.7
HR>125 bpm	1	2.8
HR>130 bpm	8	22.2
HR>140 bpm	24	66.7
Change in conscious state	36	100
Fall in GCS>2 points	22	61.1
Decrease or fall in GCS	16	44.4
Other sedation criteria	9	25
Seizures	27	75
Low urine output	16	44.4
< 50 mls in 4 hours	9	25
< 100 mls in 3 hours	2	5.6
<30 mls in 2 hours	3	8.3
<150 mls in 3 hours	1	2.8
Persistent oliguria	1	2.8
RRS = rapid response system; SBP = systolic blood pressure; GCS = Glasgow coma score; mls = millilitres; bpm = breaths per minute.		

Table 8: Suggested RRS Call Criteria

Immediate RRS call if any of the following criteria are met:	
Cardiac arrest	
Respiratory arrest	
Threatened airway	
Respiratory rate:	≤ 8 breaths per minute ≥30 breaths per minute
Oxygen saturation:	< 85% on FiO2 0.21 < 90% on ≥ FiO2 0.21
Heart rate:	≥ 130 bpm
Systolic blood pressure	< 90 mmHg > 200 mmHg
Temperature	< 34^{o}C > 40^{o}C
Level of consciousness	Glasgow Coma Scale: decrease of two (2) or more points AVPU scale: responds only to pain or unresponsive

Table 9: Services that may be required post-RRS intervention

Ward-based care
Continuous monitoring (e.g. ICU, CCU, ED)
End-of-life and palliative care
Specialist referral for consultation
Specialist referral for intervention (e.g. endoscopy, interventional radiology)
Surgery
Inter-hospital transfer
Acute psychiatry
Allied health services
Spiritual care, counselling
Communication with patient, family, substitute decision maker

Table 10: Suggested organisation requirements to support a RRS

1. Purchasing process allowing emergency kit to be consistent with contemporary standards with comparative assessment of equipment and drugs.
2. Training program for clinical teams with annual competence in use of equipment, drugs, CPR and common clinical scenarios.
3. Clinical audit and operational check on a daily shift basis for all required emergency kit.
3. Biomedical engineering scheduled servicing and rapid repair of emergency equipment.
4. Audit program of clinical response outcomes and incidents.
5. Centralised policies governing: (a) RRS operations including a potential range of calls (e.g. Obstetric, Neonatal, Trauma, Palliative, Outbuildings and sites distant from inpatient resources); (b) Standardisation of equipment and kit location and personnel responsible for rapid delivery of equipment to clinical emergency scene; (c) Readiness to deal with clinical scenarios involving neonates, obstetrics, children and adults; (d) Clear responsibilities for the restock of emergency equipment and supplies incorporating a “replacement” of total kit during restock; and (e) Security ensuring integrity of equipment and drugs following restock and equipment checks.
6. Pharmacy holding a central supply of standardised drugs in suitable replacement form for rapid emergency deployment.
7. Rapid access to pathology/radiology – including biochemistry, haematology, blood bank.

Table 11: Suggested Basic Equipment Storage Requirements for a RRS

1. Portable emergency equipment bag (a) Divisions for rapid access to equipment and supply kits - Airway and CO2 detectors - IV access - Oxygen administration and manual ventilation - Suction - Emergency Drugs and administration devices - Biological safety equipment for staff (including needle box) (gloves, goggles, apron, N95 mask and bacterial-viral filters for airways) - Stat lab local equipment - Emergency algorithm and drug dose references - Event summary record (b) Paediatric and Adult bags
2. Emergency cart (a) Robust for deployment over multiple floor surfaces at speed (b) Movement security for equipment (c) Standardised layout of drawer content and equipment placement (d) Well labelled contents of drawers (e) Separate drawers for airway, IV access, drugs (f) Portable oxygen (g) Biological safety equipment - needle disposal box, goggles, gloves, apron, N95 mask (h) Paediatric and adult trolleys (i) Specialty need trolleys –e.g. off-site trolley
3. Access to pre-prepared emergency procedure kits (a) Interosseous access (b) Raised intracranial pressure (c) Chest drain (d) Urinary catheter (e) Massive transfusion (f) Wide bore central line (g) Quad lumen central line (h) Arterial line (i) Difficult airway trolley (j) Obstetric
4. Laminated crisis algorithms and drug dose references (a) ALS/CPR national guideline flowsheet (b) Abbreviated drug dose guide and precautions (c) Rapid sequence induction (c) Tracheostomy emergency management (d) Initial ventilator settings (e) Maternity collapse checklist (f) Broselow paediatric tape (or equivalent)
5. Communications and access (a) Local communication system (i.e. DECT phone) (b) Emergency Access passes
6. Rapid access to pathology (a) Point of care equipment – haemoglobin, biochemistry, arterial blood gases

Table 12: Suggested Contents of Resuscitation Carts/Bags for a RRS(after [192])

Drawer or compartment colour coded and standardised		
Monitor/Defibrillation Tray		
Monitor/defibrillator/external pacemaker Attached therapy cable NIBP cable SpO_2 cable Monitoring/defibrillation pads Spare defibrillator battery	 Adult/paediatric	X 1 X 2 each X 1
ECG dots		X 8
Scissors	Trauma	X 1
Torch	Pencil	X 1
Sharps bin		X 1
Airway Support		
Endotracheal tubes	Uncuffed 2.5-6 mm Cuffed 5-9 mm	X 1 each X 1 each
Laryngeal masks	Size 1-5	X 1 each
Luer tip syringe	50 mls	LMA volumes for size
Adult Yankuer	Sucker and tubing	X 2
Suction catheter	Size 6-14 gauge	X 2 each
Breathing Support		
Self-inflating bag valve mask Medium capacity oxygen mask Non-rebreather mask Nebuliser mask Nasal prongs Nebulisers Oxygen tubing CO_2 indicators Nasopharyngeal airways	Infant/paediatric/adult Paediatric/adult Paediatric/adult Paediatric/adult Paediatric/adult Paediatric/adult Size 6-8 with safety pin	X 1 each X 1 each X 1 each X 1 each X 1 each X 4 X 1 X 3 each X 1 each
Circulatory Support		
Tourniquet Skin prep Retractable IV cannulas Retractable butterfly needles Manual intraosseous needles Rapid infusion device Transparent adhesive IV dressing 2.5 cm hypoallergenic adhesive tape IV 3-way tap with extension tubing IV giving sets IV burette IV pump set x 1 being used) Mucosal atomisation device Alcohol wipes Needleless injection sites Vial access cannula Non-safety needle-size Non-safety syringes Luer lock syringes Pathology blood tubes	 14-24 gauge 21-24 gauge Paediatric/adult Appropriate for pump 18-25 gauge 2-30 mL 50 mL Biochemistry Full blood count X-match	X 2 X 5 X 3 each X 1 each X 2 each X 1 X 5 X 2 rolls X 3 X 2 X 1 X 1 X 2 X 10 X 5 X 5 X 5 each X 5 each X 2 X 2 each

IV additives labels Bandages	Coagulation Blood gas syringes Blood culture – adult/paediatric 5 cm crepe or conforming	 X 5 X 2
Equipment Support		
ECG cable Disposable monitoring/defibrillation pads Therapy/pacing ECG electrodes Clippers Combine dressing Sterile gauze Spare torch batteries Paediatric SpO_2 probe	 Adult/Paediatric	X 1 X 2 each X 3 rolls X 1 set 1 packet X 1 X 1 X 2 packets X 2 X 1
Drugs ("see-through" container recommended)		
First Line		
Adrenaline	1:10,000 minijet	X 4
Atropine Sulphate	100 mcg/m minijet	X 2
Amiodarone	150 mg	2
Anginine tablets or nitrolingual spray		I Bottle/Spray
Aspirin	100 mg	1 box
Second Line		
Adenosine	6 mg/2 ml ampoule	X 4
Adrenaline	1:1000 ampoule	X 10
Amioderone	150 mg/3 mL ampoule	X 6
Atropine	600 µg/mL ampoule	X 4
Calcium gluconate	1 gm/10 ml ampoule	X 4
Ceftriaxone	1 gm ampoule	X 2
Diazepam	5 mg rectal	X 2
Glucose	50% 50 ml ampoule	X 1
Glyceryl trinitrate (GTN)	50 mg/10 ml ampoule	X 1
Magnesium sulphate	10 mmol/5 ml ampoule	X 2
Mannitol	20% (500 ml) bag	X 1
Metaraminol	10 mg/1 ml ampoule	X1
Midazolam	5 mg/5 ml ampoule	X 3
Midazolam	5 mg/1 ml ampoule	X 3
Naloxone hydrochloride	0.4 mg ampoule	X 2
Noradrenaline	2 mg/2 ml ampoule	X 3
Phenytoin	250 mg/5 ml	X 4
Phenytoin disposable filter		X 1
Sodium bicarbonate injection	8.4% 100 ml	X 2
Intravenous Fluids		
Normal saline	0.9% 1000 ml	X 4
Normal saline	0.9% 100 ml	X 2
Dextrose water	5 % 100 ml	X 2
Dextrose/saline	3%/0.3% 1000 ml	X 1
Other		
Sphygmomanometer	Manual aneroid	X 1
Stethoscope		X 1
Safety goggles		X 4
Oxygen tank holder		X 1
Oxygen cylinder	Size C with regulator and twinovac	X 1

Non-invasive blood pressure cuffs	Infant/child/small, normal, large, thigh adult	X 1 each
Electrical extension cord		X 1

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Published by CICM: November 2016