

Review

Factors influencing the activation of the rapid response system for clinically deteriorating patients by frontline ward clinicians: a systematic review

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Abstract

Purpose: To synthesize factors influencing the activation of the rapid response system (RRS) and reasons for suboptimal RRS activation by ward nurses and junior physicians.

Data sources: Nine electronic databases were searched for articles published between January 1995 and January 2016 in addition to a hand-search of reference lists and relevant journals.

Study selection: Published primary studies conducted in adult general ward settings and involved the experiences and views of ward nurses and/or junior physicians in RRS activation were included.

Data extraction: Data on design, methods and key findings were extracted and collated.

Results of data synthesis: Thirty studies were included for the review. The process to RRS activation was influenced by the perceptions and clinical experiences of ward nurses and physicians, and facilitated by tools and technologies, including the sensitivity and specificity of the activation criteria, and monitoring technology. However, the task of enacting the RRS activations was challenged by seeking further justification, deliberating over reactions from the rapid response team and the impact of workload and staffing. Finally, adherence to the traditional model of escalation of care, support from colleagues and hospital leaders, and staff training were organizational factors that influence RRS activation.

Conclusion: This review suggests that the factors influencing RRS activation originated from a combination of socio-cultural, organizational and technical aspects. Institutions that strive for improvements in the existing RRS or are considering to adopt the RRS should consider the complex interactions between people and the elements of technologies, tasks, environment and organization in healthcare settings.

Key words: patient safety, human factors, rapid response system, clinical deterioration, early warning scoring system, systematic review

Introduction

There has been a growing body of research that focus on recognizing and responding to clinically deteriorating patients in general ward settings in the past decade [1–4]. Much of this interest was prompted by studies that demonstrated patient deterioration not being recognized and responded to in a timely manner [5–10]. This lapse in patient care has led to an increase risk and incidences of serious adverse events such as unplanned admissions to intensive care units, in-hospital cardiopulmonary arrests, and unexpected deaths [11, 12]. Improving timely recognition and prompt interventions is therefore pivotal to the provision of safe and quality care to a deteriorating patient before his condition becomes life-threatening [13].

International concerns over delays or failure to recognize and escalate care for clinically deteriorating ward patients have led to the widespread implementation of a hospital-wide patient safety initiative known as the rapid response system (RRS) in acute hospitals [14, 15]. The RRS is designed with afferent and efferent components, and mechanisms for quality control, audit and administration [16]. The afferent arm involves monitoring and identifying deteriorating patients using a set of activation criteria, commonly known as the Early Warning Scoring System (EWSS), which is based on abnormal vital signs and/or observations such as threatened airway, declined neurological status and staff concerns ('worried' criterion) [17–19]. Once a patient meets the activation criteria, the efferent arm, i.e. the rapid response team (RRT) or medical emergency team (MET), comprising personnel with critical care expertise and diagnostic skills, will be activated to swiftly bring critical care expertise to the deteriorating patient [13, 17]. The RRS bypasses the traditional hierarchical escalation of care by sanctioning bedside nurses and junior physicians to promptly access senior medical assistance, outside the primary physician team's chain of command [13, 16, 20].

Theoretically, the RRS offers significant advantages over the traditional referral model of care and potentially decreases resuscitation events in general wards [21]. However, two decades of research still demonstrate mixed evidence on the effectiveness of the RRS in achieving their stated aims to reduce resuscitation events outside of the ICU, unplanned ICU admissions and hospital mortality [22–28]. Some proponents have questioned the existence of the tangible benefits of the RRS and suggested the need for higher level research and randomized controlled trials while others argued that the benefits are self-evident. Several authors have also attributed the conflicting evidence regarding

the effectiveness of the RRS to delay or failure in ward clinicians to activate the RRT despite patients fulfilling the activation criteria [24, 27, 29–32]. An epidemiology review of adult RRT patients in Australia revealed that close to 50% of the activations were delayed [33]. Apart from cognitive failure to recognize the need for RRS activation, socio-cultural factors and professional hierarchies are also strong reasons that impede adherence to the RRS protocol [34–39]. Existing studies found that junior physicians were reluctant to breach the traditional system of patient management while ward nurses feared being reprimanded if they bypassed attending physicians [21, 31, 40]. This highlights the need for a detailed analysis to understand individual and work system issues that may prevent frontline ward clinicians from activating the RRS.

Therefore, this review aims to synthesize and summarize the factors influencing an activation of the RRS by ward nurses and junior physicians in general wards. This review is also anticipated to identify reasons for suboptimal activation of the RRS, and highlight gaps for further research.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used to guide the reporting of this systematic review [41].

Eligibility criteria

The eligibility criteria are outlined in Table 1.

Information sources

A comprehensive search was performed included searching relevant electronic databases (CINHAL, PubMed, Cochrane Library, EMBASE, Scopus, ScienceDirect, Web of Science, PsycINFO and ProQuest Dissertations & Theses database), mining the reference lists of selected articles, and hand-searching Resuscitation and BMJ Quality & Safety, which are known for publishing articles related to the RRS and/or patient deterioration.

Search

Three broad search key concepts were developed: RRS, EWSS and deteriorating ward patients. Thesaurus terms of these concepts were used. Search terms were used singly and/or in combination (Appendix

Table 1 Eligibility criteria for inclusion of articles in the review

PICOS	Details of eligibility
Population	Ward nurses and junior physicians (residents, medical officers and house officers).
Phenomena of Interest	Articles related to factors influencing the RRS activation for adult patients in general wards by frontline ward clinicians and/or frontline ward clinicians' attitudes, perceptions and experiences of the RRS were included. Articles related to evaluating the effectiveness or impact of the RRS on patient outcomes and/or involved patients with the 'Do-Not-Resuscitate' order were excluded.
Context	Conducted in adult general ward settings. Articles conducted in rural, obstetric and gynecological, pediatrics and mental-health settings, as well as outside of the adult general ward settings were excluded.
Study design	Original primary studies of any design in the English language published between January 1995 and January 2016 were included. The year 1995 was chosen as the cut-off date as it marked the first study outlining the concept of the RRS. Only full text articles were included. Conference abstracts or proceedings were excluded due to insufficient study details. General editorials, case reports, and gray literature were excluded to provide a level of quality control and to reflect evidence-based practice.

PICOS, Population, Phenomena of Interest, Context, Study design; RRS, rapid response system.

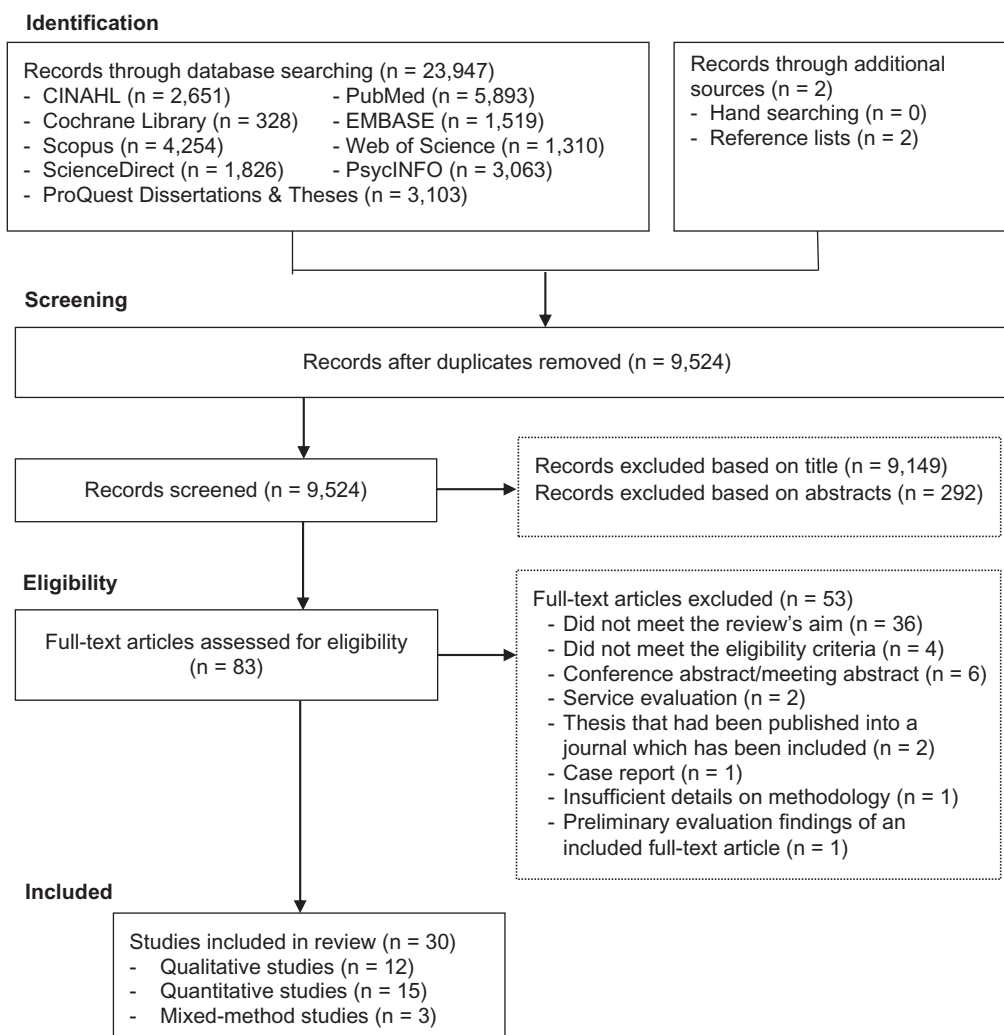


Figure 1 PRISMA flow diagram of study selection process.

1 contains the full search strategy). Literature that was published between January 1995 and January 2016 was searched. The year 1995 was chosen as the cut-off date as it marked the first published literature outlining the concept of the RRS [42].

Study selection

One reviewer (WLC) screened the titles and abstracts of relevant articles before conducting a full-text review while meeting regularly with the two other reviewers (MTAS & SYL) to discuss article eligibility. Reasons for exclusion were recorded.

Data extraction

A data extraction form was developed to catalog the author(s), publication year, study aims, country and setting of study, sample, methods for data collection and data analyses, and relevant key findings. Data were extracted independently by WLC, then reviewed by SYL. Differences were resolved by discussions among the two reviewers.

Quality assessment

All included studies were appraised independently by WLC and MTAS using the Critical Appraisal Skills Programme [43] for qualitative studies, Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument [44] for quantitative studies, and Mixed Methods Appraisal Tools [45] for mixed-method studies. Articles were scored against each item in the appraisal checklist by scores of not met ('0'), partially met ('0.5'), fully met ('1'), or unsure. A total study quality percentage was tabulated. Depending on the total appraisal score, the included articles were classified as low (<50%), medium (50–70%), or high (>70%) quality. The results were compared and disagreements were resolved by consultation with SYL.

Data synthesis

Data synthesis adopted the integrated design for mixed research synthesis [46] and the hybrid process of inductive and deductive thematic analysis [47]. The synthesis began with converting the extracted quantitative findings into qualitative forms, i.e. free codes, and, together with the extracted qualitative findings, was subjected to the inductive portion of a hybrid thematic analysis.

Table 2. Summary of study characteristics (*n* = 30)

Author	Study aim(s)	Country & setting	Years of RRS	Methods	Relevant key findings	Study quality
Astroth <i>et al.</i> [48]	To identify barriers and facilitators to nurses' decisions regarding activation of RRTs	US, community hospital	NS	Sample: Convenience sampling; registered nurses (<i>n</i> = 15) Data collection: Individual semi-structured interviews Data analysis: Concept thematic analysis	Facilitators: <ul style="list-style-type: none"> • Immediate expert assistance provided by RRT • Support and encouragement from nursing colleagues and leaders to activate RRT Barriers: <ul style="list-style-type: none"> • Condescension in tone of RRT members • Fear of appearing 'dumb' to RRT members especially among less experienced nurses • Belief that nurses should call attending physicians first • Experienced nurses confident of managing deterioration themselves • Unstandardized RRT education and no follow-up or reinforcement • Unclear about hospital's RRT policy and their role in the process 	High
Bagshaw <i>et al.</i> [49]	To evaluate nurses' beliefs and behaviors about the MET system.	Canada, teaching hospital	3	Sample: Convenience sampling; registered nurses & licensed practical nurses working in general acute units (<i>n</i> = 293) (Response rate: 93.9%) Data collection: Cross-sectional survey with open-ended questions Survey tool adopted from Jones <i>et al.</i> [37] Data analysis: Descriptive statistics; content analysis for open-ended comments	<ul style="list-style-type: none"> • 75.9% of respondents would call attending physician before activating the MET and 10.1% would not activate the MET if unable to contact & notify the attending physician about a change in patient's condition • 15.4% of respondents indicated reluctance to activate the MET because of fear of criticism • 48% indicated they would activate MET for a patient they were worried about, but has otherwise normal vital signs Comments: <ul style="list-style-type: none"> • Conflicting opinions among healthcare professionals about how to manage patients once the MET had been activated • Anecdotes of criticism and concern about how the MET was activated and the role of the unit nurse during MET activation 	Medium
Benin <i>et al.</i> [50]	To qualitatively describe the experiences of and attitudes held by nurses, physicians, administrators and staff regarding RRT	US, teaching hospital	3	Sample: Purposive sampling; registered nurses (<i>n</i> = 18), administrators (<i>n</i> = 8), senior physicians (<i>n</i> = 6), house officers (<i>n</i> = 6), RRT physicians (<i>n</i> = 4), RRT nurses (<i>n</i> = 4), RRT respiratory therapists (<i>n</i> = 3) Data collection: Individual semi-structured interviews Data analysis: Thematic & constant comparative analysis following grounded theory approach	<ul style="list-style-type: none"> • Nurses viewed RRT as a solution to pre-existing problems e.g. not getting a satisfactory outcome/response from house staff • RRS activation enables real-time redistribution of workload for nurses and physicians. It also reduces neglect of non-acutely ill patients during emergencies • Some primary team physicians discouraged the nurse from calling an RRT regardless of the severity of the situation. They felt that they are better suited in caring the patient • Perception by physicians that a call to RRT implied a failure on the part of physician and detriment to education of house officers due to inadequate exposure to decision-making process • Some participants feel that RRS activation could result in errors, disjointed care and delay due to lack of continuity as RRT members were unfamiliar with patient's medical history and condition • Need to have clear RRS protocols stating individual role and responsibilities 	High
Braaten [51]	Using cognitive work analysis to describe factors within a hospital system that shaped medical-surgical nurses' RRT activation behavior	US, acute care hospital	7	Sample: Purposive sampling; nurses (<i>n</i> = 12) Data collection: Individual semi-structured interview using cognitive work analysis framework & document review of RRT policy and protocols Data analysis: Content analysis	<ul style="list-style-type: none"> • RRT activation requires justification especially for subtle/gradual clinical changes which can lead to delay activation, i.e. increasing monitoring, waiting for bigger change to occur, waiting for higher level consult, or trying available interventions • Justification requires increase competencies e.g. deciding the need for increased observation, apply clinical reasoning, reliance on one's experience, junior nurse consulting experienced nurse while experienced nurse consulting a peer prior to activation and articulate the reasons for RRT call • Scarcity of staff/staffing level to closely observe or perform physical assessment for patients with subtle changes • Activation criteria were seen as nonspecific to diff medical condition 	Medium

Butcher <i>et al.</i> [52]	To determine whether resident physicians perceive education benefit from collaboration with RRT and the impact of RRT on their clinical autonomy	US, acute tertiary hospitals	7	Sample: Convenience sampling; physicians ($n = 236$) (Response rate: 72%) Data collection: Cross-sectional survey Survey tool developed and piloted Data analysis: Descriptive statistics	<ul style="list-style-type: none"> • RRT as last resort when there is no response from physician or no patient improvement • Expectation that nurses should first try to 'handle' the situation • Limitations of electronic monitoring equipment • 78% of the residents agreed that working with the RRT is a valuable educational experience • 76% of the residents disagreed that RRT decreased their clinical autonomy • The majority of resident physicians perceive educational benefit from interaction with the RRT, though this benefit is greater for less experienced residents 	Medium
Cioffi [53]	To explore the experiences of nurses calling the MET to ward patients who require early medical interventions	Australia, acute tertiary hospital	NS	Sample: Purposive sampling; registered nurses ($n = 32$) with ≥ 5 years of nursing experience Data collection: Individual unstructured interviews Data analysis: Thematic analysis	<ul style="list-style-type: none"> • A gut feeling, knowing the patient and past experiences with similar patients were involved in the recognition of deterioration • Nurses' decision to call the MET was made in conditions of uncertainty: mainly being unsure if the patient met the MET criteria, questioned themselves whether they were doing the 'right thing' calling the MET, do not know what will be expected of them when the MET arrives • Less experienced nurses sought the opinions of more experienced nurses while experience nurses conferred with their peers. • Decision to call the MET was also influenced by the ability of staff to support the patient or primary team physicians to support the deteriorating patient and effectiveness of team's management • RRS activation were made more frequently during night shift and on weekends as they were fewer physicians on duty to offer medical help to deteriorating ward patients and to reduce neglect of other non-acutely ill patients during emergencies 	Medium
Cioffi [54]	To investigate nurses' use of past experiences in the decision-making process to call the MET	Australia, acute tertiary hospital	NS	Sample: Purposive sampling; registered nurses ($n = 32$) with ≥ 5 years of nursing experience Data collection: Individual unstructured interviews Data analysis: Thematic analysis	<ul style="list-style-type: none"> • 63% of the nurses described using their past experiences in the decision-making process to call the MET. However, 37% of them did not overtly refer to past experiences in their accounts of calling the MET • Nurses most commonly described recognizing a similarity between the present patient's condition/situation and a group of patients they had cared for with this presenting condition/situation. The use of experience in this manner was often related to a group of patients who were exhibiting a nonspecific state of unwell or 'just not being right' 	High
Cretikos <i>et al.</i> [55]	To measure the process of the implementation of the MET system and to identify factors associated with the level of MET utilization	Australia, acute tertiary hospitals ($n = 12$)	½	Sample: Convenience sampling; nurses at initial point ($n = 708$) (Response rate: 41%), nurses at follow-up point ($n = 781$) (Response rate: 47%), Data collection: Longitudinal survey with open-ended questions Initial survey: 4 month post implementation Follow-up survey: 6 month post implementation Survey tool developed and piloted Data analysis: Descriptive statistics, correlational analysis; content analysis for open-ended comments	<ul style="list-style-type: none"> • Nurses who had attended MET education session had a significantly greater intention to call the MET (87.0% vs. 72.9%, $P < 0.001$), significantly more positive attitude to the MET than those who had not attended (91.5% vs. 78.5%, $P < 0.001$) and correctly identified more of the MET activation criteria than those who had not attended a session (5 versus 4 out of 6, $P < 0.001$) • Nurses who were more senior indicated a significantly greater intention to call the MET than more junior nurses ($P < 0.001$) • This measure of MET system utilization varied significantly across the 12 hospitals ($P = 0.002$), and was significantly associated with knowledge of the activation criteria ($P = 0.048$), understanding the purpose of the MET system ($P = 0.01$), perceptions of the hospital's readiness for a change in the way care was provided ($P = 0.004$), and an overall positive attitude to the MET system ($P = 0.003$) • Negative comments typically expressed concern about the appropriateness of activating the MET system in certain specialist areas of hospital; rude and condescending behavior/ attitude of MET team towards staff who had called the team 	Medium
Davies <i>et al.</i> [56]	To identify and assess the types and prevalence of barriers associated to the activation of the RRS by clinical staff	US, community hospital	NS	Sample: Convenience sampling; physicians ($n = 68$), registered nurses ($n = 16$) from medical & surgical wards (Respond rate: 59% for physicians and 35% for nurses) Data collection: Cross-sectional survey	<ul style="list-style-type: none"> • Self-reported adherence rate was $\leq 25\%$ for the 6 activation criteria • Respondents were most familiar with mental status change criteria (76.2%) and least familiar with 'Not looking right' (65.5%) 	Medium

Table continued

Table 2. Continued

Author	Study aim(s)	Country & setting	Years of RRS	Methods	Relevant key findings	Study quality
				Survey tool adapted from 2 previously validated surveys Data analysis: Descriptive statistics, logistic regression	<ul style="list-style-type: none"> 65% of respondents felt that they had not been trained to an adequate level on RRS despite the existence of education and in-service training (lectures, posters & orientation sessions) to reinforce on the RRS system As familiarity with, agreement with, and perceived benefit of activating the RRS increases, the self-reported adherence to the activation criteria also increases significantly ($0.001 < P < 0.05$) 	
Donohue and Endacott [57]	To examine ward nurses and critical care outreach team perceptions of the management of patients who deteriorate in acute wards	UK, acute tertiary hospital	NS	Sample: Purposive sampling; nurses ($n = 11$) & outreach team members ($n = 3$) Data collection: Individual semi-structured interviews using critical incident techniques Data analysis: Thematic analysis	<ul style="list-style-type: none"> The outreach team was perceived by ward staff as calming and reassuring to the team and patient, and providing support, knowledge and skills When assessing the patient visually, nurses compared the patient's condition across time MEWS was unreliable especially when used on chronically ill patients Some nurses indicated the need to ensure they have convincing evidence of patient's condition prior to contacting the outreach team Medical help is sought through a clear hierarchy where the call went from the RN to the junior physician, who then contacted the outreach team or after notifying more senior medical help. In some instances, junior physicians were often reluctant to seek more senior advice which frustrates nurses 	Medium
Douglas <i>et al.</i> [21]	To explore and compare nursing and medical staff's perceptions of Medical Emergency Response Team (MERT) use	Australia, tertiary hospital	NS	Sample: Convenience sampling; registered nurses ($n = 434$), medical staff ($n = 190$) (Response rate: 29.8%) Data collection: Cross-sectional survey with open-ended questions Survey tool adopted from Australian Commission on Safety and Quality in Health care Data analysis: Descriptive statistics, fisher exact tests, using analysis of covariance, adjusting for years of clinical experience Constructivist methodology for analysis of open-ended text	<ul style="list-style-type: none"> RNs held a stronger belief than medical staff in disagreeing that MERT reduced their skills in managing sick patients ($P = 0.04$) >70% of staff would contact the patient's treating physician before activating the MERT, but found more prevalent among medical staff ($P < 0.01$) 55.7% of RNs and 55.8% medical staff were uncertain or disagreed that they would activate the MERT for a patient using the 'worried' criteria if the patient's vital signs were normal. 34.2% of medical respondents and 20% of RNs agreed they would not trigger a MERT if a patient met the activation criteria but did not look unwell 17.1% of RNs and 7.9% medical staff were reluctant to activate the MERT because they feared criticism for unnecessary activations RNs perceived greater support from ward nurses ($P < 0.01$) and senior nurses ($P < 0.01$) to activate MERT than medical staffs <p>Open-ended text comments:</p> <ul style="list-style-type: none"> The system was dependent on the clinical judgment of physicians. Nurses perceived that they were often criticized for invoking a MERT call based on criteria set down by medical staff 	Medium
Green and Allison [58]	To explore nursing and medical staff's perceptions, attitudes, perceived understanding of a clinical marker referral tool implemented to assist in early identification and referral of unstable patients in the general wards	Australia, tertiary hospital	<1/2	Sample: Convenience sampling; nurses & junior medical staff ($n = 168$) (Response rate: 42.3%), residents/registrar ($n = 7$) (Response rate: 8.2%), ICU registrars ($n = 3$) (Response rate: 33.3%) Data collection: Cross-sectional survey with open-ended questions Survey tool developed and piloted Data analysis: Descriptive statistics content analysis for open-ended question	<ul style="list-style-type: none"> Respondents were generally positive to the clinical marker project/tool, offering clear guidelines for staff to respond to patient's clinical condition, and contact the medical staff and the ICU liaison team as appropriate. Only 49.2% of ward medical staff agreed that the clinical markers identified patients at risk of further deterioration, whereas 28.8% indicated that they were unsure Some ward medical and nursing staff had reservations with the clinical markers chosen (some of the criteria could be normal parameters in some cases) 74% of nurses and 85.6% of ward medical staff requested further education about clinical marker project 	Medium
Jenkins <i>et al.</i> [59]	To explore the non-ICU nurses' perceptions of facilitators and barriers to RRT activation	US, community hospital	9	Sample: Convenience sampling; non-ICU nurses ($n = 50$) Data collection: Cross-sectional survey Survey tool developed and content validated Data analysis: Descriptive statistics, bivariate correlations	<ul style="list-style-type: none"> Bivariate correlation analysis showed that older ($r = 0.330$, $P = 0.02$) and more experienced nurses ($r = 0.350$, $P = 0.014$) were more likely to call RRTs. 92% indicated receiving strong support from nursing leaders and colleagues in activating the RRT and 95% indicated they could rely on their peers to help them with other duties during the call. 	Medium

Jones <i>et al.</i> [37]	To assess whether nurses value the MET service and to determine whether barriers to calling MET exist	Australia, acute tertiary hospital	4	<p>Sample: Convenience sampling; ward nurses ($n = 351$) (response rate 100%)</p> <p>Data collection: Cross-sectional survey using personal interview approach</p> <p>Survey tool developed and piloted</p> <p>Data analysis: Descriptive statistics</p>	<ul style="list-style-type: none"> • 18% believed that they would not be treated with respect and 14–16% expected that the responding ICU nurse would complain, be condescending, or would think the call was unnecessary • 14% were unfamiliar with RRT protocols and 12% were unfamiliar with their role during the call • 50% believed inadequate continuing RRT education: 40% noted that they had not participated in RRT education for >12 months, and 42% indicated that they had never received any education on RRT • Nurses value and appreciate the potential benefit of MET • Major barrier to calling MET appears to be allegiance to the traditional approach of initially calling parent medical unit doctors • 72% of nurses indicated that they would call the covering doctor before the MET for a sick ward patient • 56% suggested that they would make a MET call for a patient they were worried about even if patient's vital signs were normal 	Medium
Kitto <i>et al.</i> [38]	To examine medical and nursing staff members' experiences of the RRS and to explore social, professional and cultural factors that mediate RRS usage	Australia, mixed settings ($n = 4$)	NS	<p>Sample: Criterion & maximum variation sampling; nurses ($n = 62$), doctors ($n = 27$)</p> <p>Data collection: Exploratory case study approach using multiple case analysis using Focus group discussions ($n = 10$)</p> <p>Data analysis: Conventional content analysis & complementary directed content analysis</p>	<ul style="list-style-type: none"> • RRS seen as nursing 'work-around' strategy • Junior nurses seek the guidance & experiential knowledge of senior nurses when deciding whether or not to activate RRS • Doctors have the authority to modify RRS criteria • Instances where missed RRS calls: ward staff accessed local support without activating the system; intimidated by the potential negative repercussion by the RRT for 'incorrect' call • Reasons for not activating RRS: RRS activation was potentially a show of incompetence by junior physicians and from a senior physicians' point of view as deskilling of junior physicians, potentially taking out their decision-making opportunities and taking away essential learning opportunities to make difficult decisions 	Medium
Leach <i>et al.</i> [60]	To investigate how RNs rescue patients in hospitals where RRTs are in place and to understand the processes involved in making the decision to call the RRT	US, acute hospitals ($n = 6$)	NS	<p>Sample: Purposive sampling; bedside RNs ($n = 14$), RRT RNs ($n = 16$), RRT respiratory therapists ($n = 2$), nurses supervisors ($n = 18$)</p> <p>Data collection: Individual semi-structured interviews</p> <p>Data analysis: Thematic & constant comparative analysis following grounded theory approach</p>	<ul style="list-style-type: none"> • Bedside RNs use their knowledge of the RRT trigger protocol, knowledge of subjective cues, interpretation of data and clinical experience to make a thought decision to call the RRT • After which, some RNs would sought consultation with other RNs to get support and affirmation that there was a need for help before enacting the decision to call the RRT • RRT RNs and bedside RNs support one another in a synergistic way to prevent adverse patient events during the rescuing process, whereby RRT RNs enables immediate access to resources and applied their expertise with critically ill patients, while bedside RNs brought patient information to the situation • In some cases, traditional hierarchies and relationships with physicians and supervisors impede some components of RN decision-making during rescuing 	Medium
Massey <i>et al.</i> [61]	To explore nurses' experiences of using and activating a MET, and to understand facilitators and barriers to nurses' use of the MET	Australia, teaching hospital	NS	<p>Sample: Consecutive sampling; registered nurses ($n = 15$) from 5 medical wards</p> <p>Data collection: Individual semi-structured interviews</p> <p>Data analysis: Inductive thematic analysis</p>	<ul style="list-style-type: none"> • Nurses appear to prefer to access help or support from among their team (consult their peers or more senior nurses) and 'use the home team' rather than the MET as a last resort, i.e. when the patient suffered from a cardiac arrest • Nurses would decide if patient could 'hang on a few more minutes' • Resisting and hesitating calling a MET due to the fear of 'being reprimanded', 'scared of the MET', 'looking like an idiot' or 'being told off'; previous experience of being reprimanded by members of MET during previous call. • Fear of reprisals for incorrect activation was related to clinical inexperience and uncertainty whether a RRT was warranted 	High
Pantazopoulos <i>et al.</i> [62]	To evaluate the relationship between nurse demographics and correct identification of	Greece, tertiary hospital	NS	<p>Sample: Random sampling; medical-surgical nurses ($n = 94$) (Response rate of 62%)</p> <p>Data collection: Cross-sectional survey</p>	<ul style="list-style-type: none"> • Participants who had graduated from a four-year educational program could identify more accurately clinical situations that necessitated MET activation ($P =$ 	Medium

Table continued

Table 2. Continued

Author	Study aim(s)	Country & setting	Years of RRS	Methods	Relevant key findings	Study quality
	clinical situations warranting specific nursing actions, including MET activation			Survey tool developed and content validated Data analysis: Descriptive statistics, Mann-Whitney test, Pearson's chi-square test and fisher's exact test	0.031) and achieved a significantly higher score in theoretical knowledge questions ($M = 4.0, SD = 1.7$ vs $M = 1.7, SD = 1.3, P = 0.002$). <ul style="list-style-type: none"> • Contribution of working experience is limited. Nurses with only a few years of service time recognize patient's life-threatening situations and act in the same way as experienced nurses (88.9% vs. 52.6%, $P = 0.008$) • Junior nurses made fewer referrals (18/407 = 4.4%) in comparison with senior nurses (202/407 = 49.6%). • Indications for referral: culmination of factors including blood results, MEWS, patients' verbalization of unwell, patients' appearances; reliance on gut instinct and intuition especially among senior nurses which developed with time and experience; familiarity of patients from continuous care; experience and theoretical knowledge • Facilitating factors for referral: confidence to make referral decision; awareness of the significance of early referrals; outreach's approachable style and non-critical attitude; ease of accessibility and prompt responses from outreach to expedite acute care; support from doctors to call CCOT • Barriers to referral (delayed referral): misjudgment of their ability to handle patients' condition due to over-confidence; ward busyness; slight sense of intimidation as CCOT viewed superior in knowledge; CCOT could result in increased workload which was difficult to manage with other patient workloads; source of conflict due to differing medical opinion and communication breakdown • Consequences of referral: Allows for easier liaison for ward nurses with doctors regarding care; junior doctors would back away slightly from their role in the care of patient 	
Pattison and Eastham [63]	To explore referrals to CCOT, the associate factors around patient management and survival to discharge, and the qualitative exploration of CCOT referral characteristics	UK, specialist hospital	NS	Sample: 407 episodes of CCOT referrals from 20 ward areas; Theoretical sampling of nurses ($n = 7$) & doctors ($n = 2$) Data collection: Phase 1: Medical record reviews Phase 2: Loosely structured interviews Data analysis: Phase 1: Descriptive statistics Phase 2: Thematic and constant comparative analysis following grounded theory approach	<ul style="list-style-type: none"> • Only 54% respondents agreed that the METal course significantly improved their skills in managing unstable patients in the ward • Major barrier to MET activation: nurses referral to the covering physician instead of the MET for deteriorating patient (62%), although significantly lesser among the more experienced (OR = 0.69 [95% CI: 0.47–0.99, $0.05 > P > 0.01$]) or a METal certification (OR = 0.6 [95% CI: 0.46–0.79, $P < 0.001$]) • Other important barriers: reluctance to call the MET in a patient fulfilling the calling criteria (21%), although was less likely to occur in physicians vs. nurses (OR = 0.65 [95% CI: 0.5–0.85, $0.01 > P > 0.001$]) • Only 5% of respondents were reluctant to call the MET because of the fear of being criticized for not caring for their patients well and 12% due to having an inappropriate call (12%). • Physicians more likely to perceive using of MET increase their workload when caring for sick patients (OR = 1.72 [95% CI: 1.2–2.49], $0.01 > P > 0.001$) 	Medium
Radeschi <i>et al.</i> [64]	To identify the attitudes and barriers to MET utilization among both ward nurses and physicians and to investigate whether these attitudes and barriers are influenced by participation in a specific educational program of MET	Italy, mixed settings ($n = 10$)	NS	Sample: Convenience sampling; nurses (1278), physicians ($n = 534$) (Response rate: 79.6%) Data collection: Cross-sectional survey Survey tool modified from Jones <i>et al.</i> Data analysis: Descriptive statistics, chi-square test, logistic regression adjusting for profession	<ul style="list-style-type: none"> • The decision to call the RRT is rooted in a combination of nurse's personal knowledge of a patient, patient assessment and intuitive knowledge. • Nursing intuition is rooted in the recognition of patterns among a complex combination of factual information and subjective inferences collected from the patient • Having collected and interpreted the assessment data, the decision to activate the RRT is moderated by emotional (e.g. concern, worry, anxiety, stress, repeatedly returning to check the patient's conditions) and physiological reactions (e.g. adrenalin, knot in stomach), collaboration with others (e.g. more experienced nurses to obtain advice about whether or not to activate the RRT), education, and 	High
Robert [65]	To explore the experiences of staff nurses using intuition in the process of activating RRT for patients being cared for in medical-surgical and telemetry units.	US, acute hospital	5	Sample: Theoretical and zig zag sampling; registered nurses ($n = 32$) Data collection: Individual semi-structured interviews using grounded theory Data analysis: Thematic & constant comparative analysis following grounded theory approach		

Salamonson <i>et al.</i> [66]	To explore nurses' satisfaction with the MET, perceived benefits and suggestions for improvement, and to examine the characteristics of nurses who were more likely to activate the MET	Australia, acute hospital	NS	<p>Sample: Convenience sampling; medical-surgical nurses ($n = 73$) (Response rate: 79%)</p> <p>Data collection: Cross-sectional survey with open-ended questions</p> <p>Survey tool developed and content validated</p> <p>Data analysis: Descriptive statistics; content analysis for open-ended text</p>	<p>historical experience (particularly the number of previous times the nurse has activated the RRT)</p> <ul style="list-style-type: none"> A positive significant relationship was found between years of nursing experience and MET activation ($P = 0.018$). Nurses who were less experienced (0–5 years) were less likely to have activated the MET than nurses who were more experienced (≥ 11 years) Suggestions for improvement: more education on medical emergencies for both ward and MET staff, a more positive attitude of the MET staff when summoned for 'borderline' cases (11% of participants) 	Medium
Sarani <i>et al.</i> [67]	To assess the perceptions of physicians and registered nurses about the effects of a MET on patient safety and their own educational experiences	US, acute tertiary hospital	1	<p>Sample: Convenience sampling; medical-surgical nurses ($n = 414$) (Response rate: 83%), Physicians from internal medicine & general surgery ($n = 103$) (Response rate: 67%)</p> <p>Data collection: Cross-sectional survey</p> <p>Survey tool reviewed</p> <p>Data analysis: Descriptive statistics, Mann–Whitney U test, Kruskal–Wallis, multivariate regression</p>	<ul style="list-style-type: none"> Both residents and RNs agreed that the MET improved patient safety, although RNs held this belief more strongly than the residents (residents = 4.0, RNs = 4.4, $P < 0.01$) Residents neither agreed nor disagreed that the MET decreased their skills and educational opportunities in critical care and resuscitation, whereas, RNs disagreed with this assertion (skills: residents = 2.7, RNs = 2.1, $P < 0.01$; education: residents = 2.9, RNs = 2.4, $P < 0.01$) 	Medium
Schiid-Mazzoccoli <i>et al.</i> [68]	To compare differences in nurse, patient and organizational characteristics in medical and surgical patients requiring a MET activation	US, tertiary hospital	15–17	<p>Sample: Convenience sampling; 108 MET activations (51 medical patients & 57 surgical patients)</p> <p>Data collection: Medical record reviews</p> <p>Data analysis: Descriptive statistics, logistic regression model</p>	<ul style="list-style-type: none"> Of 108 event, 44% were delayed and delayed events occurred more often during the night shift ($P = 0.012$) There is a significant difference in MET activation associated with patient and unit type mismatch ($P = 0.005$) Shift and patient-unit-match were significant predictors of delays There was a 3.25 greater likelihood of delayed RRS activation occurring on night shifts (95% CI:1.34–7.9, $P = 0.009$) Although not statistically significant, there was a trend for more delays when more patients were assigned (4:1 = 21% vs. 6:1 = 43%, $P = 0.609$) 	High
Shapiro <i>et al.</i> [40]	To described the impact of RRTs on staff nurses' practice, perspectives, experiences and challenges when RRTs are used.	US, mixed settings ($n = 18$)	NS	<p>Sample: Nominated sampling; nurses ($n = 56$)</p> <p>Data collection: Focus group discussions using semi-structured guide ($n = 18$)</p> <p>Data analysis: Modified thematic & constant comparison analysis</p>	<ul style="list-style-type: none"> Three reasons for activation: (1) patient exhibited signs and symptoms significantly different from baseline; (2) gut feeling; (3) nurses convinced that the patient needed immediate evaluation but was unable to get the treating physician to respond Presence of RRT allowed primary nurse to care for other patients and families when the team was responding to the crisis Nurses from robust-adopter hospitals expressed receiving clear communication regarding RRS activation and had numerous reinforcements on RRS. They had no hesitation to call the RRT and had no fear of repercussions if the call was ultimately deemed unnecessary Nurses in reluctant-adopter hospitals (nurses hesitated to activate RRT) expressed receiving mixed messages regarding RRS activation protocol and difficulty in differentiating between situations that warrants a call to the RRT versus code blue team Some physicians insisted that nurses follow the usual chain of command no matter what. They also expressed unclear individual roles and responsibilities during a rapid response 	High
Shearer <i>et al.</i> [39]	To determine the incidence of clinical staff failing to call the RRS and the socio-cultural barriers to failure to activate the RRS	Australia, mixed settings ($n = 4$)	3–13	<p>Sample: 570 observation charts; 363 760 patient cases; purposive sampling of 91 junior physicians, nursing staff, MET members & ICU teams</p> <p>Data collection:</p> <p>Phase 1: Two part medical record reviews to determine the incidence of abnormal simple bedside observations & activation of RRS</p> <p>Phase 2: individual structured interviews</p> <p>Data analysis:</p>	<ul style="list-style-type: none"> 42% did not receive an appropriate clinical response from staff (missed RRS call) despite 69.2% recognizing their patient met physiological criteria for activating RRS, and being 'quite', or 'very' concerned about their patient Actions performed prior to activating RRS: awaiting further review by medical staff (51.8%); specific treatment or investigation delay activation (50.6%); involved ICU outreach (33.7%); involved senior nursing staff (12%) Main barriers: feel that they should be able to manage patients by themselves (54.2%) 	High

Table continued

Table 2. Continued

Author	Study aim(s)	Country & setting	Years of RRS	Methods	Relevant key findings	Study quality
Stewart <i>et al.</i> [69]	To evaluate the impact of the implementation of the MEWS on the early identification of patients at risk for clinical deterioration and factors that influence how nurses use MEWS as a framework in the decision-making process for RRS activation	US, acute care hospital	1 year	Phase 1: Descriptive statistics Phase 2: Thematic analysis Sample: 39 RRS activations in pre-MEWS period & 55 RRS activations in post-MEWS period; purposive sampling of registered nurses ($n = 11$) Data collection: Phase 1: Medical record reviews 12 months before and 12 months after implementation of the MEWS scoring system Phase 2: Focus group using semi-structured guide ($n = 5$) Data analysis: Phase 1: Descriptive statistics Phase 2: Content analysis	<ul style="list-style-type: none"> Insufficient ‘face validity’ in the sensitivity and specificity of RRS activation criteria: primary team was experienced and felt RRS activation was not required (16.9%); poor communication /prioritization of medical team (15.7%) While the MEWS was considered a valuable tool to enhance interdisciplinary communication about a patient’s condition, participants do not rely exclusively on the MEWS score to prescribe an intervention The MEWS score prompts them to gather additional clinical data from a prioritized physical and behavioral assessment of the patient Participants cited that the MEWS does not assign a numeric value to nurse ‘worry or concern’ so the nursing assessments are not factored into the aggregated score Participants expressed confidence in activating the RRS if they believed it was necessary without fear of being ridiculed or reprimanded by physicians or RRT members Nursing administrators were regarded by participants as supporters of nurses’ decisions to activate the RRS Perceived barriers to utilization of MEWS system: the inability of nurses to tailor the MEWS alarm settings and limits to accommodate patients whose vital signs measurements normally fell outside predetermined threshold 	High
Tirkkonen <i>et al.</i> [70]	Using the Ustein template to study documentation of vitals before a MET call, with special reference to patients having automated patient monitoring in general ward and to identify factors associated with delayed MET activation	Finland, tertiary hospital	<1	Sample: 569 MET reviews to 458 general ward patients Data collection: Medical record reviews Data analysis: Descriptive statistics, multivariate logistic regression	<ul style="list-style-type: none"> Documentation of vital signs before MET activation was suboptimal. Particularly, documentation of respiratory rate was alarming low (75% monitored bed vs. 17% non-monitored beds) When adjusted to the documentation frequency of vitals, failure and delayed activations occurred more among monitored ward patients (monitored bed 81% vs. non-monitored bed 53%, $P < 0.0001$) Delayed and failure of ward staff to call MET immediately when patient meets the calling criteria is associated with increased hospital mortality (OR 95% CI 1.02–2.72, $P < 0.041$) 	High
Williams <i>et al.</i> [71]	To describe nurses’ experiences and perceptions of RRT	US, community hospital	4	Sample: Convenience sampling; registered nurses ($n = 14$) from 3 medical and cardiac care units Data collection: Focus group discussions using semi-structure guide ($n = 6$) Data analysis: content analysis	<ul style="list-style-type: none"> Individual nurse use intuition/‘gut feeling’ to activate the RRT However, at times they are hesitant to call RRT as RRT members could not assimilate nurses’ concerns of a patient’s condition RRS as working around people and processes (system barriers): RRT as a relief for nurses and safeguard for patients when support was needed; work around time of delays in care of having to page physicians and getting call back for orders Presence of resistance from some physicians for nurses to call the RRT for their patients Negative reactions from RRT made nurses reluctant to call an RRT 	High
Wynn <i>et al.</i> [72]	To examine nurse characteristics and nursing action related to RRT calls	US, acute tertiary medical center	1	Sample: Convenience sampling; registered nurses ($n = 97$) (Response rate: 70%) Data collection: Cross-sectional survey Survey tool developed Data analysis: Descriptive statistics, chi-square test, independent samples t test, Pearson correlation and logistic regression	<ul style="list-style-type: none"> Top 3 reasons for calling RRT: (1) ‘sudden change in patient’s condition’ (78%), (2) ‘steady decline in patient condition’ (56%), (3) ‘inadequate response from the physician’ (35%). Education and experience are the most important predictors of independent calling Independent callers were 4.95 times more likely to have a bachelor degree in nursing (95% CI: 1.43–17.16, $P = 0.01$), and 3.72 times more likely to have more than 3 years of nursing experience (95% CI: 1.07–12.92, $P = 0.04$), than nurses who called at the request of another nurse or physician, after adjusting for the effects of other independent variables 	Medium

RRT, rapid response team; US, United States; NS, not specify; MET, medical emergency team; RRS, rapid response system; RN, registered nurse; UK, United Kingdom; ICU, intensive care unit; CCOT, critical care outreach team; MEWS, modified early warning system; METal, medical emergency team alert.

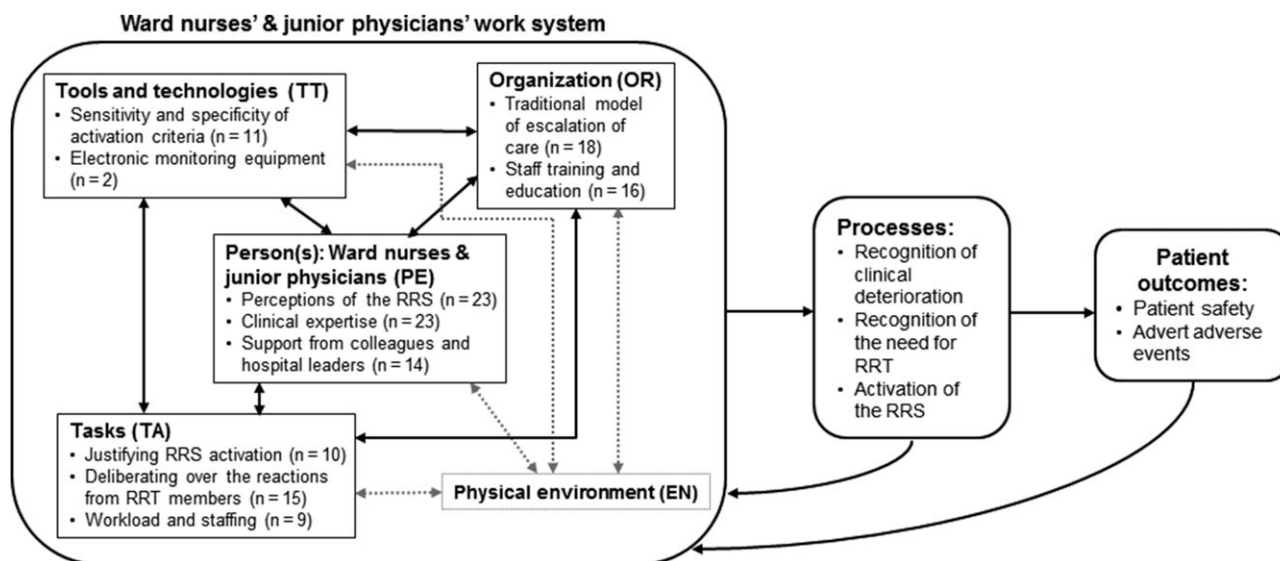


Fig. 2 The application of SEIPS model to ward clinicians' work system in the activation of the rapid response system. Dotted arrows and box: No identified interacting relationship between physical environment and the rest of the work system components (person, tools and technologies, tasks and organization). Descriptions of work system components (adapted from SEIPS model by Carayon *et al.* [73]). PE: Physical, cognitive, or psychosocial characteristics or conditions of an individual at the center of the work system. TT: Objects or instruments that the person(s) uses to do work or assist people in doing work (RRS activation). TA: Characteristics of the task such as difficulty, variety and sequence of work performed by the person(s) to accomplish the objectives. OR: Organizational conditions governing or influencing the way the person(s) performs tasks using tools and technologies in a specific environment. EN: Physical characteristics of the environment where work is performed.

Themes that explored the relevance of the categories of codes in the context of the research question were developed. The deductive portion involved categorizing the inductively developed themes into a conceptual framework [47]. While the process was initially undertaken by WLC, the groupings were further refined by discussions with the co-authors and rechecking of the included studies.

Results

Search results

The search strategy yielded 9524 records after removing duplicated articles. Following the review of titles and abstracts, 83 articles were selected for full-text review, from which 53 articles were excluded, leaving 30 studies for this review [21, 37–40, 48–72] (Fig. 1).

Study characteristics

Studies originated from the United States (US) ($n = 14$), Australia ($n = 10$), the United Kingdom ($n = 2$), along with one study each from Canada, Finland, Greece, and Italy. The study setting included acute and tertiary care ($n = 19$), community hospitals ($n = 4$), and mixed-settings ($n = 7$). Eight studies were multi-site studies. The median sample sizes were 32 participants for qualitative studies, 246 participants for quantitative studies and 407 medical record reviews and 10 participants for mixed-method studies. The population studied included ward nurses ($n = 16$), physicians ($n = 1$), both nurses and physicians ($n = 7$), a mixture of healthcare professionals ($n = 4$), and general ward patients ($n = 2$).

There were 15 quantitative, 12 qualitative and 3 mixed-methods studies. Most quantitative studies were self-administered survey-based studies ($n = 12$), except for one study, which employed face-to-face surveys. Reviews of medical records and RRT activations were used in five studies, with three of these studies using record review in conjunction with a qualitative approach (mixed-method

studies). Qualitative data were collected through interviews ($n = 9$) and focus groups ($n = 3$). Table 2 summarizes the included studies.

Quality assessment

The overall quality assessment of the study was medium ($n = 18$) to high ($n = 12$) (Appendix 2), with a substantial overall agreement of 83.3% between WLC and MTAS (Kappa = 0.658, $P < 0.001$).

The studies were generally good at providing clear research aims, congruity between the research aims and research design, providing details on the sample, and outlining the data collection and data analysis methods. More than half of the qualitative studies had inadequate clarifications for ethical issues and failed to consider the effect of the researcher–participant relationship.

The main weaknesses of the quantitative studies were the lack of considerations for confounders and insufficient psychometric evaluation of the different questionnaires administered. Only five studies addressed confounders using a statistical approach [21, 64, 67, 68, 72]. More than half of the studies have limited generalizability, given the small sample size and non-response bias due to poor response rates.

All the mixed-method studies had inadequate justifications for the need of a mixed-method design to address their research questions and did not consider the limitations associated with integration of qualitative and quantitative data.

Synthesis of results

The Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety developed by Carayon *et al.* is used as a conceptual framework to understand the barriers and facilitators to activation of the RRS by ward nurses and junior physicians [73]. The SEIPS model provides a framework for understanding the impact of work system factors on healthcare processes and patient outcomes [73]. The factors identified were grouped into 10

Table 3a Person-related factors influencing an activation of the rapid response system by ward nurses and junior physicians

Themes	Explanation	Evidence
Perceptions of the RRS	Ward clinicians' perceived benefits and drawbacks of the RRS. Both ward nurses and junior physicians valued the RRS but had concerns that hampered RRS activation	Twenty-one studies described the perceived of benefits of the RRS, which included expedited medical expertise to deteriorating patients [21, 37, 38, 40, 48–50, 52, 53, 55, 57–60, 63, 64, 66, 67, 69, 71], resolving system-related issues such as delays in getting hold of the attending physicians and limited availability of nurses [38, 40, 50, 66, 71, 72], and additional manpower from the RRT to assist in the rescue of deteriorating patients [40, 50, 53, 64] Junior physicians were concerned about deskilling in the management of clinical deterioration [21, 38, 50] while ward nurses were afraid of criticism for unnecessary activations [21, 37, 38, 49, 53, 61, 64, 65]
Clinical expertise	Most nurses found the importance of clinical expertise in calling the RRT; however, clinical expertise can also result in over-confidence to manage deterioration within their capacity. This perceived confidence is more prominent among the medical profession	Twenty-three studies identified clinical expertise as a strong factor that influences RRS activations by nurses, but less so by physicians [37, 39, 40, 48–51, 53–55, 57, 59–66, 68, 69, 71, 72]. Experienced nurses not only have greater confidence and intention to activate the RRT compared to junior nurses [53–55, 59, 61, 65, 66, 72], they also made use of their intuitive judgment gained through past experiences to recognize subtle and early signs of clinical deterioration that warrant a RRS activation [37, 39, 40, 49, 51, 53, 54, 60, 65, 69, 71]. Nurses' knowledge of patients' conditions [51, 53, 57, 60, 63, 65] and their ability to interpret clinical data gathered from patient assessment [51, 60, 65, 69] were also crucial elements to their clinical judgment in RRS activation. Clinical expertise can also lead to over-confidence in one's capability to manage patient deterioration without seeking assistance from the RRT [39, 48, 50, 63]. This was more prominently displayed by attending physicians, with the belief of being more experienced and capable in managing deteriorating patients of their own specialty compared to that of the RRT [39, 50]
Support from colleagues and hospital leaders	Ward nurses received support from their fellow nursing peers and hospital leaders in an activation of the RRS despite facing resistance from the attending physicians	Fourteen studies concurred that ward nurses generally received positive and supportive behaviors from their fellow nurses and hospital leaders in activating the RRS [21, 38, 40, 48, 50, 51, 53, 59–61, 63, 65, 69, 71]. Supportive behaviors from nursing peers consisted of giving affirmation for the need to activate the RRT [51, 53, 60, 61, 65] or assisting peers with other duties during RRT call [59]. Supportive hospital administration includes clear communication and numerous reinforcements regarding RRS activation [40] However, nurses encountered resistance from attending physicians in calling the RRT at times [40, 50, 71]. Some physicians perceived RRT activation as an implied incompetence of the attending physicians to manage patient deterioration and was detrimental to the education of junior physicians [50]

Table 3b Tools and technology-related factors influencing an activation of the rapid response system by ward nurses and junior physicians

Themes	Explanation	Evidence
Sensitivity and specificity of activation criteria	The sensitivity and specificity of the activation criteria have been criticized despite its ability to facilitate ward clinicians in the recognition of patient deterioration	Eleven studies questioned the sensitivity and specificity of the activation criteria [21, 37–39, 49, 51, 53, 56–58, 61, 64, 69, 71]. The activation criteria has been described as being oversensitive to chronically diseased patients and lacking in specificity to different medical conditions [21, 37, 49, 64, 69]. However, ward nurses reported facing delays and reluctance from physicians to modify the activation limits specific to each patient's condition [21, 38, 69], suggesting inflexibility of the calling criteria [69]. There were also evidences of underutilization of the 'worried criterion' whereby ward clinicians would not or were uncertain to activate the RRT for patients whom they were worried about but otherwise had normal vital signs [21, 37, 49, 53, 56, 61, 71]. While the fear of making unnecessary activations could be one reason for this underutilization, other attributing reasons included difficulty in articulating their worried feeling or subtle clinical changes [53, 61], and the inability of RRT members to assimilate nurses' concerns of a patient's condition [71].
Electronic monitoring equipment	The idea of electronic monitoring equipment is to facilitate the observation and identification of deteriorating patients. However, its limitations may outsmart itself and in turn compromise patient safety	Only two studies discussed the influence of electronic monitoring equipment on RRS activations, but both did not demonstrate positive effects [51, 70]. One study reported that electronic monitoring without real-time capture of vital signs may delay entry and errors in transcribing, thus delaying the recognition of clinical deterioration [51]. The other study observed that failure and delayed RRS activations was almost twice in automated monitored patients (81%) compared to non-automated monitored patients (53%) ($P < 0.001$) [70]. One possible offered explanation was alarm fatigue from an oversensitive activation criteria, which resulted in ward staff being desensitized to deranged vital signs [70].

themes, which were then categorized into the five interacting components of the work systems of the SEIPS model: the *person[s]* using various *tools and technologies* to perform *tasks* in an *environment* under certain *organizational conditions* [73]. The interaction of these components of the work systems influences the processes of RRS activation, which in turn affects patient outcomes. At the same time, feedback loops between the process and outcomes, and the work systems can inform problems and opportunities for modifying the work systems [73, 74].

Figure 2 depicts an adapted graphical representation of a ward clinician's work system that influences RRS activation. Factors influencing RRS activation were distributed across *person*, *tools and technologies*, *tasks*, and *organization*. No factor was identified in the *environment* component. Table 3a–3d provides an explanation and supporting evidence for each of the factors identified

'*Person*', which refers to ward nurses and junior physicians in this review, is at the center of the work system. The process to activation of the RRS was found to be affected by person-related factors such as perceptions of the benefits and drawbacks of the RRS, clinical expertise, and support received from colleagues and hospital leadership in the activation of the RRS (Table 3a). Although the process was also aided by '*tools and technologies*', there was apprehension about the ability of the tools and technologies to support early recognition of patient deterioration and RRS activation, particularly on the issues of sensitivity and specificity of the activation criteria and the limitations of the monitoring technology (Table 3b). The enactment of activating the RRS was made complex with the '*task*' of seeking justification and affirmation, deliberating over reactions from the RRT, and taking into consideration the workload and staffing (Table 3c). Adherence to the traditional model of escalation of care and staff education were powerful '*organizational*' factors that influenced the way ward clinicians used *tools and technologies*, and performed their tasks of activating the RRS (Table 3d).

The findings from this systematic review led us to confirm that the process to the activation of the RRS is complex and multifactorial, but underpinned by well-defined themes in the work systems of ward clinicians.

Discussion

This is the first systematic review to synthesize evidence on the factors influencing RRS activation by junior physicians and ward nurses. Using the SEIPS model, we found that the elements of person, tools and technologies, tasks, and organization were associated with RRS activation. No factor associated with physical work environment was identified. This may be due to a lack of awareness and studies examining the ergonomics of workplace on RRS activations. Nevertheless, our findings validate and expand upon the findings of a previous literature review on factors that affect nurses' effective use of the RRT [75].

The application of the SEIPS model enabled a clearer connection of the interactions of different factors in the work systems factors which influences the recognition of the need for RRT and activation of the RRS (processes) to effectively avert adverse events (outcome) resulting from uninterrupted clinical deterioration. For example, ward nurses' adherence to the traditional model of escalation of care was associated with their fear of criticism for 'incorrect' activations. Their fear of criticism is linked to a combination of insufficient clinical experience (*person-related*), inadequacy in the activation criteria (*tools and technological-related*), and dismissive responses from RRT members (*task-related*), which often leads to ward nurses

Table 3c Task-related factors influencing an activation of the rapid response system by ward nurses and junior physicians

Themes	Explanation	Evidence
Justifying RRS activation	The task of justifying RRS activations by nurses was common for patients who experience subjective, subtle, and/or gradual clinical changes	Ten studies described that nurses' decision to activate the RRS was often moderated by the task of justifying the need for a RRT through seeking affirmation from peers or more experienced nurses and/or gathering clinical data to avoid unnecessary activation [38, 39, 48, 51, 53, 60, 61, 65, 69, 71]. At times, justification included beyond seeking affirmation to 'dig deeper' (p.26) into gathering further objective data, identify an objective finding that served as a 'trigger' (p.27) for RRS activation, or even 'to wait for a bigger change' (p.28) to occur [51]. Common reasons for the need in justification included the fear of making 'incorrect' calls, lack of confidence in patient assessment, misunderstanding of the activation criteria, and inadequacy of the activation criteria [38, 39, 48, 51, 53, 60, 61, 65]
Deliberating over the reactions from RRT members	Ward clinicians' decision in an activation of the RRS was confronted with the task of deliberating over the attitudes and responses from the RRT members. The collaboration between attending physicians and the RRT members also affects RRS activation	Fourteen studies suggested the task of deliberating over reactions from the RRT members when deciding whether or not to activate the RRS [37, 38, 40, 48–50, 55, 59–61, 63, 64, 66, 69, 71]. Dismissive responses and behaviors from the RRT members such as condescension in tone, arrogant communication styles and negative repercussions by the RRT for unnecessary activations discouraged RRS activations [38, 48, 49, 55, 59, 61, 63, 64, 66, 69, 71] while collegial working relationship between ward clinicians and RRT members achieved through effective communication and mutual respect encouraged RRS activation [60]. Conflicting medical opinions regarding patient management between attending physicians and members of the RRT also hampered RRS activation [49, 50, 63]
Workload and staffing	Workload and staffing have bidirectional influences on RRS activation. While heavy workload and inadequate staffing can cause ward clinicians to feel handicapped in supporting deteriorating patients, it can also hinder their ability to provide vigilance to patients	Eight studies demonstrated mixed evidence on the impact of workload and staffing on RRS activation [40, 50, 51, 53, 59, 63, 64, 68]. Heavy workload and inadequate staffing caused ward clinicians to be under resourced in supporting deteriorating patients, which in turn encouraged RRS activation [40, 50, 53, 59, 64]. However, this can also be a barrier to close monitoring and the recognition of patients at-risk of deterioration [51, 63, 68]. A retrospective review of 108 RRS activations in a hospital from the US found a 3.25 greater likelihood of delayed RRS activation occurring on night shifts when vigilance to patients was threatened by fewer staffing (95% CI:1.34–7.9, $P < 0.01$) [68] There were also concerns of increased workload following RRS activations [63, 64]; however, this was found to be more apparent among physicians compared to nurses (OR = 1.72 (95% CI:1.2–2.49), $0.01 > P > 0.001$) [64]

Table 3d Organization-related factors influencing an activation of the rapid response system by ward nurses and junior physicians

Themes	Explanation	Evidence
Traditional model of escalation of care	The RRS 'breaks' away from the traditional model of escalation of care, which is inherently rigid to change, especially among the medical profession	Eighteen studies highlighted an allegiance to the traditional model of hierarchical escalation of care in which nurses will escalate for help from junior physicians who will then activate the RRT and/or after notifying their seniors [21, 37–40, 48–51, 53, 57, 59–61, 63, 69, 71, 72]. This inclination to the traditional model was found to be more prevalent among the medical profession, with significantly more medical staff (28% than nurses (14.7%) indicating that they would not activate the RRT if the attending physician was unavailable ($P < 0.01$) [21]. There were evidences of nurses being caught between the RRS guidelines and resistance from attending physicians in calling the RRT [40, 50, 71]. Yet, junior physicians were indecisive in their management and had to consult their seniors for a second opinion before activating the RRT [40, 50]. Delays in activation were made worse with expectations from the upper hierarchy that ward nurses and junior physicians should attempt stabilizing measures before seeking medical assistance [39, 51].
Staff training and education ($n = 18$)	Staff training and education about the RRS is not only crucial in the implementation of the RRS but also imperative in the maintenance phase in order to enhance the acceptance and uptake of the RRS	Eighteen studies identified that staff training and education on the purpose of the RRS, understanding and familiarity with the activation criteria and RRS activation protocols, and ability to identify deteriorating patient situations who require a RRT review were vital facilitators to RRS activation [21, 37, 38, 40, 48–50, 53, 55, 56, 59–64, 66, 72]. Conversely, unclear RRS protocols and guidelines to define individual roles and responsibilities impeded RRS activations [40, 48–50, 59]. In addition, cursory initial training on the RRS and sporadic follow-ups on RRS education were key reasons to unfamiliarity with the RRS protocols and confusion in individual roles during a joint rescue with the RRT [59]. Conventional education and training methods such as orientation sessions, lectures, and posters may not be adequately effective [56].

hankering after an affirmation for RRS activation. Experienced nurses were found to be more confident and capable in recognizing the need for RRT interventions based on their intuitions. Hence, they were often consulted by their juniors when an affirmation is needed.

The inadequacy of the activation criteria to detect subtle and early deterioration highlights that acquiescent reliance on the activation criteria, with vital signs derangements as the optimal cue for RRS activation, can marginalize other assessment cues [76, 77]. Overreliance on vital signs abnormalities also risks devaluing the merit of subjective data and intuitive senses within assessment reflecting early deterioration [78]. Patient assessment using sensory skills such as visual observation, palpation and listening, which aid early detection of deterioration before vital signs changes are evident, should not be compromised or replaced with electronic monitoring equipment [79–81]. It is thus essential that clinicians are equipped with the ability to conduct and interpret appropriate patient assessments. Furthermore, an overreliance on automated patient monitoring can lead to a tendency to have strong belief in the accuracy of the monitoring technology with a low degree of suspicion of error [82]. This could cause nurses to be less vigilant to patients' deteriorating conditions, thus likely to jeopardize patient safety [82].

Similar to the ward nurses, adherence to the traditional model of calling attending physicians first was the biggest barrier for junior physicians. Our findings suggest that this barrier could be attributed to their perception of threatened deskilling due to the presence of the RRT. Resistance from the medical profession towards the acceptance of the RRS due to perceived disruptive effects on junior physicians' education and clinical autonomy can be linked to the professional socialization in medicine education where physicians laid claims to their expertise and jurisdictions over patient management [85, 86]. As such, RRS activation could be deemed as incompetent and at odds with the socialization process of becoming an independent practitioner.

An initiation of the RRS involves a complex cultural system of change, which is superimposed on professional norms and boundaries in a strictly hierarchical context [83]. This initiative may be difficult to adopt unless all healthcare practitioners within an organization collectively agree to use the system [84]. Thus, hospital leaders play an essential role in transforming individual thinking, organizational culture and professional hierarchy in medicine. While it takes time for attitudes and behaviors to alter, and organizational cultural changes to be embedded, hospital leaders can introduce some quick wins as the first steps towards garnering support and acceptance from stakeholders of the RRS [87].

Implications for clinicians and policymakers, and future research

Our findings demonstrate that frontline clinicians were convinced about the value of the RRS. However, timely RRS activations should be encouraged with appropriate support. Given that junior nurses' first course of action when uncertain about the need for a RRS activation was to seek affirmation from senior nurses, an adequate skill mix of experienced nurses on shift thus becomes apparent. The considerable amount of time spent justifying RRS activation limits the RRS as an early intervention to clinical deterioration. Thus, further work is required to integrate relevant patient assessment skills and early cues of deterioration into the EWSS activation criteria, as well as equip clinicians with a more clinically specified understanding of the 'worried' criterion that is less open to subjective interpretation [21, 88, 89]. Future studies can also

examine the impact of clinicians' decision-making process on timely RRS activations and patient outcome. The lack of substantial evidence on the influence of monitoring technology also recommends research to assess the impact of monitoring technology on timely activations and patient outcome.

Socio-cultural barriers such as adherence to the traditional hierarchical escalation of care, fear of criticism and negative behaviors of the RRT responders could be mediated by hospital leaders. This can be achieved through continuous training coupled with appropriate education and training methods to encourage teamwork and clinicians to respond responsibly, clear RRS protocols, and continuously support advocating RRS activations. An exploration of other viable modes of education and training methods is warranted. Literature has highlighted that certain cultures tend to adopt vertical hierarchies in their working relationships [90], which could potentially be an obstacle to RRS activation. Future studies should be conducted beyond a non-Western context, which was not included in this review.

It is also paramount that hospital leaders periodically evaluate their hospital RRS. An important aspect not to be overlooked is the perspectives of ward nurses and junior physicians, who are key users of the RRS. Understanding the impact of the RRS on junior physicians' medical education holds strong promise to enhance the implementation process of the RRS in institutions and improve physicians' acceptance of the RRS. Researchers may seek to develop a tool to help hospital leaders identify core factors to improve each hospital's RRS. Lastly, this review recommends the adoption of human factors ergonomics perspectives to understand the interactions between the end-users of the RRS and other elements of the work system to further optimize and mitigate obstacles associated with the RRS.

Limitations

Despite an exhaustive literature search, the exclusion of studies that evaluated the effectiveness or impact of the RRS on patient outcomes, which may contain additional insights, may have been missed. Secondly, most of the quantitative studies were cross-sectional surveys that provided information about attributes at a single time-point. It is likely that the perceptions of responders will change overtime. Thirdly, there are variations in the RRS implemented across the included studies i.e. the maturity of the RRS and different composition of the RRT (physician-led RRT versus nurse-led RRT). This may have an influence on ward clinicians' decisions to activate the RRT. Fourthly, as most of the studies did not report the RRS activation rates, we could not analyze the identified factors in relation to the activation frequency. Lastly, the use of a different conceptual model might have resulted in different themes identified.

Conclusion

This systematic review has demonstrated that RRS activation is a complex intervention that involves navigating through the way clinicians interact with the interplay of socio-cultural, political and organizational considerations. Activations of the RRS were found to be influenced by key factors that include frontline clinicians' perceptions of the RRS and their clinical judgment, support from colleagues and hospital leaders, adequacy of the activation criteria, attitudes and responses of the RRT members, adherence to the traditional model of escalation of care, and staff training and education. Institutions should consider these factors in the implementation of their RRS and develop strategies to improve the utilization of the RRS. More

research efforts, along with clinical practice implications, should be central to improving suboptimal activations of the RRS.

Supplementary material

Supplementary material is available at *International Journal for Quality in Health Care* online.

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