Title: EARLY WARNING SYSTEMS AND RAPID RESPONSE TO THE DETERIORATING PATIENT IN HOSPITAL: A SYSTEMATIC REALIST REVIEW

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ABSTRACT

Aim

To determine the Rapid Response System programme theory and investigate how the mechanisms of implementation and the characteristics of context combine to enable or constrain the implementation of Rapid Response Systems and the achievement of desired outcomes.

Background

Rapid Response Systems have been implemented internationally to improve the recognition and management of patient deterioration, reduce the need for cardiopulmonary resuscitation and improve patient outcomes.

Design

Realist Review

Data sources

We searched DARE, CENTRAL, NHSEED, MEDLINE, Medline In Process, Embase, CINAHL, PubMed, Scopus, The Web of Science and PychInfo databases from 1997-2017 in addition to purposively searching the grey literature, citation and snowball searching and contacting professional groups looking for articles supporting, refuting or explaining Rapid Response System programme theories.

Review Methods

Included studies were critically appraised and graded using the Critical Appraisal Skills Programme tool. Data extraction and synthesis investigated the Rapid Response System theoretical propositions against the empirical evidence in order to refine programme theories.

Results

The review found that the Rapid Response System programme theory achieved desired outcomes when there were sufficient skills mix of experienced staff, EWS protocols were used flexibly alongside clinical judgement and staff had access to ongoing, multiprofessional, competency based education. However, ward cultures, hierarchical referral systems, workload and staffing resources impacted negatively on the implementation of the Rapid Response System.

Conclusion

To improve the recognition and management of patient deterioration policymakers need to address those cultural, educational and organisational factors that impact on the successful implementation of Rapid Response Systems in practice.

SUMMARY STATEMENT

Why is this review needed?

- There is limited research evidence to explain whether the implementation of a Rapid Response System improves recognition and management of patient deterioration in hospital.
- There is limited understanding of why Rapid Response Systems work in certain circumstances and not in others.
- Understanding what works or does not work in practice will improve the implementation and success of Rapid Response Systems internationally.

What are the key findings?

- Experienced nursing staff used clinical judgement to recognise patient deterioration.
- Early Warning System protocols empowered nurses to call for help.
- Existing ward cultures, workload and staffing issues impacted negatively on successful implementation of Rapid Response Systems.

How should the findings be used to influence policy/practice/research/education?

- Inform national staffing levels to improve early recognition.
- Utilisation of protocols to empower nursing staff.
- Provision of ongoing staff education to improve knowledge and skills in practice.

Keywords:

Realist review, Rapid Response Systems, programme theory, EWS protocols, patient deterioration, nursing.

INTRODUCTION

Rapid Response Systems (RRS) have been implemented internationally as a patient safety initiative to improve the recognition and management of patient deterioration in hospital (IHI 2006, NSPA 2007). The underlying premise is that implementation of standardised physiological scoring tools, graded referral protocols and response teams with specialist critical care knowledge and skills will prevent further patient deterioration, reduce the need for CardioPulmonary Resuscitation (CPR) and improve patient outcomes (NICE 2007). However, to date the evidence for RRS is equivocal, with systematic review evidence failing to show an effect (Esmonde *et al.* 2006, McGaughey *et al.* 2007, Winters *et al*. 2007, Chan *et al.* 2010, Alam *et al*. 2014). Experimental studies can demonstrate this apparent lack of effect but are not suited to explaining it (DeVita & Bellomo 2007). To fully understand the factors influencing the implementation of RRS the research approach needs to consider the complex nature of the intervention within the healthcare context. This highlights the need for further research to understand and explain the personal, social or organisational factors impacting on RRS. As a result this realist review is part of a larger funded research project which is outlined in the study protocol (McGaughey *et al.* 2010).

Background

The RRS consists of an number of interrelated components : a trigger arm which is the "crisis detection" and "response triggering" mechanism; a response arm which provides competent personnel and resources at the bedside; a governance structure to organize resources; and a hospital audit and improvement process to prevent future events (DeVita *et al.* 2006). To contain the depth and breadth of the review we focused the realist synthesis on the RRS components of the trigger arm and the ward response initiated by staff.

The identification of patients ‘at risk’ is fundamental to initiating the trigger arm of the RRS. To improve early identification of physiological instability Early Warning Systems (EWS) were implemented. EWS are weighted, aggregated scoring tools incorporated into the routine observation chart on general hospital wards to record physiological parameters of systolic blood pressure (BP), heart rate (HR), respiratory rate (RR), urinary output, temperature and level of consciousness (NICE 2016; RCP 2012). The weighted EWS score is compared with a predetermined physiological threshold or trigger score that assist hospital staff in recognising clinical deterioration and aid response decision-making. A response protocol or algorithm provides a clear and unambiguous action required by staff to a given trigger threshold or score.

Once a trigger threshold is reached the predefined response arm strategy initiates a call for help commensurate with the trigger score. The protocolised response strategy ensures appropriate and competent staff are alerted and then mobilised to rescue deteriorating patients (NICE 2016). Tiered education of staff is important to ensure varying levels of skill (DoH 2009, CEC 2017). A graded response strategy (low, medium and high score groups), with maximum response times specified, has been adopted as best practice (NICE 2016). Low level response increases the frequency of observations and alerts the nurse in charge; medium level response requires personnel with acute care competencies and the primary care team to be informed and a high level response should initiate an emergency call to a Rapid Response Team (RRT) who are knowledgeable, experienced, critical care staff competent in managing patient deterioration (Figure 2). This proactive management of at risk patients allows review of patient management plans, planning of admissions to higher levels of care or instituting Do Not Resuscitate (DNR) orders for patients who are too sick to benefit from resuscitation or

Intensive Care. It therefore avoids late or inappropriate cardiac arrest calls which result in unplanned and potentially avoidable admissions to the Intensive Care Unit (ICU).

Unfortunately, RRS does not always work as intended in practice. To understand how RRS works there is a need to determine the underlying programme theory - 'the ideas and assumptions underlying how, why and in what circumstances complex social interactions work' (Dalkin *et al.* 2015, p 3). To track and articulate these RRS programme theories we scoped the literature and policy documentation for theories, assumptions and rationales explaining how the intervention is supposed to work in order to map these out in broad terms from an expert and policy perspective (Figure 1). This provided initial RRS programme theories which illustrated the proposed linear and sequential process for successful implementation of RRS. However, healthcare interventions or programmes implemented in practice are often complex and non-linear. The aim of this realist review was to determine the RRS programme theory and investigate how the mechanisms of implementation and the characteristics of context combine to enable or constrain the implementation of Rapid Response Systems and the achievement of desired outcomes.

THE REVIEW

Review Question

What factors impact on nurses', doctors' and managers' ability to implement components of the Rapid Response System in practice in order to improve the recognition, referral and immediate management of acutely ill patients on general hospital wards.

Design

We undertook a realist review guided by the principles of realist synthesis (Pawson & Tilley 1997). A realist review seeks to identify the theory underlying an intervention, recognising that interventions are embodied theories, and that outcomes are a product of the interaction of context, mechanism and outcome (CMOs). An intervention alters context, which triggers mechanisms, which leads to outcomes – both intended and unintended. This allows the various components or steps of the programme to be identified and evaluated in order to understand factors influencing the achievement of the desired outcomes. A realist review is an appropriate method to identify these interactions in order to explain "What works for whom under what circumstances, how and why?" (Wong *et al.* 2013, p 2).

Identification of the RRS initial programme theories from the scoping review informed the development of four theoretical propositions (initial CMOs) which were mutually agreed by clinical and academic experts on the study steering group (Table 1). These initial RRS programme theories were then investigated by gathering empirical evidence to support or refute the propositions. This stage of the realist review process utilised a systematic approach to search, appraise, extract and synthesise the evidence from a wide range of sources to provide an understanding in terms of personal choices, context, social, cultural and implementation influences which impacted on the desired outcomes (Pawson & Tilley 1997).

Search methods

We searched CENTRAL, DARE, NHSEED, Medline, Medline In Process, Embase, CINAHL, Scopus, The Web of Science and PychInfo databases from 1997-2017 using a validated search strategy previously developed by a trials search co-ordinator for a Cochrane review (McGaughey *et al.* 2007) with both quantitative (RCT) and qualitative (Joanna Briggs

Institute 2008) methodological filters. The original search and analysis was carried out in 2010 as part of a larger study (refer to protocol). Since that time, a large number of papers have been published, so in the interests of keeping the review to a manageable size, we conducted a rapid review of the relevant literature since 2010, using the same search strategy. This rapid review process used the same methodological rigour to identify studies but omitted quality appraisal to provide information within time constraints. Our objective was to identify, a) evaluation studies that pertain to the efficacy of RRS; and b) papers that advanced theoretical understanding of how RRS works. Authors (JM and PO) scanned titles to identify key studies, then came together with the other authors to discuss findings, and to see if these papers demonstrate a tipping point in terms of efficacy or theoretical development. Thus, the results of this paper reflect our initial analysis, reviewed and modified in the light of data from key papers published since 2010.

Search outcome

Studies were included if they identified key factors that supported or hindered RRS in practice, provided an explanation of why RRS worked or did not work in practice and were qualitative or quantitative research studies. The search for evidence continued until theoretical saturation was reached. Following removal of duplicates all research citations were reviewed by JM for inclusion. In total 324 full text studies were reviewed and 222 studies which met the inclusion criteria in 2010 were included in the review. The rapid review update from 2010-2017 identified a further 53 studies (Figure 3).

Quality appraisal

All included studies were appraised by JM for relevance, rigour and credibility. Relevance judgements were based on whether the article addressed the theory under investigation and

rigour judges whether inferences drawn have sufficient methodological credibility to contribute to the theory (Pawson *et al*. 2004). Rigour was appraised using the appropriate Critical Appraisal Skills Programme tools (CASP, 2017) which facilitated quality assessment of each article using the 10 point scale. Included studies were graded as high (50), medium (95) or low quality (77) (See supplementary information table 1).

Data extraction

Data extraction was undertaken by JM. The data extraction process involved interrogating the empirical evidence against each of the four RRS theoretical propositions to assimilate those factors influencing how the programme worked in practice. This stage of the review sought both confirmatory and contradictory empirical evidence to facilitate synthesis and refinement of RRS programme theory. Data extraction involved coding emerging themes with evidence on context, mechanisms and outcomes. To enhance credibility BB checked 10% of data extraction and synthesis as it provided a reasonable sample of studies to ensure consistency in methods given the time constraints.

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Synthesis

The empirical evidence was synthesised and correlated with RRS theoretical propositions to explain the programme outcomes in terms of contexts and mechanisms. Synthesis was an iterative process which allowed supporting and refuting evidence of the initial RRS programme theories to be reviewed, compared and reappraised in light of emerging evidence (Pawson *et al*. 2004). As a result inferences were drawn from the research evidence to support, refute or refine the theoretical propositions. Members of the Steering group then reviewed and refined the emerging theories.

RESULTS

Proposition one: Evaluation of early recognition evidence

EWS validity and reliability (Mechanism)

Research evidence supporting EWS validity and reliability showed that physiological variables (HR, BP, RR) accurately predicted outcomes which were associated with an increased risk of unplanned ICU admission/ readmission and mortality in adult and paediatric patients within 24-48 hours (Etter *et al*. 2008, Cei *et al*. 2009; Cuthbertson *et al*. 2010, Smith *et al.* 2013, Massey *et al.* 2015). The risk of mortality was associated with an increased number of abnormal observations (Trinkle & Flabouris 2011, Visser 2014) and a higher EWS score (Mandell *et al*. 2015). However, refuting evidence highlights that EWS validated tools have largely been modified to individual localities whereby the sensitivity and positive predictive values were too low to predict patient deterioration in hospital (Gao *et al.* 2007, Cuthbertson *et al.* 2010, Jansen & Cuthberson 2010, Mandell *et al.* 2015). As a result the utility, validity and reliability of EWS tools has been questioned (Gao *et al.* 2007, Donohue & Endacott 2010, Shearer *et al*. 2012, Mandell *et al.* 2015).

Recording practices (Mechanism)

Implementation of EWS in several studies found improved process outcomes in relation to detection rates (Chatterjee *et al*. 2005), scoring accuracy (Higgins *et al.* 2008), compliance (Mackintosh *et al*. 2012) and recording practices, with an increase in respiratory rate recording the most noted improvement (Mitchell *et al*. 2010, Mackintosh *et al.* 2012, McKay *et al*. 2013, Kyriacos *et al.* 2015). However, refuting evidence suggests that nurses are not able to detect or interpret signals of impending danger (Despins 2009) and that incomplete or absent EWS physiological variables are a significant factor in the failure of the trigger arm to detect patient deterioration (MERIT *et al*. 2005, Chen *et al*. 2009, Oliver 2010, Tirkkonen *et al.* 2013). It is

suggested that the process fails as a result of inconsistency in recording observations, calculation errors and not communicating vital sign abnormalities (Ludikhuize *et al.* 2011, Mackintosh *et al*. 2012). These findings indicate that as the degree of physiological abnormality increased scoring errors were more likely to lead to underscoring (Peterson *et al*. 2014) and delayed referral (Smith & Oakey 2006).

Proposition two: Evaluation of early referral evidence

RRS call rates (Mechanism)

The call rates to RRTs are used to determine the utilisation of specialist teams to respond to episodes of patient deterioration in hospitals. The availability of standardised processes and procedures has increased RRT call rates (Mitchell *et al*. 2010, Etter *et al.* 2014, Herod *et al*. 2014, Frost *et al*. 2015) emphasising that more patients are being identified and referred earlier for help. The main reason or trigger for calling the RRT was found to be the subjective criteria of 'concern' which was initiated before vital sign parameters were reached (Chen *et al*. 2010, Clifton *et al.* 2015, Stafseth *et al.* 2016). Prospective audit and retrospective analysis of RRT calls showed that the most common physiological criteria which trigger calls for help were low oxygen saturation, low systolic BP, a change in conscious level or change in HR or RR (Rothschild *et al*. 2008, Calzavacca *et al*. 2008, Visser 2014). However, several studies suggest that there was a high rate of underutilisation of RRT prior to unplanned ICU admissions (MERIT *et al.* 2005, Bucknall *et al.* 2013, Davis *et al*. 2014, Massey *et al*. 2015) which Chen et al (2010) suggests is a result of reliance on physiological criteria to trigger a call for help.

The underutilisation or delays in activation were found to be due to failure to recognise deterioration (Azzopardi *et al.* 2011), lack of understanding regarding role of RRT (Massey *et*

al. 2014), escalation protocol not clear to junior nurses (Johnston *et al.* 2014, Braaten 2015), fear of criticism (Azzopardi *et al.* 2011; Johnston *et al*. 2014; Massey *et al.* 2014), staff attempting to deal with the situation by conventional ward care (Shearer *et al.* 2012, Braaten 2015), waiting for further investigations (Shearer *et al.* 2012), preference to rely on own clinical judgement when deciding to call RRT (Shearer et al 2012; Radeschi et al 2015), consulting peers (Donohue & Endacott 2010; Massey *et al.* 2014; Braaten 2015) or seeking ward medical review before calling the RRT (Azzopardi et al 2011, Oglesby et al 2011, Braaten 2015, Radeschi *et al.* 2015).

Referral protocols (Mechanism)

Evidence suggests that the EWS protocols improve communication of vital signs (McKay *et al*. 2013) and empower nurses to vocalise their concerns by 'packaging' information using clinical judgement and quantifiable evidence to call for help (Andrews & Waterman 2005, Donohue & Endacott 2010, Mackintosh *et al.* 2012, Massey *et al*. 2014). Packaging information ensures that nurses communicate using convincing, precise referral language which doctors can contextualise in order to judge and prioritise the referral (Andrews & Waterman 2005, Stafseth *et al.* 2016). Nursing experience is associated with RRT activation (Mackintosh *et al.* 2012, Johnston *et al*. 2015). However, nurses were less confident referring calls to medical staff when concerned about a patient as these subjective cues were difficult to communicate (Cioffi *et al.* 2000a, McArthur-Rose 2001, NSPA 2007), required more justification and took time to collect data to place the clinical change in context (Braaten 2015). As a result delays in referral were associated with lack of self efficacy, clinical experience and uncertainty (Massey *et al.* 2014, Roberts *et al*. 2014) and untrained and junior staff (Pattison & Eastham 2011, Ludikhuize *et al.* 2011, Radeschi *et al*. 2015).

Communication and teamwork (Context)

The process of providing healthcare is inherently interdisciplinary and team performance is crucial to patient safety (Manser 2009). However, evidence suggests that the barriers to teamwork and interdisciplinary communication are associated with role confusion (McCroroy *et al*. 2015, Michalec *et al.* 2015), nurses not knowing who to call (NSPA 2007, O'Leary *et al.* 2010), poor and inadequate communication (McCroroy *et al.* 2015, Michalec *et al*. 2015), lack of experienced staff (Peebles *et al*. 2012) and professional hierarchies (NPSA 2007). The lack of communication and teamwork is attributed to existing ways of working which demonstrate a uniprofessional perspective and a lack of cohesion between doctors' and nurses' work practices (NSPA 2007, Clinical Excellence Commission 2008).

Proposition three: Evaluation of early rescue evidence

Educational courses (Mechanism)

The provision and range of acute care courses has increased in hospitals following Government recommendations (NCEPOD 2005, NICE 2007, DOH 2009). Evaluation of educational courses and simulation training have identified improved outcomes of knowledge, confidence, attitude, teamwork, communication (Fuhrmann *et al.* 2009b, Cooper *et al*. 2013, Hogg & Miller 2016, Murphy *et al*. 2016) and enhanced competence in practice with regular in situ simulation training, clinical or outreach secondment (Cooper *et al.* 2013, Theilen *et al*. 2013). However, refuting evidence suggests that the implementation of an educational programme or simulated training does not improve knowledge, situation awareness, skill performance, clinical judgment (Sittner *et al.* 2009, Cooper *et al*. 2013) or patient outcomes (Fuhrmann *et al*. 2009a).

Role of RRT (Mechanism)

Findings indicate that the role of RRTs has a positive impact on the education of ward staff with identified improvements in confidence, knowledge, critical care skills, communication and support between critical care and ward staff (Endacott *et al.* 2009, Donohue & Endacott 2010). This supportive, educational role by RRTs empowers and supports staff (Stafseth *et al.* 2016), results in timelier organisation of care, provides weight and access to expert help and increases morale (Pattison & Eastham 2011).

Proposition four: Evaluation of patient outcome evidence

Patient outcomes (Outcomes)

The majority of studies to determine the effectiveness of RRS are based on weak, retrospective before and after studies (Moon *et al*. 2011, Joffe *et al*. 2011, Howell *et al.* 2012, Herod *et al.* 2014). The findings from these studies and from two randomised control trials (Priestley *et al*. 2004; MERIT *et al*. 2005) provide contradictory evidence on the impact of RRS on cardiac arrest, unplanned ICU admission or mortality rates. Systematic review evidence concluded that there was limited or weak evidence of RRT effectiveness on cardiac arrest or hospital mortality rates due to study heterogeneity (NICE 2007, McGaughey *et al.* 2007, Ranji et al 2007, Alam *et al.* 2014).

Explaining the equivocal evidence for RRS

Hospital and ward culture (Context)

In hospitals the recording of observations was found to be a ritualistic, task orientated practice on wards delegated to Health Care Assistants (HCAs) and student nurses in order to manage workload (Hogan 2006, Odell *et al*. 2009). The perceived increased EWS reliability EWS and weighted values legitimise delegation to HCAs (Mackintosh *et al*. 2012). As a result observations are being undertaken by the most junior staff on the ward who do not have sufficient training or experience to understand the significance or communicate findings

(NSPA 2007). This ward culture has led to the erosion of observation skills and reliance on electronic equipment which has resulted in a deficit in assimilating information and effective patient care decisions as nurses are not clinically assessing or recording observations (McQuillan *et al.* 1998, Wheatley 2006, Oakey & Slade 2006, Higgins *et al.* 2008, Odell *et al.* 2009).

Hierarchical culture (Context)

Reasons underpinning inadequate monitoring and response are associated with the traditional hierarchical referral culture in hospitals. This exists and is maintained by a set of hidden informal, institutional and cultural expectations (Farnan *et al*. 2008) whereby patients are referred up through the appropriate levels of authority. Ward staff are reluctant to breach this traditional hierarchical system by calling for help from RRTs when the trigger threshold or calling criteria are met (Donohue & Endacott 2010, Braaten 2015, Radeschi *et al*. 2015). This traditional hierarchical system delays calls for help and compromises patient care (Kerridge 2000, Garretson *et al*. 2006) as the most junior staff in the hospital attempt to care for the sickest patients on general wards (Jones *et al*. 2006, Hillman 2002).

Clinical judgement (Mechanism)

Evidence suggests that nurses detect patient deterioration through a process of intuitive knowledge and pattern recognition (Odell *et al.* 2009, Mackintosh *et al.* 2012). These assessment skills are developed by nurses from knowing the patient and from past experiences which were based on subjective rather than objective criteria (Cioffi 2000b, Mackintosh *et al.*2012). As a result findings suggest that experienced nurses use a complex interaction of intuition, protocols and clinical judgment to recognise patient deterioration and not just the objective MET criteria to refer patients (Pattison &Eastham 2011, Johnston *et al.*

2014). As a result EWS were used flexibly by senior staff to support decision making (Pattison & Eastham 2011, Mackintosh *et al*. 2012, Hands *et al*. 2013). However, junior nurses rigidly apply EWS protocol guidelines and the process of decision making was found to cause confusion for inexperienced nurses when intuition and EWS did not correlate (Odell *et al*. 2009).

Experience (Mechanism)

The ability of ward staff to refer or activate RRT in response to patient deterioration is linked to nursing experience as a result of being more confident in decision making (Massey *et al*. 2014, Braaten 2015). Critical care experience in particular was found to improve nurses' knowledge and recognition of deteriorating patients (Thompson *et al*. 2009, Pattison & Eastham 2011). Findings concluded that engagement in deliberate practice is the primary means by which nurses attain expertise (Whyte *et al*. 2009) and that the experience of staff may be fundamental in reducing risk (Wheatley 2006). Whereas, studies found that junior nurses relied on EWS score, doubted their ability to recognise deterioration and reported barriers to calling RRT (Azzopardi *et al*. 2011, Mackintosh *et al*. 2012, Roberts *et al*. 2014).

Workload and staffing resources (Context)

Evidence suggests that ward staff are struggling to recognise and manage deteriorating patients as a result of inexperience, time pressures, staffing levels and excessive workloads (Odell *et al*. 2009, Hands et al 2013; Braaten 2015, Jeddian et al 2016). To prioritise and manage workload nurses delegate much of the direct patient care to HCAs and student nurses (Wood et al 2004). Effective delivery and organisation of care requires the right number of knowledgeable and skilled nurses to the level of service provided **(**DoH 2001). However, the lack of adequate staff for patient load and acuity have been attributed to the low level of

awareness of patients at risk, response delays, failure to rescue and patient mortality (Fuhrmann *et al*. 2009a; Donohue & Endacott 2010).

Multi-professional educational strategies (Context)

Simulation training and educational programmes reduce barriers to utilisation (Radeschi *et al.* 2015) and improve recognition, escalation and review of patient deterioration (Theilen *et al*. 2013). The delivery of these programmes need to extend beyond increasing awareness of calling criteria to training staff in pre-emptive management of deteriorating patients (Naeem 2007). The rationale is underpinned by the evidence which suggests that only basic ward level interventions for breathing or circulation were required to reverse deterioration (Flabouris *et al.* 2010). These simple interventions should be within the ability of most health care staff (Bright *et al*. 2004) and nurses should have access to competency-based education and training within the workplace to ensure that they are educationally prepared to assess, document, interpret and initiate interventions within their scope of practice (NICE 2016). Fundamentally, education needs to be ongoing as a reduction in education and training over time impacts on the effectiveness of the implementation of RRS (MERIT *et al*. 2005, Higgins *et al*. 2008, Kinney 2008). However, the conflict between service provision and education requirements often results in resistance to releasing staff and not training doctors alongside their nursing colleagues (Clinical Excellence Commission 2008).

Synthesis of Emerging Programme Theories (EPT)

In the light of our results, we set out our emerging programme theories (EPTs) below, identifying the intervention (I), mechanisms (M), context (C) and outcomes (O).

EPT One: EWS scoring system with trigger threshold leads to identification of patient deterioration

Using a EWS scoring system with a trigger threshold for referral (I); enables less experienced nursing staff to make more consistent, objective judgements and provides evidence to support clinical judgements for experienced nurses (M); which improves the recognition and trigger of patient deterioration. (O). This is more likely to happen when experienced nurses have critical care experience and confidence in their clinical judgement; where there is a higher ratio of trained to untrained staff; where the skill-mix is appropriate to patient acuity; when EWS criteria are used flexibly alongside intuition and clinical judgement by experienced nurses; when experienced nurses assess patients and document EWS to detect deterioration (C). It is less likely to happen when EWS tools are unreliable; when EWS observations are delegated to junior staff; when there is increased workload and time pressure and when staff are not trained to recognise patient deterioration (C) (Figure 4).

EPT Two: Protocolised referrals lead to an appropriate and timely response to patient deterioration

The use of a standardised referral protocol (I) empowers competent nursing staff to contact and mobilise an appropriate member of staff with skills commensurate with the trigger score (M) to respond within a specified time and initiate early response strategies at the bedside to prevent patient deterioration (O). This is more likely when experienced staff use the EWS criteria flexibly in conjunction with clinical judgement to act and refer patients early based on a complex decision making process; when there are good working relationships in the multidisciplinary team; and when staff access to ongoing, competency-based multiprofessional acute care education that allows for application and transfer of learning to practice (C). This is less likely when there is an existing hierarchical (slower) referral pattern;

when nurses are unable to verbalise their subjective concerns to medical staff; when a formal communication tool (SBAR) is required to communicate concern; where acute care education is not ongoing or multidisciplinary and where nurses and doctors are anxious about the reaction of senior medical staff to referral (C) (Figure 5).

DISCUSSION

The realist review developed two emerging programme theories to explain the contexts and mechanisms enabling and constraining successful implementation of RRS.

EPT One:

A mechanistic, linear approach to decision-making is not always possible in a complex environment (Gazarian *et al*. 2010). As a result nurses use EWS more commonly to quantify deterioration once deterioration had been recognised by a combination of visual assessment, intuition and clinical judgement (Rycroft-Malone et al 2009, Cioffi *et al.* 2010). Critical care experience and acute care education improve nursing confidence to make these complex decisions. As a result it has been recommended that EWS should always be used as an adjunct to clinical judgement and experience (Fullerton *et al*. 2012). This is important given that EWS are unreliable (Chapman *et al.* 2010**)** and the use of intuitive or subjective criterion to refer patients accounts for 47% of rapid response activation (Beitler *et al.* 2011). However, key contextual factors that constrain successful EWS implementation are associated with an existing culture of delegating observations due to workload pressures and staffing resources. Review of staffing ratios and skill mix are required to allow nurses to undertake observations as currently there is no evidence that HCAs are effectively substituting for registered nurses (Ball et al 2016). To improve patient deterioration in hospital there may be no safe substitute for properly trained professionals who contribute to early detection and timely interventions that save lives (Aiken *et al.* 2011).

EPT Two:

The implementation of a standardised referral protocol empowers nurses to call for help and ensures patients are reviewed within specified timeframes. Experienced nurses use the referral protocol flexibly alongside clinical judgment and intuition to contact ward doctors for help (Brady & Goldenhau 2014). However, key contextual constraining factors were associated with the traditional hierarchical referral system, interprofessional communication and the ongoing provision of multidisciplinary education within hospitals in this review and other studies. As a result several mechanisms were triggered. Nurses were reluctant to breach hierarchical systems, referred directly to junior ward doctors, attempted to manage patients on wards and delayed referral due to uncertainty in decision-making and fear of criticism (Benin *et al*. 2012, Bagshaw *et al*. 2010). Experienced nurses assessed and referred patients more frequently than non trained nurses (Salamonson *et al*. 2006). SBAR was not used by nurses to communicate patient deterioration in this review or other studies (Bingham 2015). Education and training in EWS improves knowledge, confidence, attitude and teamwork to manage patients on general wards. However, contextual factors of workload pressures and staffing resources mitigate against ward based education due to a resistance of releasing staff for training. This review and other studies highlight that ongoing multiprofessional courses with practical applicability and opportunities to implement learning in practice are required for successful learning transfer and to breakdown cultural and professional boundaries (Baker-McClearn & Carmel 2008, Campello *et al*. 2009, Calzavacca *et al*. 2010, Smith & Aitken 2015).

Strengths and Limitations

This is the first realist review to investigate the theories underpinning the RRS programme against the research evidence available to explain the contexts and mechanisms which impact on the success or failure of implementation. The establishment of a steering group and data checking enhanced the trustworthiness of the findings. However, the review had its limitations. Due to time constraints the search and quality appraisal processes were undertaken by a single individual and only 10% of data extracted was doubled checked which may have increased the risk of bias.

CONCLUSION

The RRS dominant programme theories do not always work to produce predicted outcomes. To improve organisational and cultural practices in hospital managers and policymakers need to address those factors that are widely accepted in UK health care, such as managing increased workloads, inadequate staffing ratios and communication barriers between professions, which constrain successful RRS implementation. Recommendations for practice focus on ensuring there are adequate numbers of experienced staff on general wards for patient acuity, competency-based, multidisciplinary education is ongoing, set out standards of competence and accountability for primary, secondary or tertiary levels of response and staff are empowered through protocols to act in order to improve recognition and referral of deteriorating patients. To test and refine the RRS emerging programme theories a Realist Evaluation has been undertaken to explain why such a conceptually logical model does or does not work in practice (McGaughey et al, 2017).

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the article or revising it critically for important intellectual content. * http://www.icmje.org/recommendations/

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Figure 1: RRS Programme Theory & Implementation Chain

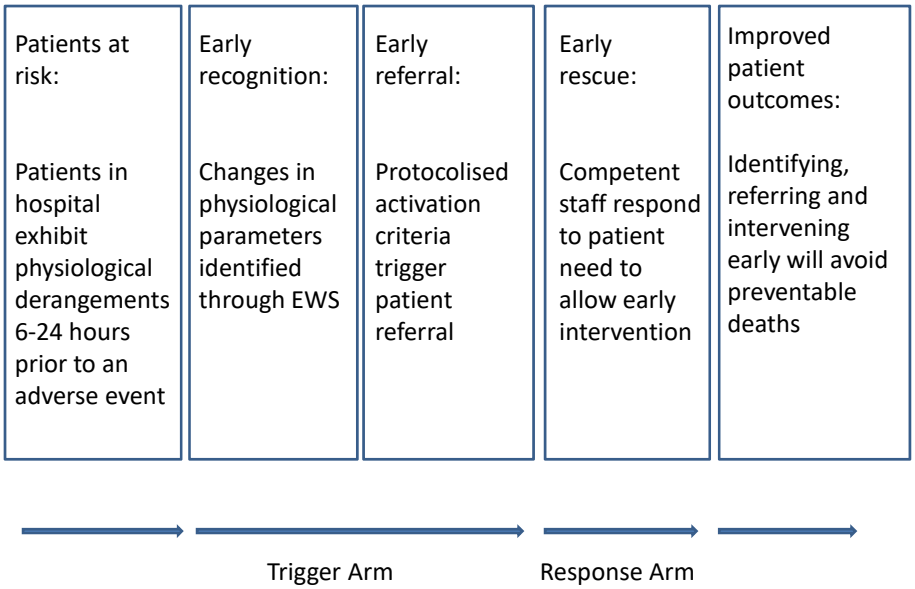

Table 1: RRS Theoretical Propositions

RRS Component	**Proposition**
Early Recognition	Accurate, regular monitoring of vital signs on general hospital wards (Context) using a standardised EWS tool alongside subjective assessment (Intervention) improves recognition of patient deterioration (Outcome) by highlighting changes in physiological parameters to nurses (Mechanism).
Early Referral	Predefined trigger thresholds with graded protocolised response strategies

	(Intervention) empower nurses to refer patients (Mechanism) to an appropriate member of staff (Context) who will attend within specified response times (Outcome).
Early Response	Educational courses in caring for the acutely ill patient for all hospital staff at varying levels of competence (Intervention) improves early intervention (Outcome) as an appropriate member of staff with the required knowledge and skills (Mechanism) will address deranged physiology according to the level of patient need at the beside (Context).
Improved outcome	The use of a sensitive and specific EWS tool, with predefined triggers and graded response algorithm (Intervention) improves early recognition, referral and response to patient deterioration by staff (Mechanism) to reduce the incidence of cardiac arrests, unplanned ICU admissions and unexpected deaths (Outcomes) in hospitalised patients (Context).

Figure 2: Overview of RRS Programme Theories

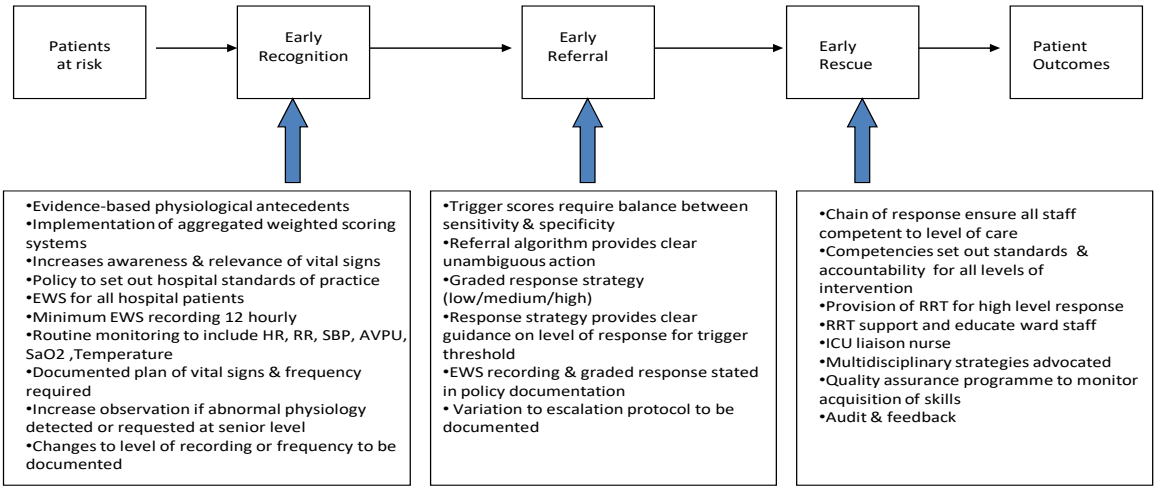

Figure 3: PRISMA

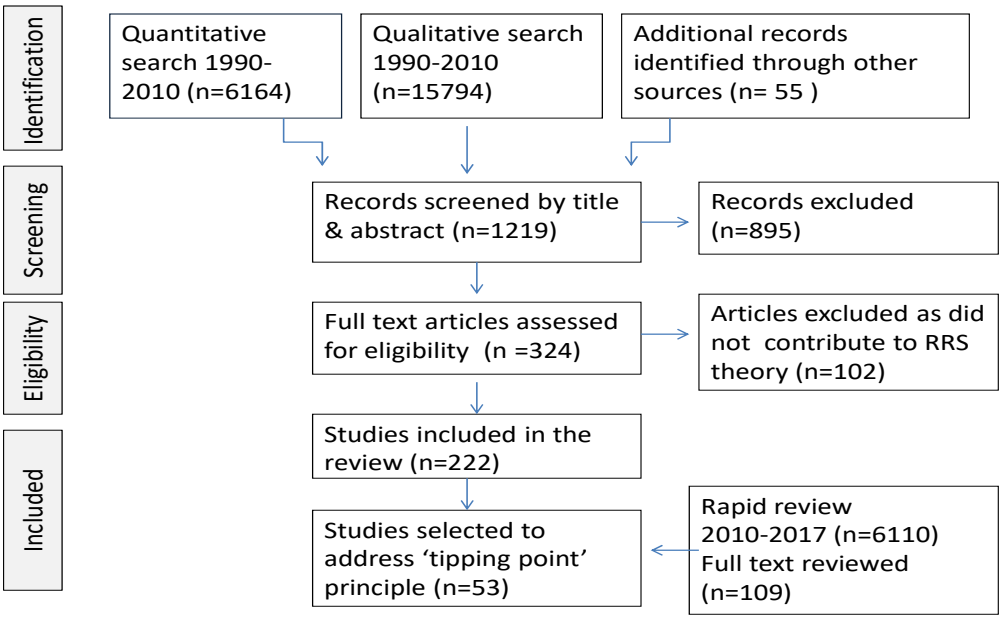

Figure 4: EPT One. EWS scoring system with trigger threshold leads to identification of patient deterioration

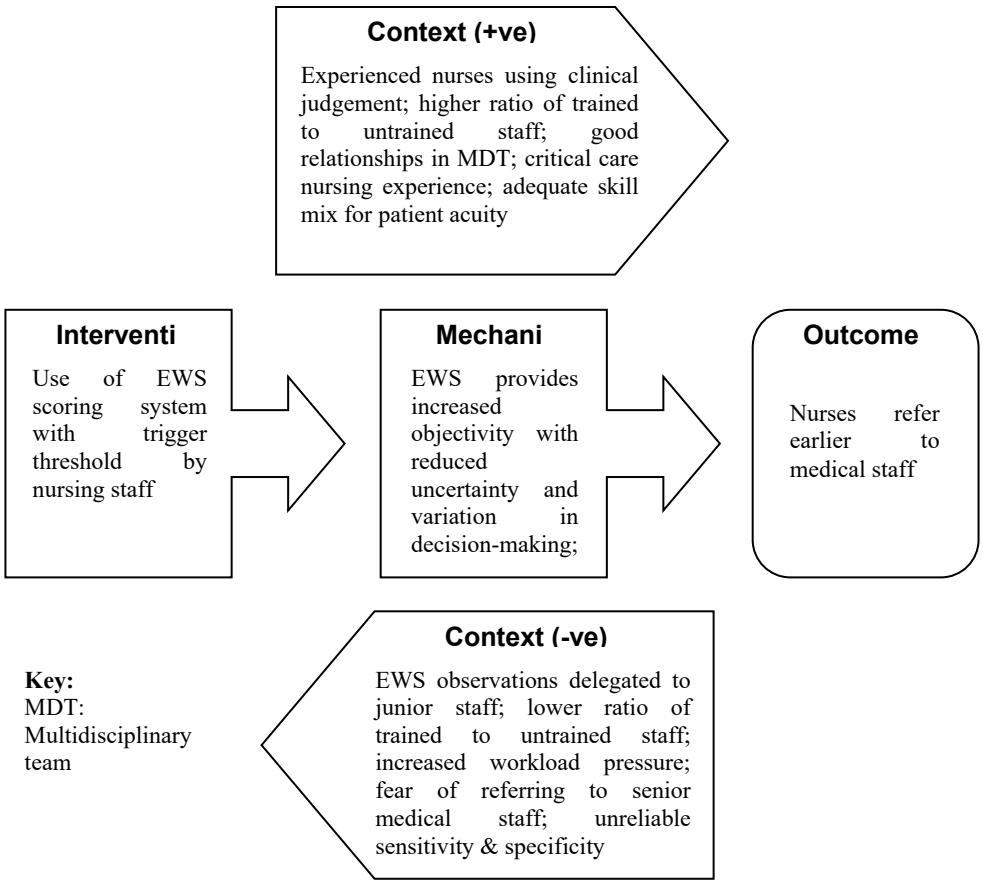
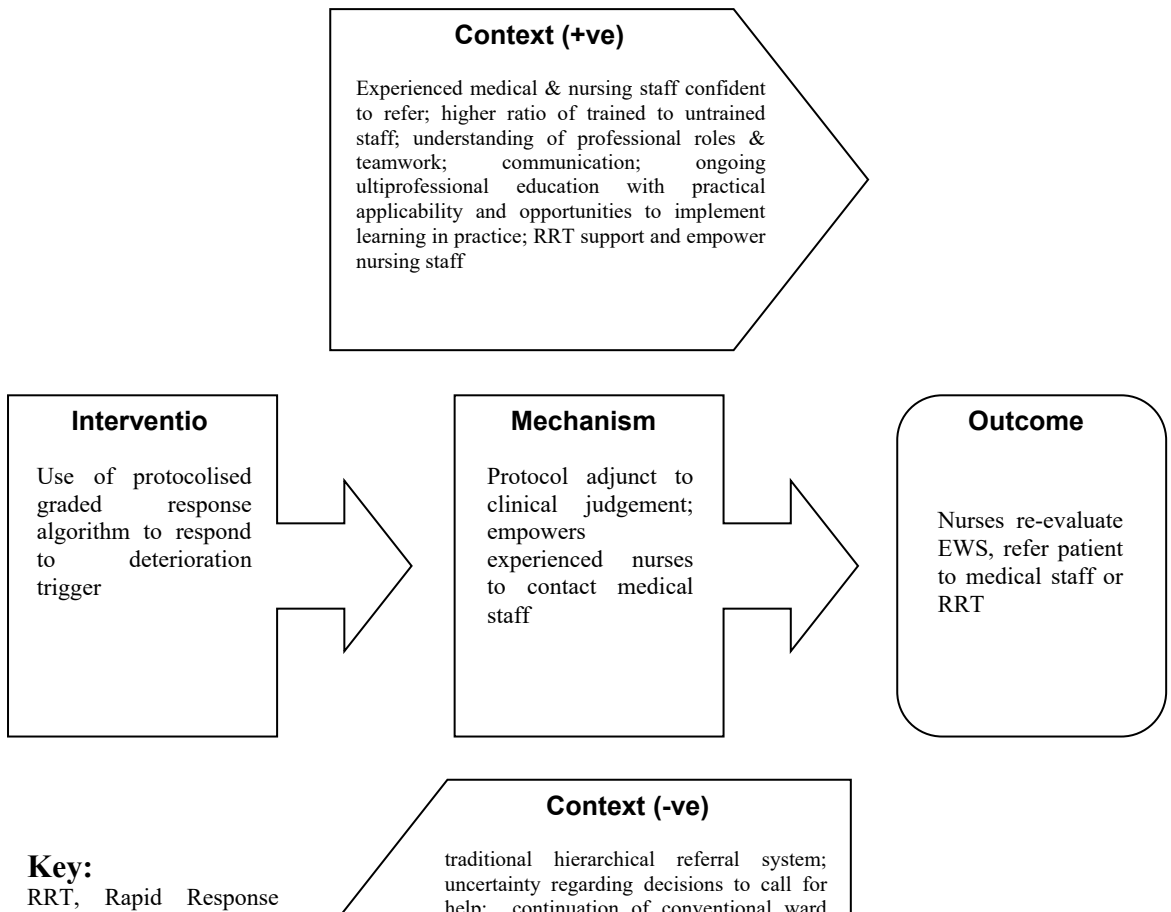
Figure 5: EPT Two. Protocolised referrals lead to an appropriate and timely response to patient deterioration