2. Failure To Rescue

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Introduction

Background

Failure to rescue (FTR) is failure or delay in recognizing and responding to a hospitalized patient experiencing complications from a disease process or medical intervention. As a patient safety and healthcare quality metric, FTR is typically defined as mortality following a complication, although there is no universally agreed upon definition and slight variations exist between institutions.[1,2] In this chapter, we discuss two patient safety practices (PSPs) that have been widely implemented to address FTR: patient monitoring systems (PMS) and rapid response teams (RRTs).

Importance of Harm Area

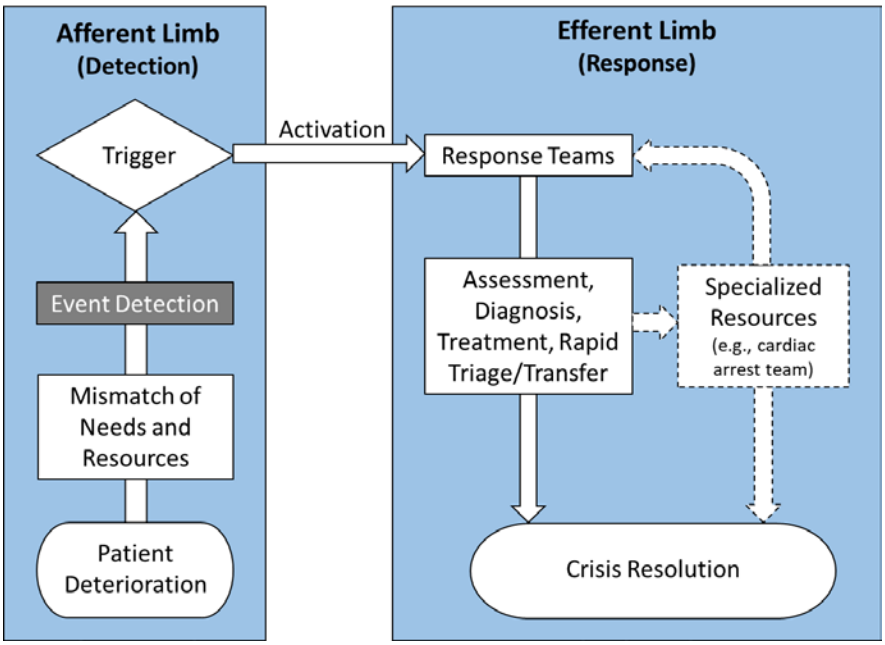
Failure to rescue is a well-established issue in patient safety and healthcare quality. Over the past two decades, there have been numerous studies identifying clinical antecedents to in-hospital mortality as well as strategies to respond to these events.[3-5] Silber and colleagues were the first to use the term as a metric for safety and quality in their 1992 study hypothesizing that FTR might be associated more with hospital characteristics than with patient illness severity.[6] Since then, many studies have investigated the variations in patient outcomes following in-hospital complications and in 2005, the Institute of Healthcare Improvement's 100,000 Lives campaign identified FTR as one of six key safety initiatives, estimating that implementation of rapid response systems could save 66,000 lives.[7] Because in-hospital complication can occur to any patient regardless of their diagnosis or disease process, FTR represents a ubiquitously significant problem and is therefore an important indicator of care quality.

PSP Selection

Using a review of guidelines and systematic reviews, an initial list of seven PSPs was developed: staff education and training, risk scoring systems, RRTs, clinical decision support, collaboration and teamwork, patient monitoring systems, and person and family engagement. Some identified PSPs (e.g., clinical decision support, patient and family engagement, and education and training) spanned multiple harm areas and appear in cross-cutting chapters. Through engagement of a Technical Expert Panel, two PSPs that are specific to FTR and have enough evidence to support a review were selected for review in this chapter: patient monitoring systems and RRTs.

Rapid response systems (RRSs) are hospital-based systems to detect and treat deteriorating patients before adverse events occur. They have emerged as an intuitive approach to address the two core contributors to FTR: failure in adequately monitoring and identifying and failure in responding to hospitalized patients who are at high risk for rapid clinical deterioration. A conceptual model for RRSs, adapted from DeVita et al,[8] depicts the relationship between the afferent limb, in which the event is detected and a trigger is activated, and the efferent limb, in which a systematic response is carried out and the crisis resolved (Figure 1). In this chapter we will be discussing patient monitoring systems as part of the afferent limb, and RRTs as part of the efferent limb of the RRS.

Figure 1: Conceptual Model for Rapid Response System[8]



Patient monitoring involves assessment of various vital signs and physiological changes. Monitoring criteria are then used to help guide activation of the RRT. Although there is no universal standard, most rapid response call criteria include abnormalities in physiologic measures such as respiratory rate, heart rate, systolic blood pressure, oxygen saturation, and urine output. Additional criteria may include staff member or family member concern about the patient's condition, mental status changes, or uncontrolled pain.[9]

Once activated by the monitoring staff, the RRT then responds to the patient to prevent avoidable morbidity and mortality. Other models exist, including medical emergency teams and critical care outreach. In this chapter we will use "RRT" as an umbrella term, as all models are conceptually united by the goal of early intervention for patients who are at high risk for clinical deterioration. The RRT team is typically multidisciplinary and can consist of a nurse, physician, and respiratory therapist, although team composition may vary depending on institutional policy and guidelines. They are able to assess the patient, diagnose, provide initial treatment, and rapidly triage the patient. Patients can then transfer to a higher level of care (i.e., intensive care unit), have their care returned care back to the primary medical team, or have their treatment plan revised. Specialized resources such as cardiac arrest teams or stroke teams are considered separate from the RRT and may be involved in the care of the patient, if warranted.

Driven by quality and safety requirements as well as recommendations, a swift uptake in RRTs has been noted in the United States and Australia, and is increasingly being seen in other developed countries. Because use of RRT is now so widespread, it has become difficult to produce high-quality, randomized controlled trials, and that causes apprehension in those who advocate for a more rigorously studied and evidence-based intervention.

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2.1 PSP 1: Patient Monitoring Systems

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Key Findings:

- There was moderate evidence of a reduction in rescue events following implementation of a patient monitoring system (PMS) with continuous monitoring (CM), but study results were inconsistent.
- PMSs with CM showed no significant effect on mortality, while PMSs with intermittent vital sign input had a moderate and inconsistent effect on mortality.
- There was moderate evidence for improvement in hospital length of stay (LOS) with a PMS, but low evidence for improvement in other outcome measures (intensive care unit [ICU] LOS, ICU transfers).
- More high-quality studies (e.g., robust prospective, randomized, quasi-experimental) are needed to test the effects of PMSs on patient outcomes.

2.1.1 Practice Description

Early clinician recognition of signs of patient deterioration is critical to reducing the risk of preventable death and other adverse events.[1] While RRTs have been widely implemented, their success depends on recognizing a deteriorating patient before serious harm has occurred.[2] Patient monitoring system (PMS) is an umbrella term for electronic systems that scan patient data (e.g. vital signs and other variables) for signs of deterioration and alert a clinician if certain criteria are met.[3] These systems can decrease the time from the onset of deterioration to the initiation of treatment, increasing the potential for better patient outcomes. While the training and clinical reasoning of staff cannot be discounted, PMSs can provide a valuable counterpart and backstop to ensure that no deteriorating patients are missed. Patients who are at a high risk of deterioration are usually admitted to a critical care setting or a telemetry unit, where patient vital signs are continuously monitored (CM) and there is a low patient-to-nurse ratio. However, most hospital beds are outside of these intensive settings, and most patients are boarded in general medical and surgical wards. These units typically do not have continuous PMS, and rely on intermittent collection of patient vital signs on a predetermined schedule (e.g., every 4–6 hours) and on nursing activation of the RRT. A delay of several hours in recognizing a patient's deterioration can lead to avoidable morbidity, ICU transfers, and mortality.[2] This section will review patient monitoring systems that use CM devices (e.g., pulse oximetry monitors), as well as electronic monitoring of intermittent manually collected vital signs.

2.1.2 Methods

To answer the question, "Does patient monitoring for deterioration improve patient outcomes?" we searched three databases (CINAHL®, MEDLINE®, and Cochrane) for articles published from 2008 to 2018 using the terms "patient deterioration," "failure to rescue," and related synonyms, as well as "hemodynamic monitoring," "patient monitoring," and other similar terms. The initial search yielded 35 results. Once duplicates had been removed and additional relevant articles from selected other sources added, a total of 29 articles were screened for inclusion, and 20 full-text articles were retrieved. Of those, eight were selected for inclusion in this review. Articles were excluded if the outcomes were not relevant to this review, the article was out of scope (including not quantitative), or study design was insufficiently described.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in report appendixes A through C.

2.1.3 Evidence Summary

A summary of key findings related to FTR and PMS appears above. This section reviews applicable studies in more depth, organized by measure type (process and outcome). Please note that sensitivities and specificities of PMSs are not examined, because PMS algorithms that scan for signs of deterioration can be constantly adjusted to fit the needs of the setting and to optimize performance. Upon designing and implementing a PMS, the clinicians/administrators typically test the system performance and adjust variable thresholds to best balance speed, sensitivity, and specificity for their setting.

All included studies took place in the hospital setting, and all in general medical/surgical units. Five of the studies used continuous vital sign monitoring systems (i.e., CM), and three used intermittent monitoring (IM) of electronically collected vital sign data.

2.1.3.1 Effect on Process Measures

While testing a PMS for its effect on outcome measures (e.g., mortality) is the ultimate goal of this PSP, it is also important to test whether the PMS improves processes of care for deteriorating patients. Seven of the eight studies reported one or more process measures for PMSs, all of which took place in general medical/surgical units. Articles assessing an effect on process measures had a variety of study designs, with one randomized trial and six experimental studies of varying type. In addition, one systematic review addressed this topic.

The most commonly reported process measure in the reviewed articles was the number of rescue events, including RRT calls or Code Blue calls (i.e., calls activated by healthcare professionals in the hospital when there is a patient in cardiac or respiratory arrest). It is unclear how to interpret this measure in relation to the PMS. A decrease in rescue events likely indicates that more deteriorating patients are discovered early and are stabilized by staff without needing to call the RRT. It could also indicate that patients in decline are being missed. Ultimately, this process measure needs to be combined with outcome measures to understand its true effect. Other reported process measures were related to vital sign collection times.

Of the six studies that reported the number of rescue events, three quasi-experimental studies found a significant difference between treatment and comparison groups after PMS implementation.[4,5,6] All three of these used CM systems. For example, Taenzer and colleagues reported that rescue events decreased from 3.4 to 1.2 per 1,000 patient discharges after implementing pulse oximetry monitoring in a 36-bed orthopedic unit within a 395-bed hospital ($p=0.01$).[4] They projected that this would lead to a decrease in annual rescue events in the unit from 37 to 11.[4] Similarly, Weller et al. found that RRT calls dropped from 189 to 158 per 1,000 discharges ($p=<0.05$) after a 26-bed neurological unit in an academic medical center implemented multi-parameter monitoring.[6] Although the quasi-experimental study by Fletcher and colleagues found no significant effect on the volume of total rescue events, they found a significant 20-percent increase in first RRT calls (as opposed to second or third calls for the same patient) after implementing a dashboard with color-coded risk levels by patient using IM (incidence rate ratio [IRR]: 1.20, $p=0.04$), while subsequent calls decreased nonsignificantly. They interpret this as a beneficial outcome, because after an initial RRT call, the providers will monitor the patient more vigilantly for deterioration.[7] These studies did not find a significant effect on outcome measures (mortality, ICU transfers, etc.), except for one study that found a decrease in the average hospital length of stay (LOS).[8]

Accurate vital sign documentation is critical for a PMS to detect patient deterioration, and CM devices that display the collected vital signs to nurses decrease the time needed to obtain and document a full set of vital signs. Two studies (McGrath et al. and Bellomo et al.) report this outcome.[9,10] As an example, Bellomo and colleagues found a significant decrease in the average time required for a nurse to obtain and record vital signs, from 4.1 minutes per patient to 2.5 minutes (p=<0.0001), which they estimate would save 1,750 nursing hours/year/ward.[10]

Seven studies, all in general hospital wards, reported outcome measures for PMS. Outcomes in these studies included mortality, ICU transfer rate, and hospital and ICU LOS. Three of these studies were also covered in a systematic review/meta-analysis. Study designs included two randomized controlled trials and five quasi-experimental studies of varying type.

It is important to note that attributing improvement in these outcomes to a PMS is difficult because patients who deteriorate are generally older, have multiple co-morbidities, and may have advance directives for end-of-life care.[11] In addition, reasons for ICU transfer and ICU length of stay are multi-factorial and not necessarily correlated with the use of a PMS.

A systematic review and meta-analysis by Cardona-Morrell and colleagues reported that implementing a PMS with CM was not associated with a reduction in mortality (odds ratio [OR]=0.87, 95% CI 0.57–1.33), while PMS with IM was associated with a statistically significant but modest reduction in mortality (OR=0.78, 95% CI 0.61–0.99).[12] This may seem counterintuitive, but the authors note that studies included in the meta-analysis were heterogeneous and most were observational. They conclude that more studies are needed of both CM and IM systems before drawing a definitive conclusion. Four other studies not included in that systematic review (3 CM and 1 IM) found no impact on mortality.[6-8,13] Several studies noted that a generally low mortality rate before and during their studies made it unlikely that they could detect a significant change without a large increase in the sample size.

2.1.3.1.1 ICU Transfers

Of the seven studies that reported ICU transfer rate, only one CM study (Taenzer et al.) found a significant reduction in the ICU transfer rate after implementing a PMS.[4] This quasi-experimental study was implemented in a 36-bed orthopedic unit in a 395-bed hospital; it found that following the implementation of a PMS there was an observed reduction in ICU transfers from 5.6 per 1,000 patient days to 2.9 (p=0.02). The authors reported that this would lower overall hospital ICU transfers from 54 to 28 annually.[4]

Four studies (3 CM and 1 IM) reported average hospital LOS, and three of these found a significant effect of a PMS (2 CM studies and 1 IM study). Study designs included one randomized study and two quasi-experimental studies. Kollef and colleagues implemented IM in eight medical units randomized to intervention versus control, and reported that average LOS was 9.4 patient days in the control units and 8.4 in the intervention units (p=0.038).[8] Interestingly, Bellomo and colleagues found a significant decrease in average LOS in the five U.S. hospitals studied (3.4 days vs. 3.0 days, p=<0.0001), but not in five non-U.S. hospitals implementing the same type of intervention, implying that other factors may affect the impact of a PMS.[10]

Two studies reported on ICU LOS, one of which found a significant effect of a CM system. Brown and colleagues implemented CM of vital signs in a 33-bed medical/surgical unit in a 316-bed community hospital, and found that ICU days per 1,000 admissions were lower in the intervention unit post-

implementation when compared with ICU days in the intervention unit pre-implementation and in the control unit post-implementation (63.5 versus 120.1 and 85.36 days, respectively; P=.04).[5] Taenzer and colleagues, as described above, reported a decrease in ICU transfers after PMS implementation, but did not find a significant reduction in ICU LOS.[4]

2.1.3.2 Unintended Consequences

2.1.3.2.1 Negative

Study authors did not indicate many unintended negative consequences as a result of implementing a PMS to detect patient deterioration. Some expressed hypothetical concern raised of over-testing and over-treating patients, but no studies measured outcomes to test these. If the PMS has a low predictive value, patients who are not deteriorating could receive unnecessary treatment or be transferred to a higher level of care as a result. However, this risk can be mitigated by ensuring the use of a highly predictive system.

2.1.3.2.2 Positive

Positive unintended consequences were mentioned by several authors. The tracking and display of patient vitals gave nurses and other clinicians a sense of increased knowledge about their patients. It also allowed the RRT and other primary team members to take a proactive approach to patient care, rather than relying solely on nursing staff activating an RRT call.[7,9] Authors also noted that when nurses did call for an RRT, the system allowed them to communicate their concerns about a patient with objective, quantifiable data. Other potential benefits included nurses spending more time on patient-centered tasks and less time on vital sign collection, and reduced reliance on RRTs. The latter is supported by several studies that found a decrease in rescue events after PMS implementation.

2.1.3.3 Implementation

Implementing a PMS can be difficult technologically, financially, and in terms of workflow changes for staff. The studies we reviewed identified factors that facilitate PMS implementation, as well as barriers to successful PMS implementation.

2.1.3.3.1 Facilitators

A PMS will be effective only if it is both sensitive and specific, to engender clinician trust and reduce false-positive alerts. To achieve this, several prospective studies used an iterative method of setting the PMS variable thresholds with input from clinicians.

When a PMS identifies a deteriorating patient, clinicians who can respond need to be quickly notified. Study authors disagreed on the best method for communicating this need to clinicians. Some favored auditory and visual alerts, and others preferred a noninterruptive dashboard at both the bedside and a central station to reduce potential alert fatigue.[3,7]

Good communication between the bedside clinicians and the RRT was also cited as a facilitator, as well as staff who are well trained and have strong clinical reasoning. Finally, in relation to cost, several PMS systems are now available as electronic health record add-on modules or as standalone systems, sparing hospitals the cost of designing, building, and testing a system.

2.1.3.3.2 Barriers

The nonspecific nature of patient deterioration makes achieving a highly predictive system difficult. Therefore, it is important for clinicians/administrators to test system performance and adjust variable thresholds to best balance speed, sensitivity, and specificity for their setting. For example, some settings may be willing to accept a lower sensitivity to reduce alarm fatigue.

A poorly designed system that is difficult to use can be a barrier. However, even in a well-designed system, staff need to understand the potential value of the PMS, be trained to use it correctly, understand the alerts/indicators it generates, and know how to respond quickly (calling the RRT or activating a Code Blue). A PMS will improve outcomes only if accompanied by comprehensive procedures for escalation, RRT activation, and audit and feedback to staff.

Some PMSs that require manual input of vital signs into the electronic health record can actually delay vital sign recording and recognition of patient deterioration. Insufficient computers to input data and the practice of busy staff taking vital signs but delaying entry of the data were cited as barriers.[7] Finally, the cost of designing, implementing, and storing data for a PMS can be prohibitive for smaller facilities.

2.1.4 Resources

The nonprofit Patient Safety Movement Foundation offers a toolkit on early sepsis detection that includes a technology plan for an automated PMS.

2.1.5 Gaps and Future Directions

More high-quality studies (e.g., robust prospective, randomized, quasi-experimental) could help to understand the effects of CM and IM patient monitoring systems on process and outcome measures in medical/surgical units as well as other hospital units. As pointed out above, the main process measure in these studies (rescue events) is somewhat ambiguous in terms of its effect on outcomes. In addition, traditional outcome measures (mortality, LOS) may be insufficient to evaluate the impact of a PMS. Therefore, clarifying the validity of existing measures with additional studies and/or using other process and outcome measures (e.g., unanticipated cardiac arrests) would be a beneficial future direction. Finally, more studies on effectiveness of different escalation systems would aid the implementation of PMS.

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2.2 PSP 2: Rapid Response Teams

Reviewers: Kristen Miller, Dr.P.H., C.P.P.S., and Katharine Witgert, M.P.H.

2.2.1 Practice Description

Brought to widespread attention by the 2005 Institute for Healthcare Improvement's 100,000 Lives Campaign, the RRT was developed in response to a growing body of evidence that revealed deficiencies in responding to rapid clinical decline in the inpatient setting.[1] A key principle underlying RRTs is that early intervention can prevent avoidable morbidity and mortality in the non-intensive care hospital setting. RRTs have since been widely implemented across the globe.

RRTs act as the efferent limb of the RRS and include the clinical care team that responds to the afferent limb's calls. This team is typically multidisciplinary, ad consists of a nurse, a physician, and a respiratory therapist, although team composition may vary slightly depending on institution policy and guidelines. The RRT assesses patient disposition, which can result in transfer of the patient to the ICU, return of care back to the primary medical team, or revision of the treatment plan.

2.2.2 Methods

To answer the question, "Do RRTs improve patient outcomes?" four databases (CINAHL®, MEDLINE®, PsycINFO®, and Cochrane) were searched for articles published from 2008 to 2018 using the terms "patient deterioration," "failure to rescue," and related synonyms, in addition to "rapid response system," "rapid response teams," "medical emergency teams," and other similar terms. The initial search yielded 121 results. Once duplicates were removed and additional relevant articles from selected other sources were added, a total of 97 articles were screened for inclusion and 37 full-text articles were retrieved. Of those, 10 were selected for inclusion in this review. Articles were excluded if the outcomes were not relevant to this review, the article was out of scope (including not quantitative), or study design was insufficiently described.

Key Findings:

- There is inconclusive evidence as to whether RRT implementation is associated with decreased overall hospital mortality or ICU transfer rates.
- There is moderate evidence that decreased non-ICU cardiac arrest rates are associated with implementation of RRT.
- Recognition of the benefits of RRT implementation often takes a long time.
- Poor safety culture and hierarchies inherent in healthcare are barriers to successful implementation.
- Future studies should focus on developing and adopting common terminology and definitions for RRT mechanisms, outcome measures, and activation mechanisms, as well as on investigating the costs associated with RRT implementation.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

2.2.3 Evidence Summary

A summary of key findings related to FTR and RRT appears above. This section reviews selected studies in greater depth, organized by process and outcome measures.

The 14 studies included in this review include three meta-analyses and two systematic reviews and took place in the non-ICU general medical/surgical units of acute care hospitals. Thirteen of the 14 studies focused on evaluating the impact of RRTs on patient outcomes. One study investigates outcome differences between ICU physician-led and senior-resident-led RRTs.

2.2.3.1 Clinical Outcomes

The included studies reported a range of outcome measures, including cardiac arrest rate, ICU admission, overall hospital mortality, cardiac arrest rate-related mortality, 1-year post-discharge mortality rate for survivors of cardiac arrest, and length of stay. While each study discussed multiple outcome measures, this review focuses on overall hospital mortality rates, cardiac arrest rates, and ICU admission rates, as these were the outcomes most relevant to our review topic as well as most frequently investigated among the included studies.

2.2.3.1.1 Overall Hospital Mortality

Of the three meta-analyses that reported the impact of RRS implementation on overall hospital mortality, two found significant decreases in mortality rates.[2,3] Chan et al.,[4] using 15 adult and pediatric studies with considerable heterogeneity (I^2=90.3%, P<0.001), found no difference in overall hospital mortality. A subgroup analysis of the four pediatric studies did show significant decrease in hospital mortality (RR, 0.79; 95% CI, 0.63-0.98), but significant heterogeneity was observed (I^2=66.0%, P=0.03). Without a control group in most studies, it is difficult to draw conclusions about causality. This is especially true for the overall hospital mortality rate, which Solomon et al. note has been falling since 2000.[3] This trend may confound the results of studies that observed decreases in hospital mortality rate following RRT implementation.

Indeed, Chen et al., in a 2016 study assessing the impact of RRT implementation across New South Wales, Australia, found that overall hospital mortality rates and cardiac arrest rates had decreased in the 2 years prior to RRT implementation.[5] There were no significant changes in these trends once an RRT had been implemented. However, there was a significant decrease in mortality among patients with low mortality risk. This decreased mortality rate was attributed to RRT prevention of cardiac arrests, suggesting that the low-risk population is where future RRT implementation may have the most impact.

2.2.3.1.2 Cardiac Arrest Rate

In their meta-analysis in 2010, Chan et al.[4] determined the pooled relative risk (RR) using 16 studies and found an overall decrease in non-ICU cardiac arrests (CA) after RRT implementation, although with substantial heterogeneity among the included studies (RR= 0.65, 95% CI 0.55-0.77; I^2=73.9%, P<0.001). In subgroup analyses, RRT was associated with a 33.8% reduction (RR, 0.66; 95% CI, 0.54-0.80) in the adult population and a 37.7% reduction (RR, 0.62; 95% CI, 0.46-0.84) in the pediatric population. Similar results were described in the meta-analysis by Maharaj et al.,[2] who found a significant reduction in CA in the adult (RR, 0.65; 95 % CI, 0.61–0.70) and pediatric (RR, 0.64; 95% CI, 0.55–0.74) populations. In the 2016 meta-analysis by Solomon et al.,[3] implementation of an RRT was found to be associated with significantly decreased rates of non-ICU CA (RR, 0.62; 95% CI, 0.55-0.69), with substantial heterogeneity among the included studies. The systematic reviews conducted by Winters et al.,[6] and McNeill et al.,[7]are in alignment with these findings, concluding that RRT significantly reduces in-hospital CA rates.

Two of the single studies reached similar conclusions [8,9] and one study[5] showed a continuing significant trend of decreasing CA that was present before the implementation of the RRT, but unchanged by its introduction.

2.2.3.1.3 ICU Transfers

Three studies reported ICU transfer/admission rates, with varying results. Blotsky et al. found a decrease in ICU admissions from 4.8 to 3.3 per 1,000 patient days (p=0.04), suggesting that the intervention of a

senior-resident-led RRT decreased ICU transfers by intervening prior to patient deterioration.[8] Conversely, Moriarty et al. found an increase in ICU transfers from 13.7 to 15.2 transfers per 1,000 floor days ($p<0.001$), hypothesizing that this could be due to a larger number of deteriorating patients being seen and transferred to the ICU appropriately by the RRT.[10] Meanwhile, Maharaj et al. found no association between RRT and ICU admissions, based on their meta-analysis of 10 studies.[2]

2.2.3.2 Process Outcomes

While all included studies were primarily interested in clinical outcomes, one study used the rate at which the monitoring team called the response team (known as the rapid response call [RRC] rate) as a measure for assessing uptake and use of RRT.

Pain et al. (2017) found that RRT implementation was associated with a 27.3-percent increased RRC rate ($p<0.05$) between initial implementation and after 3 years of RRT use, compared with a 108.6-percent increased RRC rate ($p<0.05$) between 3 and 5 years of RRT use, suggesting that there is a delay between initial implementation of an RRT and staff adaptation to the process.[9]

2.2.4 Unintended Consequences

2.2.4.1 Negative

Study authors did not raise many concerns about unintended negative consequences as a result of RRT implementation. Winters et al. mentioned the potential for a loss of skill and diversion of staff due to dependence on the RRT, staff conflict, and miscommunication.[6] Maharaj et al. suggested that "very sensitive RRC criteria may over-activate the response team, causing fatigue with no tangible benefit."[4] Despite noting potential negative consequences, none of the reviewed studies reported any data related to these hypotheses.[2]

2.2.4.2 Positive

Two studies mentioned RRT implementation impacting do-not-resuscitate (DNR) status of patients.[4,8] In these studies, RRT implementation was found to increase DNR orders, suggesting that RRTs may enhance end-of-life care by allowing earlier opportunities for discussion of patients' DNR status. This may, in turn, further reduce unnecessary ICU admissions, patient suffering, cost, and use of resources.

2.2.5 Implementation

Successful implementation of an RRT requires adoption by both monitoring and response teams, which may be influenced by cost, team composition, and staff perception. Facilitators and barriers to implementation of the RRT are described below.

2.2.5.1 Facilitators

As mentioned above, benefits from RRT implementation may become apparent only after the RRT has been in place for some time. Moriarty et al. saw significant findings beginning in the second year following response team implementation.[10] However, these changes coincided with the institution's efforts to educate nursing staff as well as to increase positive perception of the RRT, suggesting that educational efforts, rather than time, drive lasting culture and process changes. In a systematic review by Daniele et al., eight of nine studies that found significantly decreased rates of cardiac arrests were of institutions that had an RRT in place for at least 1 year.[11] In contrast, a meta-analysis by Maharaj et al.

was unable to find any dose-response relationship between duration of RRT implementation and hospital mortality.[2]

It remains unclear whether RRT composition is an important factor in successful implementation. One systematic review and two meta-analyses found that RRT composition had no impact on cardiac arrest or ICU transfer rates.[2,3,11]

In their systematic review, McNeill et al.,[7] concluded that physician-led medical emergency teams might improve survival, and reduce CA rates and unplanned ICU admissions, whereas the evidence to support nurse-led teams is equivocal. Blotsky et al. [8] studied the use of a single person, the senior resident, as the responder to the afferent limb activation. They were still able to demonstrate significantly decreased cardiac arrest and ICU transfer rates. However, because all of these single studies included a physician as part of the RRT, we cannot draw conclusions regarding optimal team composition.

2.2.5.2 Barriers

Cultural barriers and traditional hierarchical models of patient monitoring and rapid response may prevent successful implementation of RRTs. For example, Moriarty et al. suggest that the monitoring team may hesitate to activate the response team in fear of the call being viewed "as an acknowledgment of inadequacy on their part."[10] Just as a culture of clear communication and teamwork can help to facilitate successful RRT implementation, one that discourages speaking up and instead supports a hierarchical structure can impede both perceptions and use of an RRT.[6]

The RRT is dependent on the monitoring team's engagement, perception, and activation of the RRT. While all included studies detail criteria for activation of the RRT, the actual mechanism of the activation process is often left undefined, without clear descriptions of who participates, what the process involves, or whether activation is mandatory versus voluntary. One study included in Daniele et al.'s systematic review found that changing the activation mechanism from a voluntary to a mandatory call based on physiologic criteria resulted in a statistically significant decrease in cardiopulmonary arrest rates.[11] This suggests that voluntary activation may present a barrier to successful RRT use, while mandatory activation may act as a facilitator. Further research on this topic is needed.

2.2.6 Resources

The Institute for Healthcare Improvement, Agency for Healthcare Research and Quality, and other organizations offer toolkits to help facilitate implementation of an RRT.

2.2.7 Gaps and Future Directions

Despite widespread implementation of RRTs, and perhaps due to such a rapid uptake of RRTs in recent years, several gaps in the research grow increasingly difficult to address. There have been several high-quality systematic reviews and meta-analyses to date, but the methodological quality of each study included in these reviews is generally moderate. Studies to date have been mostly single center, before-after observational, and retrospective, without control groups or accounting for confounding factors. Conventional randomized controlled trials may no longer be possible due to widespread uptake, which eliminates the pool of control groups.[12] Furthermore, even if control groups can be identified, the possibility for contamination of knowledge and cultural changes around RRT is difficult to control for.

Another way to improve the quality of future studies would be for institutions and healthcare systems to develop and adopt common terminology and definitions for RRTs, including mechanisms for activation and outcome measures. This might help to better identify processes or patient groups that are most vulnerable to unnoticed deterioration and therefore stand to benefit the most from intervention, as suggested by Chen et al.[5] The mechanism of RRT activation is one such process that requires further research. Winters et al. hypothesized that RRT utilization rates may be low in some studies due to inadequate RRT activation, despite activation criteria having been met.[6] However, very few studies define the activation process and address the association between the mechanism for activation (e.g., family activation) and patient outcomes.

Finally, no studies to date have investigated the costs associated with RRT implementation.

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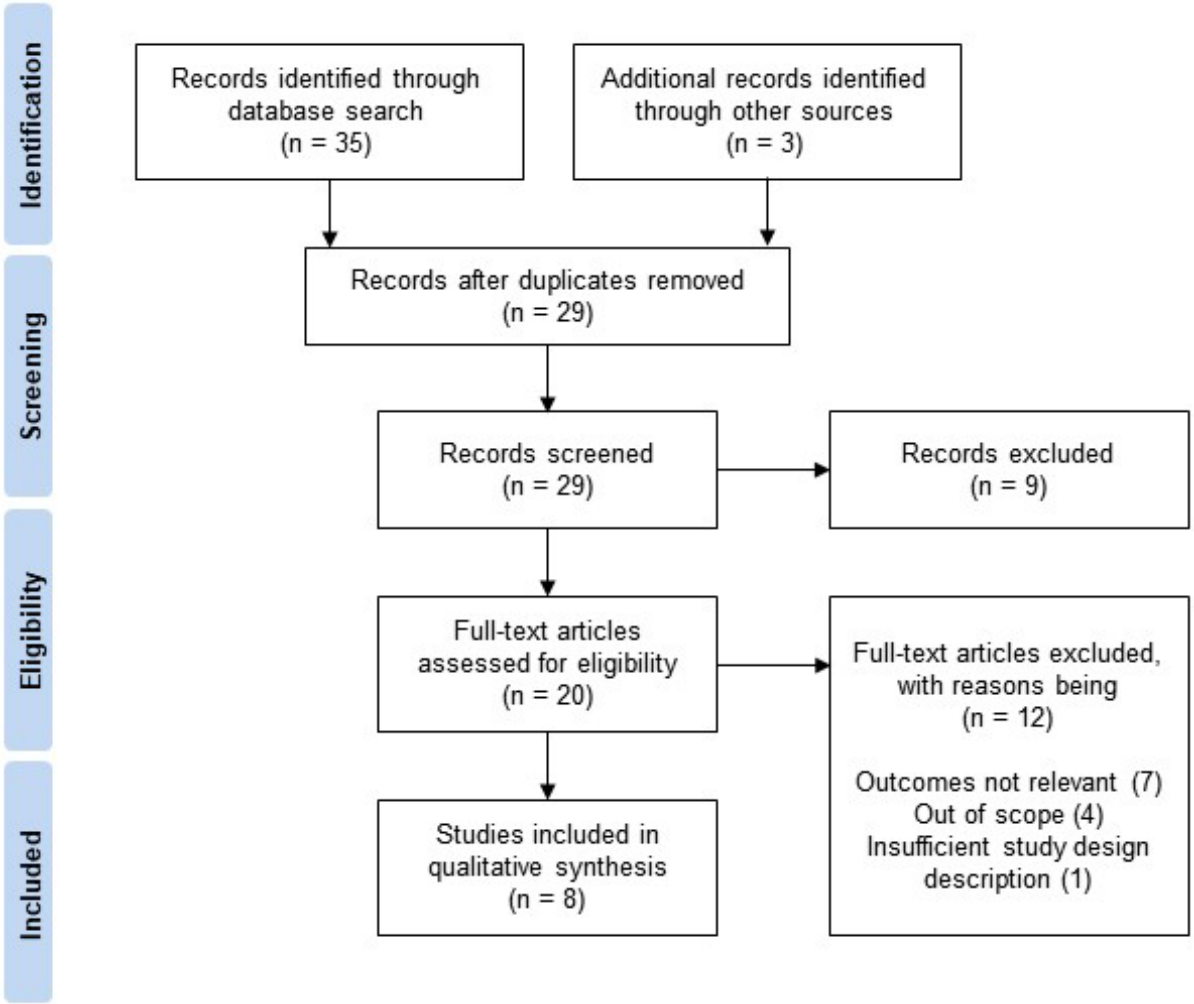
Conclusion and Comment

The PSPs reviewed in this chapter aim to reduce FTR by addressing two of its core components: failure to identify and failure to respond to hospital patients who are at risk for rapid clinical deterioration. This review of the evidence finds that implementation of continuous patient monitoring may decrease rescue events and hospital length of stay but not mortality, while IM shows a moderate but inconsistent effect on mortality. It remains unclear whether RRT reduces mortality or ICU transfer rates. Together, these findings suggest that both the afferent and efferent arms of the rapid response system decrease in-hospital adverse events but not overall mortality. Many studies were observational and had an increased risk for bias, indicating a need for more rigorous, high-quality studies.

Findings in both PSPs suggest that an RRS is most successful when there is effective and efficient communication. The electronic monitoring system, bedside staff, and rapid response staff are all susceptible to communication breakdown, and all points along the RRS pathway warrant careful consideration when deciding to implement an RRS. This requires not only education and training but also technical care so as not to create alert fatigue, as well as a cultural shift to support rather than discourage speaking up. Finally, very few studies comment on RRT activation, which is an important bridge connecting the RRS's identification of deterioration and the response to prevent harm. A better understanding of the mechanism and components of this process may elucidate further interventions for minimizing FTR.

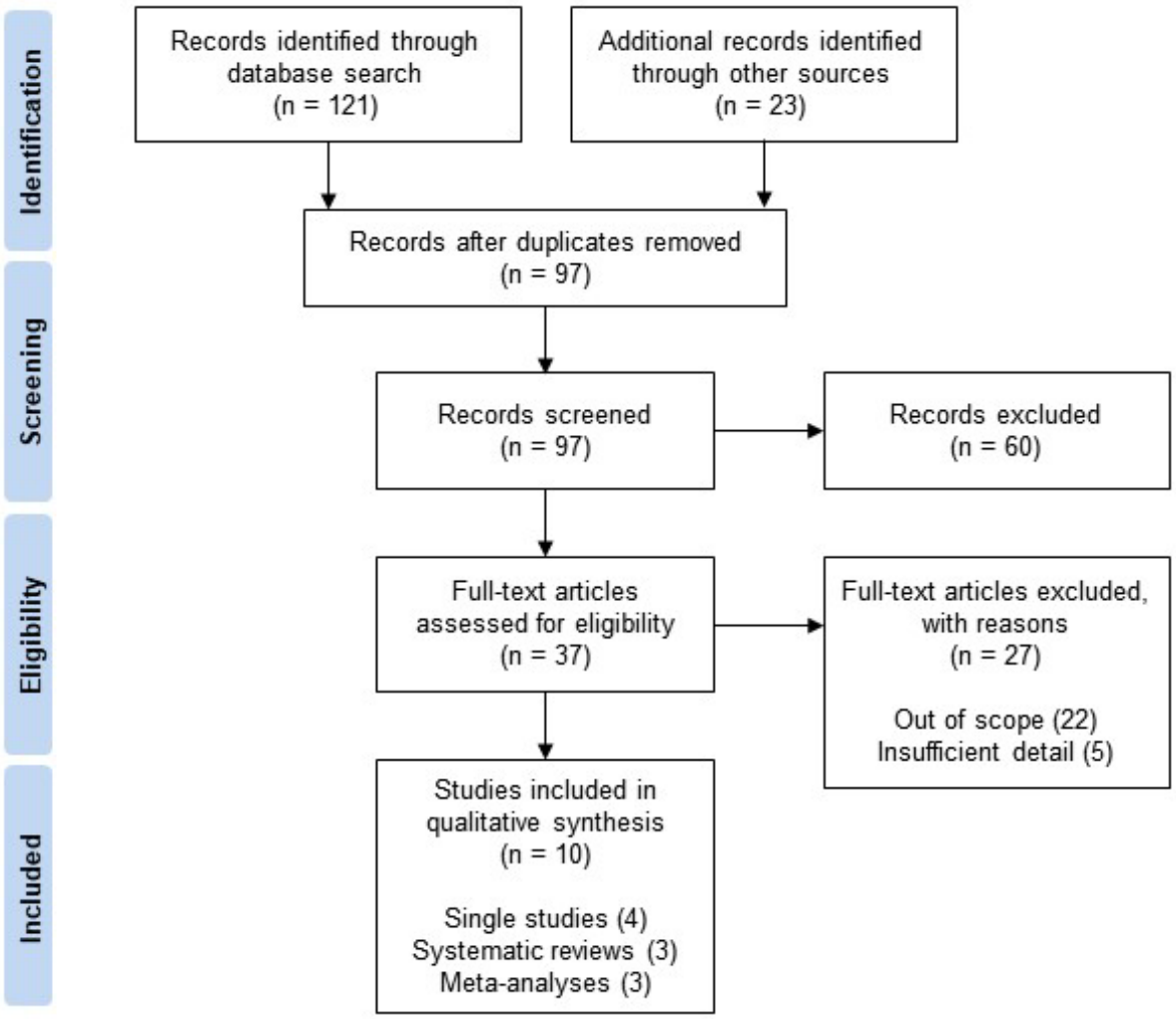
Appendix A. Failure To Rescue PRISMA Diagrams

Figure A.1: Failure To Rescue, Patient Monitoring Systems—Study Selection for Review



PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.2: Failure To Rescue, Rapid Response Teams—Study Selection for Review



PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Appendix B. Failure To Rescue Evidence Tables

Table B.1: Failure To Rescue, Patient Monitoring Systems—Single Studies

Note: Full references are available in the Section 2.1 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
Bailey et al., 2013[12]	An algorithm designed to predict the need for intensive care unit (ICU) transfer using electronically available data, with alerts sent by text page to the nurse manager	Randomized controlled crossover study; 28,927 hospitalizations on general wards; 19,116 distinct patients	Eight adult medicine wards in a 1,250-bed academic medical center; United States	Among patients identified by the early warning system, there were no differences in the proportion of patients who were transferred to the ICU or who died in the intervention group compared with in the control group.	The lack of clinical impact may have been due to relying on the alerted nursing staff to make phone calls to physicians, and not linking a specific and effective patient-directed intervention to the patient	Low
Bellomo et al., 2012[10]	Electronic automated advisory vital signs monitor to assist in the acquisition of vital signs and calculation of early warning scores	Before-and-after controlled trial; all patients admitted to the study wards included in the study: 18,305 patients	349 beds in 12 general wards in 10 hospitals in the United States, Europe, and Australia	During the control period, there were 205 rapid response team (RRT) calls (21.3/1,000 admissions), compared with 209 in the intervention period (24.1/1,000 admissions; p=.21). There was no significant overall change for in-hospital mortality (1.8% vs. 2.0%; p=0.36). However, there was a significant reduction in length of hospital stay, which was dependent on a particularly strong effect in U.S. hospitals (4 days vs. 3 days, p=<0.0001).	Findings seem to suggest that monitoring rather than intervention improves survival, because the need for all interventions decreased in the after-RRT call period.	Low-moderate

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
Brown et al., 2014[5]	Continuous heart rate and respiration rate monitoring	Controlled clinical trial; general medical, trauma, and surgical patients; 2,314 patients in intervention arm, 5,329 in control arm	Two 33-bed medical/surgical units in a 316-bed community hospital	Comparing the average length of stay, there was a significant decrease (from 4.0 to 3.6 and 3.6 days, respectively; p<.05). Total intensive care unit days were significantly lower in the intervention unit post-implementation (63.5 vs. 120.1 and 85.36 days/1,000 patients, respectively; p=.04). The rate of transfer to the intensive care unit did not change when comparing the treatment unit after implementation to the treatment unit before and the control unit (p=.19). Rates of Code Blue events decreased following the intervention, from 6.3 to 0.9 and 2.1, respectively, per 1,000 patients (p=.02).	Not provided	Low-moderate
Fletcher et al., 2017[7]	Electronic medical record-based dashboard	Quasi-experimental repeated treatment study; 6,736 eligible general medical/surgical ward patients 18 years of age and over	Inpatient general medical-surgical wards at an urban level 1 trauma center and teaching hospital with 413 beds (including 89 critical care beds) and approximately 19,000 annual admissions	There was no change in overall RRT activations (incidence rate ratio [IRR]=1.14, p=0.07), but a significant increase in first RRT activations (IRR=1.20, p=0.04). There were no significant differences in unexpected ICU transfers (IRR=1.15, p=0.25), cardiopulmonary arrests on general wards (IRR=1.46, p=0.43), or deaths on general wards (IRR=0.96, p=0.89).	The RRT dashboard allows the RRT and primary team members to monitor patients and review patients at risk, rather than relying exclusively on bedside nurses to activate an RRT.	Low-moderate
Kollef et al., 2014[8]	Electronic health record-based vital sign monitoring with real-time alerts sent to the RRT	Randomized controlled trial; 571 patients	Eight medicine units in a 1,250-bed academic medical center	ICU transfer (17.8% vs. 18.2%) and hospital mortality (7.3% vs. 7.7%) were similar for the intervention and control groups. The number of patients requiring transfer to a nursing home or long-term acute care hospital was similar for patients in the intervention and control groups (26.9% vs. 26.3%). Hospital duration was statistically shorter for the intervention group.	Communication between the RRT and the primary care teams was greater in the intervention arm, as was the use of telemetry and oximetry.	Low

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
McGrath et al., 2019[9]	Wireless patient sensors and pulse oximetry-based surveillance system monitors with advanced display and information systems	Quasi-experimental pre-post study with comparison group; 971.40 patient days in study units compared with 420.35 patient days for the comparison units	71 general care beds in two units	The enhanced monitoring system received high staff satisfaction ratings and significantly improved key clinical elements related to early recognition of changes in patient state. This included reducing average vital signs data collection time by 28%, increasing patient monitoring time (rate ratio 1.22), and increasing availability and accuracy of patient information. Impact on clinical alarms was mixed, with no significant increase in clinical alarms per monitored hour.	The significant decrease in time required to obtain and document vital signs allows staff the potential to spend time on additional patient-focused tasks. Despite the alarm rate increases, overall rates are still below the threshold where alarm fatigue would be a concern.	Low-moderate
Taenzer et al., 2010[4]	Pulse oximetry surveillance with nursing notification of violation of alarm limits via wireless pager	Quasi-experimental pre/post study with comparison units and control of confounders; over 43,000 patient days total; over 13,000 patient discharges	36-bed orthopedic unit with an average of 200 patient days and 53 patient discharges per week in a 395-bed hospital	Rescue events decreased from 3.4 (confidence interval [CI]: 1.89–4.85) to 1.2 (CI: 0.53–1.88) per 1,000 patient discharges (p=0.01) and intensive care unit transfers from 5.6 (CI: 3.7–7.4) to 2.9 (CI: 1.4–4.3) per 1,000 patient days (p=0.02), whereas the comparison units had no change.	Low nurse to patient ratios demand a different balance of sensitivity and specificity when compared with the operating room. Continuous patient surveillance can succeed only if it is not a burden to the already limited personnel resources, and thus, thoughtful implementation of the technology is the key.	Low-moderate

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
Weller et al., 2018[6]	Continuous multi-parameter patient monitoring. A wireless, portable, wearable multi-parameter vital sign monitor with automated nursing notification of alarms via smartphones.	Pre/post study with a comparison unit; 736 patients	26-bed adult, neurological/ neurosurgical unit (non-ICU) in an academic medical center	The RRT call rate was significantly reduced ($p<0.05$), from 189 to 158 per 1,000 discharges. ICU transfers per 1,000 discharges were insignificantly reduced, from 53 compared with 40 in the previous 5-month period in the same unit. Similar measures of comparison units did not change over the same period. Although unplanned patient deaths (non-compassionate care deaths) in the study unit were reduced during the intervention period, this finding was not statistically significant. Lengths of stay were similar between pre-pilot and intra-pilot study periods.	Nurses expressed a sense of increased knowledge about the status of their patient information visible on the in-room monitor (along with remote notification), reinforcing the likelihood that any increased nursing attention is a direct result of the new system, not a by-product of the guided implementation of the new process.	Low-moderate

Table B.2: Failure To Rescue, Patient Monitoring Systems—Systematic Reviews and Meta-Analyses

Note: Full references are available in the Section 2.1 reference list.

Author, Year	Description of Patient Safety Practice	Setting(s); Population(s)	Summary of SR Findings	Implementation Themes/Findings
McNeill et al., 2013[14]	Early warning systems (EWSs), emergency response teams (ERTs)	Hospital, inpatient; 43 studies reviewed	Overall evidence is of poor quality. For EWS, aggregate weighted scoring systems appear to be more effective than single parameter systems. For ERT, introduction of a medical emergency team does appear to improve hospital survival and reduces cardiac arrest rates.	Not provided
McGauhey et al., 2017[15]	EWS and rapid response system	275 studies reviewed; acutely ill patients on general hospital wards	Evidence supporting EWS validity and reliability showed that physiological variables (heart rate, blood pressure, RR) accurately predicted outcomes that were associated with an increased risk of unplanned intensive care unit (ICU) admission/readmission and of mortality in adult and pediatric patients within 24–48 hours. However, refuting evidence highlights that EWS-validated tools have largely been modified to individual localities, with the result that the sensitivity and positive predictive values were too low to predict patient deterioration in hospitals. As a result, the utility, validity, and reliability of EWS tools have been questioned.	Evidence suggests that the EWS protocols improve communication of vital signs and empower nurses to vocalize their concerns by “packaging” information using clinical judgment and quantifiable evidence to call for help.
Cardona-Morrell et al., 2016[12]	Continuous or intermittent vital signs monitoring	22 studies assessing the effect of continuous (9) or intermittent monitoring (13) and reporting outcomes on 203,407 patients in hospital wards across 13 countries	Continuous and intermittent monitoring practices led to: early identification of patient deterioration, increased rapid response activations, and improvements in timeliness or completeness of vital signs documentation. Innovative intermittent monitoring approaches are associated with modest reduction in in-hospital mortality over intermittent vital signs monitoring in “usual care.” However, there was no evidence of significant reduction in ICU transfers or other adverse events with either intermittent or continuous monitoring. This review of heterogeneous monitoring approaches found no conclusive confirmation of improvements in prevention of cardiac arrest, reduction in length of hospital stay, or prevention of other neurological or cardiovascular adverse events. The evidence found to date is insufficient to recommend continuous vital signs monitoring in general wards as routine practice.	Not provided

Table B.3: Failure To Rescue, Rapid Response Teams—Single Studies

Note: Full references are available in the Section 2.2 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
Blotsky et al., 2016[8]	Ward-based rapid response system (RRS) involving bedside nursing staff (activation) and senior medical resident (response)	Prospective before/after study; patients on medical clinical teaching unit (CTU); 95 calls were placed for 82 patients	48-bed CTU in a university-affiliated acute care teaching hospital; Canada	Total number of intensive care unit (ICU) admissions from the CTU was reduced from 4.8/1,000 patient days (±2.2) before intervention to 3.3/1,000 patient days (±1.4) after intervention (incidence rate ratio [IRR], 0.82, 95% confidence interval [CI], 0.69 to 0.99). CTU code blue rates decreased from 2.2/1,000 patient days (±1.6) before intervention to 1.2/1,000 patient days (±1.3) after intervention (IRR, 0.51, 95% CI, 0.30 to 0.89). Mortality rates did not change.	No additional clinical staffing required, so no additional funding required to implement.	Moderate
Chen et al., 2016[5]	RRS "Between The Flags" Program	Interrupted time-series population-based study; all adult hospital patients >18 years old; 9,799,081 admissions	All 232 public hospitals in New South Wales, Australia	Pre-intervention—trend of decreasing mortality, cardiac arrest rates, cardiac arrest-related mortality, and failure to rescue (FTR) rates, with stable mortality rate among low mortality diagnostic related group (LMDRGs) patients. Post-intervention—trends continued for all outcomes, including a new 20% ($p<0.001$) mortality reduction among LMDRG patients.	Not provided	Low-moderate
Moriarty et al., 2014[10]	Multidisciplinary team including a critical care nurse, critical care fellow, and respiratory therapist	Longitudinal study using control charts and Bayesian change point (BCP) analysis; all inpatients discharged between 9/1/05 and 12/31/10.	Two acute care hospitals and an inpatient psychiatric treatment center of the Mayo Clinic; Rochester, MN	A decrease in FTR, as well as an increase in the unplanned ICU transfer rate, occurred in the second-year post-RRT implementation, coinciding with an increase in RRT calls per month. No significant decreases were observed pre- and post-implementation for cardiopulmonary resuscitation events or overall mortality.	Findings support prior hypotheses that effects from RRT implementation may not be immediately noticeable.	Moderate

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)
Pain et al., 2017[9]	RRS "Between The Flags" Program	Prospective longitudinal study	225 public hospitals across New South Wales, Australia	Since the introduction of RRS, the cardiac arrest rate has declined by 42% ($p<0.05$) and the rapid response call rate has increased by 135.9% ($p<0.05$) in New South Wales.	Providing clarity about who is responsible for what at all levels of the system is crucial to successful implementation and long-term sustainability of the RRS. During implementation, consider strategies for reinforcing discretion and judgment by clinicians when patients have early warning signs.	Low-moderate

Table B.4: Failure To Rescue, Rapid Response Teams—Systematic Reviews and Meta-Analyses

Note: Full references are available in the Section 2.2 reference list.

Author, Year	Description of Patient Safety Practice	Settings and Population	Summary of Findings	Implementation Themes/Findings	Comments
Chan et al., 2010[4]	Rapid response teams (RRT)	Acute care hospital, non-intensie care unit (ICU) setting, adults and pediatrics; 18 studies published between 1950 and 2008	For adults, implementation of an RRT was associated with a 33.8% reduction in rates of cardiopulmonary arrest outside the ICU (relative risk [RR], 0.66; 95% confidence interval [CI], 0.54 to 0.80), but was not associated with lower hospital mortality rates (RR, 0.96; 95% CI, 0.84 to 1.09). For children, implementation of an RRT was associated with a 37.7% reduction in rates of cardiopulmonary arrest outside the ICU (RR, 0.62; 95% CI, 0.46 to 0.84) and a 21.4% reduction in hospital mortality rates (RR, 0.79; 95% CI, 0.63 to 0.98).	Not provided	None
Daniele et al., 2011[11]	RRT	Acute care hospital, non-ICU setting, adults; 26 studies published between 1989 and 2010	A statistically significant reduction in mortality rate was reported along with an equivocal result on length of stay in the cluster randomized control trial. An odds ratio of 0.52 (95% CI, 0.3 to 0.85) was calculated after RRT implementation.	There was no correlation between team composition and patient outcomes. Teams that were mature, dedicated, made rounds, and required mandatory activation had statistically significant results.	None
Maharaj et al., 2015[2]	Rapid response systems (RRS)	Acute care hospital, non-ICU setting, adults and pediatrics; 29 studies published between 1990 and 2013	The implementation of RRS has been associated with an overall reduction in hospital mortality in both the adult (RR, 0.87; 95% CI, 0.81 to 0.95) and pediatric (RR, 0.82; 95% CI, 0.76 to 0.89) inpatient population. There was substantial heterogeneity across studies for both populations.	There was no dose to response relationship between the duration of the implementation phase, the presence of a physician on the team, or the number of activations per 1,000 and hospital mortality.	None
McNeill et al., 2013[7]	Early warning systems (EWS), emergency response teams (ERT)	Hospital, inpatient	Overall evidence is of poor quality. For EWS, aggregate weighted scoring systems appear to be more effective than single parameter systems. For ERT, introduction of a medical emergency team (MET) does appear to improve hospital survival and reduces cardiac arrest rates.	Not provided	Also included in Patient Monitoring Systems

Author, Year	Description of Patient Safety Practice	Settings and Population	Summary of Findings	Implementation Themes/Findings	Comments
Solomon et al., 2016[3]	RRS	Acute care hospital, non-ICU setting, adults; 30 studies published between 2000 and 2014	The pooled analysis demonstrated that implementation of RRT/METs was associated with a significant reduction in hospital mortality (RR, 0.88; 95% CI, 0.83 to 0.93). There was heterogeneity among the contributing studies (I^2 =86%).	Not provided	Builds off of the meta-analysis of Chan et al., 2010
Winters et al., 2013[6]	RRS	Acute care hospital, non-ICU setting, adults; 43 studies published between 2000 and 2012	Systematic review found moderate strength of evidence that RRSs improve outcomes from both a high-quality systematic review through November 2008 and the additional literature published through October 2012.	Implementation processes differed widely across studies, and local needs and resources tended to dominate the processes. Education and promotion of the new service was often a factor in preparing for implementation. For staff training and education, several studies introduced new staff, such as a nurse educator.	None

Appendix C. Failure To Rescue Search Terms

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
Search 2008-Present, English Only MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review	Rapid Response Systems	(((MH "Failure to Rescue, Health Care") OR (AB "Failure-to-Rescue" OR "Failure to Rescue" OR "Patient Deterioration" OR "Patient Decompensation" OR "Death After a Treatable Complication")) AND ((MH "Hospital Rapid Response Team") OR (AB "Rapid Response System" OR "Rapid Response Team" OR "Rapid Response" OR "Hospital Medical Emergency Team" OR "Medical Emergency Team, Hospital")))	(((MH "Failure to Rescue, Health Care") OR (AB "Failure-to-Rescue" OR "Failure to Rescue" OR "Patient Deterioration" OR "Patient Decompensation" OR "Death After a Treatable Complication")) AND ((MH "Hospital Rapid Response Team") OR (AB "Rapid Response System" OR "Rapid Response Team" OR "Rapid Response" OR "Hospital Medical Emergency Team" OR "Medical Emergency Team, Hospital")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research Review • Systematic Review			
Search 2008-Present, English Only MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III	Patient Response Systems	(((MH "Failure to Rescue, Health Care") OR (AB "Failure-to-Rescue" OR "Failure to Rescue" OR "Patient Deterioration" OR "Patient Decompensation" OR "Death After a Treatable Complication")) AND ((MH "Monitoring, Physiologic" OR "Hemodynamic Monitoring" OR	(((MH "Failure to Rescue, Health Care") OR (AB "Failure-to-Rescue" OR "Failure to Rescue" OR "Patient Deterioration" OR "Patient Decompensation" OR "Death After a Treatable Complication")) AND ((MH "Monitoring, Physiologic" OR "Hemodynamic Monitoring" OR

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis		"Monitoring, Ambulatory" OR ("Telemetry" AND "Remote Sensing Technology")) OR (AB "Monitoring, Physiologic" OR "Hemodynamic Monitoring" OR "Monitoring, Ambulatory" OR "Intraoperative Monitoring" OR (Telemetry AND "Remote Sensing Technology") OR "Physiologic Monitoring" OR "Patient Monitoring")))	"Monitoring, Ambulatory" OR (Telemetry AND "Remote Sensing Technology")) OR (AB "Monitoring, Physiologic" OR "Hemodynamic Monitoring" OR "Monitoring, Ambulatory" OR "Intraoperative Monitoring" OR (Telemetry AND "Remote Sensing Technology") OR "Physiologic Monitoring" OR "Patient Monitoring")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Practice Guidelines • Randomized Controlled Trial • Research Review • Systematic Review			

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