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How Important Is the Problem?

General ward patients often experience unrecognized deterioration in their clinical status that may progress to cardio-respiratory arrest. Such cardio-respiratory arrests are known to carry a poor prognosis for hospitalized patients. Mortality for in-hospital arrest is as high as 80%. One study, examining patient data prior to an arrest event, found that clear signs and symptoms heralding arrest often exist in these patients for many hours prior to the arrest (median time=6 hours) yet are unrecognized and/or unappreciated. In addition, an average of two visits by health care staff occurred during those median 6 hours of developing instability without apparent recognition of the patient’s condition or any intervention.

Rapid response systems (RRSs) were developed by clinicians as a way to improve recognition of deterioration (this portion is called the Afferent Limb) and provide a critical care team to respond to those deteriorations (the Efferent Limb), in order to improve outcomes such as reducing the incidence of cardio-respiratory arrest and hospital mortality. RRSs have been implemented in many hospitals to remedy the failure of our current system model (intermittent vital signs) to monitor general ward patients adequately, to recognize the signs and symptoms of deterioration, to rescue such patients, to deliver optimal care rapidly in patients who develop signs or symptoms of clinical deterioration; and to escalate care and triage appropriately.

What Is the Patient Safety Practice?

At the 3rd International Medical Emergency Team (MET) conference, the disparate nomenclature for this intervention was codified to bring all the terms under one umbrella term: the Rapid Response System or RRS. An RRS includes a multidisciplinary team, most frequently consisting of intensive care unit (ICU)-trained personnel who are available 24 hours per day, 7 days per week to evaluate patients not in the ICU who develop signs or symptoms of clinical deterioration. RRSs include Medical Emergency Teams (METs, which includes a physician), Rapid Response Teams (RRTs, which do not include a physician), and Critical Care Outreach Teams (CCOT, which provide specific follow-up care for patients discharged from an intensive care unit to a general ward, and may also include as part of the intervention, the ability to respond to deteriorating ward patients that may or may not have been in the ICU previously). The response team is referred to as the Efferent Limb and the system of tracking and recognizing deterioration and activating the Efferent Limb is referred to as the Afferent Limb.

“Rapid Response Systems aim to improve the safety of hospital-ward patients whose condition is deteriorating. These systems are based on identification of patients at risk, early notification of an identified set of responders, rapid intervention by the response team, and ongoing evaluation of the system’s performance and hospital-wide processes of care.” Similar types of systems exist for acute myocardial infarction (AMI)/cardiac stenting emergencies (Heart Attack Teams or HATs), cerebrovascular accident (CVA) (Brain Attack Teams or BATS), and other specialty issues such as hyperkalemia. However, these are different programs, with different structures and effectiveness, designed to address very specific disease states. In
contrast, RRSs are non-specific and address a panoply of conditions. Therefore, we do not include the disease-specific systems (BATs and HATs etc.) in this review.

A Rapid Response System generally has four components:

- **Criteria for notifying the response team and a system for activating it (the Afferent Limb).** The criteria usually include vital signs (single trigger criteria or more complicated algorithms including aggregate and weighted early warning scores). However, in some cases a clinician or family member might initiate activation, based on clinical judgment and concern even though specific activation criteria are not met (e.g., heart rate >130).

- **The response team – the Efferent Limb.** Refers to personnel and equipment (can be led by a critical-care physician, other physician, or by a nurse or respiratory therapist). Team composition varies based on local needs and human resources.

- **Feedback loop to collect and analyze event data and quality improvement.**

- **Administrative component, coordinating resources, staff, equipment, and education.**

Jones et al² also cites importance of support of leadership and administration, use of criteria that are not too complicated (argues for simple vital signs triggers as opposed to complicated early warning scores), education of the personnel on the team regarding the criteria (including possibly simulation training), and involvement of physicians who can facilitate ICU transfers and end-of-life planning. In a narrative review of data from the MERIT trial (the only multi-center cluster randomized trial of RRS) and subsequent data, Jones et al. also note that RRSs exhibit a dose response curve, where utilization rates (number of RRS activations) positively correlate with reduction in the incidence of cardiac arrest. The authors found that a utilization rate of approximately 17 RRS calls/1000 patient admissions is required to reduce the incidence of cardio-respiratory arrest by 1/1000 admissions. Given this relationship, many hospitals have sought to increase utilization of their RRSs to realize improvements in outcome.

**Why Should This Patient Safety Practice Work?**

That RRSs should be able to improve patient outcomes has strong face validity. These outcomes include the incidence of cardio-respiratory arrests and unexpected mortality. All but a small number of cardio-respiratory arrests have clear antecedents indicating that the patient is deteriorating, yet these signs and symptoms of deterioration are not recognized or recognition is delayed. In usual care, even when recognition of deterioration occurs, the process of responding to that patient runs into a range of barriers, including a culture of medicine that is not patient-centered (i.e., concepts of “patient ownership”, autonomy, respect for authority and the “chain of command”) and imbalances in the need (patient) to resource (available physicians, nurses, respiratory therapy, monitoring etc.) ratio. These combined problems of poor recognition and/or poor response create the opportunity for intervention. RRSs have been the primary intervention of choice for the last decade to address the problems of poor recognition (afferent limb) and poor response (efferent limb).

The afferent limb defines the parameters that indicate deterioration and democratizes that knowledge to all clinicians. It also often allows for bedside clinicians (primarily nurses) to trigger the Efferent Limb, even in cases where individual thresholds are not met but the bedside clinician has a “sense” that something is not right. Since these signs often exist for hours before a crisis actually occurs, improving the recognition process through defined criteria and democratization of knowledge should lead to earlier recognition and hopefully intervention before the patient becomes too unstable to be rescued. Providing a critical care response team
that can be directly triggered should also help to circumvent the delays that typically occur in summoning a physician or higher level expertise. Together, these two elements (afferent and efferent limbs) should catch treatable problems early before they are life-threatening. Finally, the feedback component should help make clinicians aware of the need and benefits of using the RRS, the quality improvement component should ensure improvement or maintenance over time, and the administrative component should ensure that adequate resources are available to respond to patient rescue needs.

**What Are the Beneficial Effects of the Patient Safety Practice?**

RRSs were not addressed as a topic in “Making Health Care Safer.” RRS have mostly been implemented and evaluated since 2000, although a small number of hospitals such as Dandenong Hospital in Australia and University of Pittsburgh in the U.S established them in the mid-1990s.\(^1\)\(^3\)

For this review, a total of 2177 unique abstracts were captured by the search strategy. Of these, 1,982 were excluded during the abstract screening phase. A total of 174 additional articles were excluded at the article screening phase. Twenty one articles in total met the inclusion criteria for this systematic review. Twenty articles met the inclusion criteria for intervention studies evaluating the effectiveness of rapid response systems and 15 articles met the inclusion criteria for intervention studies evaluating the implementation of rapid response systems.

We identified seven systematic reviews of RRSs: The one high-quality review is described below. A second review addressed implementation, and we discuss it in that section. We excluded two reviews from 2007 that contained many fewer publications than reviews published in 2009 or later.\(^4\)\(^5\) We also excluded three additional reviews with low AMSTAR criteria scores (5-6/11); they generally cover the same literature and time period, and report similar findings.\(^6\)

The highest-quality systematic review and only meta-analysis\(^7\) (AMSTAR criteria score 10/11) identified 18 studies from 17 publications through November 2008, involving nearly 1.3 million hospital admissions. The meta-analysis concluded that, among adults, implementation of an RRS was associated with a statistically significant reduction in cardiopulmonary arrest outside the intensive care unit (ICU) (relative risk [RR], 0.66; 95% confidence interval [CI], 0.54 to 0.80) but not with lower hospital mortality (RR, 0.96). In children, implementation of an RRT was associated with statistically significant reductions in both cardiopulmonary arrest outside the ICU (RR, 0.62; 95% CI, 0.46 to 0.84) and hospital mortality (RR, 0.79; 95% CI, 0.63 to 0.98). The review assessed studies as high quality if they adjusted for confounding and for time trends by using either concurrent control groups or an interrupted time series design. Studies were rated as fair quality if they adjusted only for confounding. Five studies were rated high quality, two as fair quality, and the rest were rated as low quality.

This review identified two cluster-randomized, controlled trials (RCTs) but treated one in their meta-analysis as a concurrent cohort controlled study (the MERIT Study) and the other as a before-after historically controlled trial (Priestley, 2004 which used 3 different methodologies in their analysis one of which was a before-after control). A key finding was that the major multicenter RCT (the MERIT study) did not show an effect in the main analysis. However, in further analysis, the change in arrest rate was exactly as expected given the utilization rates, and exposure to the intervention was well below that which is necessary to realize a significant change. The implication was that the implementation of RRSs may be critical to their success. Additionally, in the MERIT trial, the intervention hospitals did see a statistically significant improvement compared with their baseline period (before/after historical control), but the control
hospitals demonstrated essentially the same before/after improvement as the intervention hospitals. The end result was no difference between intervention and control hospitals. Reasons for the lack of difference may include other systems changes that improved care or decreased mortality, or the Hawthorne effect since the intervention could not be blinded. Post-hoc analysis did show that control hospitals increased their code team calls for non-code events, suggesting that they engaged in “RRS-like” activities using their existing cardiac arrest teams.

We identified 20 additional effectiveness studies that met our inclusion criteria published since this systematic review. None were randomized trials or had a concurrent control group, and only one study included multiple centers. Three studies were in pediatric hospitals. Most occurred in the United States, Australia, or Canada, with only a few in Europe or Asia; most studies were conducted in teaching hospitals. Almost no studies included any information on context, and no studies reported a theoretical or logic model. The number of included hospital admissions or discharges during the study periods ranged from 2426 to 277,717.

Most studies reported the main outcomes of total hospital or non-ICU cardiac arrests and total hospital mortality; some studies also reported variations on these outcomes, such as unexpected or non-DNR cardiac arrests or mortality. Of those studies that reported results and statistics on total hospital (or non-intensive care unit) mortality, 8/14 (57%) reported statistically significantly decreased mortality in the period after the RRS was implemented; one study reported decreased mortality only on the medical (not the surgical) service (the study had separate RRSs for the two services). Two studies that also reported non-DNR or unexpected death rates in addition to in-hospital mortality also found a significant decrease in those outcomes.

Of the studies that reported the outcome of cardiac arrest, 9/14 (64%) reported a significant decrease after implementation of the RRS. One study reported unexpected cardiac arrest and found no significant change; one study reported unplanned intubations and found no significant change. Finally, of the 13 studies that reported outcomes and statistical testing for both cardiac arrest and for mortality, 4 (31%) found different results for these 2 outcomes: 2 found significant results for mortality but not for cardiac arrest, and 2 found significant results for cardiac arrest but not mortality.

The overall strength of evidence for this topic was low. Risk of bias was high for all studies due to study design issues—there were no studies using any type of randomization since the multi-institution MERIT study published in 2005; almost all studies were pre-post, with no interrupted time series or concurrent controls. Few studies reported or accounted for differences in patient populations over time or reported characteristics of providers in the two time periods. Few studies reported or attempted to control for secular trends over time that could have impacted mortality or cardiac arrest rates. The one study that did account for secular trends over time in these outcomes found that, after adjusting for them, the changes in mortality and cardiac arrest rate were no longer statistically significant. No studies reported on or accounted for other safety initiatives in the hospital that might have also contributed to trends in decreasing mortality or cardiac arrests.

No studies conducted blinded outcome assessment; although mortality is an objective outcome, the other key outcome measured, incidence of cardiac arrest, can be defined in a number of different ways (e.g., calling the code team vs. documented use of cardiac compressions, stopped breathing, etc.) and is subject to bias, as are some of the other variations in outcomes reported in some studies (e.g., unexpected mortality vs. total mortality, which required retrospective, implicit assessment of medical records). Ideally, studies should report
cardio-respiratory arrest (codes) rates outside of the ICU and Emergency Departments since these patient populations are not part of the exposure group (RRSs do not respond to these locations), yet often hospital-wide rates were reported. One study\(^9\) included ICU arrests in their analysis, concluding there was no effect, though data presented on their non-ICU code rate showed a statistically significant difference. Cardiac arrest rates are also affected by changes in patient casemix over time and the frequency of do-not-resuscitate orders and terminal illness, which most studies did not account for.

Most studies reported in-hospital mortality. Only one reported longer-term mortality (such as 180-day mortality) reflecting patient survival more accurately. Most other outcomes reported, such as the cardiac arrest rate, unanticipated intensive care unit admissions, or other health care utilization measures are also indirect outcomes. In terms of precision, we did not identify any additional studies that would have been assessed as high-quality in the 2009 meta-analysis\(^7\) – all would have been fair or poor quality. Evidence for association of RRSs with lower in-hospital mortality was not strong. A summary table is located below (Table 1).

### Table 1, Chapter 24. RRS summary table: effectiveness

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Description of PSP</th>
<th>Study Design</th>
<th>Outcomes: Benefits*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anwar ul, 2010(^10)</td>
<td>PICU physicians (Pediatric MET)</td>
<td>Pre-post</td>
<td>Cardiac arrest: Y</td>
</tr>
<tr>
<td>Bader, 2009(^11)</td>
<td>Nurse led, with Critical care outreach component (proactive rounding on ICU-discharged patients)</td>
<td>Pre-post</td>
<td>Mortality (non ICU): NR</td>
</tr>
<tr>
<td>Benson, 2008(^12)</td>
<td>Advanced practice nurses (APN) with intensivists and other disciplines involved as needed</td>
<td>Pre-post</td>
<td>Mortality: Y</td>
</tr>
<tr>
<td>Campello, 2009(^13)</td>
<td>ICU physician and ICU nurse</td>
<td>Pre-post</td>
<td>Mortality: Y</td>
</tr>
<tr>
<td>Chan, 2008(^17)</td>
<td>Respiratory therapist and 2 ICU nurses (RRT model)</td>
<td>Pre-post</td>
<td>Mortality: N</td>
</tr>
<tr>
<td>Gerdik, 2010(^14)</td>
<td>RRT (specifics not described) including option for patient and family activation</td>
<td>Pre-post</td>
<td>Mortality: N</td>
</tr>
<tr>
<td>Hanson, 2009(^15)</td>
<td>PICU fellow, resident, nurse and respiratory therapy</td>
<td>Pre-post</td>
<td>Mortality: N</td>
</tr>
<tr>
<td>Hatler, 2009(^16)</td>
<td>ICU nurse and respiratory therapy (RRT model)</td>
<td>Pre-post</td>
<td>Cardiac arrest: NR</td>
</tr>
<tr>
<td>Konrad, 2010(^17)</td>
<td>ICU nurse and ICU physician</td>
<td>Pre-post</td>
<td>Mortality (adjusted total): Y</td>
</tr>
<tr>
<td>Kotsakis, 2011(^18)</td>
<td>Peds ICU attending and/or fellow, respiratory therapists and ICU nurse, family activation</td>
<td>Pre-post</td>
<td>Mortality (hospital): N</td>
</tr>
<tr>
<td>Laurens, 2011(^19)</td>
<td>MET: anesthesiologist, medical house officer and ICU/ED nurse</td>
<td>Pre-post</td>
<td>Mortality: Y</td>
</tr>
<tr>
<td>Lighthall, 2010(^20)</td>
<td>MET: ICU fellow, anesthesiologist nurse, pharmacist, respiratory therapist</td>
<td>Pre-post</td>
<td>Mortality (all): Y</td>
</tr>
<tr>
<td>Medina-Rivera, 2011(^21)</td>
<td>MET (no specifics given)</td>
<td>Pre-post</td>
<td>Mortality: N</td>
</tr>
<tr>
<td>Rothberg, 2011(^22)</td>
<td>Hospitalist-led MET -critical care nurse, respiratory therapist, intravenous therapist, physician</td>
<td>Pre-post</td>
<td>Mortality (overall hospital): N</td>
</tr>
<tr>
<td>Santamaria, 2010(^23)</td>
<td>MET: ICU registrar, general medical registrar and the ICU nurse</td>
<td>Pre-post</td>
<td>Mortality (unexpected): Y</td>
</tr>
<tr>
<td>Sarani, 2011(^24)</td>
<td>2 METs – surgery, medicine; critical care nurse, pharmacy, respiratory therapy, resident, ICU attending /fellow</td>
<td>Pre-post</td>
<td>Mortality: Y (Medical service only)</td>
</tr>
<tr>
<td>Scott, 2009(^25)</td>
<td>ICU nurse and respiratory therapy (RRT model)</td>
<td>Pre-post</td>
<td>Cardiac arrest: NR</td>
</tr>
<tr>
<td>Shah, 2011(^26)</td>
<td>Critical care nurse and respiratory therapist (RRT model)</td>
<td>Pre-post</td>
<td>Mortality (In-hospital): Y**</td>
</tr>
</tbody>
</table>

** Cardiac arrest: NR

\(\text{Y}\) indicates a positive outcome (i.e., lower mortality or increased cardiac arrest rates), \(\text{NR}\) indicates no change or a non-significant result, and \(\text{N}\) indicates a negative outcome (i.e., increased mortality or decreased cardiac arrest rates).

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261
Table 1, Chapter 24. RRS summary table: effectiveness (continued)

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Description of PSP</th>
<th>Study Design</th>
<th>Outcomes: Benefits*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snyder, 2009</td>
<td>MET: critical care physician and nurses</td>
<td>Pre-post</td>
<td>Mortality: N&lt;br&gt;Unplanned intubations: N</td>
</tr>
</tbody>
</table>

*Overall results statistically significant – Yes, No, or NR (Not reported – no statistics reported)
** Significant in early time period but not later

What Are the Harms of the Patient Safety Practice?

Potential harms include decrease in the skills of ward staff due to dependence on the RRS, inappropriate patient care for other patients (decreased responsibility or responsiveness of the usual team), staff conflict, and diversion of critical care staff from usual care in the ICU. Unexpected beneficial consequences include improvements in the frequency and quality of end-of-life discussions with patients and their families.

Despite several papers discussing these potential harms and unexpected consequences, neither the high-quality systematic review nor any of the additional studies we identified reported any harms or unexpected consequences.

How Has the Patient Safety Practice Been Implemented, and in What Contexts?

External factors. The need for programs such as RRSs is part of the Joint Commission’s National Patient Safety Goals (Goal #16): organizations should select “a suitable method that enables health care staff members to directly request additional assistance from a specially trained individual(s) when the patient’s condition appears to be worsening.” While this goal does not specifically state RRSs as the correct strategy for meeting the goal, RRS have been the near exclusive response to this requirement. RRSs are also included as one of several interventions in the Institute for Healthcare Improvement’s 100K and 5 Million Lives Campaigns (www.ihi.org/ihi/programs/campaign).

Structural organizational characteristics. In the high-quality review, of the 12 studies that reported academic status, 10 were in academic centers and 1 multicenter study included academic and community hospitals. Studies were mainly from Australia and the United States; 2 were in England and 1 was in Canada.

Teamwork/leadership/patient safety, management tools. While the systematic reviews of RRSs we identified and reviewed did not address issues such as teamwork and leadership several papers did so individually.

Jones et al analyzed the literature for the implementation issues of factors impacting nurses’ use of Medical Emergency Teams. Five major themes emerged: education on the MET, expertise, support by medical and nursing staff, nurses’ familiarity with and advocacy for the patient, and nurses’ workload.

Rapid response systems have been implemented in a variety of contexts (different countries, and hospital and patient characteristics) and have varied in their composition, activation criteria, and implementation process. In terms of composition, the RRS studies reviewed might include physicians, nurses, respiratory therapists, and other staff with different training or based in...
different settings (intensive care unit, emergency room), as well as different management, administrative staff, or quality oversight involvement. The majority of studies utilized interdisciplinary teams comprised of at least one physician and one nurse. However, several studies examined alternative RRS configurations. For example, two studies examined systems that leveraged nurse leaders or nurse liaisons as primary first responders. Implementation processes varied widely, often guided by the Institute on Healthcare Improvement (IHI) suggestions or using IHI materials. Education and promotion of the new service was often a factor, although actual staff training (such as simulation training) was uncommon. A variety of different objective criteria were used for calling the team, and some interventions depended on nurses’ clinical judgment; a few studies also developed and promoted a system for family or patient initiation of the team.

Fifteen studies met our inclusion criteria for studies of the implementation processes surrounding Rapid Response Systems. Eleven of these studies used quantitative methods, primarily for evaluating the impact of a change in the implementation process for an RRS program, and four used primarily qualitative methods such as interviews or focus groups of staff regarding RSS implementation issues. The majority of implementation studies were conducted in academic hospitals; however two studies specifically detailed implementation efforts within community hospitals. Another study also examined the effects of separating the overall emergency response system into two teams with different activation criteria and processes in order to increase utilization. Results indicated significant increases in utilization (15.7 calls/1000 admissions vs. 24.7 admissions/1000 admissions, p < .0001) after changes were implemented.

Activation criteria and reasons for activation were focal study topics related to RRS implementation. Several studies included subjective activation criteria (e.g., staff were worried that a patient was at risk for an adverse event) in addition to traditional activation triggers based on vital sign abnormalities. For example, one study that examined data from the MERIT trial found that MET hospitals were 35 times more likely to activate their emergency response team based upon this “worried” criteria compared with control hospitals (14.1% of activations vs. 0.4% of activations, p < .001).

Descriptions of themes in the implementation processes included the categories of technology and tools, staff and training, and barriers and facilitators. In terms of technology and tools, no studies reported use of technology (such as computerized alerts) in RRS implementation. Tools mentioned included changing activation criteria, triggers, or activation methods, including one study changing to mandatory activation based on alert criteria; and review of events, feedback, and rewards. In terms of staff and education, several implementation studies brought on new staff, such as a nurse educator or liaison. Most studies indicated that implementation processes explicitly included educational activities; however, these varied in the degree to which they were strictly information-based (e.g., emails, meetings) or included dedicated training and practice opportunities for either RRS members or staff. The majority of studies also explicitly noted that on-the-job cognitive aids such as posters with activation criteria or badge cards listing activation criteria were included. Finally, barriers and facilitators mentioned included knowledge of activation criteria and other knowledge and attitudes about the RRS; communication, teamwork, and lack of criticism for calling the team; perceptions about the team’s helpfulness to nurses and patients; and the importance and role of RRS champions.

One study specifically examined MET processes over time with the maturation of the MET (and therefore potentially higher team skill level and more acceptance from ward staff). The
study found that the proportion of patients with delayed MET activation was significantly lower (40.3% vs. 22%, p < .001) and that the proportion of patients with unplanned ICU admissions was lower in a later cohort (31.3% vs. 17.5%, p < .001). A summary table is located below (Table 2).

Table 2, Chapter 24. RRS summary table: implementation studies

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Main Study objective</th>
<th>Implementation Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelstein, 2011</td>
<td>To assess if new strategies could improve the time to delivery of MET</td>
<td>Tools: centralized activation system, review of all events, automatic escalation to code team if MET did not respond within 30 min Staff/training: nurse educator for training and compliance</td>
</tr>
<tr>
<td>Buist, 2007</td>
<td>To assess impact of change programs (education for nurses and housestaff)</td>
<td>Staff/training: nurse liaison, development and education</td>
</tr>
<tr>
<td>Calzavacca, 2010</td>
<td>To assess impact of maturation of an RRS on the failure to rescue rate (recognition of deterioration) and associated outcomes</td>
<td>Barriers/facilitators: Maturation of system over time</td>
</tr>
<tr>
<td>Chen, 2010</td>
<td>To compare reasons for calling emergency help between hospitals with a MET and those without</td>
<td>Barriers/facilitators: worry about the patient, effect of teaching hospital, metropolitan hospital, patient location and time of activation</td>
</tr>
<tr>
<td>Cretikos, 2007</td>
<td>To assess process components of MET implementation correlated with utilization</td>
<td>Barriers/facilitators: knowledge of activation criteria, understanding of MET purpose, perceptions of readiness for change, overall attitude to MET program</td>
</tr>
<tr>
<td>Donaldson, 2009</td>
<td>To identify factors associated with successful implementation across hospitals - qualitative</td>
<td>Barriers/facilitators: Extra resources, rapid transfer, communication enhancement, “one stop shopping” (single team assessment), strength of adoption</td>
</tr>
<tr>
<td>Foraida, 2003, DeVita, 2004</td>
<td>To determine if specific educational and feedback interventions would increase MET utilization</td>
<td>Tools: immediate review of all stat sequential paging events, feedback to those involved in delaying MET activation, creating better objective alert criteria, dissemination and education for those new criteria.</td>
</tr>
<tr>
<td>Genardi, 2008</td>
<td>To revitalize existing RRT and improve code reductions</td>
<td>Tools: rewards program (recognition of effort), improved documentation, alter alert criteria, increase access to RRT, change to centralized paging Staff/education: education, support for nurses, critical thinking skills, ensure competencies</td>
</tr>
<tr>
<td>Jones, 2006</td>
<td>To assess whether systems changes in existing MET would increase utilization rate</td>
<td>Tools: Method of activation (changing activation methods to separate the teams), triggers (changing alert criteria for calling MET) Staff/training: team composition (separation of unified code/MET into separate teams with separate activations), re-education on purpose of MET, criteria, and the changes</td>
</tr>
<tr>
<td>Jones, 2006</td>
<td>To assess education program to increase utilization of existing MET</td>
<td>Staff/training: education, improved communication, on-the-job aids (e.g., posters, observational charts)</td>
</tr>
<tr>
<td>Jones, 2010</td>
<td>To determine if mandatory MET activation improves outcomes compared with elective</td>
<td>Tools: conversion from elective MET activation to mandatory based on alert criteria</td>
</tr>
<tr>
<td>Shapiro, 2010</td>
<td>To determine nurses’ perceptions of RRS impact on practice and what constitutes a successful RRS – qualitative</td>
<td>Barriers/facilitators: Nurse enthusiasm about teams; clarity about when to call team; concerns about being reprimanded for calling team; institutional and individual inertia; concerns about who would care for other patients during a call</td>
</tr>
</tbody>
</table>
Table 2, Chapter 24. RRS summary table: implementation studies (continued)

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Main Study objective</th>
<th>Implementation Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soo, 2009</td>
<td>To evaluate major features of the patient safety practice champion role</td>
<td>Barriers/facilitators: Both executive and managerial champions were important; were skilled communicators, well-respected and familiar with institutional culture. Champions were educators, advocated for RRT, built relationships, and navigated boundaries between professions/units.</td>
</tr>
<tr>
<td>Williams, 2011</td>
<td>To clarify nurse perceptions of RRS – qualitative</td>
<td>Barriers/facilitators: advantages of RRT to nurses (develops skills, autonomy, resource and way to circumvent unit problems), perceived benefits for patients; degree of teamwork with RRT; RRT skills; concerns about activating an RRT</td>
</tr>
</tbody>
</table>

Are There Any Data About Costs?

This was not evaluated in the high-quality systematic review by Chan in 2010 or in any of the additional effectiveness or implementation articles that we reviewed.

Are There Any Data About the Effect of Context on Effectiveness?

The high-quality meta-analysis concluded that RRSs were associated with significantly reduced hospital mortality in pediatric but not in adult populations. Effectiveness appeared high in earlier studies, but less in later studies. In our update, however, we found the opposite to be true. We found that the most recent studies are more likely to demonstrate positive results for mortality. In fact, there were 7 studies in a row, starting with Kenward in 2004 and continuing to Chan in 2008, where the point estimate of effect doesn’t go below 0.95. After Chan 2008, all point estimates are < 0.95. Potential explanations for this include maturation of the intervention and improved implementation strategies that may have led to improved results within and across institutions.

We did not find any studies evaluating the impact of context on effectiveness. One study that had two separate MET teams for the two groups showed an impact in a medical, but not a surgical population.

Conclusions and Comment

In summary, a previous high-quality meta-analysis of 18 studies published from 1990 through November 2008 found that although RRSs were associated with a significant reduction in rates of cardiopulmonary arrest outside the intensive care unit, there was a significant reduction in mortality only in pediatric studies (not in studies in adults). Our update identified an additional 20 studies, none of which was high quality, and the strength of evidence in those studies for the impact of RRSs on in-hospital mortality in both adult and pediatric populations was low.

Tools mentioned in qualitative and quantitative implementation studies included changing activation criteria, triggers, or activation methods, but technology was not mentioned. In terms of staff and education, themes included bringing on new staff or educational activities, but efforts were mainly focused on information rather than training. Finally, barriers and facilitators mentioned included knowledge and attitudes about the RRS; communication, teamwork, and lack of criticism for calling the team; and perceptions about the helpfulness of the team for nurses and patients. Studies included little information about context, and we found no evidence about how context impacted effectiveness or implementation.
Despite their strong face validity, RRSs have exhibited mixed results in the literature. There are several potential explanations for this—none mutually exclusive. The afferent limb can provide clear definitions to identify which patients are likely deteriorating and can educate staff on those definitions. However, activation triggers were originally developed through clinical chart review of patients who had arrested or been transferred to the ICU, and subsequent attempts to improve upon this model have not generated a better approach. Studies of aggregate scores, weighted scores, and single parameter triggers have not demonstrated clear superiority of one over another. Confounding this approach is the way that vital signs, which constitute most of the data for afferent limb systems, are collected. On general wards, vital signs are, at best, collected every 4 hours and more typically every 6 or 8 hours, leaving ample time for deterioration to develop unrecognized. The fidelity with which vital signs are collected and recorded is also known to be poor, amplifying the problem. Finally, vital signs are not the only variable predicting risk of deterioration. Weighted and aggregated scores try to address this issue, but the interconnectedness of these changes is complex and varies with specific populations.

There are also a number of issues with the implementation of the efferent limb (the RRS team). Optimal team composition is unknown, including the structure (including a physician or not, level or training, and overall team composition), and whether the RRS should be unified with the code team or be separate not only in function but in personnel. Hospitals are reluctant to fund free standing RRSs whose only responsibility is to attend to deteriorating patients and/or arrests. As a result, RRS team members need to leave other duties (often caring for critically ill patients in the ICU) to respond. This may limit the available resources they can bring to the ward patient and risks harm to the patients they have stepped away from. Restricted financial resources may also impact the RRS’s ability to self–audit and evaluate code events and unanticipated ICU transfers that occur outside an RRS intervention. As a consequence, the RRS cannot make appropriate assessments in order to improve systematically. Efforts to improve utilization may likewise suffer, especially given evidence that utilization (dose) matters, that utilization can be improved with changes in implementation strategies, and that many programs have low utilization rates. Utilization of RRSs is reported to be low often because of issues with the culture of safety, including reluctance on the part of the ward staff to activate the team.

Finally, there are a number of issues regarding how outcomes in RRS studies are measured. Cardiac arrests and hospital mortality can be affected by many other factors such as patient characteristics and other aspects of care, including trends over time in reducing hospital mortality and length of stay and in caring for more terminally ill patients outside the hospital setting. Additionally, several metrics commonly used to evaluate RRSs count patients who are not exposed to the intervention (i.e., total hospital mortality), potentially affecting the results. Unfortunately, using metrics such as “preventable general ward-only mortality” is more difficult and potentially introduces bias (chart review to determine preventability of a death).

In summary, RRSs are clearly associated with decreased rates of cardiopulmonary arrest, but the question of whether RRSs as currently defined and implemented affects mortality is unclear. Insufficient evidence exists on the impact of context, different implementation strategies, or RRS structure. RRSs are not likely to realize their full potential for improving outcomes without accurate, more frequent (possibly even continuous) and integrated patient specific data to inform the afferent limb, an understanding of what team structure and training works best, greater commitment to fully support RRSs so they can carry out all necessary functions unencumbered,
a greater focus on patient-centered care and patient safety, and improved measurement and reporting. A summary table is located below (Table 3).

Table 3, Chapter 24. Summary table

<table>
<thead>
<tr>
<th>Scope of the Problem Targeted by the PSP (Frequency/Severity)</th>
<th>Strength of Evidence for Effectiveness of the PSPs</th>
<th>Evidence or Potential for Harmful Unintended Consequences</th>
<th>Estimate of Cost</th>
<th>Implementation Issues: How Much do We Know?/How Hard Is it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common/High Moderate</td>
<td>Moderate Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate/Moderate</td>
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References


