

Well-implemented Early Warning Scores can help Rapid Response Teams in improving outcomes

The intersection of deteriorating patients, Early Warning Scores, Rapid Response Teams and new monitoring technology

These days, hospitals are treating increasingly complex patients with multiple co-morbidities. At any given time some of these patients may be rapidly deteriorating, for a variety of reasons. Every hospital must have a strategy to identify such patients, and be capable of providing the appropriate level of care at the right time. Early intervention on a patient who is deteriorating is likely to improve that patient's outcome.^{1,2}

Rapid Response Teams (RRTs) within hospitals are formed to rapidly assess and manage deteriorating patients in an attempt to deliver the appropriate level of care. However, much data³ suggest that responses to such patients may be inadequate or delayed. Many studies⁴ suggest that objective criteria for deterioration are needed to help trigger a RRT call, since calling criteria are crucial to optimal RRT function.

Calling criteria are typically based on deterioration in the patient's vital signs. Early Warning Scores (EWS) add allocated points for each deteriorating vital sign to obtain a global score of risk. The value of this score subsequently determines whether the RRT should be activated. Unfortunately, in many cases, vital signs are not reliably measured and EWS are, therefore, not correctly calculated.^{5,6}

This is where technology comes into play. Technology can help facilitate the measurement of vital signs, derive an EWS automatically and provide caregivers a prompt on what to do next. Recently, a Philips Healthcare Clinical Decision Support System (CDSS) that performs these functions was used in the VITAL (Vital signs to Identify, Target and Assess Level) Care Study (in press with Critical Care Medicine). This study, involving close to 20,000 patients and 10 hospitals on three different continents, found that the use of this CDSS when compared with hospitals' previous practices for measuring vital signs and calculating EWS to activate a RRT is associated with increased survival immediately after RRT treatment; shorter median hospital length of stay in patients in the U.S. hospitals included in the study; and shorter time to complete and record a set of vital signs.

EWS and RRTs are likely to continue to be of extreme importance as the need to rapidly identify and treat deteriorating patients increases. Evidence is now accumulating that this need can be addressed through an evolution in technology that automates vital signs measurement, EWS calculation and that provides advice on how to respond. The first steps in this direction are being taken. More are sure to follow. The future monitoring of patients will inevitably depend on better and better clinical decision support systems.

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Abstract

Background

Early Warning Scores (EWS) are being used in hospitals with the goal of improving the effectiveness of Rapid Response Teams (RRTs). More and more hospitals are seeking to implement them as an adjunct to rapid response teams.

Materials and methods

A comprehensive review of the published literature on rapid response teams and Early Warning Scores was completed. A series of site visits and in-depth interviews with experienced hospitals and published authors were conducted, and 45 nurse managers in sub-acute care units were surveyed with an anonymous web survey instrument.

Results

Literature review finds mixed experimental results for both rapid response teams and Early Warning Scores. Survey responses and expert interviews show a strong positive impression for Early Warning Scores, but also a critical emphasis on good implementation practices. Published literature shows evidence that execution failures undermine the success of EWS implementations.

Conclusions

Early Warning Scores have been shown to improve outcomes in specific instances. Following best practices in implementing EWS is critical for hospitals to obtain meaningful clinical and economic benefits.

Context of study:

Early Warning Scores are widely used to improve the effectiveness of Rapid Response Teams, but their impact on clinical outcomes and operational workflow is poorly understood.

Study purpose:

Review the evidence for Rapid Response Teams and Early Warning Scores, and investigate the practical implications of implementation, and determinants of success.

Key takeaways:

EWS and RRTs can improve outcomes, but only in hospitals that are well-prepared and implement them thoughtfully.



Background: An increasing focus on quality

Focus on quality

Measurement and improvement of care quality is an ever-increasing priority in American hospitals. The provision of high-quality healthcare is a moral imperative and essential to the missions of every provider organization. Increasingly, it also determines the operational and financial outcomes for a facility. Publication of performance benchmarks impact physician referrals and patient choices. More and more, quality performance will influence reimbursement structures and the financial success of hospitals.

Over the last 10 years, various hospital quality initiatives have been championed by quality groups such as the Institute for Healthcare Improvement (IHI), Agency for Healthcare Research and Quality (AHRQ) and the American Hospital Association (AHA), often with impressive results. Focused attention has changed hospital behaviors for the better in medication safety, hospital-associated infection, sharps safety, and the management of cardiac emergency patients.

Rapid Response and Early Warning

The IHI's Save 100,000 Lives Campaign also identified the deployment of Rapid Response Teams (RRTs) as one of the first six evidence-based practices to improve healthcare quality. RRTs (also known as Medical Emergency Teams – METs) remain a critical component of the successor 5 Million Lives Campaign: www.ihl.org/IHI/Programs/Campaign.

The use of Rapid Response Teams is believed to improve the outcome of sudden patient deterioration in the hospital, by enabling high acuity patient care to be delivered anywhere that it is needed in the hospital. More recently, many hospitals have sought to improve the performance of RRTs by using Early Warning Scores (EWS) to identify patient deterioration before the patient reaches a critical condition. This practice is acknowledged, but not yet promoted as best practice, by IHI: <http://www.ihl.org/knowledge/Pages/Tools/HowtoGuideDeployRapidResponseTeams.aspx>.



The problem of Rapid Patient Deterioration

The nature of the problem

The IHI's 5 Million Lives Campaign identifies unnecessary death as the rationale for Rapid Response Teams in their 'How-to-Guide: Rapid Response Teams':

“People die unnecessarily every single day in our hospitals. It is likely that each clinician can provide an example of a patient who, in retrospect, should not have died during their hospitalization.”

IHI 'How-to-Guide: Rapid Response Teams'

<http://www.ihl.org/knowledge/Pages/Tools/HowtoGuideDeployRapidResponseTeams.aspx>

The Size of the Problem

The AHRQ's Nationwide Inpatient Sample (NIS) 2008 estimates 811,211 patients that died in hospitals in the US in 2008. The NIS also shows 28,887 cardiac arrests in the database (ICD-9 code 427.5). As the NIS is designed to approximate a 20% sample of US Inpatient Episodes, this number can be multiplied by 5 to give an estimate of the overall number of cardiac arrests in all US hospitals: 144,435.

It is undoubtedly true that many of these deaths and cardiac arrests occurred as expected events in extremely sick patients cared for in high-acuity care settings such as the ICU. However, Bader et al, 2009 showed that 46% of all cardiac arrests occurred outside the ICU setting before implementing an RRT program. Similarly, Fuhrmann et al, 2008 showed that 18% of general floor patients developed abnormal vital signs measurements over a 2-month data collection period, and these patients had a three-fold risk of mortality compared to those with normal vital signs.

Death and codes on the general floor

To augment the limited data available on the burden of mortality and the frequency of cardiac arrests in the non-ICU setting, Juniper Consulting (Junicon) included some census questions in a market research study of 45 Nurse Managers. While this data is necessarily anecdotal and limited in nature, it provides a further triangulation point, based on the experiences of nurse managers responsible for nearly 1 million bed days of care per year.

Frequencies of adverse events in Sub-Acute Care Units

Mean occurrences per 1,000 bed days	
A patient dies on unit	1.868
A patient is transferred to a higher acuity care unit	4.598
A code is called on the unit	3.574

Source: Junicon Web Survey, N=45

Table 1

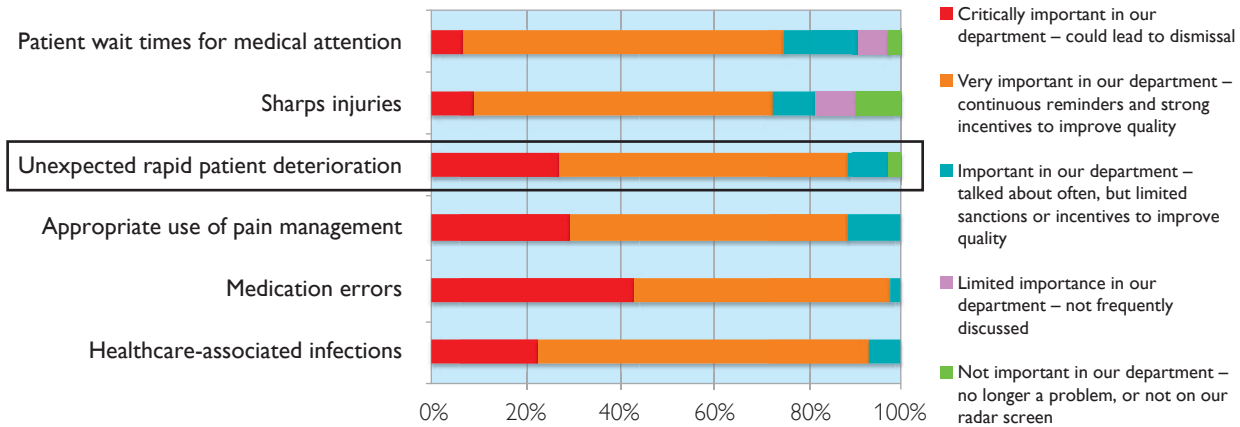
An overall estimate of the burden

The American Hospital Association (AHA) counts 944,277 total hospital beds among the 5,795 member hospitals (AHA Hospital Statistics, 2011). In a 2006 study, Halpern, et al used Center for Medicare and Medicaid Services (CMS) data to calculate that there were 93,955 high-acuity care beds in the US, and that these were increasing at 1.5% per year. Extrapolating forward, this suggests 102,735 critical care beds; and by deduction, 841,533 sub-acute care beds.

Continuing the extrapolation, this suggests that there were 573,733 deaths in sub-acute care, 1,097,751 codes called and 1,412,293 patients escalated to the ICU.

Is the problem recognized? What are US hospitals doing about it today?

Importance of different quality measures to Nurse Managers



Source: Junicon Web Survey, N=45

Figure 1

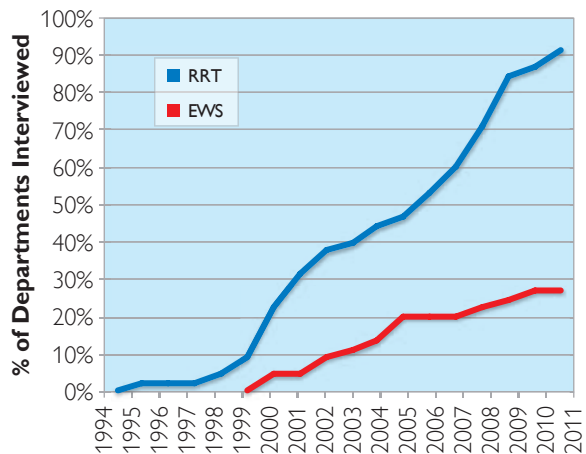
Patient deterioration is a priority

Junicon's Web Survey of sub-acute care Nurse Managers found that unexpected patient deterioration was a critical priority, comparable in importance to 'established' quality indicators such as medication errors and healthcare-associated infections. 90% of nurse managers consider it a critical or very important issue in their department (see Figure 1).

Rapid adoption of Rapid Response

In response to promotion from the IHI Save 100,000 Lives Campaign, a majority of hospitals have implemented Rapid Response or Medical Emergency Teams (RRTs/METs). Adoption was particularly rapid in the period from 2005 to 2008 (see Figure 2), with 91% of the web survey sample reporting an RRT in place in their facility. However, adoption of Early Warning Scoring systems to support and augment the use of Rapid Response Teams has been much slower: only 27% of the web survey sample hospitals have implemented an Early Warning Scoring System.

Uptake of RRTs and EWS



Source: Junicon Web Survey, N=45

Figure 2

Reasons for adoption

Web survey respondents identified both clinical and compliance drivers for adoption:

- "Patients were crashing and nobody was servicing them immediately till they coded"
- "To prepare for Joint Commission"
- "To catch emergencies before a code blue occurs, it improves patient outcomes, helps reassure new nurses especially if they are new and don't know if a patient is deteriorating"

Perceived success of Rapid Response Teams – and the need for proof

Universal acclaim...

On June 14, 2006, the Institute for Healthcare Improvement (IHI) announced that its campaign to save 100,000 lives had met and exceeded its target, by saving 122,300 lives. As a result, an extended Save 5 Million Lives Campaign was initiated, and the positive impact of each of the six Evidence-Based initiatives was widely accepted.

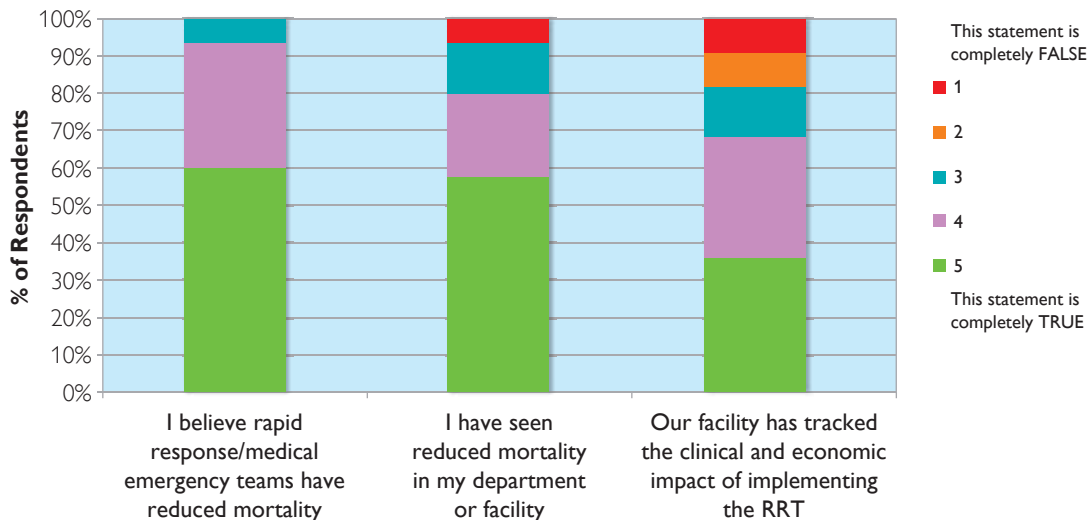
In more than 20 conversations in 7 site visits, Junicon did not find any clinicians or other hospital employees who did not believe that Rapid Response Teams had a positive impact on patient outcomes. Furthermore, 60% of web survey identified the statement “I believe rapid response / medical emergency teams have reduced mortality” as completely true for them (see Figure 3).

...But uncertain evidence

However, in the wake of the IHI announcement, Wachter and Pronovost, 2006 reviewed both the standards of evidence for each of the six interventions and the strength of evidence that the campaign had indeed saved lives. While acknowledging the undoubted impact and benefit of the campaign, the authors concluded that it was still too early to conclude that Rapid Response Teams were a clear quality measure: “the promotion of rapid response teams as a national standard is problematic.”

Furthermore, while 60% of nurse managers believe that RRTs reduce mortality, and 58% have seen reduced mortality in practice, only 34% have actually measured the clinical and economic impact of implementing an RRT in their facility.

Subjective assessment of RRT impact among Nurse Managers



Source: Junicon Web Survey, N=45

Figure 3

What is the evidence for Rapid Response Teams?

The case for:

Early evidence that RRTs reduced mortality – up to 2004

Much of the early evidence for the positive impact of Medical Emergency Teams was generated in Australia, and the UK.

The first study to show a positive impact on outcomes was a prospective, 'before and after' study conducted in an Australian hospital by Buist et al, 2002. These authors showed a statistically significant impact on mortality, with a reduction in deaths from 19.67/1,000 admits to 17.20/1,000 admits.

Ball et al 2003 conducted a much smaller study in a critical care step down unit in the UK, showing a statistically significant positive risk ratio for survival – patients after introduction of an outreach team had a 1.08x greater chance of surviving to discharge than those before.

The most compelling evidence for a benefit for MET implementation was shown by Bellomo et al, 2004. Again in Australia, this study showed a 25% relative risk reduction (RRR) for total mortality, and 56% RRR for death subsequent to a cardiac arrest, in a large population sample, with a solid prospective methodology.

Priestley et al, 2004 showed a benefit with a different methodology: they used a phased roll out of a critical care outreach team to enable randomization and control between different hospital wards in the UK. Their study showed a significant reduction in mortality risk in both of two phases of roll out.

Garcea et al, 2004 showed a substantial reduction in high 30 day mortality among patients stepping down from critical care – from 53.1% before to 32.6% after. In most US hospitals in 2012, neither of these results would be considered acceptable, but nevertheless, a positive impact was achieved by MET implementation.

Further evidence for an impact on mortality – 2005 to 2011

From 2005 onwards, evidence for the benefit of Rapid Response / Medical Emergency Teams was increasingly generated beyond Australia and the UK, demonstrating that the positive effects were not isolated to individual hospitals, nor the results of confounding factors associated with studies measuring results before and after implementation.

Brilli et al, 2007 showed a strong trend towards a significant benefit (p 0.13) in mortality in a pediatric teaching hospital in the US, with mortality reduced from 0.12/1,000 patient days to 0.06/1,000 patient days.

Sharek et al, 2007 showed significant mortality benefit in a community children's hospital in the US, with mortality reduced from 1.01/100 discharges to 0.83/100 discharges.

Tibballs et al, 2009, conducted an extended follow up retrospective study and showed a significant decrease in mortality from 4.38/1,000 admits to 2.87/1,000 admits.

Synthesis of literature – impact on mortality

Study	Deaths/1,000 – before	Deaths/1,000 – after	Impact on deaths/1,000
Buist 2002	19.67	17.20	-2.47
Bellomo 2004	14.3	10.6	-3.7
Sharek 2007	10.1	8.3	-1.8
Tibballs 2009	4.38	2.87	-1.51

Table 2

Across four studies, the impact of METs is between 1.5 and 4.0 deaths per 1,000.

Evidence that RRTs reduce cardiac arrest/Code Blue Rates

Even where a total reduction in mortality has proven elusive, several studies have shown a reduction in rates of cardiac arrest and Code Blue events.

Bellomo et al, 2004 showed a 65% reduction in cardiac arrest hospital wide after introduction of a medical emergency team. Buist et al, 2002 showed a reduction from 3.77 arrests/1,000 admits to 2.05 arrests/1,000 admits. DeVita et al, 2004 reported a significant reduction in cardiopulmonary arrests from 6.5/1,000 admits to 5.4/1,000 admits in a large US hospital.

Brilli et al, 2007 reported a significant reduction in Code Blue events, from 1.54/1,000 patient days to 0.62/1,000 patient days. Campello et al, 2009 reported a significant reduction in cardiac arrests in a Portuguese general hospital, from 4.21/1,000 admits to 3.09/1,000 admits. Chan et al, 2008 reported a significant reduction in cardiac arrests, from 11.2/1,000 admits to 7.5/1,000 admits. Sharek et al, 2007 showed a significant benefit mortality in a community children's hospital in the US, with Code Rates reduced from 2.45/100 discharges to 0.69/100 discharges.

The IHI mentoring program for RRT implementation provides anecdotal evidence of several hospitals who have achieved substantial positive changes in code and mortality rates: <http://www.ih.org/offerings/MembershipsNetworks/MentorHospitalRegistry/Pages/RapidResponseSystems.aspx>.

Evidence that RRTs reduce resource utilization

If cardiac arrest and rapid patient deterioration can be reduced, it is reasonable to expect that hospital resource utilization will also be reduced, in the form of fewer ICU admissions, fewer readmissions, and overall reduced length of stay. Indeed, these endpoints have all been shown in one or more studies: Bellomo et al, 2004 showed an 80% relative risk reduction for ICU bed days after cardiac arrest and an 88% RRR for total bed days. Bristow et al, 2000 reported significantly higher odds ratios for an unanticipated escalation to ICU in two comparator hospitals vs. a hospital in which an MET was implemented: patients were respectively 1.59x and 1.73x more likely to have an unanticipated ICU admission in the hospitals with no MET. Ball et al, 2003 showed a significantly lower odds ratio of 0.43 for readmission to critical among post-critical care patients after implementing a critical care outreach team.

Synthesis of literature - impact on cardiac arrest rates

Study	Arrests/1,000 – before	Arrests/1,000 – after	Impact on arrests/1,000
Buist 2002	3.77	2.05	-1.72
Bellomo 2004	2.98	1.05	-1.93
DeVita 2004	6.5	5.4	-1.1
Sharek 2007	2.45	0.69	-1.76
Campello 2009	4.21	3.09	-1.12
Chan 2008	11.2	7.5	-3.7

Table 3

What is the evidence for Rapid Response Teams?

The case against:

Many studies have failed to show significant benefit on mortality...

While several studies have shown a positive impact many others have failed to show any benefit. An extensive literature review conducted by Esmonde et al in 2006 included 21 different studies using 'before and after' control designs. Of the 21 studies, 7 showed a significant benefit in mortality, and 14 showed no significant benefit.

...And the largest cluster-randomized trial failed to show any impact...

Hillman et al, 2005 conducted an extensive cluster-randomized trial, phasing the roll out of medical emergency teams across 23 hospitals and comparing outcomes in those hospitals with an MET against those yet to implement the MET program.

No statistically significant benefit was seen in mortality, cardiac arrest or unplanned ICU admission.

...But, several sites were able to achieve significant benefits in terms of outcomes.

What can we conclude?

Esmonde et al concluded that Rapid Response Teams were neither proven innocent nor guilty, and that there was certainly no reason to discontinue efforts to expand their use:

“Although there is insufficient robust evidence to confirm the effectiveness of critical care outreach activity on patient or service outcomes, neither has this review demonstrated that critical care outreach activity is ineffective. There is no basis for suggesting that outreach services should be discontinued or developments halted. Rather, there is a need for a comprehensive evaluation of this expanding service.”

Esmonde et al, 2006

Perhaps the only robust conclusion that can be drawn is that different hospitals have had different levels of success in terms of improving patient outcomes after implementing Rapid Response Teams. The obvious next question is: “Why?” What is it that determines success or failure in implementing Rapid Response Teams? The literature does give us some clues:

A Rapid Response Team can only improve outcomes if it is asked to respond!

Cioffi et al, 2000 conducted a descriptive study with 32 RNs on their emotions and attitudes to placing a call to a rapid response team. A majority of nurses feel anxious, and feelings of anxiety were heightened in the absence of clear and consistent criteria for RRT activation. Campello et al, 2009 showed that an initially significant benefit in terms of cardiac arrest rates was lost over time. They concluded:

“Long-term effectiveness of these programs may decrease in the absence of periodic and continued implementation of educational interventions aimed to improve the awareness and performance of physicians, nurses, and all ward staff in the early detection and intervention in patients at risk of cardiac arrest.”

Campello et al, 2009

Activation criteria are critical to success: The rationale for Early Warning Scores

“I believe there are a number of best practices at this point...We already had an MRT [Medical Response Team] when we started our EWS experiment. There were some very loose criteria as far as when to call MRT. There was a lot of miscommunication between MRT team members and teams on the floors – ‘Why did you call? What do you expect us to do?’...Now, this is just what happens, not even a discussion...When the PICU fellow comes over the discussion is not around if the kid needs to stay or go [to the ICU], it is much more wide-ranging, reviewing treatment options and status over next 6 hours, 24 hours, etc.”

*Dr. Vossmeier, Director, General Inpatient Services
Cincinnati Children’s Hospital Medical Center*

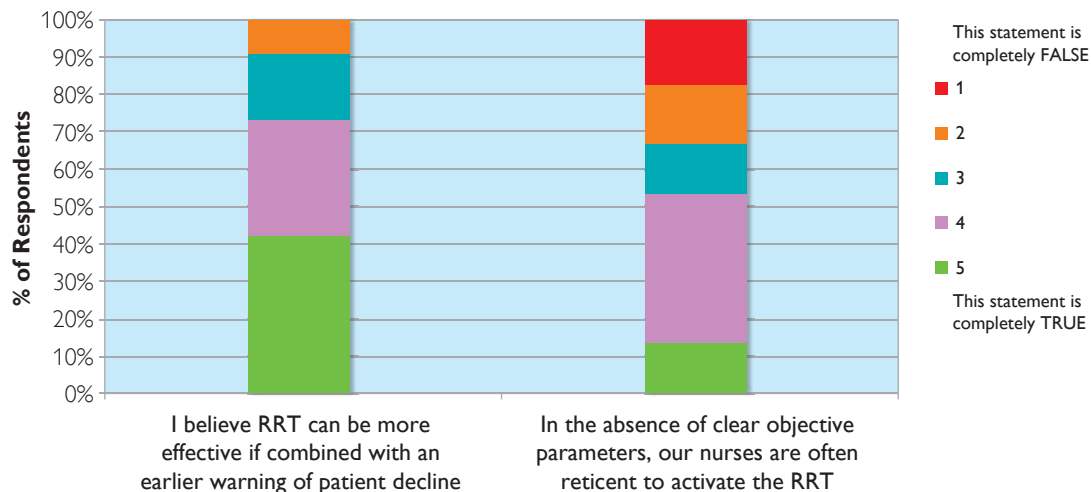
Activation of the RRT is critical

Calling a medical emergency team can be a major step, and results in a substantial use of hospital resources. As Cioffi et al, 2000 reported, nursing staff may feel anxiety about placing a call, and concern that they may be blamed for any ‘false alarms’. Different hospitals may have different cultures of tolerance for false negatives, leading to a degree of ‘self-censorship’. In these situations, sensitivity is sacrificed for specificity, and it is possible that the benefits of the Rapid Response Team are lost. Trinkle et al, 2011 showed that 22.8% of patients with RRT activation, cardiac arrest or ICU admission had a documented failure to activate the RRT (despite meeting criteria) preceding the event.

Clear parameters are vital

Junicon’s web survey identified that more than 50% of nurse managers agree that nurses are reticent to activate the RRT without a clear parameter (see Figure 4). Furthermore, timing of activation may be even more important. If the clinical team waits for one or more vital signs to reach an unambiguously critical level, then the benefit of Rapid Response may also be lost. More than 70% of nurse managers believe that Rapid Response is more effective with an earlier warning of patient decline. The need to reconcile having objective criteria to support the call, with timely activation is the driving force behind Early Warning Scores.

Beliefs about the role of activation criteria for RRTs



Source: Junicon Web Survey, N=45

Figure 4

What is the evidence for Early Warning Scores?

The case for:

Evidence that Early Warning Scores accurately give an early warning

Early efforts to validate Early Warning Scores focused on retrospectively demonstrating that they accurately predicted negative patient outcome, with an acceptable level of sensitivity and specificity (Area Under the Receiver-Operator Curve, or AUROC). However, these studies have limited value in validating the use of Early Warning Scores to guide interventions to prevent negative outcomes.

In the first study to quantify the potential impact of EWS in detecting deterioration earlier, Akre et al, 2010 conducted a retrospective chart review of 177 RRT or Code Blue calls in a pediatric hospital. They retrospectively applied the Pediatric Early Warning Score (PEWS) to the vital signs records included in the patient charts, and found that 85.5% of events could have been predicted before RRT activation or Code Blue was called, with a median advanced warning of 11.5 hours.

Evidence that Early Warning Scores increase utilization of RRTs

The purpose of the Early Warning Score is to prompt earlier escalation of care, most usually an activation of the Rapid Response Team. It is therefore reasonable to assess the effectiveness of an EWS system in terms of the increase in RRT calls.

Robb et al, 2010 reported a 2.5 fold increase in RRT calls, from 27.5/month to 70/month after initiation of an EWS system in a New Zealand hospital.

Mercy Hospital Anderson, Cincinnati experienced a 110% increase in RRT calls after implementing MEWS hospital-wide (Maupin et al, 2009).

Paterson et al, 2005 surveyed staff in a clinical audit, with 60% agreeing that implementation of the Scottish Early Warning System (SEWS) early warning system had led to earlier interventions.

Evidence that Early Warning Scores incrementally improve outcomes

Ultimately, the validation for Early Warning Scores must be in improved patient outcomes, specifically in terms of mortality and cardiac arrests / codes. Moon et al, 2010 conducted an eight year audit of outcomes, including 4 years before, and 4 years after, the introduction of MEWS to an intensive care unit. With over 200,000 admits in each period, the authors found a significant reduction in both deaths (1.4% -> 1.2%) and cardiac arrests (0.4% -> 0.2%) between the two periods.

Other centers have reported reductions in mortality, but have not been published in peer-reviewed journals. These include Cincinnati Children's Hospital (11% mortality -> 0% mortality in a pediatric ICU after PEWS initiated), and Mercy Hospital Anderson, who reported a reduction in Code Blues from 0.77/1,000 days to 0.39/1,000 days (Maupin et al, 2009).

What is the evidence for Early Warning Scores?

The case against:

Several early studies showed no clinical benefit

As with RRTs, there is a mixed body of evidence, with slightly more studies showing no significant benefit than showing a positive result.

In the first study looking at a combined PEWS and RRT, Subbe et al, 2003 found no significant differences on mortality, cardiac arrests, or ICU admission.

In a larger real-world analysis, Gao et al, 2007 reviewed the introduction of EWS + RRT throughout 108 English hospitals. They found a significant decrease in the number of ICU admissions that had previously received CPR (odds ratio of 0.84), but no significant differences in mortality or length of stay.

Systematic review has found no conclusive results

Gao et al, 2007 also conducted a systematic literature review of the benefits for EWS (referred to as physiological track and trigger warning systems or TTs). Their review considered 36 different papers and 25 different EWS scoring systems. With no formal meta-analysis attempted, they concluded that the evidence was not strong enough to ascribe a definitive effect to EWS.

McGaughey et al, 2007 conducted a formal meta-analysis for Cochrane Review, however, only 2 studies were considered of adequate methodological quality to include. The results of the meta-analysis showed no benefit to EWS.

What can we conclude?

It is important to note that while EWS and RRT studies have failed to show significant benefit in several studies, in NO studies reviewed have they shown harm, and NO studies reviewed have shown that non-implementation is non-inferior to implementation – a very different statistical calculation. It is therefore not possible to say that hospitals are better off not implementing EWS and RRTs:

“Despite the lack of rigorous testing of the published TTs, and the poor sensitivity in the evaluation of available data, this study does not constitute sufficient evidence that use of existing TTs should be discontinued.”

Gao et al, 2007

As with the inconsistent evidence for RRTs, the safest conclusion is that outcomes in a specific hospital are dependent on many factors, and that EWS+RRT can influence some of these factors more or less effectively in different hospitals. In other words, sometimes it will have a significant impact, and sometimes it will not. Two important recommendations arise from this conclusion:

1. For an individual hospital, there is no way of telling ex ante whether they should expect the positive impact on outcomes seen in Moon et al, 2010, or the neutral (not negative) impact on outcomes seen in other studies. It is therefore reasonable for hospitals to proceed in the hope of a positive impact.
2. It is vital to look for evidence on the determinants of successful or unsuccessful implementation, so that pitfalls can be avoided: Why does the EWS+RRT system fail sometimes?

Why does the EWS + RRT system fail sometimes?

The role of poor adaptation to cultural change

Early Warning Scores change RRT utilization...

Evidence from various studies has shown that effective implementation of EWS has increased the frequency of RRT calls by 25% - 200%. It is important to consider the impact this is likely to have on the workflow.

If the number of RRT calls increases dramatically, this is going to put an increased demand on RRT resources. At the most basic level, this is an obvious potential constraint to effectiveness: if additional Rapid Response resources are not provided, then either calls go unheeded, or RRT staff leave a deficit in their normal care areas when responding to a call.

Perhaps more likely to be overlooked than the increased demand for RRT services is the changing nature of the demand. With more calls for patients earlier in the decline trajectory, RRTs are likely to make fewer and less invasive interventions. Instead of emergency defibrillation, the team may be prescribing small adjustments to medication dose, or changing rate of fluid administration.

...Triggering the 'Self-Censorship' reflex

With more frequent calls resulting in less dramatic interventions, hospitals have to prepare for the workflow and cultural changes in how nursing and RRTs interact. There is some evidence that RNs start subjectively censoring some of their newly-indicated activations, perhaps based on past heuristic experience of the outcome in similar circumstances. Robb et al, 2010 showed that although RRT calls increased from 27.5/month to 70.5/month, only 30% of activation findings were resulting in a call – suggesting that the true increase in activation should have been nearly tenfold to >200/month.

Evidence that effects take time

The impact on culture and workflow is not trivial, and adjustments to ways of working may take more time to become 'standard practice' than is commonly given to evaluate success in clinical studies. Inadequate follow up, resulting in comparison of 'before' and 'transition' rather than 'before' and 'after' may be a key factor driving failure of some studies.

Notably, Santamaria et al, 2010 showed that the implementation of a medical emergency team in a large Australian hospital did not achieve a statistically significant benefit in terms of mortality until 4 years after implementation, although cardiac arrest rates reached a significant decline within 2 years.

Centennial Medical Center in Nashville TN has extensive experience with the implementation of EWS+RRT in their facility. This facility has revised their use of the Modified Early Warning Score (MEWS) four times since initial implementation in order to fit with local workflow and improve sensitivity by adding SpO₂ to the algorithm. Finding a trigger system that worked for the facility has taken time:

“The MEWS allowed them [the nurses] to start making uncomfortable decisions and have the support to back them up.”

LeeAnn Hanna, Director of RRT

Centennial Medical Center, Nashville, TN

Cincinnati Children's Hospital also had a similar experience with requiring customization to fit varying workflows. Although all based on PEWS, each department has slight tweaks to the algorithm sensitivity and specificity to fit their needs for RRT support. Matching the algorithm to local needs took time: “it was not a simple matter of go live and get immediate results!”

Why does the EWS + RRT system fail sometimes?

The system is only as good as its inputs

Human error can be the downfall

The addition of Early Warning Scores can increase the number of opportunities for human error:

- Measure each of 4-6 vital signs
- Record each result
- Calculate aggregate score and possibly calculate additional values reflecting time trend
- Assess if score warrants action
- Place call

Human error is inevitable

In the frequently busy environment of the general floor or med/surg unit, nursing staff have limited time to execute the cycle of EWS monitoring. Furthermore, calculation of aggregate scores, on paper or in electronic systems, represents new workflow, and until it is habituated, may see higher error rates. Junicon's web survey found that 62% of nurse managers believe that there is a strong risk of error any time data is transcribed by hand, and 64% believe that there is a strong risk of error any time multi-parameter calculations are conducted by hand. Error rates do not have to be high to neutralize the sensitivity and specificity of an early warning system, and eradicate net benefits.

Evidence for the impact of error

In fact, several studies have demonstrated and quantified the variation and failure of human interpretation of EWS:

- Subbe et al, 2007 showed significant, high inter-rater variability on whether or not a given MEWS profile warranted a trigger action. The study also showed that MEWS was correctly calculated less than 80% of the time by RNs in a live setting.
- Randhawa et al, 2011 reported 91% of charts with correct PEWS computation and 88.7% with full documentation of actual notification and response.
- Gordon et al, 2011 audited the Scottish Early Warning Score System (SEWS) documentation during the night shift preceding the day in which activation was triggered. They found that only 21% of night shift charts had complete and correct SEWS documentation, with no calculation in 55% of charts and incorrect calculation in 21% of charts. One or more observation was missing in 84% of charts.
- Oliver et al, 2010 found that only 52.7% of patient charts had enough data to calculate PEWS in a pre-implementation readiness study.

Poor execution could cause failure

Robb et al, 2010 found no clinical benefit after their EWS implementation, despite a steep escalation in RRT calls. However, the authors reported that the RRT was only activated in 30% of indicated situations, per the EWS. Failure to truly implement the EWS > RRT activation loop may have been responsible for the lack of clinical benefit in this study.

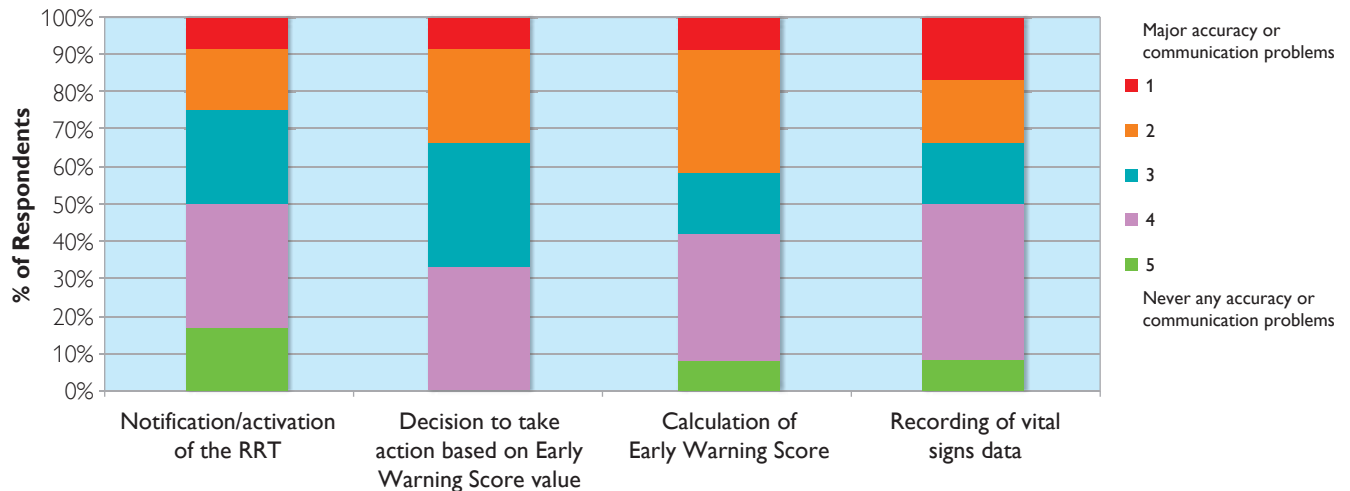
Managing the risk of human error and self-censorship

How to limit conscious and unconscious failure to use EWS optimally

The most obvious route to limit the human failings that can undermine effectiveness of an EWS+RRT system is to take as much of the process out of the reach of human error as possible. Human error rates do not have to be high to undermine composite scores, as errors are compounded. A calculated composite score based on 6 measurements, each entered by hand onto a paper score sheet, and then calculated mentally, actually has at least 13 opportunities for a reading, recording or transcription error. Any one error undermines the total score. A person that makes an error in 1% of observations or transcriptions would thus fail to calculate the correct score 1 in 8 times! Effectively, composite scores place higher demands on nursing accuracy, testing the performance of even the best nurses.

Respondents to Junicon's Web Survey who have implemented Early Warning Scores indicated that the biggest sources of failure are in calculation of warning scores and activation of the medical emergency team or referral to the hospitalists (see figure 5). Throughout the chain of detection and response, respondents find problems with accuracy and / or communication problems.

Sources of failure in current EWS+RRT implementations



Source: Junicon Web Survey, N=12

Figure 5

The role of automation in improving the performance of EWS

Taking away the opportunity for error

Automation is therefore desirable wherever possible: not just in the calculation process, but also in the recording and transcription of vital signs readings, and in the notification of the response team. Furthermore, automation minimizes the disruption to nursing workflow from implementation, and helps mitigate the potential sources of anxiety and self-censorship involved in making a discretionary judgment to activate a response team.

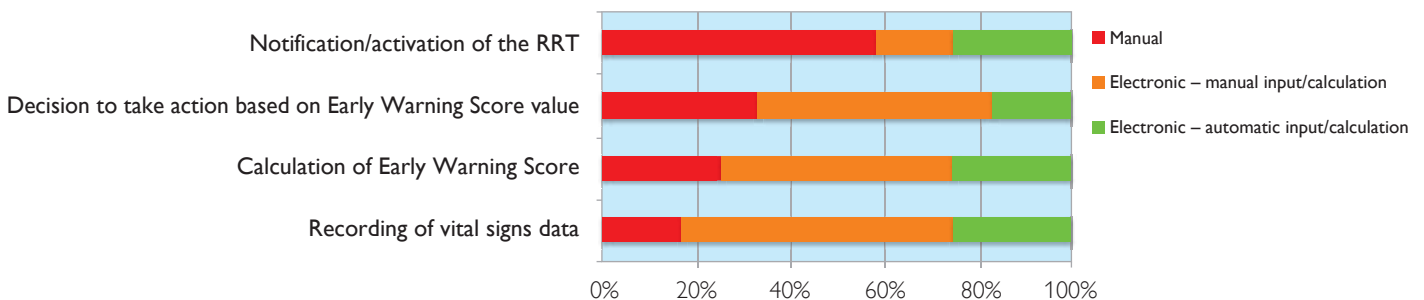
In particular, automation is likely to be vital if Early Warning Scores are 'tweaked' for different patient types or different areas of the hospital. This approach was taken at Cincinnati Children's Hospital to enable different levels of sensitivity and specificity in the PEWS system according to the patient type, and allow for practical customization of implementation across units.

Chris Subbe, Consultant in Acute Medicine at Wrexham Maelor Hospital UK, and an extensively published investigator of Early Warning Scores identifies customization as a particularly difficult thing to achieve without automation. With changeable standards, the credibility of the scoring system can be undermined, and the accuracy of calculations is likely to be diminished.

"If you went into a bank and they had all your records on paper and were calculating your taxes with a pen and paper, you would be horrified. But we still do that in hospitals, taking chances with something even more important."

*Chris Subbe, Consultant in Acute Medicine
Wrexham Maelor Hospital, UK*

Current reliance on manual vs. electronic methods



Source: Junicon Web Survey, N=12

Figure 6

Change management: Being ready for the impact of implementing EWS

Implementing EWS requires a change management process

Early Warning Scores can change workflow for floor nursing, rapid response teams, and hospitalists and intensivists. They can also increase demand for IT resources, and monitoring equipment. Without careful change management planning and process, these factors can lead to organizational bottlenecks and failed deployment.

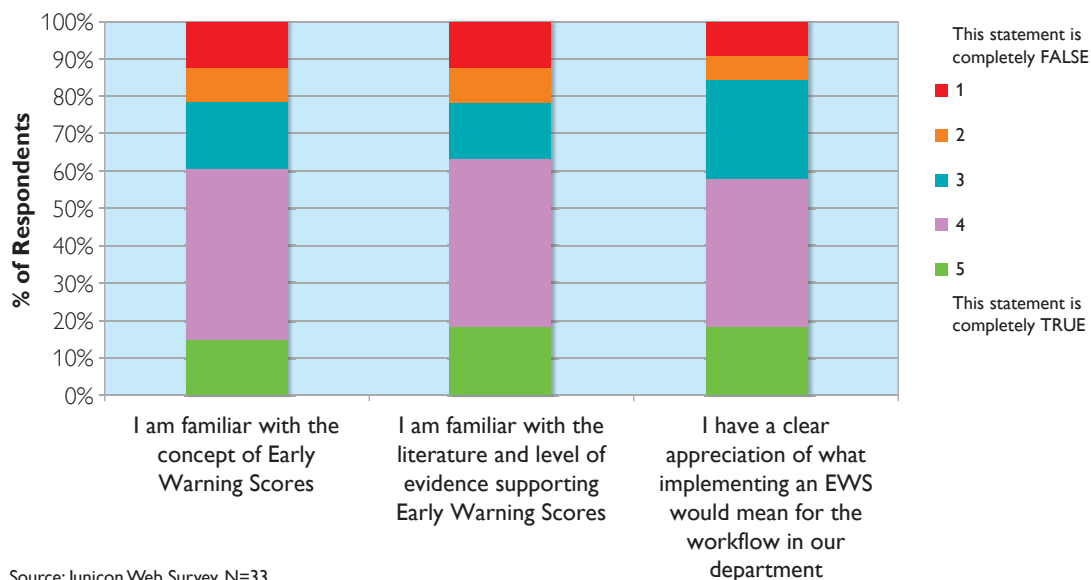
Early adopters found a need for ongoing refinement

For the Cincinnati Children’s Hospital Team, led by Dr. Mike Vossmeier, it took 14 iterations and about 18 months to get their PEWS system to a place where they felt comfortable with the design. The roll-out was purposefully slow and started on a small-scale so that data could be gathered in order to refine the process and build quantitative support before introducing to new units. At Centennial Medical Center in Nashville Tennessee, MEWS is on its 4th iteration and is constantly being evaluated and modified, often per patient population. The sensitivity and specificity of the MEWS has been adjusted dynamically: currently, alerts are generated for a MEWS score of 5 or above. When the bar was set lower, the workload was overwhelming. However, a 2pt change in a MEWS that is still below 5 can be significant.

A serious risk of underestimation

Respondents to Junicon’s web survey who have NOT yet implemented EWS show signs of under-appreciating the complexity of the evidence for EWS and the challenges of implementing EWS in a live installation. Almost all those that identified themselves as familiar with the concept also consider themselves to be familiar with the literature and clearly appreciate the workflow consequences of implementation. Based on our findings from discussions with sites that have implemented EWS, and the ambiguous literature, we suspect this shows a serious risk of underestimating the complexity and depth of engagement needed to make implementation of EWS a success.

Expectations about EWS from those who have not yet implemented



Source: Junicon Web Survey, N=33

Figure 7

Lessons from experienced centers: Change management is vital to success

Words of advice

Junicon spoke at length with several centers and investigators who have reported positive results from using Early Warning Scores. While all the centers had experienced positive results all of them felt that successful implementation requires serious commitment and work, and all found that it took time and correction to get to an optimal way of working with Early Warning Scores. As part of the interview process, Junicon asked these experts to share their 'do's and don'ts' for centers that are considering implementing an EWS system.

Drivers of successful implementation

Key success factors for a successful implementation of EWS*

- Only begin the implementation process when clinical and managerial leadership is ready and bought-in to the concept, and ensure that leaders communicate their commitment: without a clear sign of commitment from leadership, cultural changes will not happen.
- Ensure that everyone in the facility is convinced of the need – retrospectively review the charts of all cardiac arrest patients to prove the problem, conduct literature searches and community surveys.
- Engage nursing at the outset, and show that implementing EWS is not just extra work, but also a way to validate their nursing instincts.
- Build a team approach to monitoring – certified nursing assistants need to work with RNs and hospitalists to ensure appropriate response to abnormal results.
- Remember that the warning-activation-response system is a chain, and a chain is only as strong as its weakest link.
- Obtain support from organizational leadership staff members (clinical and non-clinical).
- Include key stakeholders in needs assessment, planning, implementation and evaluation activities.
- Select a scoring system that works well within the facility... (data is already routinely collected).
- Establish metrics (pre and post implementation to monitor improvement).
- Utilize front-line clinical staff members to explore content and work flow issues.
- Set expectations among the front line staff for documentation activities (timeliness, completeness and correction).
- Develop plans for downtime documentation (if electronic).
- Develop policy and procedures to establish accountability.
- Set appropriate expectations for sensitivity and specificity of an EWS – it can't stop every arrest.
- Use EWS as an adjuvant to clinical judgment, not an alternative.
- Allow for up-scoring based on clinical judgment, but not down-scoring (i.e., clinical suspicion or EWS score should trigger response, not clinical suspicion and EWS score).

*Based on comments from staff at Centennial Medical Center, Nashville, TN, Cincinnati Children's Hospital Medical Center, and Dr. Chris Subbe

Table 4

The role of a commercial offering

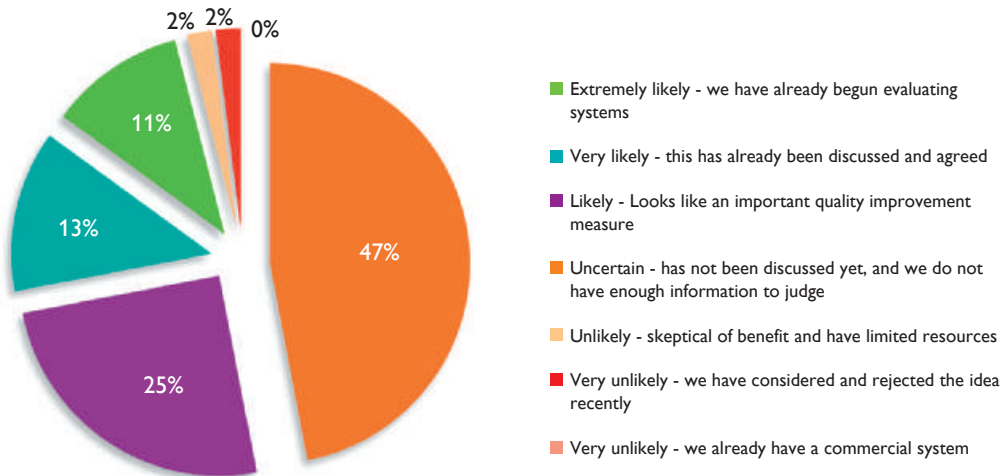
Thought-leaders and homebrews

For many pioneers and early adopters of early warning score systems, implementations of EWS + RRT have been custom creations, developed by academics and champions within the hospital. However, as Early Warning Scores are being considered more widely by hospitals throughout the US, the model of reinventing the wheel is unlikely to be sustainable – very few centers have the expertise and resources to develop everything in-house. Nearly 25% of respondents to the Junicon web survey identified themselves as very or extremely likely to acquire a commercial system (see Figure 8).

Commercial offerings

Commercial EWS offerings allow hospitals to leverage some levels of automation, and use well-established EWS systems proven elsewhere, such as MEWS and PEWS. Commercial offerings can also provide extensive consulting and value-added services support. Most respondents to the Junicon web survey strongly preferred additional support in workflow diagnostics, IT integration, 'go live' support, and ongoing measurement of effectiveness (see Figure 9).

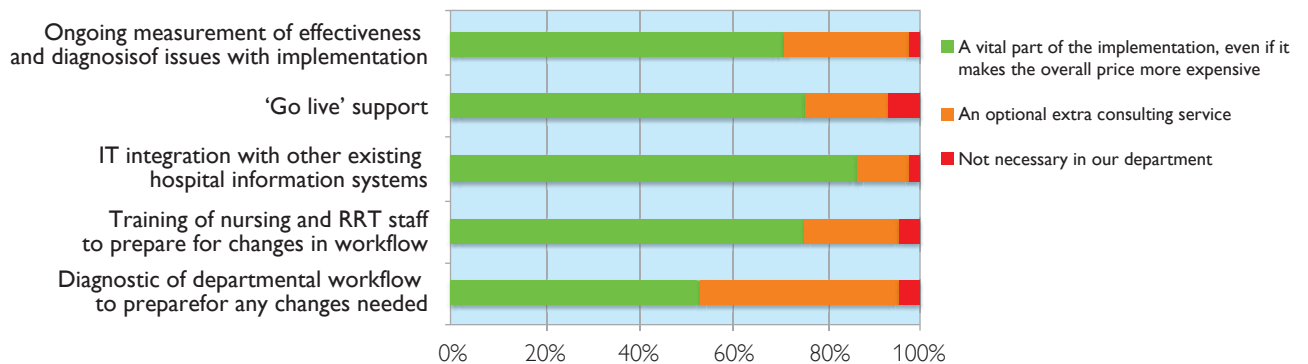
Likelihood to evaluate a commercial EWS offering



Source: Junicon Web Survey, N=45

Figure 8

Expectations for support in a commercial offering



Source: Junicon Web Survey, N=45

Figure 9

Conclusions

1: Rapid Response Teams can make a difference

Several studies have shown that RRTs were able to reduce mortality and cardiac arrest rates in several hospitals. Although other studies have shown no benefit, it is most reasonable to conclude that differences in patient populations, hospital practices and implementation approach are responsible for differing results.

2: Early Warning Scores can improve the effectiveness of RRTs

Many studies have shown that EWS systems increase the frequency of medical emergency team activation. Some studies have shown a benefit in reducing cardiac arrests, and one study has shown a benefit in mortality. Other studies have shown no benefit, but as with the literature for RRTs, it is most reasonable to conclude that variation in effectiveness reflects varied success in implementation.

3: Good implementation is vital to success, and takes serious effort

Evidence from failed studies and reports of implementation compliance indicate that human errors can seriously undermine the usefulness of Early Warning Scores. Testimony from experts and centers that have implemented Early Warning Scores suggests that the process of implementation is extensive and critical to success. Hospitals seeking to use EWS to improve outcomes must prepare for extensive change management, and a 'journey' before reaching the end goal – with many dynamic adjustments and refinements along the way. The resource commitment to implementation is extensive, and some hospitals are looking for outside help from commercial vendors: not just to supply EWS systems, but also to support the changes required for successful implementation.

4: Key success factors can be identified from the experience of early adopters

- Realistic expectations and preparedness of extensive change management
- Dedicated executive level champions
- Multi-disciplinary buy-in
- Creation of infrastructure to support the change process:
- Policies and procedures
- Standing orders

Even with the disparity of views and outcomes in published literature, we believe that those hospitals that do employ robust change management techniques will have good implementation and achieve a positive impact on outcomes. Philips continues to work with leading investigators to refine Early Warning Score systems, and generate convincing clinical evidence for their benefit.

Appendix:

Detailed descriptions of purpose and methods

Philips focus

Philips Healthcare has always had a strong commitment to providing solutions that help hospitals improve their quality performance. As the leading provider in patient vital signs monitoring, the evolving field of using multi-parametric Early Warning Score systems based on vital signs measurements was a logical field for Philips to invest in researching and developing new solutions. Philips is currently working with several leading investigators to refine and advance the use of automated electronic Early Warning Scores.

Research into EWS

In order to prepare for the challenge of implementing Early Warning Score systems in development, Philips has worked with Juniper Consulting Group, Inc. to better understand the topic. Juniper Consulting Group (Junicon) is a healthcare and life sciences consulting company, with practices in market research, strategy, and health economics & epidemiology. Together, Philips and Junicon conducted extensive research into current practices, expectations and beliefs of clinicians, and experiences with implementation of new practices. An extensive review of the evidence for RRTs and EWS was also conducted. In the light of the learning from this process, Philips has decided to share the results with US hospitals.

Methods

1: Literature Review

Junicon conducted an extensive review of the published literature on patient outcomes after implementation of Rapid Response Teams and/or Early Warning Scores. The PubMed database of abstracts was searched using the search terms “Rapid Response Teams AND outcomes”, “Medical Emergency Teams AND outcomes”, “Early Warning Scores”. References from studies retrieved under these search terms were also reviewed. Literature published between 1990 and July 2011 was considered.

2: Web Survey

Junicon also conducted a 20-minute web survey with 45 Nurse Managers leading med/surg, PACU or general floor departments. Respondents were drawn as a random sample from the Epocrates panel of >25,000 nurse managers. The first 45 sequential qualified respondents to an email invite were sampled. Interviews were completed between November 19th and November 23rd 2011.

3: Site Visits

Between March 2011 and July 2011, Junicon also conducted 7 site visits to hospitals that either have implemented early warning score systems, or who were actively considering or preparing to do so.

4: Opinion Leader Interviews

In November and December 2011, Junicon held extensive phone conversations with clinicians that have published results of RRT and EWS interventions, as well as sites with experience in the organizational changes required when implementing new protocols.

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