

## Rapid Response Systems: The Stories

# Using an Automated Risk Assessment Report to Identify Patients at Risk for Clinical Deterioration

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*Readers are invited to submit inquiries regarding their own case studies on rapid response teams (also called medical emergency teams) to Steven Berman (sberman@jcrinc.com) or Michael DeVita (mdevitam@upmc.edu).*

Several studies have shown that patients frequently display physical evidence of deterioration as much as 8–12 hours before a cardiac arrest or critical event requiring some form of intensive intervention or rescue.<sup>1–5</sup> Early recognition of these signs, followed by prompt treatment, may reduce death rates in hospitalized patients.<sup>6</sup> However, deterioration is frequently difficult to assess because of the complex nature of patient care and the need for accurate evaluation skills. To identify patients at risk more reliably, some hospitals have pioneered the use of an automated risk assessment based on key physiologic measures.

In some studies, rapid response teams (RRTs, also known as medical emergency teams [METs]) have been successful in the afferent components of rapid response systems—“event recognition and response trigger”<sup>7</sup>—in both recognizing the early signs of patient deterioration and providing the appropriate clinical interventions to help patients.<sup>8–11</sup> The typical triggers for calling an RRT are based on a set of physiologic parameters (Table 1, right). If any one of these values falls outside the specified parameters, the RRT is called for an evaluation. This type of system, sometimes called a single parameter risk assessment system, encourages the nursing staff to feel comfortable calling for assistance.

Although a single-parameter approach has been effective, some hospitals, especially in the United Kingdom, have pioneered systems that respond to multiple parameters at the same time and identify at-risk patients at the

first sign of a subtle change in vital signs. These so-called early warning scoring systems<sup>12–16</sup> use weighted scoring of several parameters, in which the score is determined on the basis of the sum of the measures for each physiologic parameter. Determining a composite score involves assigning a number to each vital sign (Table 2, page 570)—there are typically between five and seven physiologic parameters. A predetermined normal range is assigned a 0, and increasing or decreasing points up to a maximum of 3 or 4 or a minimum of –3 are awarded to increasingly abnormal values. For example, using the example in Table 2, if a patient’s systolic blood pressure is

**Table 1. Sample Rapid Response Team Calling Criteria\***

Physiologic Measure	Parameters
Heart rate	< 40 or > 130 bpm
Systolic blood pressure	< 90 mmHg
Respiratory rate	< 8 or > 28 per minute or threatened airway
Oxygen saturation	< 90% despite oxygen administration
Conscious state	Any deterioration
Urine output	< 50 mL in 4 hours
Staff concern	Any concern about the patient

\* bpm, beats per minute.

Table 2. A Sample Multiparameter Early Warning Scoring System\*

	-3	-2	-1	0	1	2	3	4
Temperature (centigrade)		≤ 35		35.1– 38.4		≥ 38.5		
Heart Rate (beats per minute)		< 40	40–50	51–100	101–110	111–129	≥ 130	
Systolic Blood Pressure (mmHg)	≤ 70	71–80	81–100	101–199	≥ 200			
Respiratory Rate (breaths per minute)		≤ 8		9–14	15–20	21–29	≥ 30	
Glascow Score				15	13–14	10–12	6–9	0–4
Urine Output (ml/kg per hour)	0–0.01	0.01–0.5	0.5–1	1.10–3	> 3			

\* The early warning score was calculated at OSF St. Joseph’s Medical Center at eight-hour intervals on the basis of these parameters and scores.

between 71 and 80, the patient gets a score of -2; if it is more than 200, the patient gets a score of 1. The sum of the scores of the vital signs yields the patient’s total score. The higher the score, the greater is the patient’s risk for deterioration. If the total score is above a certain threshold—say, ≥ 4—the nurse calls the RRT. Use of an early warning scoring system helps stratify the patients who may be at increased risk for clinical deterioration.

Since 2004, a team at OSF Healthcare System (Peoria, Illinois), using a scoring methodology based on the original system developed by Morgan,<sup>13</sup> with modifications from Stenhouse et al.,<sup>14</sup> has been developing and testing an automated, electronically generated Risk Assessment Report (Table 2, above) to identify patients at risk in a non-intensive care unit (ICU) setting. The team originally consisted of the patient safety officer/director of knowledge management [J.W.], a nurse, and a statistical analyst but eventually expanded to include all the authors.

This article describes experience at OSF St. Joseph Medical Center, which piloted the Risk Assessment Report for the six-hospital OSF Healthcare System. The pilot test was conducted to determine whether the staff used the assessment tool to reliably identify patients at risk for clinical deterioration and to ascertain the tool’s impact on the volume of calls. The remaining OSF Healthcare System hospitals have been rolling out implementation of the Risk Assessment Report since November 2005.

## Methods

### RISK ASSESSMENT REPORT DATA

The Risk Assessment Report consists of a sepsis risk score, an early warning score, key lab results, a Braden skin

score,<sup>15</sup> other criteria of interest (for example, a fall risk score), and certain graphed variables.

The data used to produce the Risk Assessment Report are an exact copy of the transactional information entered in the electronic medical record (EMR) by the clinical team. This “data depot” is created virtually in real time. Any delay between the EMR and the data depot, which we use to develop the report, is due only to the volume of transactions being sent to the database. Once the information is sent to the database, queries are created on the basis of the report’s requirements. Using the data depot for the report eliminates the need to acquire the information directly from the EMR system and eliminates the potential degradation in performance that this type of inquiry could cause.

The greatest technical challenge in developing the report was mapping the requirements to the appropriate data fields. The potential for variation in clinical documentation added to this difficulty. The report is ultimately created automatically using report-writing software and is sent to the unit-based printer of the appropriate hospital representative (Figure 1, page 571).

### DESIGN OF THE RISK ASSESSMENT REPORT

The report was designed to give caregivers a one-page “snapshot” of a patient. The team chose a paper report, which matched the flow of information on the hospital units at the time of the design work, rather than a Web-based report.

**Sepsis Risk Score.** Originally, the team based the sepsis risk score on systemic inflammatory response syndrome (SIRS) criteria. However, it soon found that those criteria

## OSF Risk Assessment Report



**Figure 1.** The Risk Assessment Report consists of a sepsis risk score, an early warning score, key lab results, a Braden skin score, other criteria of interest, and certain graphed variables.

were not specific enough to identify the non-ICU patient at risk and adopted a score of risk for worsening sepsis (Risk of Infection to Severe Sepsis and Shock Score).<sup>16</sup> The Risk Assessment Report uses four scoring brackets for sepsis risk:

1. “Low” (score, 0–8) and “moderate” (score, 8.5–16) risk groups have a cumulative estimated risk of progression to severe sepsis of 9% and 17%, respectively.

2. The “high” (score, 16.5–24) and “very high” (score > 24) risk groups have an associated risk of progression to severe sepsis of 31% and 55%, respectively.<sup>17</sup>

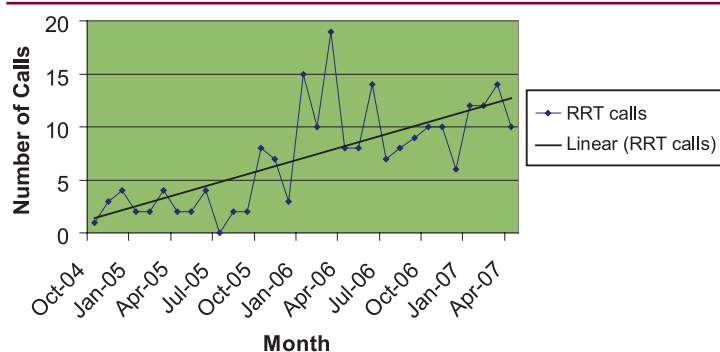
**Early Warning Score.** The early warning score is calculated at 8-hour intervals, using the parameters and scores listed in Table 2 (page 570). The use of a paper printout does not make it technically feasible to inform the team of a deteriorating patient at an earlier stage. To increase the visibility of abnormal values, all elevated early warning scores are colored green in the Risk Assessment Report. The initial set of scores is noted for the 24 hours prior to printing the report, along with the parameters that contributed to the scoring.

Farther below on the report are 12 early warning scores from the previous 96 hours. If documentation of a vital sign is missing, a cue of “missing V.S.” is indicated. In an 8-hour period when more than one set of vital signs has been measured, the score is based on the most extreme value. This methodology has the potential to elevate our early

warning scores.

**Other Criteria of Interest.** The contents of this section of the report, based on caregiver use, discussion, and subsequent redesign since 2005, display abnormal test results or additional risk parameters that are intended to alert caregivers to areas of concern. Unlike the early warning scores, the values displayed are the *most recent* results within the previous eight hours, *not the maximum values*.

### Rapid Response Team (RRT) Calls, OSF St. Joseph Medical Center, October 2004–April 2007



**Figure 2.** The average number of RRT calls per month increased from 2.3 during the first 12 months (October 2004–September 2005) to 10 calls during the last 12 months (May 2006–April 2007). The Risk Assessment Report was implemented in February 2005.

**Graphs and Drug Information.** The graphs were chosen to provide an overall and cumulative picture of the patient’s progress. Use of antibiotics, pressor agents, or anticoagulants that have been charted during the previous 48 hours are also noted, especially if sepsis is suspected. For example, anticoagulants were recorded for the patient whose Risk Assessment Report is shown in Figure 1.

#### IMPLEMENTATION OF THE RISK ASSESSMENT REPORT

During the pilot phase, which began in February 2005 (and ended in October 2005), a Risk Assessment Report was generated for each patient at least daily. Because the risk of deterioration is related to a higher score, the team needed to set a threshold for the score that would trigger calling the RRT. A lower threshold tended to capture patients who were not found to be at risk for deterioration or did not require additional interventions.

At OSF Healthcare, each facility determines its own threshold for printing a report. During the course of the pilot, the team at OSF St. Joseph Medical Center determined that a report would be generated only for patients who triggered a early warning score of 6 or a sepsis risk score of 12. The early warning score trigger was chosen empirically; staff have been educated that even a patient

with a lower score might be critically ill. This trigger score is higher than that reported elsewhere<sup>13,14,17</sup> because in an eight-hour period when more than one set of vital signs has been measured, the score is based on the most extreme value—which has the potential to elevate scores. A sepsis risk score of 12, which places the patient in the moderate risk range, seemed to be a reasonable choice.

Currently, the Risk Assessment Report is printed twice a day, including the most recent information available for calculating the early warning score and sepsis risk score. Printing occurs at 12-hour intervals, specifically at 10:00 A.M. and 10 P.M. daily. The team chose these times to ensure that morning lab data and most daily nursing documentation were completed before running the report. Additional report run times are currently under consideration.

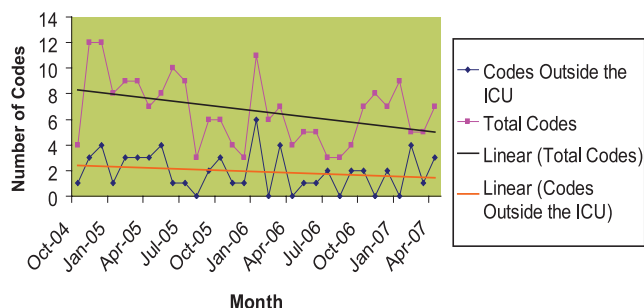
The Risk Assessment Report is programmed to print at a designated printer on each nursing unit, where the supervising nurse has responsibility for retrieving and reviewing it. The frontline nurses caring for that patient discuss the findings on the report, review the parameters that are altered, identify trends in either vital signs or lab results, and assess the need for additional interventions, including whether to contact the physician or the RRT. Non-registered nurse (non-R.N.) care providers (nurse aides) are also alerted to the importance of immediately contacting the nurse caregiver when there is any change in patient status.

#### EDUCATION OF PROVIDERS USING THE REPORT

The team educated providers who would be using the Risk Assessment Report, explaining how weighted scoring would provide a snapshot of the patient’s status. Initial education focused on the importance of using the report (1) in combination with the clinical presentation to assess the stability of a patient and (2) for observation of changes in vital signs and trending of diagnostic results. The educational plan included lectures, poster presentations, one-on-one demonstrations of the report, and evidence-based reference material. The team conducted follow-ups with the nursing staff to evaluate implementation.

The hospital unit’s nurse manager, charge nurses, and

## Intensive Care Unit (ICU) and Non-ICU Codes at OSF St. Joseph Medical Center, October 2004–April 2007



**Figure 3.** The average number of codes per month outside the ICU decreased from 2.2 for the first 12 months to 1.3 during the last 12 months. The Risk Assessment Report was implemented in February 2005.

unit-based educator also played an important role in disseminating the information and incorporating the report into daily use.

### Results

During the pilot phase, many changes were made in the Risk Assessment Report for it to better address the caregivers' work flow and information needs. When the report was rolled out in November 2005, a numerical threshold from the report automatically triggered the RRT. As shown in Figure 2 (page 572), the highest number of RRT calls occurred between November 2005 and May 2006. Many of these calls were unnecessary; often, the score would indicate that a patient was potentially at risk when further evaluation of the patient's status would reveal that the nursing staff were aware of the findings and/or the variables were already being addressed.

The nursing staff's preliminary experience suggested that the report would be less effective if the RRT were called solely based on a number rather than in combination with the patient's overall clinical picture. Consequently, as of March 2006, frontline caregivers were allowed to decide when to call the RRT on the basis of both the calculated score and their clinical judgment. (We did not collect data on the number [percentage] of patients who would have been called solely on the basis of their early warning scores.) Future studies might focus on

this issue of compliance with a treatment algorithm.

Figure 2 (page 572) shows an increase in the average number of RRT calls per month from October 2004 through April 2007—from 2.3 during the first 12 months (October 2004–September 2005) to 10.0 calls during the last 12 months (May 2006–April 2007). However, the average number of codes per month outside the ICU decreased from an average of 2.2 for the first 12 months to 1.3 during the last 12 months (Figure 3, left). Similarly, total codes at the facility also decreased.

### Discussion

A risk assessment report must be introduced into the work environment with a nuanced understanding of the caregivers' work environment. Since its conception at OSF Healthcare System, the Risk Assessment Report has undergone many iterative design changes, large and small, with each design change built on clinician end-user feedback. Piloting the report was important to identifying work-flow challenges and developing solutions—for example, when and where reports would be printed and how they would be distributed. Printing the reports at designated times helped the staff anticipate report arrival and prepare to troubleshoot issues if they occurred. In addition, all staff used the information system help center for technology-related issues, such as the failure of the report to print on a unit.

Educating the frontline providers who would be using the report was critical because, as with the earlier introduction of the RRT, some caregivers initially were uncertain about the benefits of the innovation.

Nursing's adoption of the Risk Assessment Report may have aided their early identification of deteriorating patients. Its appropriate and timely utilization of the report appears to have driven the increased critical thinking skills necessary to evaluate patient deterioration—which in turn led to the discontinuation of basing RRT calls solely on a numerical threshold from the risk report. This has expanded the role of all supervising and managerial nurses to include mentoring; the supervising nurse is able to review key parameters, the plan of care, and expectations for the patient with the direct caregivers.

In addition to OSF St. Joseph Medical Center, all but one of the remaining five hospitals (including a hospital

that has slightly modified the report for its own use) have implemented the Risk Assessment Report. These hospitals continually monitor the parameters included in the reports to establish baselines for continuous improvement initiatives. They also review the reports in an attempt to find missed opportunities to identify patients at risk for clinical deterioration, which, in turn, provides continued education on the value of the risk report.

Although early results—an increase in RRT calls and a decrease in codes outside the ICU—are encouraging, we cannot determine the Risk Assessment Report's direct contribution, given the many other process changes made to improve care at OSF St. Joseph Medical Center during this same period. More work needs to be done in further refining the report and in reliably deploying it across the OSF Healthcare System. Determination of the optimal threshold number of early warning and sepsis scores and frequency of scores in a 24-hour period is also required. Given that a patient's deterioration frequently occurs in an 8-to-12-hour window, constant real-time production of the scores might be necessary. However, this may be impractical and may not yield significant value, especially because the scores are dependent on the timing of caregiver documentation. Although many at OSF believe that the risk assessment scores should be determined more frequently than every 12 hours, the exact timing is yet to be determined. Delivery of the Risk Assessment Report in Web format within the electronic nursing work flow is also being considered. Work is currently underway at OSF Healthcare to add the risk assessment scores to an electronically generated nursing hand-off report. All of these efforts contribute, either solely or together, to identifying patients at risk for failure, facilitating appropriate clinical interventions. **J**

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