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Can proactive rapid response team rounding improve surveillance and reduce unplanned escalations in care? A controlled before and after study

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ABSTRACT

Background: Unplanned escalations manifest as a breakdown of hospital care attributable to clinician error through missed or delayed identification of physiological instability, ineffective treatment, or iatrogenic harm.
Objectives: To examine the impact of an Early Warning Score-based proactive rapid response team model on the frequency of unplanned intra-hospital escalations in care compared with a rapid response team model based on staff nurse identification of vital sign derangements.
Design: Pre- and post Early Warning Score-guided proactive rapid response team model intervention.
Setting: 237-bed community hospital in the southeastern United States.
Participants: All hospitalized adults (n = 12,148) during a pre- and post-intervention period.
Methods: Logistic regressions used to examine the relationship between unplanned ICU transfers and rapid response team models (rapid response team vs. Early Warning Score-guided proactive rapid response team).
Results: Unplanned ICU transfers were 1.4 times more likely to occur during the rapid response team baseline period (OR = 1.392, 95% CI [1.017–1.905]) compared with the Early Warning Score-guided proactive rapid response team intervention period.
Conclusions: This study reports a difference in the frequency of unplanned escalations using different rapid response models, with fewer unplanned ICU transfers occurring during the use of Early Warning Score-guided proactive rapid response team model while accounting for differences in admission volumes, age, gender and comorbidities. Implementation of this model has implications for patient outcomes, hospital operations and costs.

What is already known about the topic?

- Effective nursing surveillance of hospitalized patients is needed to provide early detection and rapid intervention for clinical deterioration to prevent undue harm.
- Rapid response systems are used as a structural/system-level intervention to address some of the barriers to effective nurse surveillance and provide improved detection and management of clinical deterioration for hospitalized patients.

What this paper adds

- Instead of measuring Failure to Rescue mortality rates, unplanned escalations in care offer a more discrete indicator that is sensitive to the surveillance function because all escalations in care signal distinct changes in nursing care intensity.
- Use of an embedded Early Warning Score to guide proactive rapid response team nurse surveillance was associated with fewer unplanned ICU transfers.

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1. Introduction

Every hospitalized patient is at some risk for clinical deterioration. This risk is partially mitigated through timely and effective implementation of evidence based practices to treat underlying disease processes. However, patient responses to illness and treatment are highly variable and context-dependent. In this context of uncertainty, some patients will experience clinical deterioration even when treated with appropriate first-line therapies. Therefore, safe practices of acute care providers dictates the need for effective surveillance of patients to provide early detection of and rapid intervention for clinical deterioration to prevent undue harm. The hospital surveillance function falls largely in the domain of nursing care. Evidence suggests, however, that nursing surveillance in hospitals can be ineffective, with substantial rates of highly preventable adverse events, unplanned escalations in care and deaths (Cho et al., 2015; Marquet et al., 2015).

The inclusion of quality indicators sensitive to the surveillance function in quality monitoring programs is increasing. Indicators of surveillance-associated adverse events include unplanned ICU transfers as a type of Failure to Rescue. Failure to Rescue is often defined as the missed recognition of patient status deterioration and missed interventions (Schmid et al., 2007). Failure to Rescue can also be defined as the in-hospital mortality rate due to surgical complications (Horwitz et al., 2007; Silber et al., 1995).

ICU transfers are sometimes anticipated, or "planned", to deliver high intensity nursing care, particularly after high risk procedures (e.g., craniotomy). Unplanned ICU transfers offer a more discrete indicator that is sensitive to the surveillance function because it signals distinct changes in patient condition. Unplanned escalations in care, particularly unplanned ICU transfers, place patients at a greater risk for hospital mortality, greater severity of illness, and longer hospital stays than patients who do not require an unplanned escalation (Chen et al., 2013; Escobar et al., 2011; Hillman et al., 2001; Jäderling et al., 2013).

2. Nurse surveillance and rapid response systems

The complex intervention of surveillance requires that a nurse access the right information at the right time to correctly identify patterns of clinical deterioration and initiate appropriate and timely intervention. Rapid response systems emerged as a structural/system-level intervention to address some of the barriers to effective nurse surveillance such as, inadequate nurse staffing, limited educational preparation/experience, interruptions, and poor team communication (Fig. 1). Rapid response systems are intended to provide improved detection and management of clinical deterioration for hospitalized patients outside the intensive care unit (ICU). Rapid response systems typically contain elements that support the cognitive and behavioral aspects of nurse surveillance and are organized into two arms. The afferent arm of the system is the "track and trigger" aspect of surveillance and includes the collection and interpretation of data points that are predictive of clinical deterioration. Such procedures frequently include the computation of Early Warning Scores based on a composite of these data points to estimate patient risk for deterioration. Early Warning Scores are tracked over time to trend changes and serve as triggers for interventions. The efferent arm of the system is the response aspect of surveillance and includes the rapid deployment of a team of expert clinicians to the bedside of patients at increased risk for clinical deterioration. These rapid response team vary in composition but almost always include a registered nurse with ICU experience. Once activated/triggered, the rapid response team is structurally empowered to intervene to facilitate timely diagnosis and management of the deteriorating patient.

3. Automated activation of rapid response teams

Proactive rapid response team rounding is a novel strategy to address many of the factors contributing to afferent arm failures. In traditional rapid response teams, the consultation and management of clinical deterioration by the rapid response team is set up as a reactive process. The decision to act may be via automated data processing systems that aid in Early Warning Score computation and data visualization, but the request for rapid response team assistance is dependent on a manual process and is subject to errors of delay and underutilization. proactive rapid response team rounding does not require a manual referral or invitation to intervene with patients at increased risk for clinical deterioration. Instead, rapid response team members make routine rounds on patients throughout the hospital following their review of automated risk profiles. Patients with risk profiles meeting pre-established criteria are automatically placed on the rapid response team rounding list and are not subject to delays associated with nurse workload or cognitive biases.

Although proactive rapid response team rounding is presumed to be superior to the traditional rapid response team approach, there is little empirical data to support this assumption. As with traditional rapid response team, the impact of proactive rapid response team rounding on patient outcomes varies, with single-center reports of both positive (Guirgis et al., 2013) and equivocal impact (Butcher et al., 2013) Therefore the purpose of this study was to examine the effect of an Early Warning Score-guided proactive rapid response team model on the frequency of unplanned intra-hospital escalations in care.

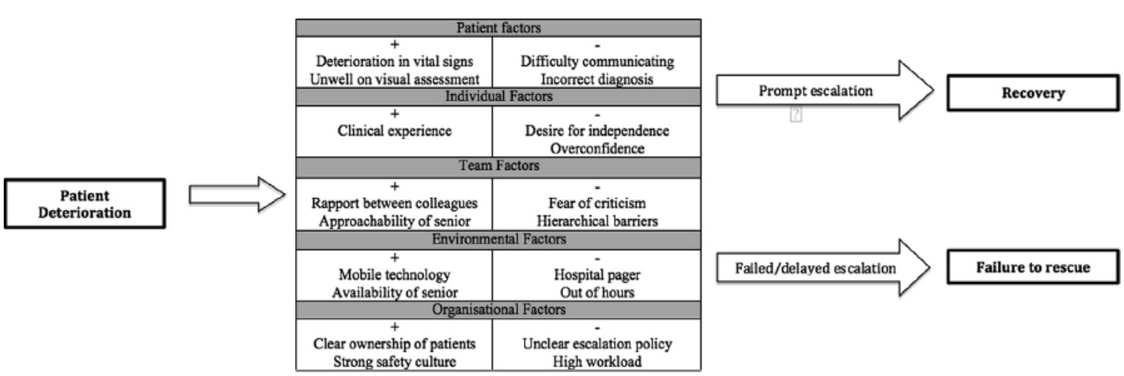

Fig. 1. Conceptual Model of Escalations in Care.

Source: (Johnston et al., 2014).

4. Methods

4.1. Setting and sample

The study was a controlled before and after study. The setting was a 237-bed community non-teaching hospital within a 1760-bed non-profit healthcare system in Florida. The sample consisted of all inpatient hospitalizations ($N = 12{,}148$) during two 6-month time periods (baseline/phase 1 and post-intervention/phase 2). During phase 1 (October 1, 2010 to March 31, 2011) a traditional rapid response team (Traditional) model requiring manual activation was operative ($n = 5875$). During phase 2 (October 1, 2011 to March 31, 2012) the new Early Warning Score-guided proactive rapid response team (Intervention) model was operative ($n = 6273$). Use of the two time periods addressed the seasonality and historical effects that might influence patient acuity, illness types, and staffing patterns. Inclusion criteria were inpatient admission to any hospital unit and an age of more than 18 years and hospital length of stay ≥2 days, selected to ensure that at least 24 h of hospital care were provided (Fig. 2). Exclusion criteria consisted of hospitalizations restricted only to ICU stays, because unplanned escalations in care in such cases were not possible. Unplanned escalations in care were identified by exclusion of planned ICU admissions, defined as post-operative admission from operating rooms, procedural areas, or recovery areas.

4.2. Rapid response team – traditional model

The traditional rapid response team model had been in place for 6 years. The rapid response team nurse role was staffed by a pool of experienced ICU nurses cross-trained to respond to patient deteriorations in non-ICU areas of the hospital and provided 24-h coverage. Manual activation of the rapid response team by non-ICU staff was based on pre-defined objective criteria related to vital signs: hypotension, tachypnea, or the development of seizure-like activity. Clinicians and family members also were encouraged to activate the rapid response team based on any subjective information that generated concern for deterioration. Manual activation of the rapid response team was achieved by paging the rapid response team nurse. Rapid response team nurses responded to the patient's bedside, typically within 5 min of notification, to assess the patient and call for additional clinicians (e.g., physicians, respiratory therapists) on a case-by-case basis. The rapid response team nurse assisted the primary staff nurse in the non-ICU area and provided time-sensitive interventions (e.g., fluid boluses) during the rapid response visit. In addition to responding to rapid response team activations, the rapid response team designated nurse also managed a patient care assignment in the ICU.

4.3. Early warning score-guided proactive rapid response team model – intervention model

The Early Warning Score-guided proactive rapid response team m model was implemented in 2012. Implementation included installation and activation of the Rothman Index application, revison of role expectations and workflows for the rapid response team nurse, development of Early Warning Score-guided proactive rapid response team activation protocols, ICU staffing adjustments, and staff education. The Rothman Index is an early warning score tool embedded within the electronic health record. Vital signs, laboratory values, and nursing system assessments are combined to compute an index value representing trends in individual patients' conditions over time. The Rothman Index generates updated composite index values up to once per hour. Line graphs representing Rothman Index values are viewable individually or in grid-like arrays for simultaneous reviews of multiple patients. The background shading of each patient's condition graph is color-coded according to the current hourly Rothman Index value, based on 48-h mortality data collected and calibrated from 170,000 patients (Rothman et al., 2013, 2012; Solinger and Rothman, 2013). To date, clinical applications of the Rothman Index focus on physiologic deteriorations and associated outcomes following hospital discharge or serve as an early warning score during hospitalization. As an early warning score, the Rothman Index has been used retrospectively to evaluate deteriorations in peri-operative complications (Tepas et al., 2013) and unplanned surgical ICU readmissions in adults in adults (Piper et al., 2014).

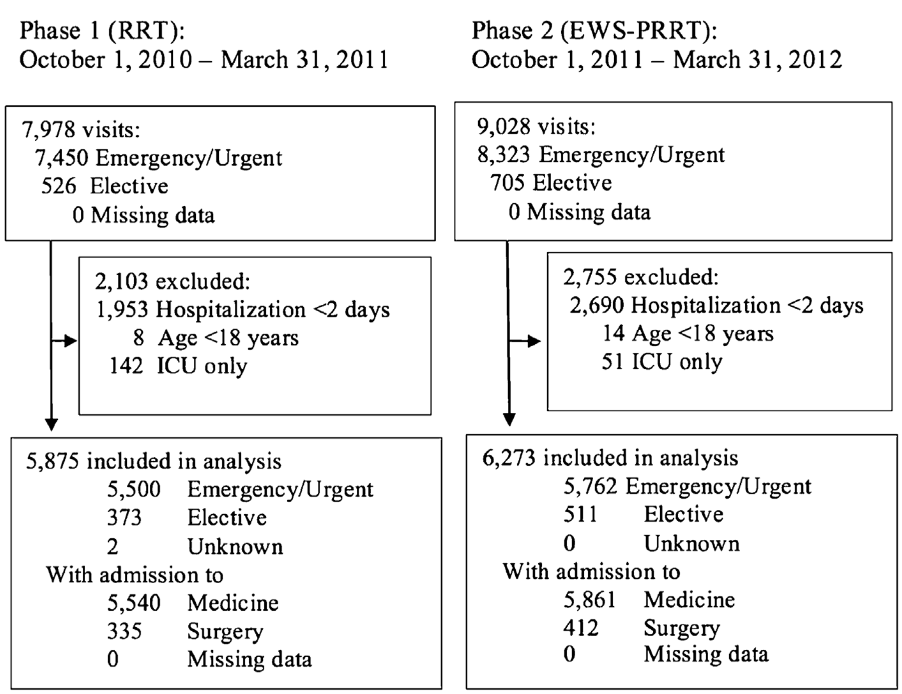

Fig. 2. Study Population Selection Process.

The role expectations for the Intervention nurse were expanded as follows: 1) review Rothman Index graphs at the start of each 12-h shift to identify patients outside the ICU at risk for deterioration; 2) generate a patient rounding list based on the RI; 3) conduct prospective surveillance rounds; 4) initiate follow-up interventions based on information gathered during surveillance rounds; and, 5) respond to all manual rapid response team activations. Patients were included in surveillance rounds based on the following criteria: current RI<40 (graphs with a red background); sharp deline in RI; and/or prolonged downtrends in the RI. Surveillance rounds included a head-to-toe nursing assessment, communication with primary nurses to support patient needs, and communication with other providers as appropriate. Similar to the traditional model, the Intervention nurses were designated each 12-h shift to provide 24-h surveillance coverage. However, in the new model the rapid response team designated nurse did not carry an additional patient or administrative assignment in the ICU. All Intervention nurses completed training and were instructed in the use of the Rothman Index in the electronic health record before data collection was initiated. The training included a review of the Early Warning Score-guided proactive rapid response team study protocol and web-based modules on the use of the Rothman Index as an early warning score. The Institutional Review Boards at the study hospital and university approved the study protocol and waived the need for informed consent from patients.

4.4. Data sources and measures

Escalations in Care: Charge records for inpatient rooms were extracted from the charge management application used by the study hospital. Each hospital admission was treated as a separate unit of analysis and was categorized dichotomously as either having or not having any type of unplanned escalation during the hospitalization (yes/no) and unplanned ICU transfers. *Comorbidities*: The Deyo ICD-9-CM Charlson Comorbidity Index (CCI) was calculated for each hospitalization, based on ICD-9 codes in existing billing databases. *Rapid Response Team Activations*: The frequencies of the Traditional Model and Intervention Model activations were extracted from an existing rapid response team database. *Early Warning Score Graph Usage*: Patient graphs were generated when users accessed the RI tab within the electronic health record. The number of patients viewed, the number of graphs selected within each array viewed, and the number of times users accessed the RI tab within the electronic health record were recorded.

4.5. Statistical analysis

Continuous variables are reported as mean ± SD, and nominal variables as frequencies and percentages. Comparisons of patients' characteristics between patients before and after the intervention were compared using *t*-tests and χ^2 tests. Binary forward logistic regression was conducted to examine the effect of Early Warning Score-guided proactive rapid response team on unplanned escalations of care, while controlling for patient comorbidities (Charlson Comorbidity Index), demographics (age, gender), and hospital length of stay. A separate logistic regression with unplanned ICU transfers as the dependent variable was also conducted. All data were managed using SPSS Version 23. A two-sided p value of <.05 was considered statistically significant.

5. Results

During the study periods, a total of 12,148 hospitalizations were included for analysis (Table 1). Of these, most were for medical patients. The average age of hospitalized patients in both phases was similar, and gender was equally distributed in both phases. Approximately half of the hospitalized patients had at least one comorbid condition, and there was a significant difference in number of comorbid conditions between groups. Patients in Phase 1 (traditional rapid response team model) had more comorbid conditions and more unplanned ICU transfers. The mean number of rapid response team activations by staff nurses and volume-adjusted monthly rate of rapid response team activations by staff nurses were not statistically significant between phases.

Application of the Rothman Index criteria in phase 2 resulted in 1440 activations for proactive surveillance rounds. This represents a 312% increase in total rapid response team activations compared to phase 1.

Table 1
Patient Demographics and Hospitalization Characteristics.

Variable	Phase 1 (*n* = 5875) Rapid Response Team October 1, 2010 – March 31, 2011	Phase 2 (*n* = 6273) Early Warning Score-Guided Proactive Rapid Response Team October 1, 2011 – March 31, 2012	*p*
Mean age (years ± *SD*)	60.0 ± 18.0	59.2 ± 18.0	.018[a]
18–44 (*n*, % total)	1246 (21.2)	1392 (22.2)	
45–64 (*n*, % total)	2133 (36.3)	2332 (37.2)	
≥ 65 (*n*, % total)	2496 (42.5)	2549 (40.6)	
Male gender (*n*, % total)	3343 (57.3)	3665 (58.4)	.219[b]
Admitting Service (*n*, % total)			.047[b]
Medicine	5540 (94.3)	5861 (93.4)	
Surgery	335 (5.7)	412 (6.6)	
Admission type (*n*, % total)			<.001[b]
Emergency/Urgent	5,500 (93.6)	5762 (91.9)	
Elective	373 (6.3)	511 (8.1)	
Unknown	2 (<0.01)	0 (0)	
Hospital length of stay (mean ± *SD*)	5.5 ± 6.3	5.3 ± 6.1	.208[a]
Charlson Comorbidity Index (mean ± *SD*)	1.24 ± 2.0	1.11 ± 2.1	.007[a]
Charlson Comorbidity Index ≥1 (*n*, % total)	3264 (55.6)	3161 (50.4)	
Unplanned Intensive Care Unit Transfers/1,000 patient days	8.85	6.73	.001[a]
Early Warning Score-guided proactive rapid response activations, monthly (mean ± *SD*)	N/A	238 ± 12.1	

Abbreviations: SD = standard deviation.
[a] Independent *t*-test.
[b] Chi-square test.

Table 2
Logistic Regression: Unplanned Intensive Care Unit Transfers (n = 12,148).

Variable	ß	Wald	*p*	OR	95% CI
Rapid response model	.331	.160	.039	1.392	1.017–1.905
Age	.010	.005	.031	1.010	1.001–1.020
Gender	−.225	.160	.159	.799	.584–1.092
Charlson Comorbidity Index	.077	.046	<.098	1.080	.986–1.182
Hospital length of stay	.245	.015	<.001	1.277	1.240–1.316
Goodness-of-fit statistics	*df*	χ^2			
Model	5	251.752	<.001		
Hosmer-Lemeshow	5	23.658	.003		
−2 log likelihood			1525.076		

Abbreviations: CI = confidence interval; OR = odds ratio.

The Intervention Model had a significant effect on unplanned ICU transfers while controlling for age, gender, hospital length of stay, and comorbidities (Table 2). Unplanned ICU transfers were 1.4 times more likely to occur during Phase 1 when the Traditional Model was in place (OR = 1.39, 95% CI [1.03, 1.91]). Patient age, and hospital length of stay also were significant predictors of unplanned ICU transfers. Patients with a longer hospital length of stay were 1.3 times more likely to have an unplanned ICU transfer than were those without a prolonged hospital length of stay when controlling for all other factors.

6. Discussion

This is the first study to document a positive effect of proactive surveillance guided by automated Early Warning Scores data on unplanned ICU admissions. The Intervention Model (Early Warning Score-guided proactive rapid response team) protocol resulted in a 312% increase in total rapid response team activations and a 40% reduction in unplanned ICU admissions compared to the Traditional (rapid response team) model. This reflects significant improvement in the afferent arm of the Intervention Model (event detection and trigger response). Our findings suggest that afferent limb failures in this Model can be reduced by shifting some of the responsibility for event detection and trigger response activation from nurses on acute care units to nurses in the ICU with special training, access to automated Early Warning Scores, and dedicated time to conduct proactive surveillance rounds. The enhanced efficiency of automated Early Warning Scores presented in color-coded graphical displays made it possible for one nurse to provide timely estimation of risk for clinical deterioration across multiple patients from one remote ICU location. Moreover, because the Intervention Model nurses did not carry additional patient care assignments, they could focus exclusively on the surveillance function and were not likely subject to the same degree of distractions, interruptions, and cognitive shifting inherent to the role of acute care nurses.

The increase in rapid response team activations also could be related to the empowerment of ICU nurses to initiate surveillance rounds based on objective data accessed directly instead of waiting for a referral or invitation by acute care staff. This shift in responsibility for the response trigger to the ICU nurses effectively bypassed trigger choice options for acute care staff. The risk for delay or avoidance of a response trigger based on implicit biases and other contextual influences related to hierarchical organizational cultures was removed. The established protocols and role expectations served as a “forcing function” (Grout, 2006), since rapid response team activation was no longer optional for patients meeting defined criteria.

An additional potential benefit of the Intervention Model lies in the increased exposure time and interaction between rapid response system clinicians and acute care staff associated with more team activations. This may promote more nurse-to-nurse coaching and education while Intervention Model activations are completed. When interventions resulted from proactive rounds, they were more often related to coaching acute care nurses and nursing assistants on vital sign acquisition and prompting calls to providers. For example, respiratory rate was assessed during proactive rounds and was compared with recent documentation, and laboratory results were reviewed for worrisome values to call in to the provider in advance of daily rounds. When coaching patient care, Intervention Model nurses offeerd guidance and advice for care planning and facilitated dialogue with family members at the bedside, including code status, contact isolation procedures, inbutation decision-making and end-of-life/palliation discussions (Danesh and Jimenez, 2011)

The present study has the following limitations. First, the study was a single-center design. An area for future research would be to replicate the analysis in a multi-site study. Second, hospital occupancy, nurse staffing, and healthcare provider characteristics, which were not available for analysis, might explain some of the findings. Third, the retrospective collection of patient transfer data paired with the prospectively collected rapid response team data design makes the findings vulnerable to undocumented data and validity threats associated with uncontrollable differences between the two time periods. These were mitigated in part by the use of volume adjustments and control for comorbidities for the historical comparison, with attention focused on maintaining temporal trends related to seasonality between the study periods, to improve the internal validity of the analyses (de Groot et al., 2003).

7. Implications

Rapid response systems began as specialized cardiac arrest (“code”) teams and progressed to medical emergency teams (MET) and rapid response team models that provide critical care interventions in the presence of unexpected physiological deterioration (Jones et al., 2011). This study provides empirical evidence to support a new direction for the evolution of rapid response systems. The Early Warning Score-guided proactive rapid response team (Intervention Model) approach can be used to reduce afferent arm failures and improve the cognitive and behavioral components of nurse surveillance for hospitalized patients. Realization of these benefits is contingent upon careful implementation of this Model. The following structural supports are instrumental to this process: investment in technology, structural empowerment of nurses, and an effective quality monitoring system. Applications to support automation of event detection based on validated predictive composite scores are available. Structural empowerment of the nursing staff to effectively support the Team includes clearly defined role expectations and workflows, a staffing plan to support dedicated time for proactive surveillance, and staff education to support role expectations.

Unplanned ICU transfers are an established metric to assess hospital safety and quality in Australia (Australian Commission on Safety and Quality in Health Care, 2012), but are not widely reported globally. Unplanned ICU transfers can be derived from administrative datasets relatively easily, since patient flow among nursing units is tracked for billing purposes. These administrative datasets, previously unexplored in the context of operations research and informatics, present an area of increasing interest with respect to patient outcomes, the nurse work environment, and financial metrics. The use of administrative datasets to monitor unplanned ICU transfers could contribute to hospital safety net strategies for improved patient outcomes.

8. Underuse & delayed activation of rapid response teams

Despite widespread international adoption of rapid response teams, evidence to support effectiveness in enhancing the nurse surveillance function and improving patient outcomes is equivocal (Chan et al., 2010; Winters et al., 2013). A recent review pointed to potential breakdowns in the afferent arm of rapid response teams resulting in underuse and/or delays in activation of rapid response teams as a key underlying factor (McGaughey et al., 2017). The efficacy of Early Warning Scores as cognitive tools to facilitate clinical decision-making related to risk for clinical deterioration has been established and these tools are increasingly made available to bedside nurses (McGaughey et al., 2017). Although efficacy and availability are necessary conditions for effective integration of these tools into practice, they are not sufficient. As currently designed, rapid response teams are still subject to human factor limitations, organizational culture, and implicit bias.

Initially, computation of Early Warning Scores was a manual and time consuming process that required nurses to retrieve multiple data points from multiple sources. Automation of this process is becoming more prominent due to the increased adoption of integrated electronic health records embedded with Early Warning Score programs (e.g., Rothman Index (Rothman et al., 2013, 2012; Rothman et al., 2017), electronic Cardiac Arrest Risk Triage [eCART] (Kipnis et al., 2016)). Nevertheless, timely computation of Early Warning Scores can still be adversely affected by delayed or absent documentation of required data points. Moreover, automated computation of Early Warning Scores does not ensure timely access to and/or interpretation of the information. Even automated Early Warning Scores may be overlooked by bedside nurses experiencing time scarcity, excessive cognitive loads, frequent interruptions and distractions. Other human factors and cultural norms contributing to trigger failure include: preference to relay on clinical judgment rather than Early Warning Scores alone for rapid response team activation, fear of criticism for rapid response team activation, preference to manage deterioration without rapid response team assistance, lack of familiarity with escalation protocol, and fear of rapid response team activation without provider permission (Chen et al., 2015; Davies et al., 2014). These factors represent types of implicit bias in clinical decision-making. Strategies to overcome these biases are needed to increase timely utilization of rapid response team, reduce rapid response team afferent arm failures, and reduce the morbidity and mortality associated with clinical deterioration.

9. Conclusion

Clinicians should continue to explore alternative approaches to the design of event detection and response triggering in rapid response systems. Alternative approaches to physiologic deterioration, event detection, and rapid response team triggering criteria merit continued exploration. Criteria-based surveillance approaches to Early Warning Score-guided proactive rapid response team activations could potentially be applied to most electronic health records using a filter to identify pre-defined indicators of risk.

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Conflict of interest

There are no conflicts of interest for any of the authors.

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