Generic response to deteriorating patients:

90 Day Learning Cycle

Project Charter

July 2019
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Intent statement

A 90 day learning cycle on a generic response to deteriorating patients will start in July 2019. The intent of this 90 day learning cycle is to explore with key partners the concept of testing and implementation of an overarching generic response to deteriorating patients from any cause, for example sepsis, delirium and an acute kidney injury (AKI) in acute hospitals in Scotland. By reviewing what currently exists in Scotland, considering published academic literature and talking to experts in the field, we will have a better understanding of:

- the key components in implementation of a generic response to a deteriorating patient,
- how complex this could be, and
- the benefits of a generic response are to staff and service users.

We will then use this information to consult with key stakeholders and define how best to provide improvement support to service providers in their implementation of a generic response for deteriorating patients.

Background

Over the last 10 years hospitals have worked with Scottish Patient Safety Programme (SPSP) to improve experiences and outcomes for patients. Improvement work in Scottish Acute hospitals has contributed to a reduction in cardiac arrest rate by 31% since 2008 and mortality from sepsis by 21% since 2008. A range of work has supported this reduction, including National Early Warning Score (NEWS) implementation, sepsis recognition and treatment, escalation processes and person-centred care planning.

The Acute Kidney Injury (AKI) collaborative was launched in August 2017 and ran until April 2019 with the aim of testing processes to reduce harm from AKI through improved recognition, response and review across the boundaries of care.

Through all of this work to date, there is an emerging need to better describe and support the many different ways to recognise and respond to physiological deterioration from any cause. We want to explore with you the potential to simplify and standardise the current SPSP offering around process improvement for deteriorating patients.
Aim statement

By the end of October 2019 we will have explored the potential for a method for recognition and response for people who are acutely deteriorating from any cause. We will have tested this approach with a view to further testing and implementation within boards.

The findings from the 90 day learning cycle will inform the design of the improvement support delivered by Healthcare Improvement Scotland.

Approach

To achieve our aim, Healthcare Improvement Scotland’s SPSP Acute Adult programme proposes a using 90-Day learning cycle to explore the benefits and risks of this development. This is a methodology for understanding and developing new concepts and provides a reliable and efficient way to explore ideas, assess their potential and bring them to action.

Essential team reading on the 90 day learning cycle includes:

- 90 day process Handbook – Carnegie Foundation
- Institute for Healthcare Improvement 90-Day Research and Development Process.

The 90 day learning cycle is appropriate for this purpose as there is minimal information available about a generic response for deteriorating patients which includes NEWS, Delirium, Sepsis and AKI.

Initial literature search

Initial exploration of published literature in the pre-planning stage suggested there are no examples of people undertaking similar approaches within hospital settings.

Key findings from the initial literature search (appendix 1):
What have we done?

To generate innovative and pertinent information we have sought feedback from a number of expert interviews. We have also developed the feedback received over the duration of the AKI collaborative work.

What will we do?

We will host a clinical expert group who will help us explore and answer our questions in relation to a generic response to deteriorating patients.

Key deliverables and intended results

<table>
<thead>
<tr>
<th>Phase 1 [Scan]</th>
<th>July – August 2019</th>
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<tbody>
<tr>
<td>Following on from pre-cycle literature reviews, interpret in more detail what already exists in Scotland and explore examples. This will entail both an in-depth literature review and interviews with key experts, for example clinical staff who have an expertise within deteriorating patients.</td>
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<tr>
<td>By the end of the first 30 days, we will have reviewed the literature and the output of the interviews.</td>
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<tr>
<td><strong>Proposed deliverables</strong></td>
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<tr>
<td>Produce literature review.</td>
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<tr>
<td>Agree members for the Clinical Reference Group.</td>
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<tr>
<td>Produce a flash report – highlighting key themes</td>
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<tr>
<td><strong>Dates and Review</strong></td>
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<td>20 August 2019</td>
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<tr>
<th>Phase 2 [Focus]</th>
<th>August – September 2019</th>
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<tr>
<td>We will consult with experts in the field to co-design and test a generic response for deteriorating patients.</td>
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<tr>
<td><strong>Proposed deliverables</strong></td>
<td></td>
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<tr>
<td>An approach that can be tested in clinical practice.</td>
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<tr>
<td><strong>Dates and Review</strong></td>
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<td>28 September 2019</td>
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Phase 3 [Summarise and Disseminate]  
September – October 2019 (plus 2 weeks for review)  

Review tests and further refine the approach through consultation. Prepare a final report of learning and developments from the learning cycle. Decide next steps and, if appropriate, begin to design support for Health boards.

<table>
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<tr>
<th>Proposed deliverables</th>
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<tr>
<td>Final revisions for bundle/flowchart/pro forma and possible approaches to measurement.</td>
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<tr>
<td>Final report of learning</td>
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<tr>
<td>Recommendations on next steps</td>
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<th>Dates and Review</th>
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<tr>
<td>November 2019</td>
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A project plan plotting milestones throughout the 90 day learning cycle can be viewed in Appendix 2.

For a detailed project plan, please contact the Team Lead for this work  
wendy.nimmo@nhs.net

**Audience for the work**

Once we are clear on the output from this 90 day learning cycle, we will create a communications plan to disseminate the learning.

**Team**

The core team will steer this work and generate progress week to week.

- Wendy Nimmo - Lead for this work
- Calum McGregor - Clinical lead
- Hannah Horsfield - Project support
Approval and reporting

The Acute Care Advisory Group will be consulted throughout the 90 day learning cycle as critical friends.

A final report will be generated for approval by Alison Hunter (Improvement Advisor) and Geraldine Jordan (Portfolio lead), before being disseminated.
Appendix 1

Early Warning Scores to recognise acute deterioration: bibliography

Search methodology
A search of the secondary literature was carried out 6-11 September 2018 to identify review articles published in the last five years on tools to recognise acute deterioration other than the National Early Warning Score in adult patients. Cinahl, Cochrane Library, Embase, Medline, and Web of Science databases were searched. Key websites were searched for guidelines and summaries/overviews. Concepts used in all searches included: deterioration, early warning scores, and early warning systems. A full list of resources searched and terms used are available on request.

Bibliography

Guidelines


Other online publications


Review articles
Background
Acute deterioration in critically ill patients is often preceded by changes in physiological parameters, such as pulse, blood pressure, temperature and respiratory rate. If these changes in the patient’s vital parameters are recognized early, excess mortality and serious adverse events (SAEs) such as cardiac arrest may be prevented. The Early Warning Score (EWS) is a scoring system which assists with the detection of physiological changes and may help identify patients at risk of further deterioration.

OBJECTIVES: The aim of this systematic review is to evaluate the impact of the use of the Early Warning Score (EWS) on particular patient outcomes, such as in-hospital mortality, patterns of intensive care unit admission and usage, length of hospital stay, cardiac arrests and other serious adverse events of adult patients on general wards and in medical admission units.

DESIGN AND SETTING: Systematic review of studies identified from the bibliographic databases of PubMed, EMBASE.com and The Cochrane Library.

SELECTION CRITERIA: All controlled studies which measured in-hospital mortality, ICU mortality, serious adverse events (SAEs), cardiopulmonary arrest, length of stay and documentation of physiological parameters which used a EWS on the ward or the emergency department to identify patients at risk were included in the review.

DATA COLLECTION AND ANALYSIS: Three reviewers (NA, AT and EH) independently screened all potentially relevant titles and abstracts for eligibility, by using a standardized data-worksheet. Meta-analysis was not possible due to heterogeneity.

MAIN RESULTS: Seven studies met the inclusion criteria. The results of our included studies were mixed, with a positive trend towards better clinical outcomes following the introduction of the EWS chart, sometimes coupled with an outreach service. Six of the seven included studies used mortality as an endpoint: two of these studies reported no significant difference in in-hospital mortality rate; two found a significant reduction of in-hospital mortality; two other studies described a trend towards improved survival. Although, both ICU mortality and serious adverse events were not significantly improved, there was a trend towards reduction of these endpoints after introduction of the EWS. However only two studies looked respectively at each endpoint. There were conflicting results concerning cardiopulmonary arrests. One study found a reduction in the incidence of cardiac arrest calls as well as in the mortality of patients who underwent CPR, while another one found an increased incidence of cardio-pulmonary arrests. Neither study met all methodological quality criteria.

CONCLUSION: The EWS itself is a simple and easy to use tool at the bedside, which may be of help in recognizing patients with potential for acute deterioration. Coupled with an outreach service, it may be used to timely initiate adequate treatment upon recognition, which may influence the clinical outcomes positively. However, the use of adapted forms of the EWS together with different thresholds, poor or inadequate methodology makes it difficult in drawing comparisons. A general conclusion can thus not be generated from the lack of use of a single standardized score and the use of different populations. In future large multi-centre trials using one standardized score are needed also in order to facilitate comparison.

the field of heart failure management. Areas covered: The literature on decision-analytical models for the economic evaluation of early warning systems for the management of chronic heart failure patients was systematically reviewed. Nine electronic databases were searched through the combination of synonyms for heart failure and sensitive filters for cost-effectiveness and early warning systems. Expert commentary: The retrieved models show some variability with regards to their general study characteristics. Overall, they display satisfactory methodological quality, even though some points could be improved, namely on the consideration and discussion of any competing theories regarding model structure and disease progression, identification of key parameters and the use of expert opinion, and uncertainty analyses. A comprehensive definition of early warning systems and further research under this label should be pursued. To improve the transparency of economic evaluation publications, authors should make available detailed technical information regarding the published models.

Atkins TEH, Ohman MC and Brabrand M. External validation of a decision tree early warning score using only laboratory data: A retrospective review of prospectively collected data. European Journal of Internal Medicine. 2018; 51(25-28).

Introduction: Early warning scores (EWS) have been developed to identify the degree of illness severity among acutely ill patients. One system, The Laboratory Decision Tree Early Warning Score (LDT-EWS) is wholly laboratory data based. Laboratory data was used in the development of a rare computerized method, developing a decision tree analysis. This article externally validates LDT-EWS, which is obligatory for an EWS before clinical use. Method: We conducted a retrospective review of prospectively collected data based on a time limited sample of all patients admitted through the medical admission unit (MAU) on a Danish secondary hospital. All consecutive adult patients admitted from 2 October 2008 until 19 February 2009, and from 23 February 2010 until 26 May 2010, were included. Validation was made by calculating the discriminatory power as area under the receiver-operating curve (AUROC) and calibration (precision) as Hosmer-Lemeshow Goodness of fit test. Results: A total of 5858 patients were admitted and 4902 included (83.7%). In-hospital mortality in our final dataset (n = 4902) was 3.5%. Discriminatory power (95% CI), identifying in-hospital death was 0.809 (0.777-0.842). Calibration was good with a goodness-of-fit test of $X^2 = 5.37$ (7 degrees of freedom), $p=0.62$. Conclusion: LDT-EWS has acceptable ability to identify patients at high risk of dying during hospitalization with good precision. Further studies performing impact analysis are required before this score should be implemented in clinical practice.


Purpose: To identify the barriers to, and facilitators of, the implementation of physiological track and trigger systems (PTTSs), perceived by healthcare workers, through a systematic review of the extant qualitative literature. Data sources: Searches were performed in PUBMED, CINAHL, PsycInfo, Embase and Web of Science. The reference lists of included studies were also screened. Study selection: The electronic searches yielded 2727 papers. After removing duplicates, and further screening, a total of 10 papers were determined to meet the inclusion criteria and were reviewed. Data extraction: A deductive content analysis approach was taken to organizing and analysing the data. A framework consisting of two overarching dimensions (‘User-related changes required to implement PTTSs
effectively' and 'Factors that affect user-related changes'), 5 themes (staff perceptions of PTTSs and patient safety, workflow adjustment, PTTS, implementation process and local context) and 14 sub-themes was used to classify the barriers and facilitators to the implementation of PTTSs. Results of data synthesis: Successful implementation of a PTTS must address the social context in which it is to be implemented by ensuring that the users believe that the system is effective and benefits patient care. The users must feel invested in the PTTS and its use must be supported by training to ensure that all healthcare workers, senior and junior, understand their role in using the system. Conclusion: PTTSs can improve patient safety and quality of care. However, there is a need for a robust implementation strategy or the benefits of PTTSs will not be realized.


**BACKGROUND:** Early warning scores are widely used to identify deteriorating patients. Whilst their ability to predict clinical outcomes has been extensively reviewed, there has been no attempt to summarise the overall strengths and limitations of these scores for patients, staff and systems. This review aims to address this gap in the literature to guide improvements for the optimization of patient safety. **METHODS:** A systematic review was conducted of MEDLINE(R), PubMed, CINAHL and The Cochrane Library in September 2016. The citations and reference lists of selected studies were reviewed for completeness. Studies were included if they evaluated vital signs monitoring in adult human subjects. Studies regarding the paediatric population were excluded, as were studies describing the development or validation of monitoring models. A narrative synthesis of qualitative, quantitative and mixed-methods studies was undertaken. **FINDINGS:** 232 studies met the inclusion criteria. Twelve themes were identified from synthesis of the data: Strengths of early warning scores included their prediction value, influence on clinical outcomes, cross-specialty application, international relevance, interaction with other variables, impact on communication and opportunity for automation. Limitations included their sensitivity, the need for practitioner engagement, the need for reaction to escalation and the need for clinical judgment, and the intermittent nature of recording. Early warning scores are known to have good predictive value for patient deterioration and have been shown to improve patient outcomes across a variety of specialties and international settings. This is partly due to their facilitation of communication between healthcare workers. There is evidence that the prediction value of generic early warning scores suffers in comparison to specialty-specific scores, and that their sensitivity can be improved by the addition of other variables. They are also prone to inaccurate recording and user error, which can be partly overcome by automation. **CONCLUSIONS:** Early warning scores provide the right language and environment for the timely escalation of patient care. They are limited by their intermittent and user-dependent nature, which can be partially overcome by automation and new continuous monitoring technologies, although clinical judgment remains paramount.


**INTRODUCTION:** Early warning scores (EWSs) are used extensively to identify patients at risk of deterioration in hospital. Previous systematic reviews suggest that studies which develop EWSs suffer methodological shortcomings and consequently may fail to perform well. The reviews have also
identified that few validation studies exist to test whether the scores work in other settings. We will aim to systematically review papers describing the development or validation of EWSs, focusing on methodology, generalisability and reporting. METHODS: We will identify studies that describe the development or validation of EWSs for adult hospital inpatients. Each study will be assessed for risk of bias using the Prediction model Risk of Bias Assessment Tool (PROBAST). Two reviewers will independently extract information. A narrative synthesis and descriptive statistics will be used to answer the main aims of the study which are to assess and critically appraise the methodological quality of the EWS, to describe the predictors included in the EWSs and to describe the reported performance of EWSs in external validation. ETHICS AND DISSEMINATION: This systematic review will only investigate published studies and therefore will not directly involve patient data. The review will help to establish whether EWSs are fit for purpose and make recommendations to improve the quality of future research in this area. PROSPERO REGISTRATION NUMBER: CRD42017053324.


BACKGROUND: Acute kidney injury (AKI) often takes a complicated course if diagnosed late and undertreated. Electronic alerts that provide an early warning of AKI are intended to support treating physicians in making the diagnosis of AKI and treating it appropriately. The available evidence on the effects of such alert systems is inconsistent. METHODS: We employed the PRISMA recommendations for systematic literature reviews to identify relevant articles in the PubMed, Scopus, and Web of Science databases. All of the studies that were retrieved were independently assessed by two of the authors with respect to the methods of computer-assisted electronic alert systems and their effects on process indicators and clinical endpoints. RESULTS: 16 studies with a total of 32 842 patients were identified. 8.5% of admitted patients had community-acquired or hospital-acquired AKI, with an in-hospital mortality of 22.8%. Fifteen electronic alert systems were in use throughout the participating hospitals. In 13 of 15 studies, alarm activation was accompanied by concrete treatment recommendations. A randomized controlled trial in which no such recommendations were given did not reveal any benefit of the alert system for the patients. In controlled but non-randomized trials, however, the provision of concrete treatment recommendations when the alert was activated led to more frequent implementation of diagnostic or therapeutic measures, less loss of renal function, lower in-hospital mortality, and lower mortality after discharge compared to control groups without an electronic alert for AKI. CONCLUSION: Non-randomized controlled trials of electronic alerts for AKI that were coupled with treatment recommendations have yielded evidence of improved care processes and treatment outcomes for patients with AKI. This review is limited by the low number of randomized trials and the wide variety of endpoints used in the studies that were evaluated.


OBJECTIVES: Early Warning Scores are used to evaluate patients in many hospital settings. It is not clear if these are accurate in predicting mortality in sepsis. We performed a systematic review and meta-analysis of multiple studies in sepsis. Our aim was to estimate the accuracy of EWS for mortality in this setting. METHODS: PubMed, CINAHL, Cochrane, Web of Science and EMBASE were searched to October 2016. Studies of adults with sepsis who had EWS calculated using any appropriate tool (e.g.
NEWS, MEWS) were eligible for inclusion. Study quality was assessed using QUADAS-2. Summary estimates were derived using HSROC analysis. RESULTS: Six studies (4298 participants) were included. Results suggest that EWS cannot be used to predict which patients with sepsis will (positive likelihood ratio 1.79, 95% CI 1.53 to 2.11) or will not die (negative likelihood ratio 0.59, 95% CI 0.45 to 0.78). Two studies were rated as low risk of bias and one as unclear risk of bias on all domains. The other three studies were judged at high risk of bias in one domain. CONCLUSION: Early Warning Scores are not sufficiently accurate to rule in or rule out mortality in patients with sepsis, based on the evidence available, which is generally poor quality.


AIMS AND OBJECTIVES: To describe, interpret and synthesize the current research findings on the impact of the Early Warning Score and Rapid Response Systems on nurses' competence in identifying and managing deteriorating patients in general hospital wards. BACKGROUND: As patient safety initiatives designed to ensure the early identification and management of deteriorating patients, the Early Warning Score and Rapid Response Systems have broad appeal. However, it is still unclear how these systems impact nurses' competence when these systems are used in general hospital wards. METHODS: CINAHL, PubMed, Cochrane, EMBASE and Ovid MEDLINE databases were systematically searched for relevant articles. Articles were appraised, a thematic analysis was conducted, and similar and divergent perspectives on emergent themes and subthemes were extracted by a team of researchers. RESULTS: Thirty-six studies met the inclusion criteria. The analysis of findings showed how the Early Warning Score and Rapid Response Systems impacted three competence areas: (i) Nurses' competence in assessing and caring for patients related to the subthemes: (a) sensing clinical deterioration and (b) the development of skills and knowledge. (ii). Nurses' competence in referring patients, related to the subthemes: (a) deciding whether to summon help and (b) the language and communication lines in the referral process. (ii) Nurses' coping and mastery experiences. CONCLUSION: The impact of the Early Warning Score and Rapid Response Systems on nurses' competence in identifying and managing deteriorating patients is beneficial but also somewhat contradictory. RELEVANCE TO CLINICAL PRACTICE: A greater understanding of nurses' development of competence when using the Early Warning Score and Rapid Response Systems will facilitate the design of implementation strategies and the use of these systems to improve practice.


To evaluate the need for, and the development and utility of, pen-and-paper (Modified) Early Warning Scoring (MEWS/EWS) systems for adult inpatients outside critical care and emergency departments, by reviewing published literature. Serious adverse events can be prevented by recognizing and responding to early signs of clinical and physiological deterioration. Of 534 papers reporting MEWS/EWS systems for adult inpatients identified, 14 contained useable data on development and utility of MEWS/EWS systems. Systems without aggregate weighted scores were excluded. MEWS/EWS systems facilitate recognition of abnormal physiological parameters in deteriorating patients, but have limitations. There is no single validated scoring tool across diagnoses. Evidence of prospective validation of MEWS/EWS systems is limited; neither is implementation based on clinical trials. There is no evidence that
implementation of Westernized MEWS/EWS systems is appropriate in resource-poor locations. Better monitoring implies better care, but there is a paucity of data on the validation, implementation, evaluation and clinical testing of vital signs' monitoring systems in general wards. Recording vital signs is not enough. Patient safety continues to depend on nurses' clinical judgment of deterioration. Resources are needed to validate and evaluate MEWS/EWS systems in context.

Recognising patient deterioration is a vital nursing role. Observation based on vital signs and early warning scores are mandatory for all adult patients in acute hospital care and are the first steps in identifying deterioration. However, they rely on users' understanding of the significance of the results they find and their ability to escalate to senior colleagues if necessary. This article examines the non-technical skills nurses require to recognise and escalate patient deterioration. It explores and analyses the literature on this topic and suggests there is a need for greater focus on situational awareness in nurse training and in healthcare in general, as this is linked to improved patient safety.

ABSTRACT Aim: To explore the variations between acute care and intensive care nurses' understanding of patient deterioration according to their use of this term in published literature. Background Evidence suggests that nurses on wards do not always recognize and act upon patient deterioration appropriately. Even if resources exist to call for intensive care nurses' help, acute care nurses use them infrequently and the problem of unattended patient deterioration remains. Design Dimensional analysis was used as a framework to analyze papers retrieved in a nursing-focused database. Method A thematic analysis of 34 papers (2002-2012) depicting acute care and intensive care unit nurses' perspectives on patient deterioration was conducted. Findings No explicit definition of patient deterioration was retrieved in the papers. There are variations between acute care and intensive care unit nurses' accounts of this concept, particularly regarding the validity of patient deterioration indicators. Contextual factors, processes and consequences are also explored. Conclusions From the perspectives of acute care and intensive care nurses, patient deterioration can be defined as an evolving, predictable and symptomatic process of worsening physiology towards critical illness. Contextual factors relating to acute care units (ACU) appear as barriers to optimal care of the deteriorating patient. This work can be considered as a first effort in modelling the concept of patient deterioration, which could be specific to ACU. Relevance to clinical practice: The findings suggest that it might be relevant to include subjective indicators of patient deterioration in track and trigger systems and educational efforts. Contextual factors impacting care for the deteriorating patient could be addressed in further attempts to deal with this issue.

INTRODUCTION: Early warning systems (EWS) were developed as a means of alerting medical staff to patient clinical decline. Since 85% of severe adverse events are preceded by abnormal physiological signs, the patient bed-side vital signs observation chart has emerged as an EWS tool to help staff identify and quantify deteriorating patients. There are three broad categories of patient observation
chart EWS: single or multiple parameter systems; aggregated weighted scoring systems; or combinations of single or multiple parameter and aggregated weighted scoring systems. OBJECTIVE: This scoping review is an overview of quantitative studies and systematic reviews examining the efficiency of the adult EWS charts in the recognition of in-hospital patient deterioration. METHOD: A broad search was undertaken of peer-reviewed publications, official government websites and databases housing research theses, using combinations of keywords and phrases. DATA SOURCES: CINAHL with full text; MedLine, PsycINFO, MasterFILE Premier, GreenFILE and ScienceDirect. Also, the Cochrane Library database, Department of Health government websites and Ethos, ProQuest and Trove databases were searched. EXCLUSIONS: Paediatric, obstetric and intensive care studies, studies undertaken at the point of hospital admission or pre-admission, non-English publications and editorials. RESULTS: Five hundred and sixty five publications, government documents, reports and theses were located of which 91 were considered and 21 were included in the scoping review. Of the 21 publications eight studies compared the efficacy of various EWS and 13 publications validated specific EWS. CONCLUSIONS: There is low level quantitative evidence that EWS improve patient outcomes and strong anecdotal evidence that they augment the ability of the clinical staff to recognise and respond to patient decline, thus reducing the incidence of severe adverse events. Although aggregated weighted scoring systems are most frequently used, the efficiency of the specific EWS appears to be dependent on the patient cohort, facilities available and staff training and attitude. While the review demonstrates support for EWS, researchers caution that given the contribution of human factors to the EWS decision-making process, patient EWS charts alone cannot replace good clinical judgment.


OBJECTIVE: Early warning systems (EWSs) are an integral part of processes that aim to improve the early identification and management of deteriorating patients in general wards. However, the widespread implementation of these systems has not generated robust data regarding nurses' clinical performance and patients' adverse events. This review aimed to determine the ability of EWSs to improve nurses' clinical performance and prevent adverse events among deteriorating ward patients. METHOD: The PubMed, CINAHL, EMBASE, and Cochrane Library databases were searched for relevant publications (January 1, 1997, to April 12, 2017). In addition, a grey literature search evaluated several guideline Web sites. The main outcome measures were nurses' clinical performance (vital sign monitoring and rapid response team notification) and patients' adverse events (in-hospital mortality, cardiac arrest, and unplanned intensive care unit [ICU] admission). RESULTS: The search identified 888 reports, although only five studies fulfilled the inclusion criteria. The findings of these studies revealed that EWSs implementation had a positive effect on nurses' clinical performance, based on their frequency of documenting vital signs that were related to the patient's clinical deterioration. In addition, post-implementation reductions were identified for cardiac arrest, unplanned ICU admission, and unexpected death. CONCLUSIONS: It seems that EWSs can improve nurses' clinical performance and prevent adverse events (e.g., in-hospital mortality, unplanned ICU admission, and cardiac arrest) among deteriorating ward patients. However, additional high-quality evidence is needed to more comprehensively evaluate the effects of EWSs on these outcomes.

Background: Failure to promptly identify deterioration in hospitalised patients is associated with delayed admission to intensive care units (ICUs) and poor outcomes. Existing vital sign-based Early Warning Score (EWS) algorithms do not have a sufficiently high positive predictive value to be used for automated activation of an ICU outreach team. Incorporating additional patient data might improve the predictive power of EWS algorithms; however, it is currently not known which patient data (or variables) are most predictive of ICU admission. We describe the protocol for a systematic review of variables associated with ICU admission. Methods/design: MEDLINE, EMBASE, CINAHL and the Cochrane Library, including Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials (CENTRAL) will be searched for studies that assess the association of routinely recorded variables associated with subsequent unplanned ICU admission. Only studies involving adult patients admitted to general ICUs will be included. We will extract data relating to the statistical association between ICU admission and predictor variables, the quality of the studies and the generalisability of the findings. Discussion: The results of this review will aid the development of future models which predict the risk of unplanned ICU admission. Systematic review registration: PROSPERO: CRD42015029617


Researchers have found that patients exhibit physiological changes up to 8 hours prior to an arrest event. Deaths have been attributed to a lack of observation, lack of documentation of observations, inability of a caregiver to recognize early signs of deterioration, and lack of communication between healthcare providers. This integrative review examines early warning scoring systems and their effectiveness in predicting a patient's potential for deterioration and considers whether these scoring systems prevent unplanned intensive care unit admissions and/or death. Three databases (MEDLINE, CINAHL [Cumulative Index to Nursing and Allied Health Literature], and the Cochrane Collaboration) were searched to identify the instruments and clinical support systems available to assist healthcare personnel in recognizing early clinical deterioration. Key search words included modified early warning score, early warning score, early warning systems, deteriorating patient, patients at risk, shock index, track and trigger systems, and failure to rescue. Two prior literature reviews examined early warning scoring systems and their effects on patient outcomes; however, the most recent one reviewed only articles published before 2007. This review examined studies of early warning systems and the incorporation of clinical support published from 2007 to 2012. Nine studies fitting the search criteria were included in this review. Early warning scoring systems that interface with electronic medical records and are supplemented with decision aides (algorithms) and clinical support systems produce an effective screening system for early identification of deteriorating patients. This multifaceted approach decreases unplanned intensive care unit admissions and hospital mortality.

Background Despite the fact that outreach and early warning systems (EWS) are an integral part of a hospital wide systems approach to improve the early identification and management of deteriorating patients on general hospital wards, the widespread implementation of these interventions in practice is not based on robust research evidence. Objectives: The primary objective was to determine the impact of critical care outreach services on hospital mortality rates. Secondary objectives included determining the effect of outreach services on intensive care unit (ICU) admission patterns, length of hospital stay and adverse events. Search methods The review authors searched the following electronic databases: EPOC Specialised Register, The Cochrane Central Register of Controlled Trials (CENTRAL) and other Cochrane databases (all on The Cochrane Library 2006, Issue 3), MEDLINE (1996-June week 3 2006), EMBASE (1974-week 26 2006), CINAHL (1982-July week 5 2006), First Search (1992-2005) and CAB Health (1990-July 2006); also reference lists of relevant articles, conference abstracts, and made contact with experts and critical care organisations for further information. Selection criteria Randomised controlled trials (RCTs), controlled clinical trials (CCTs), controlled before and after studies (CBAs) and interrupted time series designs (ITS) which measured hospital mortality, unanticipated ICU admissions, ICU readmissions, length of hospital stay and adverse events following implementation of outreach and EWS in a general hospital ward to identify deteriorating adult patients versus general hospital ward setting without outreach and EWS were included in the review. Data collection and analysis: Three review authors independently extracted data and two review authors assessed the methodological quality of the included studies. Meta-analysis was not possible due to heterogeneity. Summary statistics and descriptive summaries of primary and secondary outcomes are presented for each study. Main results: Two cluster-randomised control trials were included: one randomised at hospital level (23 hospitals in Australia) and one at ward level (16 wards in the UK). The primary outcome in the Australian trial (a composite score comprising incidence of unexpected cardiac arrests, unexpected deaths and unplanned ICU admissions) showed no statistical significant difference between control and medical emergency team (MET) hospitals (adjusted P value 0.640; adjusted odds ratio (OR) 0.98; 95% confidence interval (CI) 0.83 to 1.16). The UK-based trial found that outreach reduced in-hospital mortality (adjusted OR 0.52; 95% CI 0.32 to 0.85) compared with the control group. Authors’ conclusions: The evidence from this review highlights the diversity and poor methodological quality of most studies investigating outreach. The results of the two included studies showed either no evidence of the effectiveness of outreach or a reduction in overall mortality in patients receiving outreach. The lack of evidence on outreach requires further multi-site RCT’s to determine potential effectiveness. Plain language summary Ward and organisational practices to recognise and manage patient deterioration in hospital Research has shown that patients in general hospital wards often show early signs and symptoms, such as changes in breathing and pulse, when their condition is getting worse. If treatment for these patients is delayed they could die or require admission to intensive care (ICU). It is thought that if hospital staff could identify and manage these patients earlier then there would be less deaths and ICU admissions. One way to identify and treat patients who are deteriorating is to introduce outreach services. This usually includes the introduction of an Early Warning System to record physiological observations, training of hospital staff to recognise signs or creating special teams to respond to calls when a patient is deteriorating. This summary of a Cochrane review presents what we know from research about the effect of outreach services for patients on general hospital wards. The review found two studies which were of good quality. One study compared 12 hospitals with outreach services to 11 that did not. Another study compared 16 wards with outreach to general wards without outreach. One of the studies showed that outreach reduced the number of hospital deaths,
while the other study found no differences between hospitals with outreach and those with no outreach. It is not clear whether outreach reduces hospital deaths or ICU admissions. High quality research is needed to determine the effect of outreach services.

AIM: To determine the Rapid Response System programme theory and investigate how the mechanisms of implementation and the characteristics of context combine to enable or constrain the implementation of Rapid Response Systems and the achievement of desired outcomes. BACKGROUND: Rapid Response Systems have been implemented internationally to improve the recognition and management of patient deterioration, reduce the need for cardiopulmonary resuscitation and improve patient outcomes. DESIGN: Realist review. DATA SOURCES: We searched DARE, CENTRAL, NHSEED, MEDLINE, Medline In Process, EMBASE, CINAHL, PubMed, Scopus, The Web of Science and PsychInfo databases from 1997 - 2017 in addition to purposively searching the grey literature looking for articles supporting, refuting or explaining Rapid Response System programme theories. REVIEW METHODS: Included studies were critically appraised and graded using the Critical Appraisal Skills Programme tool. Data extraction and synthesis investigated the Rapid Response System theoretical propositions against the empirical evidence to refine Rapid Response System programme theories. RESULTS: The review found that the Rapid Response System programme theory achieved desired outcomes when there were sufficient skills mix of experienced staff, EWS protocols were used flexibly alongside clinical judgement and staff had access to ongoing, multiprofessional, competency-based education. However, ward cultures, hierarchical referral systems, workload and staffing resources had a negative impact on the implementation of the Rapid Response System. CONCLUSION: To improve the recognition and management of patient deterioration, policymakers need to address those cultural, educational and organizational factors that have an impact on the successful implementation of Rapid Response Systems in practice.

BACKGROUND: For critical care to be effective it must have a system in place to achieve optimal care for the deteriorating ward patient. OBJECTIVES: To systematically review the available literature to assess whether either early warning systems or emergency response teams improve hospital survival. In the event of there being a lack of evidence regarding hospital survival, secondary outcome measures were considered (unplanned ICU admissions, ICU mortality, length of ICU stay, length of hospital stay, cardiac arrest rates). METHODS: The Ovid Medline, EMBASE, CINAHL, Web of Science, Cochrane library and NHS databases were searched in September 2012 along with non-catalogued resources for papers examining the effect of early warning systems or emergency response teams on hospital survival. Inclusion criteria were original clinical trials and comparative studies in adult inpatients that assessed either an early warning system or emergency response team against any of the predefined outcome measures. Exclusion criteria were previous systematic reviews, non-English abstracts and studies incorporating paediatric data. Studies were arranged in to sections focusing on the following interventions: Early warning systems - Single parameter systems - Aggregate weighted scoring systems (AWSS) Emergency response teams - Medical emergency teams - Multidisciplinary outreach services. In each section an appraisal of the level of evidence and a recommendation has been made using the
SIGN grading system. RESULTS: 43 studies meeting the review criteria were identified and included for analysis. 2 studies assessed single parameter scoring systems and 4 addressed aggregate weighted scoring systems. A total of 20 studies examined medical emergency teams and 22 studies examined multidisciplinary outreach teams. LIMITATIONS: The exclusion of non-English studies and those including paediatric patients does limit the applicability of this review. CONCLUSIONS: Much of the available evidence is of poor quality. It is clear that a 'whole system' approach should be adopted and that AWSS appear to be more effective than single parameter systems. The response to deterioration appears most effective when a clinician with critical care skills leads it. The need for service improvement differs between health care systems.


AIM: In 2013, a National Early Warning System (EWS) was implemented in Ireland. Whilst evidence exists to support the clinical effectiveness of EWS in the acute health care setting, there is a paucity of information on their cost and cost effectiveness. The objective of this systematic literature review was to critically evaluate the economic literature on the use of EWS in adult patients in acute health care settings for the timely detection of physiological deterioration. METHODS: A systematic literature review was conducted to accumulate the economic evidence on the use of EWS in adult patients in acute health care settings. RESULTS: The search yielded one health technology assessment, two budget impact analyses and two cost descriptions. Three of the studies were Irish, and considered the national EWS system. A Dutch study reported financial consequences of a single parameter EWS, as part of a rapid response system, in a surgical ward. The fifth study examined an advanced triage system in a medical emergency admission unit in Wales. CONCLUSIONS: The economic evidence on the use of EWS amongst adult patients in acute health care settings for the timely detection of physiological deterioration is limited. Further research is required to investigate the cost effectiveness of EWS, and the appropriateness of using standard methods to do so. The recent implementation of a national EWS in Ireland offers a unique opportunity to bridge this gap in the literature to examine the costs and cost effectiveness of a nationally implemented EWS system.

Nannan Panday RS, Minderhoud TC, Alam N and Nanayakkara PWB. Prognostic value of early warning scores in the emergency department (ED) and acute medical unit (AMU): A narrative review. European Journal of Internal Medicine. 2017; 45 (20-31).

Background A wide array of early warning scores (EWS) have been developed and are used in different settings to detect which patients are at risk of deterioration. The aim of this review is to provide an overview of studies conducted on the value of EWS on predicting intensive care (ICU) admission and mortality in the emergency department (ED) and acute medical unit (AMU). Methods A literature search was conducted in the bibliographic databases PubMed and EMBASE, from inception to April 2017. Two reviewers independently screened all potentially relevant titles and abstracts for eligibility. Results 42 studies were included. 36 studies reported on mortality as an endpoint, 13 reported ICU admission and 9 reported the composite outcome of mortality and ICU admission. For mortality prediction National Early Warning Score (NEWS) was the most accurate score in the general ED population and in those with respiratory distress, Mortality in Emergency Department Sepsis score (MEDS) had the best accuracy in patients with an infection or sepsis. ICU admission was best predicted with NEWS, however in patients with an infection or sepsis Modified Early Warning Score (MEWS)
yielded better results for this outcome. Conclusion MEWS and NEWS generally had favourable results in the ED and AMU for all endpoints. Many studies have been performed on ED and AMU populations using heterogeneous prognostic scores. However, future studies should concentrate on a simple and easy to use prognostic score such as NEWS with the aim of introducing this throughout the (pre-hospital and hospital) acute care chain. Copyright © 2017 European Federation of Internal Medicine

Panday RSN, Minderhoud TC, Alam N and Nanayakkara PWB. Prognostic value of early warning scores in the emergency department (ED) and acute medical unit (AMU): A narrative review. European Journal of Internal Medicine. 2017; 45(20-31).

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OBJECTIVE: To evaluate the effectiveness and predictive accuracy of early warning scores (EWS) to predict deteriorating patients in pre-hospital settings., METHODS: Systematic review. Seven databases searched to August 2017. Study quality was assessed using QUADAS-2. A narrative synthesis is presented., ELIGIBILITY: Studies that evaluated EWS predictive accuracy or that compared outcomes in populations that did or did not use EWS, in any pre-hospital setting were eligible for inclusion. EWS were included if they aggregated three or more physiological parameters., RESULTS: Seventeen studies (157,878 participants) of predictive accuracy were included (16 in ambulance service and 1 in nursing home). AUCs ranged from 0.50 (CI not reported) to 0.89 (95%CI 0.82, 0.96). AUCs were higher (>0.80) for prediction of mortality within short time frames or for combination outcomes that included mortality and ICU admission. Few patients with low scores died at any time point. Patients with high scores were at risk of deterioration. Results were less clear for intermediate thresholds (>=4 or 5). Five studies were judged at unclear risk of bias, all others were judged at high risk of bias., CONCLUSIONS: Very low and high EWS are able to discriminate between patients who are not likely and those who are
likely to deteriorate in the pre-hospital setting. No study compared outcomes pre- and post-implementation of EWS so there is no evidence on whether patient outcomes differ between pre-hospital settings that do and do not use EWS. Further studies are required to address this question and to evaluate EWS in pre-hospital settings. Copyright © 2018. Published by Elsevier B.V.

Petersen JA. Early warning score challenges and opportunities in the care of deteriorating patients. Danish medical journal. 2018; 65(2):

Clinical deterioration of patients hospitalized on general wards is often preceded by worsening vital signs. If identified early and acted upon quickly, it is conjectured that further deterioration can be prevented. To this means the early warning score (EWS) was implemented in all hospitals in the Capital Region of Denmark in 2013. EWS consists of an aggregated weighted track-and-trigger system (TTS), to identify at-risk patients early, and a treatment protocol to escalate care appropriately and determine the level of competency of the provider. A similar system is endorsed by the Royal College of Physicians for use at hospitals in the UK. Despite wide dissemination of EWS and similar systems serious adverse events presaged by deteriorating vital signs continue to be a major source of morbidity. This is either due to inherent inadequacies of EWS, lack of adherence to the treatment protocol, or a combination of both. All studies included in this thesis were conducted at Bispebjerg Hospital, an inner-city Hospital in Copenhagen, Denmark with 500 beds and a catchment area of approximately 300,000. The aim of the thesis was to investigate the reasons for failure of the EWS by trying to answer the following research questions: 1. How often and why does the system fail? 2. What are the barriers and facilitating factors related to the use of the EWS protocol? 3. Is there a correlation between monitoring frequency and clinical deterioration? To answer the first question an observational study was conducted, in which all unexpected deaths, cardiac arrests, and unintended ICU admission on general wards during a 6 months period were reviewed. A total of 144 events were recorded; in only 12 (8 %) of these the escalation protocol was adhered to strictly. Monitoring frequency was not adhered to in 81 % of cases; doctors were not notified about patients' condition in 42 % of cases, and the medical emergency team or senior doctors were not notified appropriately in 52 % of the cases. Leading to the conclusion that violations of the escalation protocol was common prior to serious adverse events on general wards. To answer the second question semi-structured focus group interviews with nurses from the surgical and medical acute care wards were performed to investigate: 1) why monitoring frequencies are not adhered to, 2) why junior doctors are not notified about deteriorating patients, and 3) why review by the medical emergency team (MET) is often delayed or missed? The main findings from this study showed that time constraints and under staffing was mentioned as a main reason for non-adherence to monitoring frequencies. Confidence in their own abilities to take care of deteriorating patients, and the large number of patients with elevated EWS was mentioned as the main reason, for not notifying junior doctors. And fear of reprimands and lack of non-technical skills among members of the MET were mentioned among the main reasons for reluctance to call. The third study investigated the role of monitoring frequency on clinical deterioration in a ward-level randomized study. It was hypothesized that 8 h monitoring intervals were superior to 12 h in preventing deterioration, defined as a rise in EWS to >= 2 after 24 h, among newly admitted patients with an initial EWS of 0 or 1. Of 3185 patients screened for eligibility, 1346 patients were included to the trial, and data from 544 patients were available for final analysis. Of these 49 % percent were allocated to the 8h group and 51% to the 12h group; of these, 23% and 20% had an elevated EWS>=2 at 24h, respectively (p=0.456), OR 1.17 (0.78-1.76). There were no significant differences in regard to the secondary outcomes: cardiac arrests, ICU
admissions, review by MET, length of hospital stay, mortality, or elevated EWS at 48h. Copyright
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author(s) and source are credited.

Roney JK, Whitley BE, Maples JC, Futrell LS, Stunkard KA and Long JD. Modified early warning scoring
(MEWS): evaluating the evidence for tool inclusion of sepsis screening criteria and impact on

AIMS AND OBJECTIVES: To evaluate current research evidence reporting outcomes from modified early
warning scoring system tools utilisation to prevent failure to rescue in hospitalised adult medical-
surgical/telemetry patients. BACKGROUND: Early sepsis detection exhibits clinical significance to
practitioners and patients. Thorough and timely clinical observations, along with a willingness of nurses
to call for help, are pivotal to survival of hospitalised patients. This project examined effects of
modified early warning scoring system tool usage on patient mortality and failure to rescue events in
hospitalised adult medical-surgical/telemetry patients as reported in the literature. DESIGN: A
comprehensive review and evaluation of published peer-reviewed literature was conducted.
METHODS: Electronic databases searched included PubMed, MEDLINE, CINAHL, Cochrane Library of
systematic reviews and Agency for Healthcare Research and Quality through 2014. RESULTS: Eighteen
articles were identified for review. Evidence ratings included 6% (1) Level I, 44% (8) Level IV, 6% (1)
Level V, 33% (6) Level VI and 11% (2) Level VII. Six reported mortality predictive value and/or reduction,
three measured impact on emergency calls, and four reported impact on mortality and rapid response
team utilisation. CONCLUSION: While modified early warning scoring system tools have been widely
adopted and are recommended for utility in detection of inpatients at-risk for clinical deterioration,
limited high-level data and no clinical trials linking use of modified early warning scoring system tool
usage to robust outcomes were found. Established criteria for validating modified early warning
scoring system criteria, organisational-specific reliability testing and multi-site trials are recommended.
RELEVANCE TO CLINICAL PRACTICE: Development of all-cause illness screening tools, including sepsis, is
imperative. The clinical picture may be quantified with scoring tools to assist nurses' clinical decision-
making, thus leading to improved outcomes and decreased incidence of failure to rescue. Clinical
outcomes of interest should be measured and reported in peer-reviewed literature to disseminate the
impact on clinical outcomes.

Saab MM, McCarthy B, Andrews T, Savage E, Drummond FJ, Walshe N, Forde M, Breen D, Henn P,
Drennan J and Hegarty J. The effect of adult Early Warning Systems education on nurses' knowledge,
AIMS: This review aims to determine the effect of adult Early Warning Systems education on nurses'
knowledge, confidence and clinical performance. BACKGROUND: Early Warning Systems support timely
identification of clinical deterioration and prevention of avoidable deaths. Several educational
programmes have been designed to help nurses recognize and manage deteriorating patients. Little is
known as to the effectiveness of these programmes. DESIGN: Systematic review. DATA SOURCES:
Academic Search Complete, CINAHL, MEDLINE, PsycINFO, PsycARTICLES, Psychology and Behavioral
Science Collection, SocINDEX and the UK & Ireland Reference Centre, EMBASE, the Turning Research
Into Practice database, the Cochrane Central Register of Controlled Trials (CENTRAL) and Grey
Literature sources were searched between October and November 2015. REVIEW METHODS: This is a quantitative systematic review using Cochrane methods. Studies published between January 2011 - November 2015 in English were sought. The risk of bias, level of evidence and the quality of evidence per outcome were assessed. RESULTS: Eleven articles with 10 studies were included. Nine studies addressed clinical performance, four addressed knowledge and two addressed confidence. Knowledge, vital signs recording and Early Warning Score calculation were improved in the short term. Two interventions had no effect on nurses’ response to clinical deterioration and use of communication tools. CONCLUSION: This review highlights the importance of measuring outcomes using standardized tools and valid and reliable instruments. Using longitudinal designs, researchers are encouraged to investigate the effect of Early Warning Systems educational programmes. These can include interactive e-learning, on-site interdisciplinary Early Warning Scoring systems training sessions and simulated scenarios.


Upper limb morbidity is a well-recognised consequence of treatment for breast cancer that can develop for up to 6 years after treatment. However, the capacity to fully integrate evidence-based rehabilitation pathways into routine care for all patients is questionable due to limited resources. A long term surveillance programme must therefore be accessible to all patients, should identify those at risk of developing morbidity and target the interventions at the high risk population of patients. The proposed model uses a surrogate marker for assessing risk of morbidity, incorporated into an Early Warning System (EWS), to produce a technology-lead, prospective surveillance programme.


As a global effort toward improving patient safety, a specific area of focus has been the early recognition and rapid intervention in deteriorating ward patients. This focus on "failure to rescue" has led to the construction of early warning/track-and-trigger systems. In this review article, we present a description of the data behind the creation and implementation of such systems, including multiple algorithms and strategies for deployment. Additionally, the strengths and weaknesses of the various systems and their evaluation in the literature are emphasized. Despite the limitations of the current literature, the potential benefit of these early warning/track-and-trigger systems to improve patient outcomes remains significant.


RATIONALE: Early warning system (EWS) scores are used by hospital care teams to recognize early signs of clinical deterioration and trigger more intensive care. OBJECTIVE: To systematically review the evidence on the ability of early warning system scores to predict a patient’s risk of clinical deterioration and the impact of early warning system implementation on health outcomes and resource utilization. METHODS: We searched the MEDLINE, CINAHL, and Cochrane Central Register of Controlled Trials
databases through May 2014. We included English-language studies of early warning system scores used with adults admitted to medical or surgical wards. We abstracted study characteristics, including population, setting, sample size, duration, and criteria used for early warning system scoring. For predictive ability, the primary outcomes were modeled for discrimination on 48-hour mortality, cardiac arrest, or pulmonary arrest. Outcomes for the impact of early warning system implementation included 30-day mortality, cardiovascular events, use of vasopressors, respiratory failure, days on ventilator, and resource utilization. We assessed study quality using a modified Quality in Prognosis Studies assessment tool where applicable. MEASUREMENTS AND MAIN RESULTS: Of 11,183 citations studies reviewed, one controlled trial and 20 observational studies of 13 unique models met our inclusion criteria. In eight studies, researchers addressed the predictive ability of early warning system tools and found a strong predictive value for death (area under the receiver operating characteristic curve [AUROC], 0.88-0.93) and cardiac arrest (AUROC, 0.74-0.86) within 48 hours. In 13 studies (one controlled trial and 12 pre-post observational studies), researchers addressed the impact on health outcomes and resource utilization and had mixed results. The one controlled trial was of good quality, and the researchers found no difference in mortality, transfers to the ICU, or length of hospital stay. The pre-post designs of the remaining studies have significant methodological limitations, resulting in insufficient evidence to draw conclusions. CONCLUSIONS: Early warning system scores perform well for prediction of cardiac arrest and death within 48 hours, although the impact on health outcomes and resource utilization remains uncertain, owing to methodological limitations. Efforts to assess performance and effectiveness more rigorously will be needed as early warning system use becomes more widespread.


Background: Prior studies concentrated on unplanned intensive care unit (ICU) transfer to gauge deterioration occurring shortly following hospital admission. However, examining only ICU transfers is not ideal since patients could stabilize with treatment, refuse ICU admission, or not require ICU evaluation. To further explore etiologies of early clinical deterioration, we used rapid response team (RRT) activation within 48 hours of admission as an index of early clinical worsening. Methods: A retrospective analysis of prospectively gathered admissions from the emergency department in an academic medical center was done. Data were reviewed independently by two physicians. We assessed severity of illness, functional status, comorbidity, the frequency of ICU and palliative care consultations, and changes in advance health care directives. Results: Of 655 rapid responses (RRs) within the study period, 24.6% occurred within 48 hours of admission. Disease trajectory was the most frequent perceived reason for RRs (55.6% and 58.9%, reviewer 1 and 2, respectively) followed by medical error (15.6% and 15.2%). Acute physiology and chronic health evaluation II (APACHE-II) and modified early warning scores (MEWS) were higher at the time of RR compared to admission (p<0.0001). However, admission APACHE-II, MEWS, functional status, and comorbidity scores did not predict early RRs. One third of RRs resulted in ICU consultation and 95% were accepted. Palliative care consults were requested for 15%, the majority (65%) after RR and all resulting in advance directive change. Conclusion: Disease trajectory accounted for most clinical deterioration and medical error contributed to 15%. Our data suggest that it is difficult to predict early clinical deterioration as none of the measured parameters were associated with RRT activation. Copyright © 2017 Wang et al.

Aim: To examine whether early warning scores (EWS) can accurately predict critical illness in the prehospital setting and affect patient outcomes. Methods: We searched bibliographic databases for comparative studies that examined prehospital EWS for patients transported by ambulance in the prehospital setting. The ability of the different EWS, including pre-alert protocols and physiological-based EWS, to predict critical illness (sensitivity, odds ratio [OR], area under receiver operating characteristic [AUROC] curves) and hospital mortality was summarised. Study quality was assessed using the Newcastle-Ottawa Scale. Results: Eight studies were identified. Two studies compared the use of EWS to standard practice using clinical judgement alone to identify critical illness: the pooled diagnostic OR and summary AUROC for EWS were 10.9 (95% CI 4.2-27.9) and 0.78 (95% CI 0.74-0.82), respectively. A study of 144,913 patients reported age and physiological variables predictive of critical illness: AUROC in the independent validation sample was 0.77, 95% CI 0.76-0.78. The high-risk patients stratified by the national early warning score (NEWS) were significantly associated with a higher risk of both mortality and intensive care admission. Data on comparing between different EWS were limited; the Prehospital Early Sepsis Detection (PRESEP) score predicted occurrence of sepsis better than the Modified EWS (AUROC 0.93 versus 0.77, respectively). Conclusion: EWS in the prehospital setting appeared useful in predicting clinically important outcomes, but the significant heterogeneity between different EWS suggests that these positive promising findings may not be generalisable. Adequately powered prospective studies are needed to identify the EWS best suited to the prehospital setting. (C) 2016 Elsevier Ireland Ltd. All rights reserved.


BACKGROUND: Changes to physiological parameters precede deterioration of ill patients. Early warning and track and trigger systems (TTS) use routine physiological measurements with pre-specified thresholds to identify deteriorating patients and trigger appropriate and timely escalation of care. Patients presenting to the emergency department (ED) are undiagnosed, undifferentiated and of varying acuity, yet the effectiveness and cost-effectiveness of using early warning systems and TTS in this setting is unclear. We aimed to systematically review the evidence on the use, development/validation, clinical effectiveness and cost-effectiveness of physiologically based early warning systems and TTS for the detection of deterioration in adult patients presenting to EDs.

METHODS: We searched for any study design in scientific databases and grey literature resources up to March 2016. Two reviewers independently screened results and conducted quality assessment. One reviewer extracted data with independent verification of 50% by a second reviewer. Only information available in English was included. Due to the heterogeneity of reporting across studies, results were synthesised narratively and in evidence tables. RESULTS: We identified 6397 citations of which 47 studies and 1 clinical trial registration were included. Although early warning systems are increasingly used in EDs, compliance varies. One non-randomised controlled trial found that using an early warning system in the ED may lead to a change in patient management but may not reduce adverse events; however, this is uncertain, considering the very low quality of evidence. Twenty-eight different early
warning systems were developed/validated in 36 studies. There is relatively good evidence on the predictive ability of certain early warning systems on mortality and ICU/hospital admission. No health economic data were identified. CONCLUSIONS: Early warning systems seem to predict adverse outcomes in adult patients of varying acuity presenting to the ED but there is a lack of high quality comparative studies to examine the effect of using early warning systems on patient outcomes. Such studies should include health economics assessments.
# Appendix 2

## Generic Response to Deteriorating Patients - 90 Day Approach

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Pre-planning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flash reports</td>
<td>Complete</td>
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<tr>
<td></td>
<td>Initial exploration of published literature</td>
<td>Complete</td>
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<td></td>
<td>Initial expert interviews</td>
<td>Complete</td>
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<tr>
<td></td>
<td>Draft interview email template for expert reference group</td>
<td>In Progress</td>
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<tr>
<td></td>
<td>Meet with AIA - person centred care</td>
<td>In Progress</td>
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<td></td>
<td>Work with HIS Communications team to plan &amp; implement communication &amp; engagement strategy</td>
<td>In Progress</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Draft project charter</td>
<td>In Progress</td>
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<tr>
<td></td>
<td>Share pre-plan phase findings &amp; key questions</td>
<td>Not started</td>
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<tr>
<td></td>
<td><strong>Phase 1</strong></td>
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<tr>
<td></td>
<td>In depth literature review</td>
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<td></td>
<td>Identify and develop core themes</td>
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<tr>
<td></td>
<td>Expert interviews</td>
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<tr>
<td></td>
<td>Compile and analyse core findings</td>
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<td></td>
<td>Agree members of expert reference group</td>
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<td></td>
<td>Revise &amp; finalise project charter</td>
<td>In Progress</td>
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<tr>
<td></td>
<td>End of phase meeting</td>
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<td></td>
<td>End of phase flash report</td>
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<td></td>
<td><strong>Phase 2</strong></td>
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<td></td>
<td>Produce draft template from phase 1 learning</td>
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<tr>
<td></td>
<td>Consult with expert reference group to draft generic response</td>
<td>24-Sep-19</td>
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<tr>
<td></td>
<td>Test generic response</td>
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<tr>
<td></td>
<td>Conduct focused interviews with service users</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Compile and analyse core findings</td>
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