

Early warning scores: a health warning

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Summary

Early warning scores are frequently used in UK adult Emergency Departments (ED) and gaining traction in paediatric emergency care. Like many innovations with inherent face validity they have great appeal to clinicians, managers and commissioners. However it is important to ensure unintended consequences and balancing measures are mitigated. We review the background to their development and introduction in the ED, the evidence for their usefulness, their limitations in our field and areas for further research.

Introduction

Early warning scores (EWS) are a routine feature of Emergency Department practice in the UK as use of the National Early Warning Score, published by the Royal College of Physicians of London, is now a requirement (1), despite concerns with its use in this clinical environment (2). Even before this over half of UK EDs were using an EWS to trigger senior review of particular patients (3). Queensland also has a statewide ED “Adult Deterioration Detection System” (4), and we have reports of EWS use in EDs in South Australia and South Carolina. Anecdotal polling of personal contacts revealed only occasional encounters with EWS in US and Canadian EDs.

We do not aim to present here a systematic review of EWS or track and trigger systems as these exist both for adults and children (5) (6) but wish to highlight their limitations in the ED setting.

Where did EWS come from?

EWS initially developed following retrospective reviews of care preceding unplanned admission to intensive care units, where a recurrent theme was that of well documented physiological deterioration over many hours that was either not recognised or not acted upon (7). Similarly, the 2006 CEMACH report “Why children die” identified failure to recognise severity of illness in children as a significant remediable factor in paediatric deaths and recommended “a standardised and rational monitoring system with imbedded early identification systems for children developing critical illness – an Early Warning Score” (8).

Early trials of “track and trigger” systems (TTS) incorporating an EWS and a mandated response demonstrated a reduction in complication rates, particularly in surgical patients (9), although these results were not universally replicated (10). These early results prompted widespread enthusiasm for EWS. Guidance from the National Institute for Health and Clinical Excellence (NICE, an arms-length non-governmental body sponsored by the English Department of Health which aims to reduce practice variation) on the management of the acutely ill adult in 2007 defined various types of TTS (table 1) and recommended their adoption (11).

Table 1: NICE categorisation of Track and Trigger systems

Single parameter system	Periodic observation of selected vital signs that are compared with a simple set of criteria with predefined thresholds, with a response algorithm being activated when any criterion is met.
Multiple parameter system	Response algorithm requires more than one criterion to be met, or differs according to the number of criteria met.
Aggregate scoring system	Weighted scores are assigned to physiological values and compared with predefined trigger thresholds.
Combination system	Single or multiple parameter systems used in combination with aggregate weighted scoring systems.

The National Early Warning Score (NEWS) currently mandated for adults in the UK is a modification of the VitalPAC™ EWS (ViEWS) developed on a large Acute Medical Unit dataset⁽¹²⁾. Sadly the working group developing NEWS did not include any Emergency Physicians and were unable to locate any relevant literature relating to ED patients.

There is as yet no universal EWS for children, and although multiple versions have been developed at local levels (13)(14) with anecdotal reports of introduction into many EDs direct evidence of their benefit is lacking for their utility even at ward level⁽⁶⁾.

How well researched is EWS in the ED?

Previous systematic reviews of EWS have related to their use in in-patient settings; in both adults and children these demonstrated limited sensitivity and heterogeneity of trigger criteria (5) (6). To examine the current state of play we conducted a brief scoping review of both the paediatric and adult literature relating to EWS in the ED. We identified 16 publications since 2006 in adults; 2 of these were in non-English journals (1 German, 1 Chinese). Of these only 6 were prospective observational studies; 2 (both from Hong Kong) derived a new score, while 7 more examined tools (mostly the Mortality in ED Sepsis score) designed for the ED. The paediatric literature included 7 full papers and 11 abstracts; 7 were prospective studies and 8 examined a score designed for ED use (4 of these assessed the Paediatric Observation Priority Score tool). Full details are in table 2. The following two sections will explore the implications of this literature.

Table 2: Results of literature review

Title	Year	Type of article	Type of study	Bespoke ED system?
Adult				
THERM: the Resuscitation Management score. A prognostic tool to identify critically ill patients in the emergency department (15)	2014 Hong Kong	Paper	Prospective observational	Bespoke, compared with nonbespoke
Comparison of the trauma and injury severity score and modified early warning score with rapid lactate level (the ViEWS-L score) in blunt trauma patients (16)	2014 South Korea	Paper	Retrospective comparison	No
The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department (17)	2014 Turkey	Paper	Prospective observational	No
Utility of a single early warning score in patients with sepsis in the emergency department (18)	2014 Scotland	Paper	Retrospective comparison	No
Severity illness scoring systems for early identification and prediction of in-hospital mortality in patients with suspected sepsis presenting to the emergency department (19)	2013 Germany	Paper	Prospective observational	Bespoke, compared with nonbespoke
Evaluation of the modified MEDS, MEWS score and Charlson comorbidity index in patients with community acquired sepsis in the emergency department (20)	2013 Turkey	Paper	Prospective observational	Bespoke, compared with nonbespoke
Modified early warning score with rapid lactate level in	2013 South	Paper	Retrospective comparison	No

critically ill medical patients: the ViEWS-L score (21)	Korea			
A new approach to scoring systems to improve identification of acute medical admissions that will require critical care (22)	2011 Scotland	Paper	Mixed retrospective/prospective	Bespoke, compared with nonbespoke
Nurse-administered early warning score system can be used for emergency department triage (23)	2011 Denmark	Paper	Retrospective comparison	Yes
Performance of the maximum modified early warning score to predict the need for higher care utilization among admitted emergency department patients (24)	2010 USA	Paper	Retrospective comparison	No
A comparison of severity of illness scoring system for emergency department patients with systemic inflammatory response syndrome (25)	2009 China	Paper	Unclear	Bespoke, compared with nonbespoke
Derivation of a prognostic score for identifying critically ill patients in an emergency department resuscitation room (26)	2009 Hong Kong	Paper	Derivation	Bespoke, compared with nonbespoke
Predictive value of the modified Early Warning Score in a Turkish emergency department (27)	2008 Turkey	Paper	Prospective observational	No
Use of an admission early warning score to predict patient morbidity and mortality and treatment success (28)	2008 Ireland	Paper	Prospective observational	No
Modified early warning score predicts the need for hospital admission and in-hospital mortality (29)	2008 South Africa	Paper	Retrospective comparison	No
Validation of physiological	2006	Paper	Retrospective	Bespoke,

scoring systems in the accident and emergency department (30)	Wales		comparison	compared with nonbespoke
Paediatric				
The effect of pediatric early warning system scoring upon admission from the pediatric emergency department on emergency response calls (31)	2015 US	Abstract	Retrospective observational	No
Evaluating the Pediatric Early Warning Score (PEWS) System for Admitted Patients in the Pediatric Emergency Department (32)	2014 USA	Paper	Prospective observational	No
The paediatric observation priority score (POPS): Outcomes of 24000 patients (33)	2014 UK	Abstract	Prospective observational	Yes
Developing a new warning score in the emergency department (34)	2014 US	Abstract	Case-control	Yes
The paediatric observation priority score (POPS): A more accurate predictor of admission risk from the Emergency Department than the Manchester Children's Early Warning System (ManChEWS) (35)	2014 UK	Abstract	Retrospective comparison	Yes
Pediatric early warning score at time of emergency department disposition is associated with level of care (36)	2014 US	Paper	Prospective observational	No
Validity of different pediatric early warning scores in the emergency department (37)	2013 Netherlands	Paper	Retrospective validation	No
The paediatric observation priority score (pops): a useful tool to predict likelihood of admission from the emergency department (38)	2013 UK	Abstract	Prospective validation	Yes

Efficacy of the pediatric early warning score (PEWS) in predicting placement of a pediatric placement to the ward or PICU (39)	2012 US	Abstract	Retrospective observational	No
PEWS program in the emergency department halves unanticipated in-hospital transfers for respiratory complaints (40)	2012 US	Abstract	Before and after	No
Relationship between pediatric early warning score and emergency department disposition (41)	2012 US	Paper	Prospective observational	No
Pews assessment in the emergency department halves unanticipated in-hospital transfers to a higher level of care (42)	2011 US	Abstract	Before and after	No
Correlation of the pediatric early warning score (PEWS) and clinical deterioration among children admitted in a private tertiary hospital from may 1, 2009-august 31, 2009: A prospective study (43)	2011 Philippines	Abstract	Prospective observational	No
Determining the effect of objective and subjective criteria on a risk assessment tool in a children's emergency department (44)	2011 UK	Abstract	Prospective observational	Yes
The utility of a pews score to improve triage accuracy in the emergency department (45)	2011 US	Abstract	Unclear	Yes
Use of a paediatric early warning system in emergency departments (46)	2009 UK	Paper	Review article	Yes
The PAWS score: validation of an early warning scoring system for the initial assessment of	2008 UK	Paper	Retrospective validation	Yes

children in the emergency department (47)				
Can paediatric early warning score be used as a triage tool in paediatric accident and emergency? (48)	2008 UK	Paper	Prospective observational	Yes

What is the purpose of EWS in ED care?

In analysis of the progress in establishing critical care outreach, the UK NHS Modernisation Agency made a number of comments about the utility and limitations of TTS (table 3) ⁽⁴⁹⁾. These include the suggestion that EWS can “red flag” critical illness and secure help for sick patients.

Table 3: Utility and limitations of TTS

TTS are	TTS are not
An aid to good clinical judgement	Substitutes for clinical judgement
“Red flag” markers of potential or established critical illness	Predictors of the inevitable development of critical illness
Aids to effective communication and a means of securing appropriate help for sick patients	A comprehensive clinical assessment tool
Indicators of physiological competence	Indicators of the need for immediate critical care admission
Indicators of physiological trends	

It would be reasonable to suppose that most clinicians would hope to use a score which identified high-risk patients in order to focus beneficial interventions towards these patients, and to this end the EWS would be the afferent limb of a system which also included a skilled team as the efferent limb [figure]. A preliminary study from Rees and Mann piloted the use of a physiological “patient at risk” score to trigger automatic intensive care review in the ED, although only 3 of the 30 patients reviewed were actually admitted to ICU⁽⁵⁰⁾. McGillicuddy et al’s much larger before-and-after trial of immediate tannoy-based physician attendance to a patient who met specific physiological criteria at triage showed reductions in time to physician evaluation (median 11 minutes vs 21) and first therapeutic intervention (median 26 minutes vs 58). It is unclear, however, how the “standard care” before the tannoy system prioritised patients (51).

One overlooked aspect of the benefit of EWS in Emergency Care is improving communication, especially in respect of creating a common language between ED’s and admitting teams. Communication tools such as SBAR⁽⁵²⁾ lend themselves very well to having a common format to discuss the acuity of a patient. With preventable deaths more likely to occur on the wards than in the ED⁽⁵³⁾ it would seem sensible to maximise the transfer of relevant information at the time of transfer.

Can EWS do this?

Various groups, identified from prior systematic reviews and our scoping study, have examined the predictive value of EWS in the adult ED. Only one of these, however, addressed the whole population of admitted patients in the manner suggested by the NHS Modernisation Agency; Heitz et al found that the maximum MEWS in the ED had an AUROC of 0.73 for the prediction of death or ICU admission (24).

Other studies have evaluated EWS in specific patient subgroups; Corfield et al identified 2003 adult patients with sepsis presenting to Scottish EDs and found NEWS to have an area under the ROC curve (AUROC; c-statistic) of 0.7 for prediction of 30-day mortality and 0.67 for admission to intensive care with 2 days⁽¹⁸⁾. Christensen et al examined use

of a modified EWS at triage in a Danish ED and found that a Bispebjerg EWS (BEWS) of over 5 at triage identified 63% of patients who died or were admitted to ICU within 48 hours. These were, however, patients who had already been identified by nursing gestalt as “red” and therefore in need of immediate or acute treatment⁽²³⁾. In 790 medical patients in a South African ED, Burch et al found that increasing scores on an older EWS, which did not include points for oxygen saturations or supplemental oxygen, were associated with increased hospital mortality (p for trend <0.001). However there was no calculation of sensitivity or specificity for any specific cut-off scores (29).

The diversity of potential end-points for ED based warning scores and systems has challenged both the development and research of such tools. This is especially true in paediatric practice where mortality is very low but physiological variation extremely common at the point of triage⁽⁵⁴⁾. In paediatric practice there is developing evidence that bespoke systems may allow early identification of risk of admission⁽³⁸⁾ (38) but previous studies to identify the most critically ill may lack specificity if applied to all presenting patients (47).

What can't EWS do?

EWS were developed on the premise that early identification and intervention in the deteriorating patient could reduce mortality. There is limited evidence for this in the adult literature; the landmark cluster randomised trial of a Medical Emergency Team, MERIT, found an increase in calls to the emergency team (from 3.1 to 8.7 per 1000 admissions), but no reduction in cardiac arrest calls (1.31 vs 1.64 per 1000 admissions), unplanned intensive care admissions (4.19 vs 4.68 per 1000 admissions) or unexpected deaths (1.06 vs 1.18 per 1000 admissions)⁽⁵⁵⁾. This may reflect earlier findings that MET calls often identified dying patients and resulted in the implementation of a DNAR order⁽⁵⁶⁾. Alam et al's systematic review of the effects of introduction of EWS demonstrated mixed outcomes; of the six studies assessing hospital mortality two reported statistically significant mortality reduction, two a trend towards reduction, and two no change (57). However all these studies were on limited sites, in specific clinical areas and of a before-and-after design, which limits their generalisability to the ED.

The hope that an EWS in the ED can reduce mortality is based on the premise that deaths in the ED or soon after admission are preventable. This assumption has not been widely explored; when Lu et al examined 210 cases where death occurred within 24 hours after ED admission (excluding post-cardiac arrest patients and those with terminal cancer), only 32 were deemed to have been preventable (25.8%) (58). Even this is higher than Hogan et al's much larger study of 1000 deaths in English acute hospitals, where only 5.2% were judged to have been preventable; of these 19 were identified to have had a problem in their assessment in the ED⁽⁵³⁾.

Although EWS can identify the patient with deranged physiology, it cannot differentiate between specific illnesses such as sepsis versus pancreatitis, or COPD versus cardiogenic pulmonary oedema. There are also clearly limitations in using EWS in isolation as a

triage tool, as some clearly time-critical presentations such as STEMI or acute CVA may present with normal physiology. In emergency and acute paediatrics there is a national drive to improve recognition of serious bacterial illness however the majority of patients presenting with potential features of serious bacterial illness such as pyrexia have self-limiting viral infections. The search for the very small proportion of children with septicaemia may not be the best use of a EWS system. This confusion between triage, illness identification and early warning systems may be one reason why no standard tool has been introduced nationally. Furthermore it is not clear what criteria should be used in children to determine abnormal heart and respiratory rate values⁽⁵⁹⁾. Given the large number of children discharged home a more appropriate utilisation of EWS for children may be identification of safe discharge rather than identification of illness⁽⁶⁰⁾.

What else do we need to know?

A number of issues around EWS in the ED still need to be addressed. Cuthbertson identified four questions for users of EWS in 2008 (61) and they remain applicable today:

1. Does the EWS I use utilise and suitably weight early signs of deterioration such as heart rate & respiratory rate?
2. Does the EWS I use avoid giving disproportionate weight to late signs of deterioration such as blood pressure?
3. What is the diagnostic accuracy of the EWS I use in the populations in which I use it, and can it be improved?
4. What is the optimal cut point for the EWS I use and do I use this as the trigger for activating a response?

In order to answer these questions clinicians need to consider the purpose for which the EWS is being used; if it is at the front door, is it any better than the existing triage system or than unstructured assessment by the triage clinician? Fullerton et al found that use of an EWS in the prehospital environment added little to the judgment of the treating paramedic in identifying the critically ill patient⁽⁶²⁾. As Foëx and Jones eloquently commented in an editorial on the Fullerton paper, the value of a diagnostic test is in fact whether it affects patient outcome⁽⁶³⁾.

We need to know if EWS can reliably provide information we need in the ED, such as need for time-critical interventions, safety of discharge, or potential workload (either nursing or medical) related to the patient stay. None of these has as yet been addressed adequately. This should be remedied by robust assessment of NEWS as it is implemented in UK EDs. Equally, the patient safety aspect of potentially improved communication using a standardised system should be formally assessed.

Discussion

It seems that EWSs are likely to remain an expected safety measure, certainly for the

forseeable future. We would, however, encourage ED clinicians to assess how best they can be applied in our environment. Although an EWS can flag the patient deteriorating towards death, this is not necessarily the patient who can benefit the most from emergency intervention (64) and much more evidence needs to be developed before we can assume that EWS will reliably prioritise ED patients. Additionally, the higher prevalence of seriously sick and injured patients in an ED will cause problems if a tool developed for lower-acuity areas such as wards is applied with no modification of trigger thresholds as the false negative rate (alarm triggered but no new intervention required) will rise.

In order for a track and trigger system in any setting to be of value, the identification of a patient at risk by the afferent limb needs to be matched by an efferent limb intervention. Although studies of Rapid Response Teams have shown that patients who benefited did so from critical care interventions (65), this would generally be already available in an ED without need for specific calling criteria.

In summary, it is not clear that an EWS will add any value to the processes and staff expertise already present in the ED.

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