



## Review Paper

# Scoping review: The use of early warning systems for the identification of in-hospital patients at risk of deterioration



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## ARTICLE INFORMATION

## Article history:

Received 8 May 2016

Received in revised form 24 October 2016

Accepted 31 October 2016

## Keywords:

Early warning systems

Track-and-trigger

Severe adverse events

Patient deterioration

In-hospital patients

Unplanned ICU admission

Preventable mortality

Patient outcomes

## ABSTRACT

**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.

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## 1. Introduction

Recognising patient deterioration is a priority for many health care facilities.<sup>1</sup> The ability of a hospital to respond appropriately

to patient clinical decline is a reflection of the facility's quality of care and can strengthen or undermine public confidence in the health care system.<sup>2,3</sup> Patient deterioration may be preventable and can often be attributed to human error.<sup>3</sup> Inadequate nursing skills, infrequent patient monitoring, poor documentation and a lack of timely action exacerbate patient deterioration.<sup>4–7</sup> The correct implementation of early warning systems (EWS) helps overcome subjectivity by providing clinical staff with quantitative evidence of a patient's declining clinical condition and by guiding the staff response.<sup>8</sup>

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Early warning systems, also known as ‘track-and-trigger’ (T&T) systems, have evolved as a means of alerting health professionals to patient clinical decline.<sup>9</sup> Since 85% of severe adverse events (SAE) are preceded by abnormal vital signs,<sup>10–13</sup> the bed-side vital signs observation chart forms the basis of most EWS. The EWS consists of both afferent and efferent limbs; the afferent limb is the use of early warning scores, as determined by the bed-side observation chart, to recognise patients at risk of deterioration. The efferent limb is represented by the appropriate response and actions of the Medical Emergency Teams, Rapid Response Systems or Critical Care Outreach Services.<sup>12,14</sup> Although there has been some debate regarding the heavy reliance on abnormal vital signs in recognising patient deterioration,<sup>15</sup> most EWS charts continue to utilise a combination of the following parameters: respiration rate, oxygen saturation level, supplementary oxygen flow rate, systolic blood pressure, heart rate, temperature, and level of consciousness. Despite being a subjective parameter pain score is often also included in EWS. Some EWS charts also include urine output and the Glasgow coma scale.<sup>1,16</sup> All EWS charts follow the same principle; a given threshold score(s) triggers a prescribed set of actions intended to escalate patient care.<sup>8</sup> There are a variety of EWS charts but most fit into three categories: (a) single or multiple parameter systems which trigger an intervention when a predefined threshold is reached; (b) aggregated weighted scoring systems which allocate a ‘weight’ to each vital sign score reflecting its level of abnormality; and (c) a combination of (a) and (b), single or multiple parameter and aggregated weighted scoring systems.<sup>17</sup>

This scoping review presents a broad overview of published works related to the use of the patient bed-side vital signs observation chart EWS in the recognition of in-hospital adult patient deterioration. The aim of the review is to report on the efficacy of the various EWS, as they appear in the literature, in identifying clinical deterioration of hospital patients. Thus, emphasis is placed on publications involving quantitative research and systematic reviews.

## 2. Methods

A scoping review is a specific method that aims to ‘map the literature’ on a topic of interest to identify gaps in knowledge.<sup>18–20</sup> It is an appropriate approach for this review as it allows for the inclusion of a wide range of study designs, particularly in areas with emerging evidence. It differs from a systematic review in that it does not involve the assessment of the quality of the studies. Rather it summarises a range of evidence in order to report the breadth and depth on a specific topic. The five stages, as outlined by Arksey and O’Malley,<sup>18</sup> guided the review; (1) clarification of the purpose and search question; (2) identification of relevant studies; (3) selecting the studies; (4) presenting the data as a chart and qualitative themes; and (5) data collation, and writing a report. The search question for this review was: What is the reported efficacy of the various EWS patient observation charts in identifying clinical deterioration of in-hospital adult patients?

We searched CINAHL with full text, MedLine, PsycINFO, MasterFILE Premier, GreenFILE, Cochrane Library and ScienceDirect databases using the search terms: Early warning systems; track-and-trigger systems; patient deterioration; patient deterioration and vital signs; EWS and patient outcomes; in-hospital severe adverse events; and combinations of these terms. In addition, government websites pertaining to the Department of Health and postgraduate theses were searched through Ethos, ProQuest and Trove databases. The search was supplemented by scanning the reference lists of included studies. Searches were performed without year restrictions but the following filters were applied: patient above 18 years of age; full text English language papers only; and peer reviewed journals or official government documents.

When selecting the relevant studies, the researchers considered the extent and ability of the study to answer the research question.<sup>21</sup> Inclusion criteria were publications relating to the comparison of the various EWS charts and their efficiency or validation. Relevant systematic reviews and literature reviews were also included. Additionally studies addressing the development, use of, testing and efficacy of the bed-side patient vital signs observation charts used in general medical and surgical hospital wards were considered. The exclusion criteria comprised studies pertaining to obstetric and paediatric patients, and studies involving emergency departments and intensive care units (ICU). These studies were excluded because they involve EWS observation charts specifically designed for that patient cohort and are not comparable with in-hospital adult EWS charts. Studies involving the use of EWS at the point of patient hospital admission were also excluded given that they do not involve in-hospital patients. Also excluded were EWS charts used in non-hospital situations as well as editorial articles.

Determining which studies to include in the scoping review was an iterative process predominantly lead by the lead author with team discussions to clarify this step. Summary data of study aims and methods from relevant publications were entered onto a Microsoft Excel sheet with the final conclusions presented as tables. Emphasis was placed on quantitative studies since these statically validate the efficiency of the various EWS. Such studies included: prospective and retrospective observational studies, case-controlled studies, cross-sectional studies, ‘before-and-after’ studies, and statistical validation retrospective data analysis studies. Consideration was also given to reports, qualitative and mix method studies and literature reviews of quantitative studies.

## 3. Results

### 3.1. Study selection

The database searches produced 565 items comprising 520 journal articles, 32 articles obtained from reference lists, eight government reports and five PhD theses. Following a review of the abstracts, 246 full-text records were assessed and 91 articles and reports were given serious consideration, of which 21 were included in the scoping review (Tables 1 and 2, Fig. 1). The publications deemed unsuitable included those not fulfilling the inclusion criteria, editorials, training manuals and studies focusing on the efferent limb of the EWS. Also excluded were studies pertaining to the development of EWS, including establishing the most appropriate trigger scores and chart designs as well as studies looked at the human aspect of responding to patient deterioration. Of the 21 studies which answered the search question, eight publications focused on comparing various EWS,<sup>9,22–28</sup> of which five studies involved clinical trials,<sup>22–25,28</sup> one compared the parameters and trigger scores used in the various EWS,<sup>27</sup> and two publications were systematic reviews of the literature<sup>9,26</sup> (Table 1). The remaining 13 studies<sup>29–41</sup> focused on testing the efficiency or validation of EWS of which two were systematic reviews<sup>29,41</sup> (Table 2).

### 3.2. Comparative studies of early warning systems

Several variations of EWS have been developed with few researchers undertaking quantitative comparisons of their efficacy under clinical ward conditions. The efficiency of the Modified Early Warning Score (MEWS), widely used to predict SAE,<sup>42,43</sup> was compared to an easy to use EWS called HOTEL (Hypotension, Oxygen saturation, Temperature, ECG abnormality, Loss of independence) and a cohort-specific system called TOTAL (Tachypnoea, Oxygen saturation, Temperature, Alert, Loss of independence) in predicting hospital mortality.<sup>28</sup> The study showed that under

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