Resuscitation 85 (2014) 1699–1703

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Serious adverse events in a hospital using *early warning score* – What went wrong?☆

John Asger Petersen[a,*], Rebecca Mackel[a], Kristian Antonsen[b], Lars S. Rasmussen[c]

[a] Department of Anaesthesia and Intensive Care, Bispebjerg Hospital, University of Copenhagen, Bispebjerg Bakke 24, 2400 Copenhagen NV, Denmark
[b] Board of Directors Bispebjerg Hospital, University of Copenhagen, Bispebjerg Bakke 24, 2400 Copenhagen NV, Denmark
[c] Center of Head and Orthopedics, Rigshospitalet, University of Copenhagen, Blegdamsvej 9, 2100 Copenhagen Ø, Denmark

ARTICLE INFO

Article history:
Received 8 May 2014
Received in revised form 6 August 2014
Accepted 20 August 2014

Keywords:
Early warning score
Rapid response system
Medical emergency team
In-hospital cardiac arrest

ABSTRACT

Aim: To evaluate the performance of a new early warning score (EWS) system by reviewing all serious adverse events in our hospital over a 6-month time period.
Method: All incidents of unexpected death (UD), cardiac arrest (CA) and unanticipated intensive care unit admission(UICU) of adult patients on general wards were reviewed to see if the escalation protocol that is part of the EWS system was followed in the 24 h preceding the event, and if not where in the chain of events failure occurred.
Results: We found 77 UICU and 67 cases of the combined outcome (CO) of CA and UD. At least two full sets of EWS were recorded in 87, 94 and 75% of UICU, CA and UD. Patients were monitored according to the escalation protocol in 13, 31 and 13% of UICU, CA and UD. Nurses escalated care and contacted physicians in 64% and 60% of events of UICU and the corresponding proportions for CO were 58% and 55%. On call physicians provided adequate care in 49% of cases of UICU and 29% of cases of the CO. Senior staff was involved according to protocol in 53% and 36% of cases of UICU and CO, respectively.
Conclusion: Poor compliance with the escalation protocol was commonly found when serious adverse events occurred but level of care provided by physicians was also a problem in a hospital with implemented early warning system. This information may prove useful in improving performance of EWS systems.

1. Introduction

Rapid response systems (RSS) are widely used to detect and treat acutely deteriorating patients on hospital wards. These systems may prevent serious adverse events like cardiac arrest (CA), unanticipated intensive care unit (ICU) admission (UICU) and unexpected death (UD). RRS have an afferent and an efferent limb, where the former consists of a track and trigger system to identify at-risk patients, combined with a treatment protocol that tells staff when and how to escalate care and activate the efferent limb, usually the medical emergency team (MET). MET is manned with physicians and/or nurses with special competence in critical and emergency care.[1] The Vitalpac™ early warning score (ViEWS) is considered the best performing track and trigger system to date, and the use of a slightly modified version, the national early warning score (NEWS) is recommended for use across the UK by the Royal College of Physicians.[2–5] ViEWS was developed to predict death within 24 h in acutely admitted, medical patients and its performance in an abbreviated version (AbEWS) was confirmed in a mixed medical and surgical population.[6] The ability of NEWS to predict the combined outcome of CA, UICU and death was recently found to be superior to other EWS.[4] However, despite its wide dissemination, serious adverse events still occur frequently, and can be considered failures of the system.[7–9] They may result from intrinsic shortcomings of EWS, i.e., lack of sensitivity to detect at-risk patients, or non-adherence to the escalation protocol. While the original studies [2,6] showed good discriminative power for the outcome in question (death after 24 or 48 h) they did not investigate to what extent it was related to non-adherence to the escalation protocols, or suboptimal care. So there remain a number of unanswered questions as to why serious adverse events still occur, and at what level in the chain of events, from detection to treatment of deteriorating patients, the system fails.

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2014.08.037.

* Corresponding author.
E-mail address: john.asger.petersen@regionh.dk (J.A. Petersen).

http://dx.doi.org/10.1016/j.resuscitation.2014.08.037
0300-9572/

Table 1
Early warning score with physiological parameters and corresponding weighted score and normal range.

Vital sign	3	2	1	0	1	2	3
Respiratory rate pr min	<9		9–11	12–20		21–24	>24
Oxygen saturation	<92%	92–93%	94–95%	>95%			
Supplemental oxygen		Yes		No			
Temperature degrees centigrade	<35.1		35.1–36.0	36.1–38.0	38.1–39.0	>39	
Systolic blood pressure mmHg	<91	91–100	101–110	111–219			>219
Heart rate per min	<41		41–50	51–90	91–110	111–130	>130
Level of consciousness				A			V, P, U

We recently introduced a EWS system based on NEWS (Table 1) at our institution, and aimed to investigate its performance by reviewing all incidents of UD, CA, and UICU occurring in our hospital over a 6-month time period. We analyzed if these incidents could be attributed to lack of sensitivity of EWS or lack of adherence to the escalation protocol, and if so at what level it occurred.

2. Materials and methods

2.1. Study design

This was an observational study of prospectively collected data related to serious adverse events occurring on departments of surgery and internal medicine during a 6-month study period in 2013 (1st January–30th June). We recorded all cases of CA, UD and UICU occurring in adult patients. CA was defined as an event where a patient without a do not attempt resuscitation (DNAR) order received chest compressions and/or defibrillation by healthcare staff or was pronounced dead by the CA team. UD was defined as death without DNAR order or DNAR order given within less than 6 h prior to the event. Deaths where the DNAR order was given by the admitting physician and deaths occurring on the palliative care ward were excluded. UICU was defined as an ICU admission of patients who had been in hospital for more than 24 h.

We excluded events occurring outside general wards (i.e., emergency department, cardiac care unit, ICU, operating rooms or recovery area) and we also excluded events in subjects not admitted to hospital (i.e., outpatients, visitors or staff), because the EWS system is not used in these subjects and areas of the hospital.

The study was conducted at Bispebjerg University Hospital, Copenhagen, Denmark a 475-bed hospital that serves a population of 300,000. There are 280 medical and 195 surgical beds, and a mixed ICU with ten beds. The hospital has had a fully implemented RRS since 2008.

2.2. Early warning score system

In May 2012 the single parameter track and trigger system at our hospital was replaced by an aggregated weighted track and trigger system based on NEWS that includes measures for respiratory rate, arterial hemoglobin oxygen saturation, pulse rate, systolic blood pressure, level of consciousness according to AVPU score, temperature, and whether the patient receives supplementary oxygen (Table 1). Each vital sign can be assigned between 0 and 3 points (supplementary oxygen 0 or 2) depending on how much it deviates from a predefined threshold; the values are added to an aggregated score from 0 to 20, higher scores indicating more severe disease. An escalation protocol that directs the type of clinical response and competency of the provider according to EWS triggers was introduced as an integrated part of the system (Table 2). Scores 0–1 are considered low risk, and no actions are to be taken. In every patient with a score $\geq$2 staff must assess airway patency, breathing, and circulation and intervene appropriately according to a predefined algorithm. Monitoring frequency is increased to 6, 4 and 1 h(s) for scores 2, 3 and 7, respectively, and to every 30 min for EWS $\geq$ 9. Scores 3–5 mandate nurses to inform the on-call physician, who must assess the patient and document additional treatment and/or diagnostic plan. Patients with a score of 6–8 must be evaluated by a physician immediately. Patients with EWS $\geq$ 9 must be evaluated by a senior physician or a MET without delay. The treating physician has the option to assign modified thresholds for individual vital signs in patients with chronically impaired physiology due to chronic disease, e.g., patients with chronic hypoxemia. In these patients the threshold for arterial oxygen saturation could be lowered to 92% and the EWS will be calculated according to this new threshold. The escalation protocol, however, is the same, once the trigger score is reached.

Implementation of EWS at our institution was conducted through involvement of specially trained members of the nursing staff and physicians together with heads of departments. All new employees are introduced to the system and there is ongoing training for all healthcare providers on general wards in assessment and initial stabilization of acutely deteriorating patients.

2.3. Data collection

The CA team reported every CA call to the study investigators, who reviewed each event for eligibility and included it into the study population if inclusion criteria were met. Data from ICU admissions were obtained from the electronic patient data management system (CIS, Daintel, Denmark) and reviewed for inclusion by the study investigators. All deaths were reported on a weekly basis from the Unit of Municipal Collaboration of the Capital Region and reviewed for inclusion. Paper copies of the EWS, and nursing charts were retrieved for all included events, while medical records were retrieved from the patient data management system (OPUS, CSC, Denmark).

2.4. Chart review

Adherence to escalation protocol in the 24 h preceding an event was evaluated through chart review performed independently by two of the investigators (JP and LR). In case of disagreement, the two investigators reviewed the events together to find consensus, and a third investigator (KA) decided in case of disagreement at this stage.

Charts were evaluated in regard to whether monitoring frequency was adhered to, for scores $\geq$2 if patients were appropriately assessed and stabilized, for scores $\geq$3 if the on-call physician was informed about the patient condition, for scores $\geq$6 if the on-call physician evaluated patients in a timely and appropriate manner, and for scores $\geq$9 if the patient was evaluated by a senior physician or the MET.

2.5. Statistical analysis

We used median and interquartile range for continuous data in descriptive statistics. Categorical variables were compared using Chi square test. Calculations were performed with RStudio, version 0.98.501 software package (RStudio, Inc.).