Resuscitation 101 (2016) 91–96

Contents lists available at ScienceDirect

Resuscitation

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

Rapid response systems

Frequency of early warning score assessment and clinical deterioration in hospitalized patients: A randomized trial☆

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

[a] Department of Anaesthesia and Intensive Care, Bispebjerg-Frederiksberg Hospital, University of Copenhagen, Bispebjerg Bakke 24, 2400 Copenhagen NV, Denmark
[b] Bispebjerg-Frederiksberg 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 7 July 2015
Received in revised form 29 January 2016
Accepted 8 February 2016

Keywords:
Early warning score
Rapid response systems
Medical emergency system
On the ward deteriorating patient

ABSTRACT

Aim: To explore whether early warning score (EWS) measurements at 8 h intervals is associated with better outcomes than 12 h intervals. We hypothesized that the proportion of patients that deteriorated to a higher EWS at 24 h after hospital admission would be lower with 8 h interval than with 12 h interval.
Method: This was a pragmatic, ward-level randomized, non-blinded, controlled trial at an urban University hospital. During two six weeks periods acutely admitted surgical and medical patients, with an initial EWS of 0 or 1, were monitored either every 8th hour or every 12th hour. The primary outcome was clinical deterioration 24 h post-admission, estimated by the proportion of patients with an EWS ≥ 2 at 24 h after the initial EWS on admission.
Results: Of 3185 patients screened for eligibility, 1346 patients were included to the trial. Forty-nine percent were allocated to the 8 h group and 51% to the 12 h group; of these, 23% and 20% had an elevated EWS ≥ 2 at 24 h, respectively ($p = 0.456$), OR 1.17 (0.78–1.76); 3.4% and 2.2%, respectively had an EWS ≥ 5 ($p = 0.391$), and one patient in each group had an EWS ≥ 7 at 24 h ($p = 1.0$). Multiple logistic regression analysis showed no significant interactions for the primary outcome and the predefined variables: age, gender, ward type, and inclusion period, with an adjusted OR 1.20 (0.79–1.82). There were no significant differences in regard to the secondary outcomes: cardiac arrests, ICU admissions, review by medical emergency team (MET), length of hospital stay, or elevated EWS at 48 h. Thirty-day mortality was 1.1% vs. 1.8% ($p = 0.357$) in the 8 h group and the 12 h-group, respectively (OR = 0.60 (0.23–1.50), $p = 0.279$).
Conclusion: We found no significant reduction in the proportion of clinical deterioration with monitoring frequencies of 3 vs. 2 times daily among patients acutely admitted to a surgical or medical ward and an initial EWS of 0–1.

Introduction

Clinical deterioration of patients on general wards is often preceded by worsening vital signs.[1–3] If identified early and acted upon quickly, it is conjectured that further deterioration can be prevented.[4] Therefore, many hospitals use early warning scores (EWS) to detect abnormalities and trigger an appropriate response from staff.[5] There is consensus that patients require monitoring, and a number of studies have evaluated the performance of different EWS systems in predicting serious adverse events (SAE) and found the Vitalpac™ EWS (ViEWS) superior to predict short term mortality among acutely admitted patients.[5–10] ViEWS consists of respiratory rate, arterial oxygen saturation, blood pressure, heart rate, level of consciousness, and whether supplemental oxygen is administered. A higher score reflects more severe disease. A slightly modified version, termed national EWS (NEWS), is recommended for use across the UK, and was found to perform well in predicting short term mortality and unexpected ICU admission.[11] So while there is evidence to support which vital signs to monitor and at what thresholds staff should act, it remains to be established how often vital signs should be monitored.[11] Present recommendations for stable patients on general wards vary widely with little evidence to support them.[5] A recently published study showed doubling in medical emergency team (MET) calls on wards randomized to mandatory intermittent monitoring compared to monitoring on indication. However, this did not result in

☆ 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.2016.02.003.

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

http://dx.doi.org/10.1016/j.resuscitation.2016.02.003
0300-9572/

better patient outcomes.[12] An observational study showed increased afferent limb failure among continuously compared to intermittently monitored patients, and a randomized trial of 402 high-risk surgical patients also failed to show beneficial effect on SAE rates for continuously monitored patients.[13,14] Patients with EWS of 0–1 are at low risk of clinical deterioration, however, risk increases with higher EWS and the concept of rapid response systems is based on early detection and timely intervention, therefore, an increase in EWS to above or equal 2 can be considered clinically significant. The optimal monitoring frequency for low risk populations is unknown and based on compromise between patient safety and work load issues.[15] The present study aims to explore whether an 8 h monitoring interval is associated with a better outcome than 12 h intervals in a low risk population of acutely admitted patients. We hypothesized that the proportion of patients that deteriorated to a higher EWS at 24 h after hospital admission would be lower with 8 h interval than with 12 h interval.

Methods

Study design and setting

This was a pragmatic, ward-level randomized, non-blinded, controlled trial at an urban 700 beds University hospital to determine the effect of two vs. three EWS measurements daily on clinical deterioration among acutely admitted surgical and medical patients. The study took place at the surgical and medical acute care wards of Bispebjerg University Hospital that serves a population of 400,000 people in the Capital Region of Copenhagen, Denmark. The surgical ward has 20-beds and receives approximately 6500 patients annually. The medical ward has 36 beds, and an annual intake of approximately 7500 general medical patients. Patients can be admitted either from the general practitioner, emergency department, other departments and outpatient clinics of the hospital, or transferred from other hospitals. The wards were randomized to monitor patients with an initial EWS of 0 or 1 on admission, either three times daily (the intervention arm) or follow standard care with two daily measurements (control arm). Randomization occurred at the ward level with a random number generator, to determine which ward should start with the intervention. The design was chosen to avoid contamination of the intervention. The trial period had two phases: In phase 1 (weeks 1–7) surgical patients were allocated to the intervention arm and medical patients to the control arm. In phase 2 (weeks 8–15) monitoring frequencies were crossed over, and the medical patients allocated to the intervention arm and surgical patients to the control arm. The first week of phase 1 and the first two weeks of phase 2, were designated adaption periods to avoid carry-over effect between phases. Patients admitted during these intervals were not included in the study, leaving a period of 6 weeks for inclusion of patients during each phase. Residual effects of ward type, periods-effects, age, and gender on the primary outcome after randomization were assessed with multiple regression analysis.

Prior to study start and during the study period, nurses were briefed about the protocol by the primary investigator (JAP). Furthermore, ward nurses continuously checked for adherence to protocol and reminded nurses about the study at handovers. Additionally adherence to protocol was audited weekly by checking the time between EWS measurements for included patients.

Early warning score

An aggregated track-and-trigger system based on NEWS has been in use at our institution since May 2012. The system has been previously described in detail; briefly the EWS includes 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).[6] Each vital sign can be assigned between 0 to 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. Scores 0–1 are considered low risk, and patients are to be monitored at 12 h intervals. Monitoring frequency is increased according to a predefined algorithm to 6, 4 and 1 h for scores 2, 3 and 7 respectively, and to every 30 min for EWS $\geq$ 9. 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 can be lowered to 92% and the EWS calculated according to this new threshold.

Participants

All patients admitted during the inclusion periods of phase 1 and 2 were screened for eligibility and included if the first EWS on admission was either 0 or 1. We excluded patients that had been included earlier, or if they fulfilled any of the following: age <18 years, chronically elevated EWS, transfer from another hospital or outpatient clinic, admission due to a condition that warranted closer observation according to hospital guidelines (e.g., diabetic ketoacidosis, intoxication, hepatic coma, significant upper or lower gastrointestinal bleeding), or terminal disease. Baseline, admission, and outcome data were retrieved from the electronic patient data management system (OPUS, CSC, Denmark) and mortality data were obtained from the Danish Civil Registration System.

Intervention

The study intervention was an increase in monitoring frequency from the usual standard of two times daily (12 h interval) in the control group (12 h group) to three times daily (8 h interval) in the intervention group (8 h group). Except for the intervention all patients received the usual standard of care according to EWS algorithm and department guidelines.

Outcomes

The primary outcome was the proportion of patients with an EWS $\geq$ 2 at 24 h after the initial EWS on admission.

Secondary outcome measures included:

- Proportion of patients with an EWS $\geq$ 2 at 48 h
- Proportion of patients with an aggregated score of EWS $\geq$ 5 or $\geq$7 at 24 h
- Proportion of cardiac arrest, ICU admission or review by the medical emergency team (MET) during first 72 h of admission
- Length of hospital stay (LOS)
- Mortality at 72 h
- Mortality at 30 days

Adherence to study protocol was assessed by calculating the intervals between EWS measurements in the two groups for all patients with LOS > 24 h.

Statistical analysis

The sample size calculation was based on the assumption that 30% of eligible patients in the standard care group would experience an EWS $\geq$ 2 after the first 24 h of admission. With an expected drop-out rate of 20% enrollment of minimum 144 patients in each group