Short communication

CREWS: Improving specificity whilst maintaining sensitivity of the National Early Warning Score in patients with chronic hypoxaemia☆

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A R T I C L E   I N F O

A B S T R A C T

Background: The National Early Warning Score (NEWS) is being introduced across the UK, but there are concerns about its specificity in patients with chronic hypoxaemia, such as some patients with COPD. This could lead to frequent clinically insignificant triggers and alarm fatigue.
Aims of study: To investigate whether patients with chronic hypoxaemia trigger excessively with NEWS, and to design a simple variant of NEWS for patients with chronic hypoxaemia: a Chronic Respiratory Early Warning Score (CREWS).
Methods: Data was collected from respiratory wards at two hospitals in North Wales. Components of NEWS and frequency of trigger thresholds being reached were recorded. CREWS was applied retrospectively to patients' observations.
Results: 196 admissions were analysed, including 78 for patients with chronic hypoxaemia. Patients with chronic hypoxaemia frequently exceeded trigger thresholds using NEWS during periods of stability/at discharge. Using CREWS, triggers during stability/at discharge were reduced from 32% of observations to 14% using a trigger threshold of a score greater than 6, and from 50% to 18% using a score greater than 5. All patients with chronic hypoxaemia who died within 30 days still reached CREWS trigger thresholds, and the area under receiver operated curves for NEWS and CREWS was comparable.
Conclusion: CREWS is a simple variant of NEWS for patients with chronic hypoxaemia that could reduce clinically insignificant triggers and alarm fatigue, whilst still identifying the sickest patients.

1. Introduction

The National Early Warning Score (NEWS),[1] an adaptation of the VitalPAC Early Warning Score (ViEWS),[2] is being introduced in hospitals across the UK following a recommendation by the Royal College of Physicians.[1] NEWS includes three respiratory parameters: respiratory rate, use of supplementary oxygen, and oxygen saturations. Points for oxygen saturations begin to be allocated when levels fall below 96%. Patients with respiratory conditions associated with chronic hypoxaemia such as chronic obstructive pulmonary disease (COPD) often have oxygen saturations below the "normal" range of 94–98%, even when their condition is stable.[3] This could lead to persistently high NEWS, resulting in poor specificity of NEWS in this population. Persistent triggers could lead to unnecessary reviews and alarm fatigue,[4] where important triggers are not acted on because of the frequency of clinically insignificant triggers – the "crying wolf" phenomenon. Modification of NEWS for patients with chronic respiratory conditions has been suggested as a possible solution,[1,5,6] though adoption of a standardised evidence-based approach has not occurred to date.

The aim of the present study was to investigate whether patients with respiratory conditions associated with chronic hypoxaemia have persistently high NEWS even during stability, and to design a simple variant of NEWS to improve specificity whilst maintaining sensitivity for such patients; a Chronic Respiratory Early Warning Score (CREWS).

2. Methods

Data was collected between August and October 2012 on respiratory wards at Ysbyty Gwynedd and Wrexham Maelor Hospital; two NHS District General Hospitals in North Wales, UK. Both wards care for a mixture of respiratory and general medical patients. Data was collected prospectively from patients' hospital notes, prescription and observations charts using standardised proformas. For patients re-admitted during the study period, only data

Table 1
Scores allocated for oxygen saturations (%) for NEWS, and for CREWS for CH patients.

Scoring system	Score for oxygen saturations			
	3	2	1	0
NEWS	≤91	92–93	94–95	≥96
CREWS	≤85	86–87	88–89	≥90

from the first admission was included. The components of NEWS were recorded for each patient at admission, at peak NEWS of the admission, and for three consecutive scores during a period of stability or prior to discharge, for which mean scores were calculated. Target oxygen saturations were determined by target saturations prescriptions, or based on review of hospital notes and blood gas results where oxygen was not prescribed. Outcome data including 30-day mortality was collected 6 weeks after initial data collection.

Patients were split into two groups based on target oxygen saturations as described in the British Thoracic Society guideline for emergency oxygen use in adult patients[3]: those with target saturations of 88–92% (patients with chronic hypoxaemia, CH) and those with target saturations of 94–98% (others, O). For CH patients, an alternative scoring system (CREWS, Table 1) was applied retrospectively for comparison with NEWS. CREWS was created empirically following preliminary testing of several potential variants scoring systems. This was an observational cohort study undertaken as part of a service improvement project; no intervention was undertaken, therefore ethical approval was not required.

Data was analysed using SPSS v18. Results are expressed with standard deviations where appropriate. Distribution of scores with NEWS and CREWS were calculated, as were trigger rates for NEWS/CREWS for scores of five or more (the trigger used in England) and six or more (Wales). The area under receiver operator curves (AUROC)[7] was calculated with 95% confidence intervals (CI) for scores during stability/at discharge using 30-day mortality as the outcome.

3. Results

Two hundred and seventeen admissions were reviewed. Forty-seven patients (22%) were re-admitted to hospital within 30 days of discharge, with twenty-one patients (10%) re-admitted to the same ward within the data collection period; for these patients, only the first admission during the study period was included. Of the 196 included admissions, 98 (50%) were male; 91 (46%) had COPD; and mean age was 70 years (range 19–102, interquartile range 63–82). Ninety-eight patients (50%) had an arterial blood gas measurement on admission, of whom 44 (22%) were hypercapnic ($CO_2 > 6.0$ kPa). Seventy-eight patients (40%) had target oxygen saturations of 88–92% (i.e. CH patients) and 26 (12%) received long-term oxygen therapy. Median length of stay was 10 days (interquartile range 6–17).

Mean NEWS on admission was 6 ± 3 for CH patients and 3 ± 3 for O patients. Mean peak NEWS during admission was 9 ± 3 for CH patients and 6 ± 3 for O patients. Mean NEWS during stability/at discharge was 5 ± 2 for CH patients and 2 ± 2 for O patients. Fig. 1 shows the distribution of scores during stability/at discharge for CH and O patients using NEWS (Fig. 1a), and for CH patients using CREWS and O patients using NEWS (Fig. 1b). The number of patients with a score greater than 5 and 6 during stability/at discharge using NEWS and CREWS is shown in Table 2.

Twenty-three patients (11%) died within 30 days of admission, including 12 CH patients. All twelve CH patients (100%) with a score greater than 6 at peak score using NEWS and CREWS. For O patients, 9/11 (82%) scored 6+ at peak NEWS; the two remaining patients (18%) had a peak score of 4 and did not trigger at thresholds of 5+ or 6+ during admission.
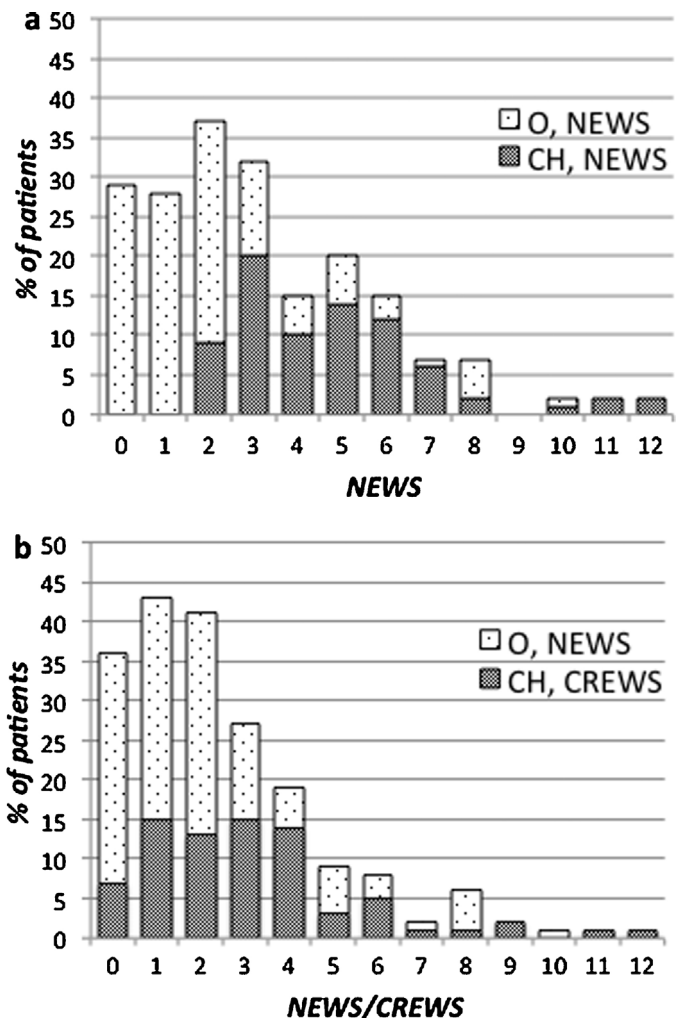
Fig. 1. Distribution of NEWS scores for CH and O patients during stability/at discharge (a), and CREWS and NEWS scores when CREWS applied to CH patients' scores during stability/at discharge (b).

Table 2
Percentage of patients reaching trigger thresholds of six or more (6+; trigger used for NEWS in Wales) and five or more (5+; trigger used in England) using NEWS and CREWS.

Scoring system (patient group)	Patients scoring 6+	Patients scoring 5+
NEWS (all)	18% (35/196)	28% (55/196)
NEWS (O)	8% (10/118)	14% (16/118)
NEWS (CH)	32% (25/78)	50% (39/78)
CREWS (CH)	14% (11/78)	18% (14/78)

For CH patients, AUROC during stability/at discharge for 30-day mortality was 0.876 (95% CI 0.788–0.963) using NEWS and 0.913 (0.845–0.981) using CREWS. AUROC using NEWS for all patients during stability/at discharge was 0.829 (0.703–0.955), and 0.747 (0.516–0.977) for O patients alone.

4. Discussion

The present study shows that patients with CH, defined as those with target oxygen saturations of 88–92%, have persistently high NEWS during stability/at discharge. NEWS is based on an early warning score system designed to maximise both sensitivity (the ability to detect patients at risk of dying) and specificity (the minimisation of false alarms) for unselected patients admitted to Medical Admissions Units.[1,2] However, NEWS clearly lacks

specificity for CH patients, who make up a significant proportion of hospital admissions.[8] For CH patients, in whom lower oxygen saturations are acceptable and indeed desirable,[9] it is not logical to score highly on NEWS for oxygen saturations when these are within the target range.

We designed a simple variant of NEWS for CH patients: CREWS. When CREWS was applied retrospectively to CH patients' observations there was a marked reduction in the number of scores reaching trigger thresholds when patients were stable, which could reduce the associated problems of unnecessary reviews and alarm fatigue. All CH patients who subsequently died still triggered at peak scores with CREWS, and AUROCs were similar when NEWS and CREWS scores were applied to CH patients, suggesting that sensitivity to detect the sickest patients is maintained.

Kane et al. suggested that use of NEWS could lead to excess use of supplemental oxygen and proposed an alternative scoring system for CH patients where patients score for saturations above and below the target range.[5] However, incorrect manual calculation of early warning scores is a well-recognised problem,[10,11] and whilst electronic monitoring systems could reduce errors,[12] their use in not currently widespread. The unidirectional scoring of oxygen saturations in CREWS is consistent with NEWS and would allow implementation with minimal alteration to existing documentation and charts. Whilst excess supplemental oxygen can be harmful,[9] CREWS may act as a prompt for oxygen prescription and could potentially improve prescription rates and oxygen administration.

The main limitation of this study is the relatively small sample size, derived from two district general hospitals. Other factors such as the use of long-term oxygen therapy or tachycardia due to beta-2 agonists could also lead to persistently high NEWS in CH patients; these factors were not addressed in the present study. The low number of patients who died limited our ability to detect differences in sensitivity, although our results do not suggest any major reduction in sensitivity of CREWS compared to NEWS. We plan to use CREWS in a larger prospective study utilizing an electronic monitoring system where different scoring variants can be applied to different patient groups.

5. Conclusion

CREWS is a simple variant of NEWS for patients with chronic hypoxaemia that could reduce unnecessary triggers and alarm fatigue, whilst still identifying the sickest patients.

Conflict of interest statement

C. Subbe is principal investigator for a study by Philips Healthcare exploring bedside monitoring. The other authors have no relevant conflicts of interest. No external funding was received for this study.

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