

Using a Local Early Warning Scoring System as a Model for the Introduction of a National System

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Abstract

Background

Chelsea and Westminster Hospital introduced the Chelsea Early Warning Score (CEWS) in 2007 to aid the recognition of acutely unwell patients. The Royal College of Physicians subsequently recommended a National Early Warning Score (NEWS) for implementation across the NHS. The aim of this study was to evaluate local adherence to CEWS to identify potential obstacles to the consistent implementation of NEWS.

Method

Emergency Department (ED) and Acute Assessment Unit (AAU) notes were retrospectively reviewed for a convenience sample of 102 patients admitted to the AAU. Outcome measures were completeness of documentation of CEWS parameters, documentation and accuracy of aggregate CEWS scores. Aggregate NEWS scores were calculated from the documented observations and the calculated CEWS and NEWS scores were compared.

Results

Physiological observations were documented for all patients attending the ED and AAU. Heart rate, blood pressure, respiratory rate, oxygen saturation and conscious level were documented in over 95% of ED and AAU patients. Urine output was recorded for only 48% of ED and 69% of AAU patients. Aggregate CEWS scores were documented for 66% of ED and 84% of AAU patients. These were calculated accurately in 73% of ED and 79% of AAU patients. Calculation errors were eleven times more likely to result in under-scoring than over-scoring. NEWS scores were significantly higher than CEWS for the same observations and would have resulted in a 71% increase in patients requiring escalation of care in the ED and a 116% increase in AAU.

Conclusion

Concerns highlighted with CEWS were the incomplete and inaccurate recording of aggregate scores, with underscoring resulting in the potential failure to recognise deteriorating patients. It is anticipated that NEWS will be accompanied by standardised documentation and training across the NHS which will support more complete and accurate recording of physiological data. Furthermore, NEWS appears from this study to be more sensitive than CEWS, thereby minimising the chance of missed deterioration.

Introduction

It is acknowledged that acute medical admissions are often at their least stable at point of entry to care; nevertheless, patients may deteriorate at any stage. Failure to recognise patients with potential or established critical illness has implications for morbidity and mortality and hospital costs.^{1, 2} Early recognition of patients at risk of deterioration enables prompt delivery of appropriate medical intervention and escalation of care.

Early warning scores (EWS) have been advocated as a method of ensuring accurate and timely recognition of the acutely unwell patient.³⁻⁵ Their development has occurred in parallel with a programme of critical care outreach, promoted by the National Health Service (NHS) Modernisation Agency and the Department of Health.^{6, 7} There are a large number of local EWS currently in use across the United Kingdom.⁸ These vary in the physiological parameters they use to derive

their scores and in the weighting given to these parameters. Furthermore, there is local variability in the recording of physiological parameters and in the assignment and summation of EWS.^{9, 10}

The Royal College of Physicians (RCP) have proposed that the physiological assessment of all patients should be standardised across the NHS, with the establishment of a National Early Warning Score (NEWS)³ (Figure 1). The perceived advantages are to support clinical education, enhance good clinical practice, support standardised recording of vital data and to provide documentation for audit and quality control.

Chelsea and Westminster Hospital introduced the Chelsea Early Warning Score (CEWS) in February 2007. Initially, the score was used in conjunction with existing observation charts. In April 2009, a hospital-wide observation chart was introduced, into which CEWS was incorporated. The chart was colour coded with weighted scores

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National Early Warning Score (NEWS)							
PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Consciousness Level				A			V, P, or U

* a weighting score of 2 should be added for any patient requiring supplemental oxygen

Figure 1. Proposed National Early Warning Score framework (ratification ongoing); RCP 2011.

for each vital sign according to the magnitude of deviation from normal/expected values (Figure 2). A separate escalation chart was produced to guide the clinical response to the aggregate CEWS score.

At both time-points, the Critical Care Outreach Team undertook a programme of awareness-raising and education. Articles were published in the hospital newsletter and posters were distributed around the hospital. Ward based training was provided for healthcare assistants, nursing and medical staff and educational lectures were delivered at departmental meetings, junior doctor induction and grand round.

In this study we used CEWS, as an example of an established local EWSS, to identify potential challenges and solutions relevant to the consistent implementation of NEWS. The study assessed the degree of adherence to CEWS and the accuracy of data recording. CEWS and NEWS scores were compared for the study population to further highlight the implications of introducing NEWS relative to current practice.

Method

Chelsea and Westminster Hospital is a university teaching hospital in Northwest London. The Acute Assessment Unit (AAU) operates 24 hours a day, seven days a week, and accepts patients from the Emergency Department (ED) and directly from General Practitioners. Around 8,000 medical and 4,000 surgical patients pass through the Unit per year. The Unit has 36 inpatient beds, 9 Level 1 beds, and a 10-trolley assessment area.

The study was undertaken over a ten day period, including one weekend, in October 2011. Convenience sampling was used to select the study population. Medical notes were reviewed for all patients present on AAU at nine o'clock each

morning, who had been admitted in the preceding 24 hours. A total of 102 patients were identified.

The initial observation data sets recorded in the ED and AAU were obtained for each patient. Outcome measures were completeness of documentation of CEWS physiological parameters (temperature, heart rate, blood pressure, respiratory rate, oxygen saturation, conscious level, urine output), documentation of an aggregate CEWS score and accuracy of documented aggregate CEWS scores compared with a post hoc calculated CEWS score.

Using the documented observations, plus the presence/absence of supplemental oxygen therapy, an aggregate NEWS score was also calculated. The Wilcoxon signed ranks test was used to analyse differences between median aggregate CEWS and NEWS scores. The proportions of patients requiring escalation of care with CEWS and NEWS were compared. The threshold for escalation with CEWS was taken as an aggregate score ≥3 and with NEWS as an aggregate score ≥4 or a score ≥3 in any individual parameter (Figures 1 & 2). McNemar's test was used to test for differences in paired proportions for escalation between the two scoring systems.

Results

Data were collated for 102 patients, of whom 50 (49%) were male, with median age 64.5 years (range 21-99 years). Observations were recorded in AAU for all 102 patients and in the ED for 94 patients. The 8 patients without ED observations had been admitted directly to AAU.

Figure 3 demonstrates the percentage of patients in whom the parameters required for the calculation of CEWS were recorded in the ED and AAU.

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Date												CEWSS Parameters	
Time													
Temp	>40°C											3	>40°C
	>39°C											1	>38.5°C
	>38.5°C												
	38°C											0	
	37°C												
	36°C												
	<35°C											1	<35°C
Heart Rate	>170											3	>170
	160												
	150											3	>120
	140												
	130												
	120											1	>105
	105												
Blood Pressure	100											0	
	90												
	80												
	70												
	60												
	50											1	<90
	<40											3	<40
Respiration	Rhythm												
	>210											3	>200
	200											1	>180
	190												
	180												
	170												
	160											0	
SpO ₂	150												
	140												
	130												
	120												
	110												
	100											1	<95
	95											3	<80 or drop >30mmHg below baseline BP
Respiration (write rate in corresponding box)	>35											3	>35
	22-34											1	22-34
	9-21											0	
	<8											3	<8
O ₂ %/lpm	Target SpO ₂											0	
	>94												
	89-93%											1	<93%
O ₂ delivery system	<88%											3	<88%
Neuro response	Confusion (new)											1	Confusion
	Alert											0	Alert
	Verbal											1	Verbal
	Pain											3	Pain
Urine output	Unconscious												Unconscious
	>30ml/hr											0	>30ml/hr
	NPU >6 hrs or <30ml/2 hrs											1	NPU >6 hrs or <30ml/2 hrs
	(NPU = not passed urine) NPU >12 hrs or NPU >2 hrs											3	NPU >12 hrs or NPU >2 hrs
CEWSS Score												CEWSS Score	
Signature												Signature	
Pain score	n° at rest												n° at rest
	n° on movement												n° on movement

Pain Score

0 - No pain	3 - Severe pain
1 - Mild pain	4 - Unbearable pain
2 - Moderate pain	

name

date of birth

hospital number

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Figure 2a. Chelsea Early Warning Score observation chart.

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Observation Chart

Ward	Consultant/Team	Weight (kg)

Observation frequency	5 minutes	15 minutes	30 minutes	1 hour	2 hours	4 hours	other
Observation frequency	5 minutes	15 minutes	30 minutes	1 hour	2 hours	4 hours	other
Date							
Target SpO ₂							

Chelsea Early Warning Scoring System (CEWSS)

Parameter	Score of 1	Score of 3
Respiration (breaths/minute)	≥22 (max 34)	<8 or ≥35
O ₂ Saturations %	89-93%	≤88%
Heart rate (bpm)	≤50 or ≥105 (max 119)	≤40 or ≥120
Systolic blood pressure	≤95 or ≥180mmHg	≤80 or ≥200 or a drop of ≥30mmHg below baseline SBP
Temperature °C	≤35°C or ≥38.5°C (max 39.9°C)	≤34.5°C or ≥40°C
Urine output (catheterised)	<30ml/hr for 2 hours	No urine output (NPU) >2 hours
Urine output (not catheterised)	Has Not Passed Urine (HNPU) >6 hours	Has Not Passed Urine (HNPU) >12 hours
Alteration in mental status (CAVPU/GCS)	New onset confusion or responds only to voice or drop in GCS >2	Responds only to pain or unrousable or GCS 3-8

GCS - Glasgow Coma Scale
 SBP = Systolic blood pressure
 CAVPU = Confusion, Alert, Verbal, Pain, Unconscious/unrousable

Escalation criteria
 Symbols
 < - Less than ≤ - Less than or equal to
 > - Greater than ≥ - Greater than or equal to

White	Amber	Red
Not scoring Observations/care as planned No escalation required	Total score of 1 or 2 Contact FY1/FY2 Recheck observations within 30 minutes Inform nurse in charge Start interventions Set parameters Reassess	Total score of 3 or more Contact FY1/FY2 Inform SpR (medical staff must respond within 30 minutes) Inform Nurse-In-Charge Call CCOT/CSM on bleep 0104 at any time

Is the patient 'just not right'?

Bleep 0104

CCOT 0800-2000
CSM 2000-0800

Does this patient require a higher level of critical care?

Bleep 0104

(Critical Care Outreach Team)

CW1454

Figure 2b. CEWSS framework and Escalation criteria.

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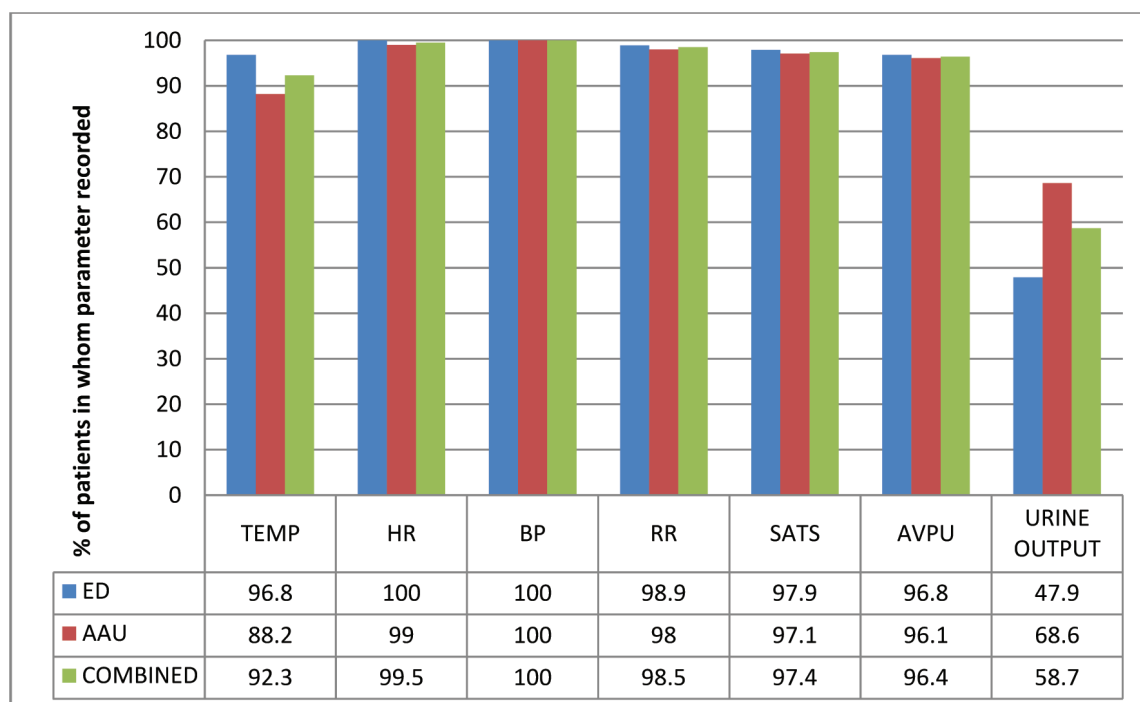


Figure 3. The percentage of patients in whom CEWS parameters were recorded in the ED, AAU and as a mean of the two areas combined.

Oxygen supplementation is not a requisite parameter for CEWS but is included in NEWS. Its presence or absence was recorded for 93/94 (98.9%) ED patients and 99/102 (97.1%) AAU patients.

An aggregate CEWS was recorded in 62/94 (66.0%) patients in the ED and 86/102 (84.3%) in the AAU. Nevertheless, 20/62 (32.3%) of ED and 23/86 (26.7%) of AAU aggregate CEWS were potentially underestimated as a result of one or more parameters having been omitted.

Considering omitted parameters as scoring zero (i.e. assuming these to be “normal”), aggregate CEWS were correctly calculated in 45/62 (72.6%)

ED patients and 68/86 (79.1%) AAU patients. 16/62 (25.8%) patients in the ED and 18/86 (20.9%) patients in AAU were underscoring. By contrast, only 1 patient in the ED (1.6%) and 2 patients in AAU (2.3%) were overscoring; thus, underscoring occurred 11.3 times more often than overscoring.

If aggregate CEWS had been calculated correctly for the total study population (scoring omitted parameters as zero), 10 more ED patients and 4 more AAU patients would have met the criteria for escalation of care than was recorded, representing a percentage increase of 142.9% and 50% respectively.

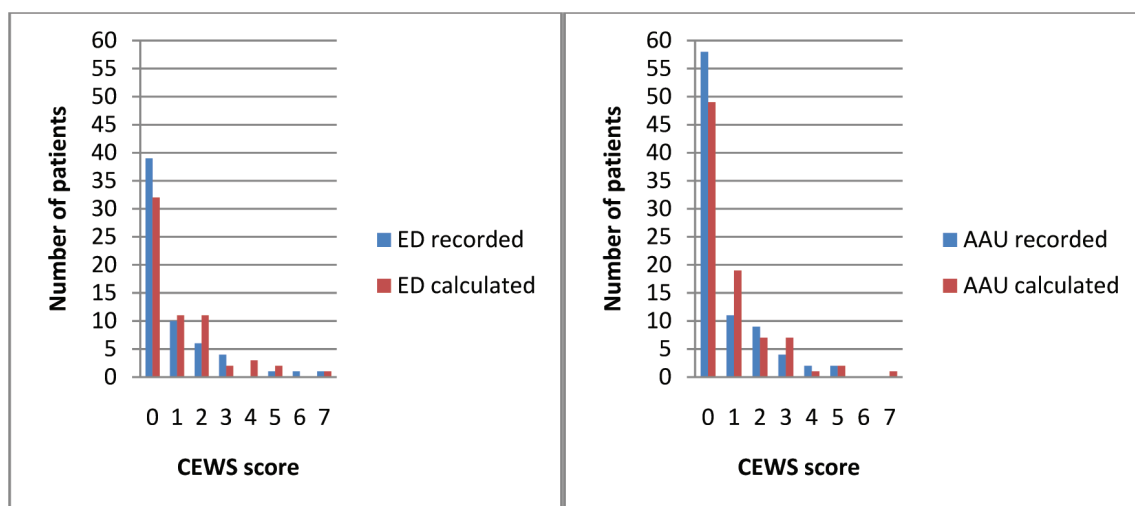


Figure 4. Aggregate CEWS for patients in the a) ED b) AAU.

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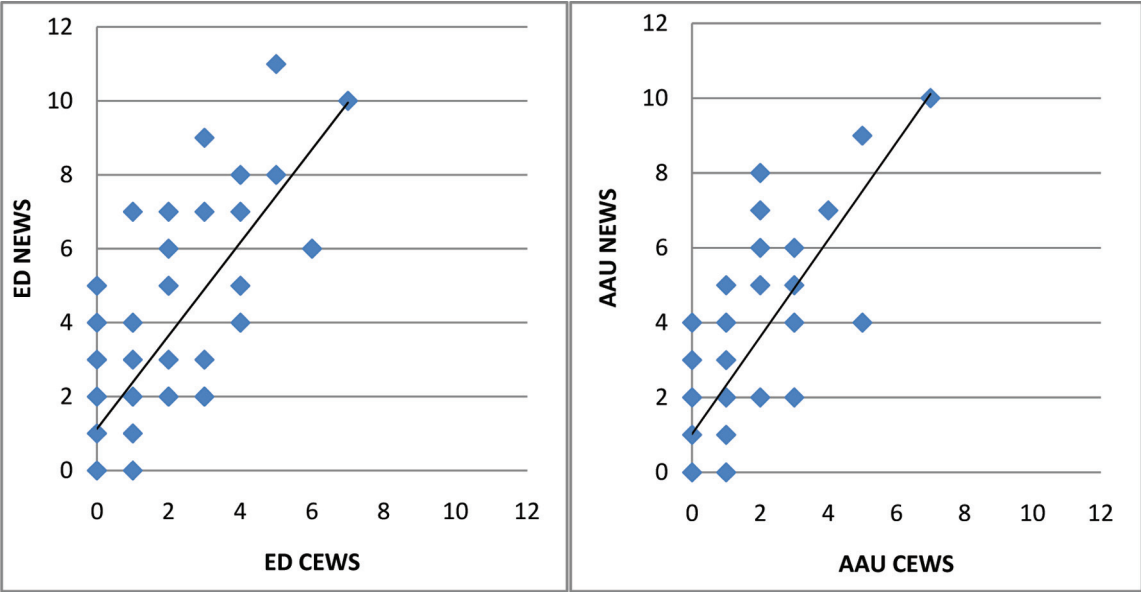


Figure 5. Aggregate CEWS vs NEWS for patients in the a) ED b) AAU.

Table 1. Comparison of median aggregate CEWS and NEWS for patients in the ED and AAU.

	MEDIAN SCORE		SIGNIFICANCE	
	CEWS	NEWS	Z VALUE	P VALUE
ED	1	2	-6.366	<0.01
AAU	0	1	-6.739	<0.01

Table 2. Comparison of the proportion of patients requiring escalation of care in the ED and AAU based on aggregate CEWS and NEWS.

	NUMBER OF PATIENTS REQUIRING ESCALATION		PERCENTAGE CHANGE	SIGNIFICANCE
	CEWS	NEWS		P VALUE
ED	17	32	88.2	<0.010
AAU	12	26	116.7	<0.010

Aggregate (calculated) CEWS are plotted against aggregate NEWS for the same populations in Figure 5, with linear trendlines generated by Microsoft Excel.

Aggregate CEWS in the ED ranged from 0-7 and aggregate NEWS ranged from 0-11. In the AAU, aggregate CEWS ranged from 0-7 and aggregate NEWS ranged from 0-10. Table 1 demonstrates significant differences between median aggregate CEWS and NEWS scores for both clinical areas. The effect of using NEWS on the proportion of patients requiring escalation of care is shown in table 2; significant increases are demonstrated in the ED and AAU.

Discussion

CEWS is an example of a locally devised EWS, which has been in use for over four years, integrated into trust-wide documentation and supported by a staff awareness and education programme. This study demonstrates that recording of physiological

parameters at point of entry to care was routine and that CEWS was calculated and documented for the majority of patients. Nevertheless, there was variability in the extent to which CEWS has been adopted across the departments admitting acutely unwell patients.

With the exception of urine output, staff in the ED more consistently recorded the parameters required to calculate an aggregate CEWS score than staff on the AAU, but were less inclined to document an aggregate CEWS and slightly less accurate when they did so. Differences between the two departments may reflect the fact that the ED uses CEWS charts only for unstable patients and those due to be admitted to hospital. Patients triaged as low risk or likely for discharge have their observations recorded on “Casualty Cards”, in which aggregate CEWS is documented separately from other baseline observations and there is no guidance on CEWS calculation. The ED staff may

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therefore be less practiced in the use of CEWS. Using standardised documentation throughout the whole patient journey, from pre-hospital to inpatient care, as is proposed with NEWS, may minimise this issue.

Urine output was the most poorly recorded parameter in both the ED and AAU. In the ED this may reflect the limited timeframe within which initial observations are performed. In both settings there may also be difficulty measuring fluid output without a urethral catheter in situ and fluid output may be recorded preferentially on dedicated fluid balance charts. The relatively poor recording of urine output mirrors previous studies which have shown that even in deteriorating patients, fewer than 50% have their fluid output documented.^{11, 12} In agreement with previous NICE guidance on the optimum assessment of acutely unwell patients,⁵ the RCP have not included urine output in NEWS.

In comparison with previous studies,^{13, 14} respiratory rate (traditionally seen as an early marker of clinical deterioration) was well recorded in both the ED and AAU. The use (or not) of supplemental oxygen was recorded in 99% of ED and 97% of AAU notes, despite this not being a mandatory requirement for CEWS. In NEWS a weighting score is added for any patient requiring supplemental oxygen. Our findings suggest this parameter may be readily incorporated into existing practice as a trigger for the escalation of care.

Aggregate CEWS score was documented in only 66% of ED notes and 84% of AAU notes. In comparison with another university teaching hospital, the Royal Infirmary of Edinburgh, where aggregate EWS was documented in 55% of patients causing clinical concern,¹⁰ it appears documentation at Chelsea and Westminster Hospital may be more routine. Nevertheless, any failure to calculate an aggregate score may result in a failure to recognise the deteriorating patient or trigger the appropriate clinical response. Thus the adoption and accurate completion of NEWS may be as relevant to its success as the nature of the scoring systems itself.

It has been suggested that comprehensive staff training and familiarity with EWS may enhance documentation.¹⁵ Whilst CEWS was supported by an intensive education programme, it is recognised that within London hospitals there is internal migration and circulation of health professionals,¹⁶ who bring varied levels of competence in the use of EWS. Furthermore, such competence may be limited to highly individualised local EWS. The introduction of NEWS will facilitate standardisation of training and education, with the potential to incorporate such training earlier into clinical careers. Standardised training across the spectrum of healthcare professionals is likely to be beneficial not only in EWS documentation but also interpretation.

When recorded, aggregate CEWS was frequently underscored. The implication was that patients

may receive suboptimal care through lack of recognition of clinical urgency. Existing research suggests underscoring more commonly arises from the inaccurate assignation of individual vital sign parameters rather than summation of the aggregate scores.¹⁷ The RCP have recommended that NEWS charts should be colour coded to provide both numeric and visual prompts. Furthermore, NEWS will minimise the impact of miscalculation through the introduction of a dual method for triggering a clinical alert; firstly an aggregate NEWS score above a set threshold and secondly an extreme variation of any single physiological parameter.

Evidence suggests that the use of hand-held computers may also improve the accuracy and efficiency of EWS documentation in acute hospital care and that this method is acceptable to nursing staff.¹⁸ Computer-based systems may also be of merit in the collation of data to validate and optimise the performance of NEWS.¹⁹

In this study, NEWS was demonstrated to generate significantly higher aggregate scores than CEWS for the same patient data sets. Despite the higher escalation thresholds set for NEWS, a significantly greater percentage of patients would have required escalation using NEWS than CEWS for the same observations, suggesting NEWS to be a more sensitive model. An increase in sensitivity has the potential to result in a loss of specificity and hence inappropriate escalation of care in stable patients. Accordingly, there may be a risk of over-burdening critical care services. The advantage of a nationwide EWS is that large scale audit will be possible to define more clearly the sensitivity and specificity of NEWS and to optimise the scoring system and escalation thresholds as data becomes available.

Finally, this study demonstrates differences in EWS scores for the study population as they move between the ED and AAU. Whilst this is to be expected, with clinical intervention hopefully resulting in stabilisation as patients progress through the system, this supports the RCP recommendation that a single EWS i.e. NEWS should be used throughout all clinical areas in the NHS to ensure parity of assessment and recognition of true improvement or deterioration.

Limitations

This study provides a snapshot of local EWS use over a short period in a single centre. The results should therefore be extrapolated with caution to a wider population. Whilst it is hoped that our convenience sample approximated to a random selection of patients admitted to the ED and AAU, the use of this methodology may also have introduced selection bias.

This study did not analyse escalation measures undertaken by clinical staff and therefore cannot comment whether incomplete or inaccurate documentation of CEWS equated to an inferior

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clinical response. Analysis of the patient journey would allow evaluation of concerns that even when threshold criteria for EWS are achieved, the clinical response may be delayed or inappropriate.

Conclusion

Pending the introduction of NEWS, as recommended by the RCP, this study evaluated the use of an established local EWS. Concerns highlighted with CEWS were the incomplete and inaccurate recording of aggregate scores, with

underscoring resulting in a potential failure to recognise deteriorating patients. This may have been the result of staff favouring documentation other than CEWS, inconsistent staff training and clinical experience. The study further suggests that NEWS may be a more sensitive measure of clinical deterioration than CEWS. Through embedded documentation, standardised training and ongoing clinical governance, NEWS will seek to address the obstacles to EWS use identified at a local level.

References

- Garrard C, Young D. Suboptimal care of patients before admission to intensive care: is caused by a failure to appreciate or apply the ABCs of life support. *BMJ* 1998; **316**(7148): 1841–2.
- McGloin H, Adam SK, Singer M. Unexpected deaths and referrals to intensive care of patients on general wards. Are some cases potentially avoidable? *J R Coll Physicians Lond* 1999; **33**(3): 255–9.
- RCP. Acute medical care. The right person, in the right setting – first time. London, 2007.
- NHS QIS. Emergency Medical Admissions Scoping Group Final Report. Scotland, 2004.
- NICE. CG 50: Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital. London, 2007.
- DH. Comprehensive critical care – a review of adult critical care services. London, 2000.
- DH & NHS Modernisation Agency. The National Outreach Report 2003: Critical care outreach 2003 – progress in developing services. London, 2003.
- Patterson C, Maclean F, Bell C, Mukherjee E, Bryan L, Woodcock T, *et al.* Early warning systems in the UK: variation in content and implementation strategy has implications for a NHS early warning system. *Clin Med* 2011; **11**(5): 424–7.
- Smith AF, Oakey RJ. Incidence and significance of errors in a patient ‘track and trigger’ system during an epidemic of Legionnaires’ disease: retrospective casenote analysis. *Anaesthesia* 2006; **61**(3): 222–8.
- Gordon CF, Beckett DJ. Significant deficiencies in the overnight use of a Standardised Early Warning Scoring system in a teaching hospital. *Scottish medical journal* 2011; **56**(1): 15–8.
- Chellel A, Fraser J, Fender V, Higgs D, Buras-Rees S, Hook L, *et al.* Nursing observations on ward patients at risk of critical illness. *Nurs Times* 2002; **98**(46): 36–9.
- Jonsson T, Jonsdottir H, Moller AD, Baldursdottir L. Nursing documentation prior to emergency admissions to the intensive care unit. *Nurs Crit Care* 2011; **16**(4): 164–9.
- NCEPOD. An acute problem? A report of the National Confidential Enquiry into Patient Outcome and Death. 2005.
- Cretikos MA, Bellomo R, Hillman K, Chen J, Finfer S, Flabouris A. Respiratory rate: the neglected vital sign. *Med J Aust* 2008; **188**(11): 657–9.
- McBride J, Knight D, Piper J, Smith GB. Long-term effect of introducing an early warning score on respiratory rate charting on general wards. *Resuscitation* 2005; **65**(1): 41–4.
- Young R WH, Buchan J. Health Professional Mobility in Europe and the UK: A Scoping Study of Issues and Evidence, 2010.
- Edwards M MH, Van Leuvan C, Mitchell I. Modified Early Warning Scores: inaccurate summation or inaccurate summation of score? *Crit Care* 2010; **14**(1).
- Mohammed M, Hayton R, Clements G, Smith G, Prytherch D. Improving accuracy and efficiency of early warning scores in acute care. *Br J Nurs* 2009; **18**(1): 18–24.
- Prytherch DR, Smith GB, Schmidt PE, Featherstone PI. ViEWS – Towards a national early warning score for detecting adult inpatient deterioration. *Resuscitation* 2010; **81**(8): 932–7.