Impact of implementation of the National Early Warning Score on patients and staff

The National Early Warning Score (NEWS) has been criticized for increasing workload and decreasing attention to signs of deterioration. This study highlighted the significant mortality of ward patients referred to critical care, and showed that the NEWS identified high-risk patients without increasing workload or worsening outcomes.

There is a recognized association between abnormal physiology and adverse outcomes (Kause et al, 2004; Harrison et al, 2006): patients who suffer cardiopulmonary arrest or who die in hospital generally have abnormal physiological values – known as vital signs – recorded in the preceding period, as do patients requiring transfer to the critical care unit (Kause et al, 2004; Harrison et al, 2006).

As a consequence, from 2000 onwards, most UK hospitals introduced some form of early warning scoring system based on measurement of vital signs to aid recognition of deteriorating ward patients, although there were few formal evaluations of the effects of early warning scoring on processes or outcomes. By 2008, at least 72 different early warning scoring systems had been developed (Smith et al, 2008a,b), and there were probably many more unreported versions. However, the considerable variation in practice was viewed as a potential risk to patient safety (Patterson et al, 2011), prompting the Royal College of Physicians (2012) to recommend implementation of a single National Early Warning Score (NEWS). The NEWS used parameters found in some of the previous systems (*Table 1*), with scores ascribed to vital sign measurements indicating various levels of risk of adverse outcomes added together to make a total 'aggregate weighted score'. The NEWS scores and values were derived from analysis of 35 585 acute admissions – and 198 755 observation sets – at Portsmouth Hospitals (Prytherch et al, 2010). The Royal College of Physicians (2012) also recommended minimum standards for hospital patient monitoring and the responses required for different aggregate scores.

Table 1. Parameters used in the National Early Warning Score (NEWS)

Respiratory rate
Oxygen saturations
Temperature
Systolic blood pressure
Pulse rate
Level of consciousness
Supplemental oxygen administration

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Notwithstanding support from key professional bodies, the concept of standardized early warning scoring had some critics (McGinley and Pearse, 2012; Teasdale, 2012). Many hospitals had invested considerable effort in developing and embedding their own early warning scoring systems. There were concerns that the NEWS might be too sensitive, so would unnecessarily increase patient referrals and overload clinical services (Khan and Carle, 2014). Conversely, there was anxiety that the focus on physiological parameters might prevent ward staff using what are known to be useful subjective criteria as a basis for referral (Chen et al, 2010), e.g. simply being 'worried' about a patient.

Aims of study

The authors investigated the impact of implementing the NEWS on both patients and staff at University College Hospital, with a particular focus on patients with sepsis. A previous analysis of 644 ward patients referred to the critical care outreach service found that about half (52.7%) had a likely or very likely diagnosis of sepsis (Harris, 2013). The null hypotheses were that the implementation of NEWS at University College Hospital would not significantly change:

- Identification of deteriorating patients and subsequent requirement for critical care admission
- Identification of patients with sepsis, or the proportion of patients with sepsis deteriorating to severe sepsis and septic shock
- All-cause mortality or mortality from sepsis
- Staff workload with regards to number of referrals to critical care services, duration of follow up required following referral and admission rates to the intensive care unit.

Study site

University College Hospital is the largest hospital of University College London Hospitals NHS Foundation Trust. Over 125 000 patients attend the University College Hospital emergency department each year, and there are 586 inpatient beds – including 35 in critical care – and another 151 for maternity inpatients. A local early warning scoring system had been developed and was in use in the Trust from 2001 as a means of identifying deteriorating ward patients to primary medical teams and the critical care outreach service (*Table 2*). The outreach service at University College Hospital is available at all times throughout the hospital, and is known as the Patient Emergency Response & Resuscitation Team (PERRT). Referral of all at-risk and deteriorating ward patients to the PERRT has become routine practice at University College Hospital, with regular audits showing that few if any of these patients were not known to the team.

Implementation of NEWS at University College Hospital

In February–April 2014, despite organizational confidence in the existing system, it was decided to change to the NEWS model on all non-obstetric adult wards across the Trust. Time was taken beforehand to develop, test, evaluate and agree a user-friendly vital signs chart incorporating the NEWS parameters and values. The agreed responses to increasing NEWS scores at University College Hospital can be found in *Table 3*. Training in the calculation and use of the NEWS was provided to all ward staff in order to facilitate effective implementation, recognizing that it was a significant change from the previous system. The value of using a standardized tool based on the best published evidence was emphasized, as was the fact that review of previous cases of delayed escalation suggested that the NEWS would have signalled deterioration at an earlier point.

Method

A retrospective comparison observational study was conducted assessing clinical outcomes of consecutive patients referred to the University College Hospital PERRT before implementation of the NEWS over 2 months in 2013, and consecutive patients referred after implementation over 2 months in 2014. All ward patients aged 16 years and over referred to the PERRT team on the basis of the PERRT calling criteria then in use during May–June 2013 and those referred using NEWS criteria in May–June 2014 were included. Patients under 16 years or known to be pregnant were excluded, together with those simply receiving routine PERRT follow up after discharge from critical care and those with incomplete records. Both paediatric and obstetric patients have their own early warning scoring chart in practice, which differs from that of the NEWS chart in terms of physiological ranges and clinical outcomes. These cohorts were also excluded from the original NEWS study (Prytherch et al, 2010).

Table 2. The original University College Hospital Patient Emergency Response & Resuscitation Team (PERRT) calling criteria

(Single parameter system, i.e. referral can be made on the basis of just one of the criteria below)
■ Respiratory rate >25 or <8 breaths/min
■ Oxygen saturation <90% on 35% or more inspired oxygen
■ Systolic blood pressure <90 or >200 mmHg (or a sustained fall >40 mmHg from normal value)
■ Pulse rate >125 or <50 beats/min
■ Sustained alteration in conscious level
■ Patient looks unwell or the clinician feels worried about his/her clinical condition

Table 3. Required actions in response to NEWS score

Total 0	Low risk	■ Vital signs at least 12-hourly. Repeat sooner if concerns or adverse signs
Total 1–4	Low risk	■ Vital signs at least 4-hourly. Consider need for fluid input and output charting
Total 5–6 or any single score of 3	Medium risk	■ Registered nurse to urgently inform patient's medical or surgical team (night nurse practitioner at night) and PERRT ■ Urgent assessment by medical, surgical team or PERRT: decide need for further escalation ■ Vital signs at least hourly ■ Ensure fluid input and output charted
Total 7 or more	High risk	■ Immediately inform patient's medical or surgical team (night nurse practitioner at night) and PERRT ■ Rapid response required from senior doctor. In medical emergency or cardiorespiratory arrest, call 2222

NEWS = National Early Warning Score; PERRT = Patient Emergency Response & Resuscitation Team

Comparing referral rates and clinical outcomes

Data were collected from a proprietary database (Mela Solutions 'MedICUs Outreach') used by PERRT to record all patient encounters. Information collected included:

- Patient demographics and reason for hospital admission
- Date, time and location of referral – and referrer details
- Reason for PERRT referral
- Subsequent location
- Date of discharge from PERRT
- Number of days of PERRT follow up.

NEWS scores at the point of referral of pre-implementation patients were calculated retrospectively from the vital sign observations recorded in the database, while NEWS scores of patients in the post-implementation period were available anyway. Data about each patient were also collected from the 'NHS spine' (the National Health and Social Care Information Centre set of databases for the NHS), including: hospital discharge date, and date and time of death – if this occurred – allowing mortality at different time points to be determined. A statistical *t*-test and Levene's test for equality of variances was used to test

for the true difference between means, and Pearson's chi-squared analysis was used to test for true difference between categorical data. R-squared was used to determine how close the data were to the fitted regression line. All statistical tests were assessed at a significance level of 0.05 using SPSS software v. 22 (SPSS Inc., Chicago, IL, USA).

Study measures

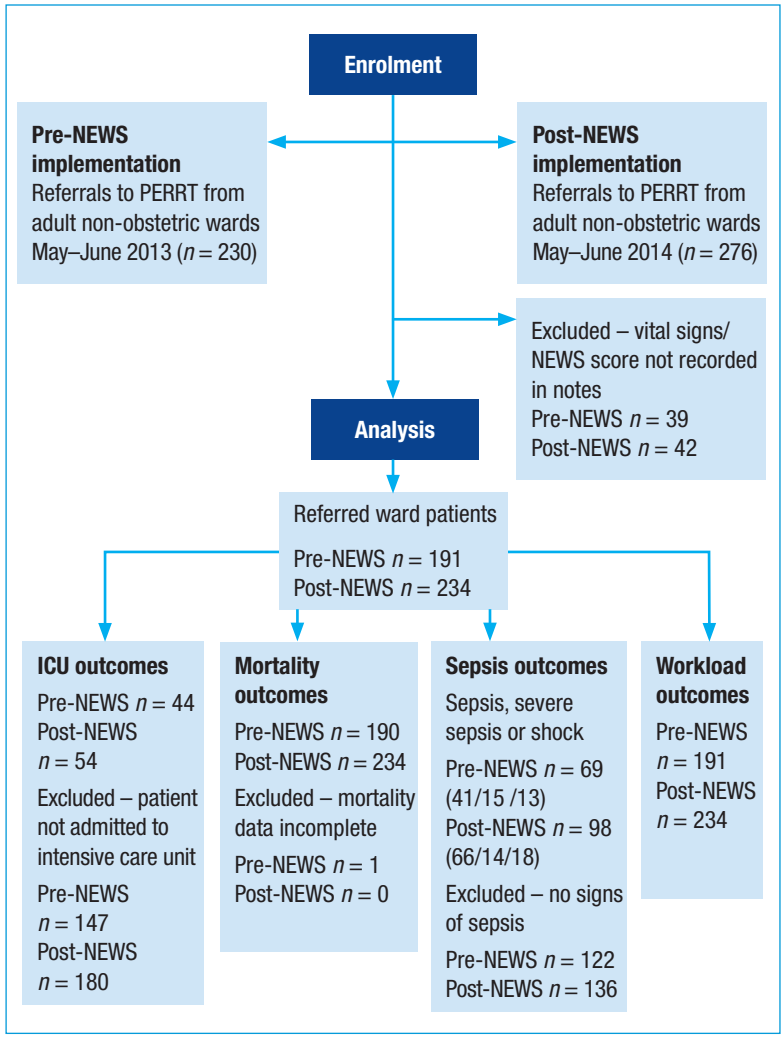
As in the original validation of NEWS (Prytherch et al, 2010), patterns of unplanned admissions to critical care and in-hospital mortality were assessed. The numbers, progression and outcomes of patients with sepsis were also investigated. Severity of sepsis was classified using the then standard definitions (Angus and van der Poll, 2013). Finally, workload was examined as indicated by patterns of referral to the PERRT, transfers to the critical care unit and the length of PERRT follow-up time required for referred patients.

Results

The records of 230 patients referred to the University College Hospital PERRT before implementation of the NEWS and 276 patients referred after implementation of NEWS were assessed in the first instance. *Figure 1* displays the enrolment and analysis schema and shows the various sub-groups and exclusions as appropriate.

Many of the patient characteristics, patient flow and outcome measures were not statistically significantly different before or after NEWS implementation.

Figure 1. Study enrolment and analysis (inclusion and exclusion). NEWS = National Early Warning Score; PERRT = Patient Emergency Response & Resuscitation Team.



Patient characteristics, flow, and workload

There was a 10% increase in hospital admissions to University College Hospital in May–June 2014 (post-NEWS) compared to the previous year (pre-NEWS). The number of referrals to PERRT also increased. However, there was no statistically significant difference before or after NEWS implementation in the proportion of patients referred to PERRT (normalized per 1000 hospital admissions) and clinical outcomes, as demonstrated in *Table 4*.

Of patients referred to PERRT and then admitted to critical care, those transferred within 24 hours of referral had a mean initial NEWS score of 6.96, while those transferred later – at 24–48 hours – had a mean initial NEWS score of 5.80. This was not seen to be statistically significant. Later transfers to critical care were the result of a decision at referral not to escalate rather than to critical care bed availability. When aggregated, the NEWS scores of patients kept on the ward and those admitted to the critical care unit were 6.25 and 6.51 respectively.

Mortality

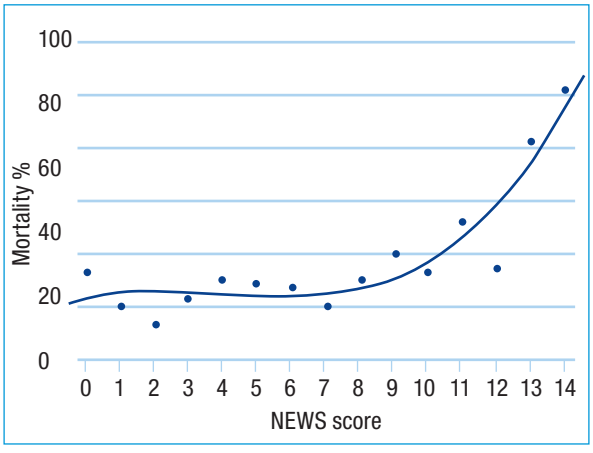
The overall hospital mortality of patients referred to PERRT was 20.4%. A total of 9.1% of patients died within 7 days, and 17.0% within 30 days. Again, there were no statistically significant differences in these outcomes before or after NEWS implementation. *Figure 2* shows the hospital mortality of all study patients (before and after NEWS implementation), according to the NEWS score at first assessment by PERRT. There is a positive correlation (R^2=0.854) between higher NEWS scores and hospital mortality. Those with initial NEWS scores of 0 up to 8 had a similar and substantial (approximately 20%) mortality rate despite some having relatively low levels of physiological derangement. At NEWS scores of 9 or above – albeit with a decreasing sample size – mortality rates demonstrate a steep incremental rise.

Patients with sepsis

Overall, 39.3% of ward patients referred to PERRT were diagnosed with sepsis. NEWS scores at referral of patients with sepsis averaged 7 and above – higher than the average for all referred patients – putting patients with sepsis in the 'high risk' group requiring immediate escalation and a rapid response in the NEWS protocol.

Of patients with sepsis, 78.7% had sepsis (without features of severe sepsis or shock) and 21.3% had severe sepsis; 20.58% were admitted to critical care. The hospital mortality of patients referred with sepsis was 25% (very similar to the 26.9% mortality reported in the National

Figure 2. Hospital mortality for each National Early Warning Score (NEWS) score.



Confidential Enquiry into Patient Outcome and Death (2015) into care received by patients with sepsis). There were no statistically significant differences in these variables before or after NEWS implementation.

Discussion

This analysis found that introduction of the NEWS at University College Hospital did not increase staff workload in terms of the proportion of the ward that were escalated to the critical care outreach service (the PERRT), the number of days of follow up required, or the proportion of patients needing admission to the critical care unit. There was also no change in key outcome measures such as length of stay or mortality at different time points.

Nonetheless, the 20.4% hospital mortality of patients referred to the PERRT is striking, albeit similar to the mortality rates – approximately 25% overall – found in other studies (Jones, 2014). These data reinforce the fact that these are high-risk patients, all considered by ward teams to be appropriate for escalation, even though only 23% were then admitted to critical care. This may reflect that it can be difficult to differentiate seriously ill patients who will benefit from aggressive treatments from those who will not; and that many hospital patients are actually in the last months of life: a prevalence cohort study of 10 743 inpatients in 25 Scottish hospitals found that 8.9% died within 30 days, and 21.2% in 6 months (Clark et al, 2014).

The NEWS scores of patients referred to the PERRT at University College Hospital positively correlated with mortality, as would be expected from the main published analysis of the NEWS system, which found the area under the receiver-operating characteristic for NEWS for death within 24 hours was 0.894 (Smith et al, 2013).

However, the authors did not find that NEWS scores at referral to PERRT differentiated those patients judged appropriate to remain on the ward from those transferred to the critical care unit. Therefore, although high NEWS scores were generally associated with high mortality, other factors were used in decisions about which patients should be transferred to the intensive care unit.

Table 4. Demographics and patient outcomes

	Pre-NEWS (May/June 2013)	Post-NEWS (May/June 2014)	*P* value
Mean age (years)	63.7	61.4	0.288
Proportion of male patients (%)	57.6	49.6	0.099
Referrals to PERRT (per 1000 hospital admissions)	32.8	36.5	0.260
Referrals to PERRT then transferred to intensive care unit (%)	23.0	23.1	0.992
Mean NEWS at referral to PERRT	6.39	6.24	0.627
Mean NEWS at referral to PERRT of patients later transferred to critical care	6.70	6.35	0.582
Mean NEWS at referral to PERRT of patients not transferred to critical care	6.30	6.20	0.767
Mean duration of PERRT follow up (days)	2.82	2.68	0.482
Median length of intensive care unit admission (days)	4	4	–

NEWS = National Early Warning Score; PERRT = Patient Emergency Response & Resuscitation Team

Study limitations

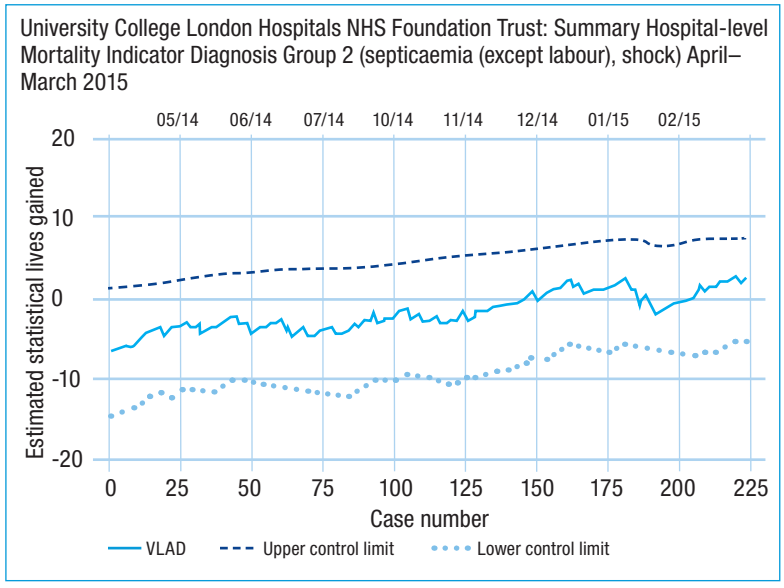
The post-NEWS evaluation occurred within 3 months of implementation, which may not have been enough time for the system to be completely embedded or its full effects to become apparent. It is also the case that the Trust has generally done well on indicators of patient safety, with consistently low inpatient cardiac arrest rates (0.9/1000 admissions in 2014–15; National Cardiac Arrest Audit, 2015), and among the lowest three Summary Hospital-level Mortality Indicators of any NHS trust in 2012, 2013 and 2014 (Health and Social Care Information Centre, 2015). This might mean that it would be relatively difficult to produce a significant improvement in outcomes. Nonetheless, post-hoc analysis of the outcomes of University College Hospital patients with sepsis in the following year to March 2015 suggested a (non-significant) improvement in mortality (*Figure 3*). The data presented here represent all patients coded for sepsis in the Summary Hospital-level Mortality Indicator data set. Summary Hospital-level Mortality Indicator is an indicator used to analyse mortality at trust level across the NHS in England. A standard methodology is used to assess all patients who die in hospital or within 30 days of discharge. The observed outcome (0 for survived, 1 for died) is subtracted from the calculated risk of death occurring in hospital or within 30 days of discharge. This is plotted cumulatively. An upward trend indicates a run of fewer deaths than expected.

It should be noted that all patients in this study diagnosed with sepsis (both pre- and post-NEWS implementation) were diagnosed using the criteria in use at the time (developed in 2001 (Angus and van der Poll, 2013)). These criteria have since been recognized

KEY POINTS

- The National Early Warning Score (NEWS) accurately identified high-risk patients.
- Ward patients referred to critical care have high mortality rates.
- Implementation of NEWS has not lead to worse outcomes or increased workload for critical care outreach services.

Figure 3. Variable life adjustment display (VLAD) chart of sepsis patients' lives gained.



to be over-sensitive and insufficiently specific to allow identification of patients likely to have adverse outcomes. New definitions of sepsis were published in early 2016, based on retrospective analyses of several large electronic health record databases (Singer et al, 2016). These authors re-emphasized the importance of early identification of abnormal physiology, and highlighted the particular value of three of the NEWS criteria in indicating patients likely to have sepsis (if infection is also present); that is, tachypnoea, hypotension and altered consciousness. However, the use of the NEWS system as a tool to aid identification of high-risk patients with sepsis has yet to be tested prospectively.

Conclusions

This evaluation of the early impact of NEWS on patients and staff found no negative effects on clinical processes and outcomes, or for staff and system workload. In particular patients with sepsis had high mortality rates, in line with other studies, further exemplifying this as a poor outcome episode for hospital patients. **BJHM**

Conflict of interest: Mr J Welch was a member of the Royal College of Physicians National Early Warning Score Development & Implementation Group; Dr D Gamble and Dr S Farenden: none.

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