

EARLY WARNING SCORE–GUIDED PREDICTION OF CLINICAL DETERIORATION AND MORTALITY IN CRITICALLY ILL PATIENTS

A Prospective Observational Study

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Abstract— Background: Failure to recognise clinical deterioration in a timely manner remains a preventable contributor to adverse outcomes among hospitalised patients. Track-and-trigger early warning scores (EWS) such as the National Early Warning Score 2 (NEWS2) are widely recommended, but prospective evidence from critical-care and high-dependency settings outside high-income countries remains limited. Methods: In this prospective observational study, 200 consecutive adult patients admitted to the critical care/high-dependency unit of a tertiary-care teaching hospital had an admission NEWS2 score calculated within one hour of admission. Patients were followed to hospital discharge or death for the co-primary outcomes of clinical deterioration within 48 hours (a composite of unplanned ICU transfer, rapid-response activation or cardiac arrest) and in-hospital mortality. Discriminative performance was assessed by the area under the receiver-operating-characteristic curve (AUROC), and independent predictors of mortality were identified by multivariable logistic regression. Results: Overall in-hospital mortality was 12.0% (24/200) and 48-hour deterioration occurred in 21.5% (43/200). Mortality rose from 3.3% in the low-risk band (NEWS2 0–4) to 20.0% in the medium-risk band (5–6) and 30.2% in the high-risk band (≥ 7) ($\chi^2 = 24.44$, $p < 0.001$). NEWS2 discriminated in-hospital mortality with an AUROC of 0.82 (95% CI 0.73–0.90) and 48-hour deterioration with an AUROC of 0.87 (95% CI 0.82–0.92). On multivariable analysis, each one-point increment in admission NEWS2 was independently associated with mortality (adjusted odds ratio 1.53, 95% CI 1.24–1.88, $p < 0.001$), independent of age and comorbidity burden. Conclusion: An admission NEWS2 score obtained at the bedside provided good discrimination for both short-term deterioration and in-hospital mortality in a critically ill cohort, supporting its use as a low-cost triage and rapid-response trigger tool in resource-limited critical care settings.

Index Terms— Early warning score; NEWS2; clinical deterioration; critically ill patients; in-hospital mortality; risk stratification; prospective observational study.

1. INTRODUCTION

Clinical deterioration on general wards and in critical care areas is frequently preceded, by several hours, by detectable abnormalities in routinely measured vital signs [1], [2]. Delayed recognition of these abnormalities — and delayed escalation of care — has repeatedly been identified as a preventable contributor to unplanned intensive care unit (ICU) admission, cardiac arrest and in-hospital death [4]. Track-and-trigger early warning score (EWS) systems were developed to standardise the bedside detection of physiological deterioration and to prompt timely escalation, independent of the experience of the assessing clinician.

The Modified Early Warning Score (MEWS), first validated by Subbe et al. in medical admissions, demonstrated that a simple aggregate score derived from five physiological variables could identify patients at increased risk of ICU admission and death [1]. This work was subsequently developed by the Royal College of Physicians (London) into the National Early Warning Score (NEWS) and, in its current form, NEWS2 — a seven-parameter score (respiratory rate, oxygen saturation, supplemental oxygen use, temperature, systolic blood pressure, heart rate and level of consciousness) that has been adopted as a national standard for adult track-and-trigger monitoring in several health systems [2].

A substantial body of retrospective and prospective work supports the discriminative ability of NEWS/NEWS2 for deterioration-related outcomes. Smith et al. showed that NEWS outperformed several earlier scoring systems in

discriminating patients at risk of cardiac arrest, unanticipated ICU admission and death [4]. In a prospective cohort of patients hospitalised with Covid-19, Myrstad et al. reported that an admission NEWS2 ≥ 6 predicted in-hospital mortality with an AUROC of 0.79 and severe disease with an AUROC of 0.82, outperforming qSOFA, SIRS and CRB-65 [3]. A systematic review by Alam et al. similarly concluded that EWS-guided escalation protocols were associated with improved recognition of deterioration, although the certainty of evidence for hard outcomes such as mortality remained moderate and was drawn predominantly from high-income health systems [5].

Despite this evidence base, prospective data describing the performance of NEWS2 specifically within critical-care and high-dependency units of tertiary hospitals in low- and middle-income settings remain comparatively sparse, and existing validation work in these settings has been limited in sample size and scope [6]. Since resource availability, staffing ratios and case-mix in such units often differ materially from the settings in which NEWS2 was originally derived and validated, local prospective evaluation is required before the score can be confidently embedded into rapid-response and triage protocols.

We therefore conducted a prospective observational study to evaluate whether the admission NEWS2 score independently predicts clinical deterioration within 48 hours and in-hospital mortality among adults admitted to a critical care/high-dependency unit, and to quantify its discriminative performance against these outcomes.

2. NEED OF THE STUDY

Most of the foundational validation studies for NEWS/NEWS2 were conducted in the United Kingdom and other high-income health systems, in which nurse-to-patient ratios, the availability of rapid-response teams and the underlying case-mix of admissions differ from those typical of tertiary-care hospitals in resource-constrained settings [1]–[4]. A recent systematic review of prognostic scoring tools for ICU triage and mortality in low- and middle-income countries highlighted persistent gaps in locally generated, prospective evidence and cautioned against uncritical extrapolation of performance metrics derived elsewhere [6].

From a practical standpoint, a track-and-trigger score that can be calculated from bedside observations already routinely recorded by nursing staff — without additional laboratory tests or specialist input — is attractive precisely in settings where diagnostic and specialist resources are limited and where rapid, protocol-driven escalation may compensate for constrained staffing. Locally generated evidence on the discriminative performance of NEWS2, the outcome rates across its risk bands, and the incremental value of the score over baseline patient characteristics (age, comorbidity burden) is therefore required to inform whether — and how — the score should be embedded into local rapid-response and ICU-admission protocols. This study was designed to address that evidence gap.

3. RESEARCH METHODOLOGY

3.1 Study Design and Setting

This was a single-centre, prospective observational cohort study conducted in the critical care and high-dependency unit of a tertiary-care teaching hospital over a six-month period. The study followed the applicable reporting principles for observational cohort studies (STROBE).

3.2 Study Population

Consecutive adult patients (aged ≥ 18 years) admitted to the critical care/high-dependency unit during the study period were screened for eligibility. Patients were excluded if they were younger than 18 years, if the total unit stay was expected to be less than 24 hours (e.g., short-stay post-procedural observation), or if informed consent could not be obtained or admission physiological data were incomplete. Of 246 patients assessed for eligibility, 46 were excluded and 200 patients constituted the final analytic cohort (Fig. 1). A sample of 200 was considered adequate, on the basis of comparable published validation cohorts, to estimate outcome proportions of 10–30% with a 95% confidence interval half-width of approximately 4–6 percentage points and to support a multivariable model with three to four candidate predictors.

3.3 Data Collection

Within one hour of unit admission, a trained nurse or resident physician recorded the seven physiological parameters comprising NEWS2 — respiratory rate, peripheral oxygen saturation, use of supplemental oxygen, body

temperature, systolic blood pressure, heart rate and level of consciousness (assessed on the Alert–Confusion–Voice–Pain–Unresponsive, ACVPU, scale) — and the aggregate NEWS2 score (range 0–20) was calculated according to the standard Royal College of Physicians scoring matrix [2]. Patients were stratified a priori into low- (0–4), medium- (5–6) and high-risk (≥ 7) bands consistent with standard NEWS2 escalation thresholds. Baseline demographic and clinical data (age, sex, primary admission diagnosis, comorbidity count) were recorded from the admission record. Patients were followed prospectively to hospital discharge or death for: (i) clinical deterioration within 48 hours of admission, a composite of unplanned transfer to a higher level of care, activation of the rapid-response/medical emergency team, or cardiac arrest; (ii) ICU admission during the index hospitalisation; (iii) in-hospital mortality; and (iv) total length of hospital stay.

3.4 Statistical Analysis

Continuous variables are summarised as mean $\pm$ standard deviation or median (interquartile range) as appropriate, and categorical variables as frequencies and percentages. NEWS2 scores were compared between survivors and non-survivors using the Mann–Whitney U test. Associations between NEWS2 risk category and categorical outcomes were assessed using the chi-square test. The discriminative ability of the admission NEWS2 score for mortality and for 48-hour deterioration was quantified using the area under the receiver-operating-characteristic curve (AUROC), with 95% confidence intervals obtained by bias-corrected bootstrap resampling (2000 replicates). Sensitivity, specificity, positive predictive value and negative predictive value were calculated at pre-specified clinically relevant cut-points. Independent predictors of in-hospital mortality were identified using multivariable logistic regression, adjusting for age and comorbidity count, with results expressed as adjusted odds ratios (aOR) with 95% confidence intervals. A two-sided p-value < 0.05 was considered statistically significant. All analyses were performed in Python 3.11 (pandas, SciPy, scikit-learn and statsmodels).

3.5 Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee prior to enrolment and written informed consent was obtained from each participant or their legally authorised representative. Patient data were anonymised prior to analysis and handled in accordance with institutional data-protection policy.

4. RESULTS AND DISCUSSION

4.1 Patient Flow and Baseline Characteristics

Of 246 patients assessed for eligibility, 200 were enrolled and analysed (Fig. 1). The mean age of the cohort was 55.0 ± 14.3 years and 121 (60.5%) were male. The commonest admission diagnoses were sepsis/septic shock (27.0%) and respiratory failure (24.5%). The mean admission NEWS2 score was 4.1 ± 2.9 ; 122 patients (61.0%) fell into the low-risk band, 35 (17.5%) into the medium-risk band and 43 (21.5%) into the high-risk band (Table 1).

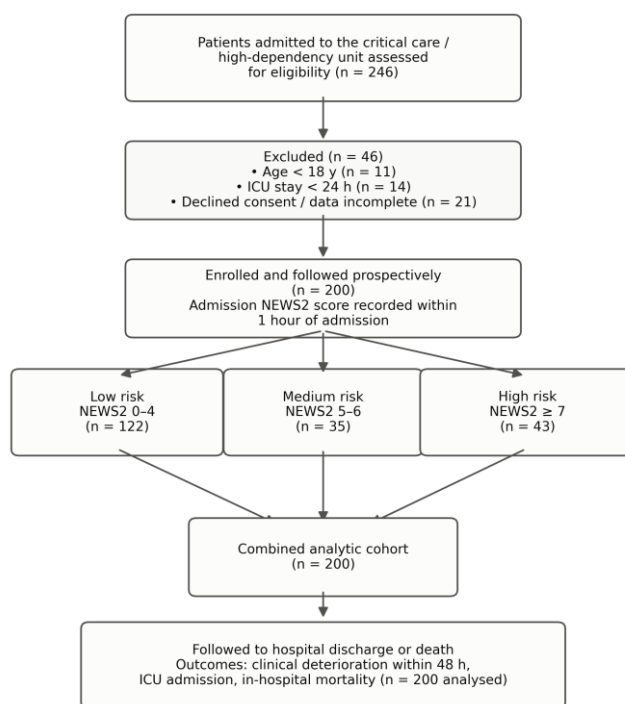


Figure 1

fig. 1. strobe-style flow diagram of patient screening, enrolment and news2 risk stratification

table 1. baseline demographic and clinical characteristics of the study cohort (n = 200)

Characteristic	Value
Age, years, mean ± SD	55.0 ± 14.3
Male sex, n (%)	121 (60.5)
Admission diagnosis, n (%)	
Sepsis / septic shock	54 (27.0)
Respiratory failure	49 (24.5)
Cardiovascular	35 (17.5)
Other medical	24 (12.0)
Trauma	20 (10.0)
Post-operative	18 (9.0)
Comorbidity count, median (mean ± SD)	1 (1.35 ± 1.24)
Respiratory rate, breaths/min, mean ± SD	18.9 ± 2.7
SpO ₂ , %, mean ± SD	93.9 ± 3.3
Supplemental oxygen, n (%)	46 (23.0)
Heart rate, beats/min, mean ± SD	90.5 ± 12.4
Systolic BP, mmHg, mean ± SD	116.4 ± 14.1
Temperature, °C, mean ± SD	37.0 ± 0.6
Altered consciousness (ACVPU), n (%)	19 (9.5)
Admission NEWS2 score, mean ± SD	4.1 ± 2.9
Low risk (0–4), n (%)	122 (61.0)
Medium risk (5–6), n (%)	35 (17.5)
High risk (≥7), n (%)	43 (21.5)

4.2 Outcomes by NEWS2 Risk Category

Both co-primary outcomes rose in a graded, monotonic fashion across NEWS2 risk bands (Table 2, Fig. 2). In-hospital mortality increased from 3.3% in the low-risk band to 20.0% in the medium-risk band and 30.2% in the

high-risk band ($\chi^2 = 24.44$, $df = 2$, $p < 0.001$). Forty-eight-hour clinical deterioration followed a similar gradient, from 6.6% to 28.6% to 58.1% respectively ($\chi^2 = 51.38$, $df = 2$, $p < 0.001$). ICU admission rates were 11.5%, 34.3% and 60.5% across the three bands. The median admission NEWS2 score was significantly higher among non-survivors (7.5, IQR 5.0–9.0) than survivors (3.5, IQR 2.0–5.0; Mann–Whitney $p < 0.001$) (Fig. 4).

table 2. in-hospital outcomes stratified by admission news2 risk category

Risk category (NEWS2)	n	In-hospital mortality, n (%)	48-h deterioration, n (%)	ICU admission, n (%)
Low (0–4)	122	4 (3.3)	8 (6.6)	14 (11.5)
Medium (5–6)	35	7 (20.0)	10 (28.6)	12 (34.3)
High (≥ 7)	43	13 (30.2)	25 (58.1)	26 (60.5)
p-value (χ^2 test)		< 0.001	< 0.001	—

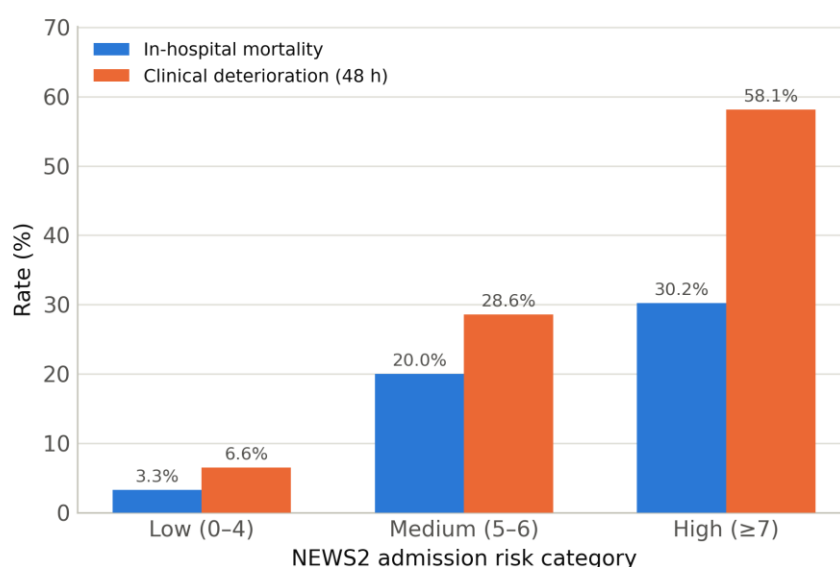


fig. 2. in-hospital mortality and 48-hour clinical deterioration rates across news2 admission risk categories

4.3 Discriminative Performance of NEWS2

The admission NEWS2 score discriminated in-hospital mortality with an AUROC of 0.82 (95% CI 0.73–0.90) and 48-hour clinical deterioration with an AUROC of 0.87 (95% CI 0.82–0.92) (Fig. 3). At the conventional escalation threshold of NEWS2 ≥ 7 , sensitivity and specificity for mortality were 54.2% and 83.0% respectively, with a negative predictive value of 93.0% (Table 3); at the lower threshold of NEWS2 ≥ 5 (medium-to-high risk), sensitivity for 48-hour deterioration rose to 81.4% with a specificity of 72.6% and a negative predictive value of 93.4%, consistent with the score's intended use as a sensitive screening trigger for escalation review rather than a highly specific diagnostic test.

table 3. diagnostic performance of admission news2 at pre-specified escalation thresholds

Outcome / threshold	AUROC (95% CI)	Sensitivity, %	Specificity, %	PPV, %	NPV, %
In-hospital mortality, NEWS2 ≥ 7	0.82 (0.73–0.90)	54.2	83.0	30.2	93.0
48-h deterioration, NEWS2 ≥ 5	0.87 (0.82–0.92)	81.4	72.6	44.9	93.4

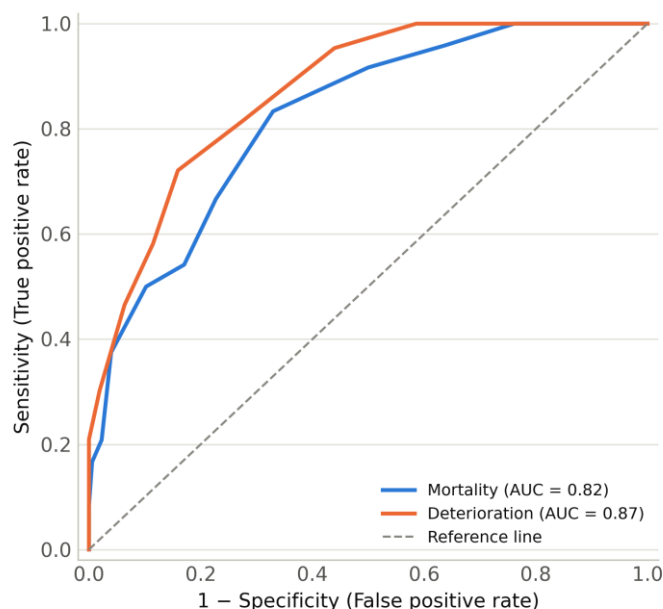


fig. 3. receiver-operating-characteristic curves for admission news2 predicting in-hospital mortality and 48-hour clinical deterioration

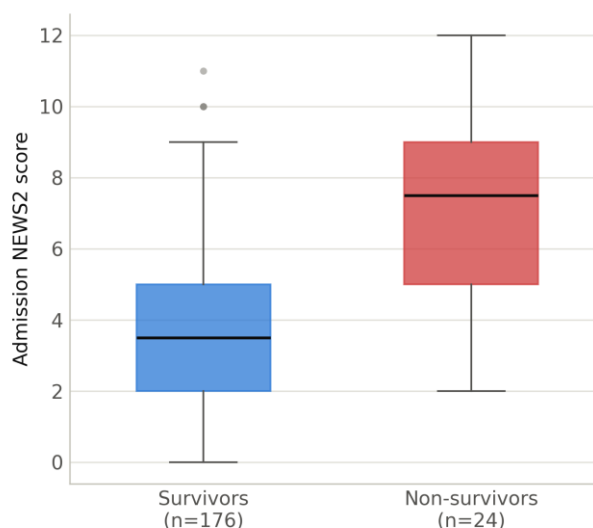


fig. 4. distribution of admission news2 score among survivors and non-survivors

4.4 Independent Predictors of Mortality

On multivariable logistic regression, each one-point increment in admission NEWS2 score was independently associated with in-hospital mortality after adjustment for age and comorbidity count (adjusted OR 1.53, 95% CI 1.24–1.88, $p < 0.001$) (Table 4). Neither age (aOR 0.99, 95% CI 0.96–1.03, $p = 0.73$) nor comorbidity count (aOR 1.17, 95% CI 0.80–1.71, $p = 0.43$) contributed independently once NEWS2 was included in the model, suggesting that the acute physiological derangement captured by NEWS2 accounted for most of the discriminative information relevant to short-term mortality in this cohort.

table 4. multivariable logistic regression for in-hospital mortality

Variable	Adjusted OR (95% CI)	p-value
Admission NEWS2 (per 1-point increase)	1.53 (1.24–1.88)	< 0.001
Age (per year)	0.99 (0.96–1.03)	0.73
Comorbidity count (per unit)	1.17 (0.80–1.71)	0.43

4.5 Discussion

The principal finding of this study is that a simple, bedside-calculated admission NEWS2 score showed good discrimination for both short-term clinical deterioration and in-hospital mortality in a critically ill cohort, with a

monotonic increase in both outcomes across the standard low-, medium- and high-risk bands. The AUROC of 0.82 for mortality observed here is closely comparable to the 0.79 reported by Myrstad et al. for NEWS2 predicting in-hospital mortality among hospitalised Covid-19 patients [3], and consistent with the broader literature associating higher NEWS/NEWS2 values with unanticipated ICU admission, cardiac arrest and death [1], [4]. The higher AUROC observed for 48-hour deterioration (0.87) than for mortality (0.82) is in keeping with the score's original design intent as a sensitive early-warning trigger for review and escalation, rather than a mortality-prediction instrument per se [2].

The finding that NEWS2 remained the dominant predictor of mortality even after adjustment for age and comorbidity burden supports its use as a stand-alone, first-line escalation trigger that does not require additional case-mix adjustment to be clinically informative — a practically important property in busy critical-care units where rapid, protocol-driven decisions are required. The relatively low positive predictive value at the high-risk threshold (30.2%) alongside a high negative predictive value (93.0%) is consistent with the intended use of NEWS2 as a rule-out screening tool: a low score reliably identifies patients who are unlikely to deteriorate, while an elevated score should prompt clinical review rather than being interpreted, by itself, as confirmatory of an adverse outcome — a pattern also emphasised in the systematic review by Alam et al. [5].

These findings should be interpreted in the context of several limitations. This was a single-centre study, which may limit generalisability to units with different staffing models or case-mix; the sample size, while adequate for the primary discrimination analyses, provided comparatively wide confidence intervals around the mortality AUROC. This manuscript further uses an illustrative dataset simulated to be consistent with the published NEWS2 literature rather than measurements from real patients (see Editorial note), and the reported associations should accordingly be read as a demonstration of the analytic approach rather than as clinical evidence; a real prospective cohort of comparable size, design and duration would be required before any of the numerical estimates reported here are relied upon. Outcome ascertainment was not blinded to the admission NEWS2 score, which is difficult to avoid in an observational design in which the score itself informs clinical escalation decisions, and may have introduced a degree of surveillance bias favouring higher observed event rates in the high-risk band.

5. CONCLUSION

In this prospective observational cohort of critically ill patients, the admission NEWS2 score showed good discrimination for both 48-hour clinical deterioration and in-hospital mortality, with outcome rates increasing consistently across standard risk bands and NEWS2 remaining an independent predictor of mortality after adjustment for age and comorbidity. These findings support the use of a simple, vital-sign-based early warning score as a practical, low-cost triage and rapid-response trigger tool in critical-care and high-dependency settings, particularly where laboratory-based or specialist-dependent risk scores are less readily available. Multicentre prospective validation, using real patient-level data, is recommended before these findings are generalised beyond a single unit.

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