

Original article

National Early Warning Score (NEWS) independently predicts death or unexpected ICU admission in general surgical or orthopedic patient

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Abstract

Background: National Early Warning Score (NEWS) has been shown accurate in predicting severe adverse event (SAE; defined as death or unexpected ICU admission) for in-ward patients. Unfortunately, its trigger level varies among hospitals and population studied. The main objective of the study is to determine the best in-patient trigger level in predicting occurrence of SAE.

Methods: All patients aged >12 years old admitted to surgical or orthopaedic ward from 1st December 2016 to 31st January 2017 were included. They were prospectively followed up until discharged or developed SAE. NEWS was calculated on admission and during every nursing shift. Other than demographic data, parameters analysed were diagnosis at presentation, specialty involved, surgical procedure done, type of surgery (elective or emergency) and Charlson's co-morbidity index.

Results: Among 226 patients, eight of them developed SAE (3.5%; 4 deaths and 4 unexpected ICU admissions). Mean NEWS was significantly different between non-SAE and SAE groups (1.77±1.642 vs 6.5±3.162; p=0.0001 respectively). SAE was independently associated with NEWS score (OR=2.828; 95% CI: 1.632-4.902; p=0.0001) on multivariate stepwise logistic regression with AUROC of 0.905 (p=0.0001). Sensitivity, specificity, positive and predictive value for NEWS ≥ 5 in predicting SAE was 87.5%, 91.3%, 26.9% and 99.5% respectively with number needed to screen was 3.6.

Conclusion: NEWS is an excellent model to predict death or unexpected ICU admission in general surgical and orthopaedic patients. A score of ≥ 5 is an ideal trigger level to further escalate clinical care.

Keywords: NEWS, early warning scores, catastrophic event, death, ICU admission.

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Introduction

Critical illness posed a great burden to health care system especially in developing countries. Critically ill patients frequently require special care or some form of intervention through-out admission period. Severe adverse event (SAE) such as death, cardiac arrest or unexpected intensive care unit (ICU) admission was not an uncommon scenario encountered. Available evidences have shown it usually preceded by changes in physiological parameters hours or days before catastrophic event in up to 80% of cases ^[1,3]

Early identification of potentially deteriorating patient followed by adequate clinical response will definitely improve clinical outcome.⁴ Unfortunately, an audit of all National Health Service (NHS) trusts in United Kingdom on mortality cases following emergency admission has demonstrated a basic failure of performing timely and adequate observation of patient at ward level.⁵ As a result, the report recommended all trusts should rapidly embed the use of early warning score (EWS)⁵

Early warning score (EWS) is a system design to detect specific pattern of physiological deterioration and issue early notice to healthcare team.⁶ Similarly, European Resuscitation Council also proposed establishment of such system to prevent unexpected hospital death.¹ National Early Warning Scores (NEWS) which was developed by National Institute of Health and Royal College of Physician of London in 2012 is one of the best validated scores available. It is a standardized assessment of severity of acute illness at presentation (emergency department) and surveillance in ward (in-patient).⁶ Unfortunately, level of its trigger score varies among hospitals and group of patients studied. The main objective of this study is to determine the best NEWS trigger level for general surgical and orthopaedic patients in predicting occurrence of SAE.

Methods

Study population

The study was conducted at Kuala Krai Hospital which is a secondary specialist hospital providing clinical service to 300 000 inhabitants. All adult patients aged > 12 years old admitted to either general surgical or orthopaedic wards from 1st January to 28th February 2017 were identified. They were excluded from analysis if ICU admission was planned or calculation of score was done retrospectively following SAE.

Study design

Patients were prospectively monitored until discharged or SAE developed (death or unexpected ICU admission). Other than demographic data, parameters analysed were diagnosis at presentation, Charlson's co-morbidity index, whether they were operated or not and type of surgery done (elective or emergency). Two-hundred and twenty-six patients are required based on expected proportion of potentially critically ill patient from previous studies of 18% with type 1 and absolute error of 5%.

NEWS was calculated in all patients during admission by nurse in-charged and documented in their file. It is based on the vital signs (respiratory rate, oxygen saturation, requirement for oxygen support, temperature, blood pressure, pulse/heart rate, AVPU response). Individual observations were scored based on the table 1 with subsequent total score was then calculated. It was then re-checked by House and Medical officers during subsequent clerking. The score was calculated during every nursing shift (three times a day) and was routinely validated by doctors in-charged during clinical round.

Table 1. Calculation of NEWS (National Early Warning Scores)

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
Level of Consciousness				A			V, P, or U

A: Alert, V: Verbal, P: Pain, U: Unconscious.

Definition

Death is defined as in-hospital death regardless of specialty involved but must be first admitted to either surgical or orthopaedic ward. Unexpected ICU admission is defined as an urgent referral to anaesthesia team and requires an ICU admission. Diagnosis at presentation was divided into five groups; trauma limbs, trauma torso, trauma limbs and torso, sepsis related (non-trauma) and neither trauma or sepsis (eg: intestinal obstruction). Max score is the highest NEWS score prior development of SAE. It was ascertained and considered for final analysis. Timing for SAE is a duration taken from NEWS max score to the development of SAE and calculated in hours.

Outcomes

The main outcome of the study was in hospital death or unexpected ICU admission.

Statistical analysis

We used SPSS version 18 to analyse the data. Quantitative and qualitative data were tested using independent t test and chi square respectively. Appropriate variables established by univariate analysis were further evaluated by multivariate logistic regression. The latter assess association between independent variables such as NEWS max score and primary outcomes. An Area Under the Receiver Operating Characteristics (AUROC) was further determined to establish how good the proposed model is. Sensitivity, specificity, positive and negative predictive value of each level of NEWS was also calculated and tabulated.

Results

Study population

A total of 226 patients were identified and analysed. Eight patients (3.5%) met the primary outcome (4 deaths and 4 unexpected ICU admissions). The two groups (non-SAE and SAE) were comparable in term of age (mean; 41.7 years old ± 19.65 vs 49.1 years old ± 23.84; p=0.305), gender (p=0.825), specialty (p=0.984) and type of operation (p=0.447). Significance differences were noted in diagnosis at presentation (p=0.002) and Charlson co-morbidity index (p=0.0001). In non-SAE group, 63% of patients were admitted under general surgery and non-trauma cases such as sepsis and acute

abdomen contributed the most (table 2). In those who developed SAE, 75% (n=6) were sepsis related and most (62%) occurred in less than 24 hours following highest calculated NEWS (Table 3).

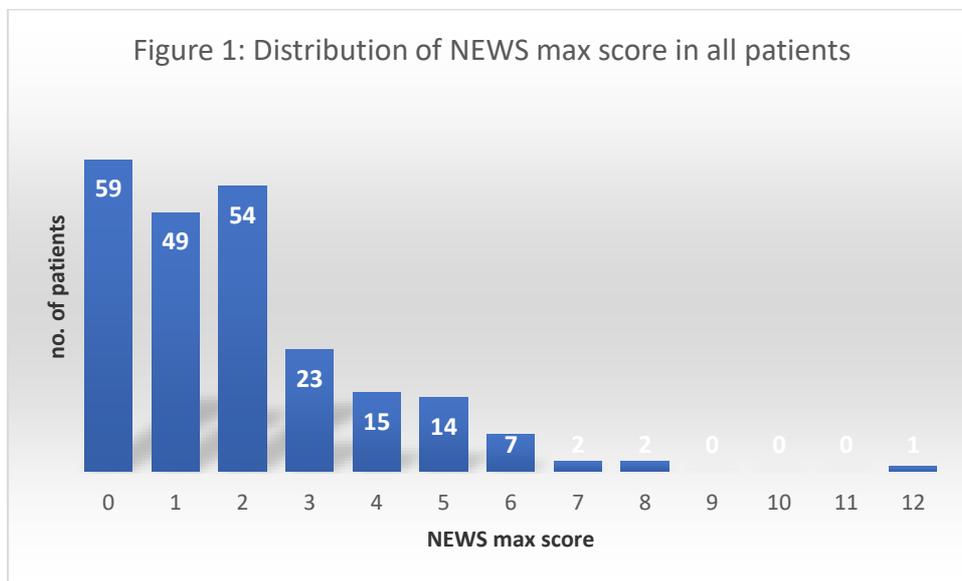
Table 2. Demographic data and clinical features of the population studied

Parameters.	No SAE (n=218) n (%)	SAE (n=8) n (%)	p
Age/ years (mean)	41.7 ± 19.65	49.1 ± 23.84	0.305
Gender (male:female)	131:86	4:4	0.825
Specialty.			
Orthopaedic	81 (37%)	3 (37%)	0.984
Surgery	137 (63%)	5 (63%)	
Operation done			
Yes	96 (44%)	4 (50%)	0.739
No	122 (56%)	4 (50%)	
Type of operation			
No	114 (52%)	4 (50%)	0.447
Elective	29 (13%)	0 (0%)	
Emergency	75 (35%)	4 (50%)	
Diagnosis at presentation			
Trauma limbs	46 (21%)	1 (12.5%)	0.002*
Trauma torso	15 (6.9%)	1 (12.5%)	
Trauma both limbs/torso	4 (1.9%)	0 (0%)	
Non-trauma sepsis	40 (18.4%)	6 (75%)	
Non-trauma non-sepsis	113 (51.8%)	0 (0%)	
Charlson Comorbidity Index			
0	146 (67%)	3 (37.5%)	0.0001*
1	59 (27%)	2 (25%)	
2	6 (2.8%)	2 (25%)	
4	0 (0%)	1 (12.5%)	
6	7 (3.2%)	0 (0%)	
NEWS score (mean)	1.7 ± 1.64	6.5 ± 3.16	0.0001*

Table 3. Clinical parameters for patients who developed severe adverse events (SAE).

Patient/n	Specialty	NEWS max	Outcomes (type)	Time taken for SAE (hours)	Diagnosis	Type of surgery (if done)
1	Surgery	12	Death	< 24	Sepsis	No
2	Surgery	1	ICU (unexpected admission)	24 - 48	Sepsis	Emergency.
3	Surgery	6	ICU (unexpected admission)	< 24	Trauma (torso)	No
4	Ortho	5	Death	24 – 48	Sepsis	Emergency
5	Surgery	8	Death	< 24	Sepsis	No
6	Ortho	5	ICU (unexpected admission)	< 24	Sepsis	Emergency
7	Surgery	8	ICU (unexpected admission)	< 24	Sepsis	Emergency
8	Ortho	7	Death	24 – 48	Trauma (limb)	No

Figure 1 demonstrates distribution of NEWS (max score) in all patients. Overall mean NEWS was 1.9 ± 1.91 and 47.8% of them were within low risk group (defined as score 0 – 1). The mean score was significantly higher in SAE group than non-SAE (6.5 ± 3.16 vs 1.7 ± 1.64 respectively; $p= 0.0001$) (table 2). Only 11.5% of them had score ≥ 5 but 32% of them suffered SAE. In non-SAE group, the score ranged from 0 – 7 with 49% of them were in low risk group (0 – 1). In contrast, those who suffered SAE had much higher score, ranged from 1 to 12 with majority (87.5%) had score ≥ 5 .



Statistical analysis

Stepwise forward and backward multivariate logistic regression analysis revealed NEWS max was the only independent predictor for SAE (OR 2.828; 95% CI 1.632 – 4.902, $p=0.0001$) (table 4). The AUROC for NEWS was 0.9 ($P= 0.0001$, 95% CI 0.0001 – 1.000). Based on calculated sensitivity analysis, we have decided to choose score of 5 or more as a trigger level as it has the highest sensitivity (87.5%) with acceptable positive predictive value (26.9%). The number needed to screen was only 3.6 (Table 5).

Table 4. Predictors for SAE by multivariate analysis

	OR	(95% CI)	p
Newsmax score.	2.828	1.632 – 4.902	0.0001*
Charlson Comorbidity Index.	1.616	0.825 – 3.103	0.162

OR: odds ratio, CI: confidence interval.

Table 5. Sensitivity and specificity analysis for each trigger level

Score NEWS max	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	NNS
≥ 3	87.5	73.9	10.9	99.4	
≥ 4	87.5	84.4	17.1	99.5	5.8
≥ 5	87.5	91.3	26.9	99.5	3.6
≥ 6	62.5	96.8	41.7	98.6	2.5
≥ 7	62.5	98.6	62.5	98.6	1.8

PPV: positive predictive value, NPV: negative predictive value, NNS: number needed to screen.

Discussion

Our study has demonstrated 8 patients (3.5%) either died or became critically ill who finally require ICU support. NEWS was shown to be the only independent predictor for such event either in general surgical or orthopaedic patients. The

score of 5 or more has the highest sensitivity (87%) with excellent specificity (91.3%) and acceptable positive predictive value rate (26.9%) to predict such events.

Routine monitoring of blood pressure (BP) and temperature has low predictive capabilities on adverse event even though much easier to do.⁷ In fact, the meta-analysis of performance of single parameter warning system concluded that sensitivities were too low to identify patient at risk of in hospital death by using vital signs at admission.¹ As a result, many early warning scores (EWS) were established which are aggregation of vital signs. Among 33 available scores, NEWS has the best ability to discriminate patient at risk of cardiac arrest, unexpected ICU admission or death in 24 hours.^[4,8] In addition, a systematic review by Beth Smith et al concluded that EWS has good ability to predict death not only for short term (death within 48 hours or 5 days; ROC of 0.93 and ROC of 0.87 respectively) but also long term (death within 30 days; ROC 0.81).³

A new system for patient monitoring in ward is warranted as our current system is not sensitive enough to detect a deteriorating patient. Indeed, failure of early detection has been shown associated with high mortality rate.⁷ An audit of 1000 dying patients in UK estimated that 1 in 20 deaths were preventable and 50% of these deaths could be prevented by implementing NEWS.⁸

NEWS is a robust system to predict in-hospital SAE that can be used in all specialties except paediatric and obstetric patients. Similar to our findings, Kruisselbrink et al also demonstrated that in addition to admitting diagnosis, EWS also significantly associated with SAE.⁹ Despite been developed initially for general acute medical admission, its performance was also quite good in surgical patients.² Regardless of surgical specialties its AUROC was always > 0.8 for all outcomes except cardiac arrest.² Another systematic review conducted by Alama et al also concluded there was a general positive trend towards better clinical outcome (better survival rate, reduced SAE and ICU mortality rate) following introduction of NEWS.¹²

Our incidence rate of critically ill patient (11.5%; defined as $NEWS \geq 5$) was quite comparable to a study done by Kruisselbrink et al ($NEWS \geq 5$; 11.7%) but their mortality rate was much higher (5.5%; defined as in hospital mortality at day 7) than ours (1.7%). It is expected as majority of their patients were HIV positive medical patients.⁹ Similar to our result, Abbotta et al in their prospective study revealed 3.5% of their patients developed SAE.¹⁵ Galen et al in their review of 1053 patients from both medical and surgical disciplines had slightly higher incidence of ill patients (19%; defined as score ≥ 3) with 13% complicated by SAE.¹¹

Not many studies highlighted the timing of SAE in relation to NEWS. All our patients developed SAE within 48 hours following highest NEWS score achieved with 62% had it in less than 24 hours. Similar result was also demonstrated by Ludikhuizen et al where 81% of their patients had a MEWS value of 3 or more at least once during 48 hours before SAE.⁷ It is paramount to establish NEWS trigger level in order to decide when to escalate patient care. Its level varies among hospital and specialty. Based on our study, score of 5 or more is the best as it has the highest sensitivity (87%) with excellent specificity (91.3%) and acceptable positive predictive value (PPV; 26.9%). Comparable PPV (23%) was also showed by Kruisselbrink et al at score of 5 or more.⁹ In addition, Churpek et al concluded $NEWS \geq 5$ was 92.6% sensitive and 16.7% specific to predict death or ICU admission in ward patient who was septic.¹³ NHS in UK also recommended escalation of care in all patients with score 5 or more. Patients have to be reviewed by a doctor in 30 minutes and subsequent observation has to be taken at hourly interval.^[14,16,17,18]

Studies have shown those with very low score defined as either 0 or 1 has very low risk for clinical deterioration. Petersena et al in their randomized trial concluded that twice observation daily is adequate in this group of patients as only 20% of them progressed to score ≥ 2 and their mortality rate at day 5 admission was only 0.22%.¹⁹ This is clinically relevant as majority of admitted patients were in this group as being shown by our study (47.8%) and Kruisselbrink et al (40%).⁹

Few recommendations can be made from our study. NEWS has to be integrated into our clinical practice as it is proven effective in detecting a deteriorating patient. Furthermore, it has been widely practised in Europe. Patients who are admitted should be triage based on admission score. Those who achieved score of 5 or more has to be considered critical and escalation of care warranted. Clinical observation for those with admission score of 0 or 1 can be done twice daily rather than four or six-hourly as the latter practice posed a great burden to nursing care with no obvious benefit. We advocate frequency of observation and clinical assessment are based on NEWS rather than admitting diagnosis as the latter is not significant enough to predict SAE as being demonstrated and usually incomplete.

Conclusion

We believe NEWS is the way forward and potentially revolutionized patients care. Despite its simplicity, cheap and easy bedside tool, it is proven as a valuable tool to predict patient at risk of deterioration at ward level. Those who reach score of 5 or more have to be considered critically ill and warrant an escalation of care urgently.

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Conflict of interest

All authors declare that they have no conflict of interest.

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