Original Article

Use of the National Early Warning Score (NEWS) to Identify Acutely Deteriorating Patients with Sepsis in Acute Medical Ward

Wan Tin Lim, [1]*MBBS, MRCP (UK), FAMS*, Andrew HS Fang, [2]*MBBS, MMed (FM), MTech (EBA)*, Chian Min Loo, [3]*MBBS, MRCP (UK), FAMS*, Kok Seng Wong, [4]*MBBS, FAMS, FRCP (London)*, Tharmmambal Balakrishnan, [1]*MD, MRCP (UK), FAMS*

Abstract

Introduction: The National Early Warning Score (NEWS) is well established in acute medical units to identify acutely deteriorating patients and is shown to have good prognostic value. NEWS, however, has only been used in the Emergency Department as a triage tool. We aimed to evaluate the validity of NEWS in Acute Medical Ward (AMW) that treats predominantly acute infection-related conditions to the Internal Medicine service. Materials and Methods: We undertook a retrospective cohort study and analysed NEWS records of all patients admitted to AMW at Singapore General Hospital between 1 August 2015 and 30 July 2017. The outcome was defined as deterioration that required transfer to Intermediate Care Area (ICA), Intensive Care Unit (ICU) or death within 24 hours of a vital signs observation set. Results: A total of 298,743 vital signs observation sets were obtained from 11,300 patients. Area under receiver operating characteristic curve for any of the 3 outcomes (transfer to ICA, ICU or death) over a 24-hour period was 0.896 (95% confidence interval, 0.890-0.901). Event rate was noted to be high above 0.250 when the score was >9. In the medium-risk group (score of 5 or 6), event rate was <0.125. Conclusion: NEWS accurately triages patients according to the likelihood of adverse outcomes in infection-related acute medical settings.

Ann Acad Med Singapore 2019;48:145-9

Key words: Death, Infection, Intensive care, Intermediate care

Introduction

The National Early Warning Score (NEWS) is a well established tool that is used to aid early recognition and response to clinical deterioration in patients with acute illnesses. NEWS uses a simple scoring system in which a score is assigned to physiological measurements such as respiratory rate (RR), peripheral oxygen saturation, need for supplemental oxygen, body temperature, systolic blood pressure (SBP), heart rate (HR) and neurological status on the Alert, Verbal, Painful and Unresponsive (AVPU) scale.[1] Although many early warning scores are available, NEWS is widely used in hospitals.[2,3] Since its introduction, various studies have validated the usefulness of NEWS as a track-and-trigger system to predict unplanned intensive care admissions or death.[4] The efficacy of NEWS in specific settings such as the acute medical unit and Emergency Department (ED) has been investigated by Nannan Panday and associates and they concluded that it has good prognostic value.[5] Other studies on sepsis patients—who generally have a high mortality rate—in ED have corroborated findings of NEWS as a better predictor of unexpected outcomes than other existing warning scores.[6,7]

Failure to identify deteriorating patients not only elevates mortality risk, but it can also increase resource utilisation

[1]Department of Internal Medicine, Singapore General Hospital, Singapore
[2]SingHealth Medical Informatics, SingHealth Polyclinics, Singapore
[3]Department of Respiratory and Critical Care Medicine, Singapore General Hospital, Singapore
[4]Department of Renal Medicine, Singapore General Hospital, Singapore
Address for Correspondence: Dr Lim Wan Tin, Department of Internal Medicine, Academia@SGH, 20 College Road, Singapore 169856.
Email: lim.wan.tin@singhealth.com.sg

with more intensive care management and longer hospital stay.[8,9] It is therefore imperative to identify at-risk patients and to initiate appropriate and timely treatment to reduce serious adverse events and death, especially in acute medical units. In large hospitals where care fragmentation is unavoidable, a standardised method of triaging patients is crucial to ensure patient care and safety.[10,11]

In this study, we evaluated the validity of NEWS in Acute Medical Ward (AMW) that admits patients with an acute infection from ED.

Materials and Methods

The AMW is a 67-bed ward that cares for general medical patients. The mean hospital stay is 72 hours. As part of routine clinical care, AMW nurses measure and document every patient's vital signs and the data is entered into the hospital's electronic medical record system. NEWS was introduced to the hospital when it was used in AMW while all other patients were monitored under the existing care management system. Vital signs observation sets were monitored at 4-hour intervals and a decision to increase its frequency was made by the primary physician depending on the clinical condition of patients.

Data on admission to AMW in Singapore General Hospital and vital signs over a 2-year period between 1 August 2015 and 31 July 2017 was extracted retrospectively using Singhealth-IHIS Electronic Health Intelligence System. The data included date and time of observation set, HR, RR, SBP, peripheral oxygen saturation, body temperature and neurological status measured on the AVPU scale. Additionally, data on whether patients were on supplemental oxygen was also entered for each observation set.

We included all admissions to AMW under Internal Medicine service, intermediate care area (ICA)—described as high dependency care in most literature—and intensive care unit (ICU). Patients aged below 18 years and under the care of other services were excluded. The data was validated against information in the electronic medical record system to ensure accuracy. To define the population subgroup, we included the primary discharge diagnosis based on the International Classification of Diseases, 10th revision (ICD-10).

Like the validation study of NEWS in the United Kingdom (UK)[9], we defined an outcome as deterioration in vital signs that occurred over 24 hours. However, our study differed from that study in that instead of using cardiac arrest, unanticipated ICU admission, death and any of the above outcomes, we modified the definition of outcome to refer to a composite of death or unplanned transfer to a higher acuity care area such as ICA or ICU.

Data analysis was performed using R (version 3.4.4) in RStudio (version 1.1.419).[12] The add-on R package, lubridate,[13] was used for date and time manipulation. An adverse outcome that occurred over 24 hours subsequent to the vital signs observation set was assessed using area under the receiver operating characteristic (AUROC) curve. Other add-on R packages included ROCR[14] to plot receiver operating characteristic curve and derive AUROC and pROC[15] to calculate AUROC confidence intervals (CI). We also followed the assumption made in the UK validation study that each vital signs observation set from the same admission was independent of each other.

Results

Our analysis included 11,300 patients (mean age, 69.27 years) and 51% were male. A breakdown of ethnicity in Table 1 shows a slight elevation of Indian ethnicity at 12.18%. The mean stay in AMW was 3.45 days. The primary discharge diagnoses were pneumonia and lower respiratory tract infection (19.29%), upper respiratory tract infection (6.82%), skin and soft tissue infection (9.41%), urinary tract infection (10.25%), dengue (1.88%) and gastroenteritis and colitis (5.28%). All other infectious conditions were classified as "Other diagnoses" due to their heterogeneity (Table 1).

A total of 298,743 vital signs observation sets were obtained from 11,300 patients who had a complete set of vitals charted based on NEWS. The number of observation sets followed by any of the composite outcomes of transfer to ICA, ICU or death within 24 hours was 4476 (1.50%). Mean NEWS score was 1.49 and 6.52 for all patients and patients who had any of the composite outcomes, respectively. As shown in Table 2, all parameters were significantly abnormal in patients who had positive outcomes.

Figure 1 shows the distribution of NEWS for the 3 outcomes (transfer to ICA, ICU or death) over 24 hours. NEWS score ranged from 0 to 20 and event rate was noted to be high (above 0.25 when the score is >9). In medium-risk patients (score of 5 or 6), event rate was <0.125. AUROC for any of the 3 outcomes was 0.896 (95% CI, 0.890-0.901).

Discussion

NEWS is regarded as the highest performing scoring system relative to other early warning scores.[9] In our study, AUROC was significantly better than the UK study.[9] A possible reason for our finding could be attributed to the higher frequency of vital signs observation and recording by our hospital. In the UK study, 198,755 observation sets were obtained from 35,588 patients or a mean of 5.6

Table 1. Baseline Characteristics of Patients

Variable	Aggregate (n = 11,300)	%
Gender		
Female	5553	49.14
Male	5747	50.86
Age (years, mean ± SD)	69.27 ± 16.64	
Ethnicity		
Chinese	8113	71.80
Indian	1376	12.18
Malay	1431	12.66
Others	380	3.36
Primary discharge diagnosis (ICD-10)		
Infection-related diagnoses	6677	59.09
Pneumonia and lower respiratory tract infection	2180	19.29
Upper respiratory tract infection	771	6.82
Skin and soft tissue infection	1063	9.41
Urinary tract infection	1158	10.25
Dengue	212	1.88
Gastroenteritis and colitis	696	6.16
Other diagnoses	5220	46.19
Length of stay in acute medical ward (days, mean ± SD)	3.45 ± 3.00	

ICD-10: International Classification of Diseases, 10th revision; SD: Standard deviation

Table 2. Physiological Parameters of Patients at 24 Hours Prior to Positive or Negative Outcome

Variable	Aggregate (n = 298,743)	Composite Outcome		*P* Value
		Negative (n = 294,267)	Positive (n = 4476)	
SBP (mmHg)	127.46 ± 20.07	127.70	111.73	<0.001
HR (beats per minute)	80.02 ± 14.33	79.82	93.10	<0.001
RR (breaths per minute)	18.51 ± 1.64	18.47	21.15	<0.001
Oxygen saturation (%)	96.86 ± 2.24	96.90	94.29	<0.001
Oxygen required (%)	55,081 (18.44)	51,509 (17.50)	3572 (79.80)	<0.001
Temperature (degree Celsius)	36.63 (0.65)	36.63	36.74	<0.001
AVPU scale (%)				<0.001
Alert	290,952 (97.39)	287,772 (97.79)	3180 (71.04)	
Verbal	3703 (1.24)	3319 (1.13)	384 (8.58)	
Pain	2991 (1.00)	2511 (0.85)	480 (10.72)	
Unresponsive	1097 (0.37)	665 (0.22)	431 (9.65)	
NEWS	1.49	1.42	6.52	<0.001

HR: Heart rate; NEWS: National Early Warning Score; RR: Respiratory rate; SBP: Systolic blood pressure
Data presented as mean ± standard deviation.
P value for independent samples t-test.

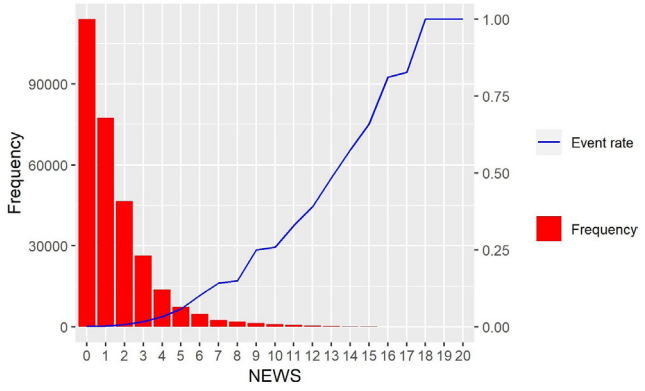

Fig. 1. Distribution of NEWS frequency and event rate. NEWS: National Early Warning Score

observation sets per admission. In comparison, our study had a mean of 26.5 observation sets for each admission. The assumption is that abnormal vital signs would trigger off more frequent recordings of these observations which could artificially improve NEWS sensitivity and increase AUROC in our study.

The methodology of the UK study is based on the assumption that each vital signs observation set from the same admission was independent of each other.[4] It can be argued that this assumption does not hold true since each set of abnormal vital signs tend to be carried forward, likely leading to more frequent measurements of those abnormal vitals and interventions that would affect subsequent sets of vitals from the patient. Hence, a more realistic way to assess NEWS and other early warning scores might be to look at each admission rather than each vital signs observation set, and to assess if a particular threshold score was met during a specified time interval such as from 0 to 24 hours prior to the outcome.

Our study is fairly large and has demonstrated that NEWS can perform as well, if not better, in a cohort of patients with infectious conditions and can discriminate those at risk of the combined outcomes of transfer to ICA, ICU or death within 24 hours of a NEWS trigger in AMW. It is well documented that patients could exhibit physiological derangement hours before clinical deterioration.[9,16] Our study examined a select group of patients with infectious conditions who had the greatest potential to deteriorate during their hospital stay. Although pneumonia was present in a small proportion of our study population, it nevertheless supports existing evidence of NEWS as a predictor of inadvertent outcome.[17]

Our study is the first in Singapore to evaluate the accuracy of NEWS in a patient cohort with predominantly infection-related conditions. Further discrimination of NEWS based on specific diagnoses will help to improve early identification of critically ill patients. Our study supersedes a previous local retrospective study of ED patients which showed that the use of a modified early warning score did not predict poor outcomes in critically ill patients.[18]

Our study has several limitations. It is a single-centre study of patients admitted to Internal Medicine service. It is further limited by the fact that scoring was done in a single location—that is, AMW—and the findings cannot be generalised to patients who were treated for other medical as well as surgical conditions in the entire hospital.[19] Since the identification of ill patients was based on individual physiological derangement, we were also not able to compare the performance of NEWS against that of the existing monitoring system. This was because the latter lacks a validated trigger threshold and standardised response plan, both of which are essential elements in the "chains of prevention".[8,20] Finally, since NEWS was only implemented in AMW, we were not able to capture the outcomes of patients who were transferred out of AMW for reasons other than escalation of care.

Although NEWS is a good predictive tool, compliance and adherence to NEWS with good clinical judgement still needs to be enforced.[21] The challenge lies in instituting a cultural change—through education and training—to ensure that deterioration is recognised in a timely manner and communicated for appropriate escalation of care. In a large tertiary hospital like ours, it is crucial to implement this early warning system throughout the institution to predict clinical deterioration in patients. Our study also creates an opportunity to further evaluate the need to review specific diagnoses and frequency of parameter recording in each patient.

Conclusion

We have demonstrated that NEWS is a validated tool to triage patients with sepsis-related conditions. Further studies are needed to improve the accuracy of NEWS to identify patients at risk of clinical deterioration.

Acknowledgements

The authors would like to thank the medical, nursing, administrative and information technology staff in Singapore General Hospital for their assistance and support in the study.

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