

Association between the National Early Warning Score and the Mortality among Neuroemergency Patients

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Abstract

Objective: The objective of this study was to determine the association between the National Early Warning Score (NEWS), a standardized tool for assessing acute illness severity, and the mortality of the neuroemergency cases seen in the emergency room (ER). **Subjects and Methods:** This retrospective cohort study was conducted from July to December 2017 in the ER at the Dr. Cipto Mangunkusumo Hospital in Jakarta, Indonesia. All of the ER patients examined by the neurology team were included in this study. The demographic, NEWS, Glasgow Coma Scale, and mortality data were collected from the medical record. **Results:** Of the 1526 patients admitted, the NEWS data were available for 907 of the cases (59.4%). Of the 1421 well-documented patients, 143 died. There was a significant relationship between the NEWS category and the mortality risk ($P < 0.001$). Going from the low to the medium and from the medium to the high NEWS categories dramatically increased the mortality risk, with relative risks of 20.238 (8.808–46.501) and 6.466 (2.466–16.957), respectively. The NEWS cutoff point for determining mortality in this study was 6, with a sensitivity of 73.5% and specificity of 80.1%. **Conclusion:** The NEWS category was significantly related to the mortality risk of neuroemergency patients; therefore, it should be implemented routinely to help predict the mortality in the ER.

Keywords: Emergency, mortality, neuroemergency

INTRODUCTION

In this modern era of practicing medicine, it is imperative that all patients be assessed appropriately and monitored carefully from the initiation of their hospital admission, and hence that each improvement or deterioration is detected as early as possible. In fact, by doing so, the short-term prognosis can be determined as well. The short-term prognosis is an important factor that can influence the physician's decisions about the next treatment steps and the appropriate use of resources while managing a patient. Therefore, the Early Warning Score (EWS) was developed to assist a physician in the decision-making process. Fundamentally, this system was designed to detect the worsening clinical condition of a patient and to quantify the acute illness severity. With the use of this system, healthcare providers are speaking the same language when assessing patients with critical illnesses.^[1,2] The National EWS (NEWS), which is one example of an EWS, consists of several vital physiological parameters that are evaluated while the physician is seeing the patient. Each parameter is scored based on the patient's condition; then, the total score is categorized to determine whether the

patient is at a low (0–4), medium (5–6), or high risk (>7).^[1] Although the NEWS has been implemented in several types of emergency cases, its application in neuroemergency cases is rare. For example, the NEWS has been applied in acute stroke and traumatic brain injury cases, in which it was reported to be a significant determinant for predicting mortality.^[1,2] However, these results cannot be directly extrapolated to other neuroemergency conditions, such as encephalitis, status epilepticus, and metabolic encephalopathy. Therefore, additional studies involving more extensive and varied cases are urgently needed. This study was designed not only to describe the application of the NEWS in patients with neuroemergencies but also to determine the relationship between the NEWS and the mortality of these patients in the emergency room (ER). In situations with limited resources, this information could help a physician decide on the best

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care for this particular patient type from the moment that the patient is admitted to the hospital.

SUBJECTS AND METHODS

A retrospective cohort study was conducted from July to December of 2017 in the ER at the Dr. Cipto Mangunkusumo Hospital in Jakarta, Indonesia. All of the ER patients that were referred to a neurologist or received consultations from other physicians but were examined by a neurology resident and/or neurologist were included in this study. The ethical clearance of this study has been granted by the Ethical Committee, Faculty of Medicine, Universitas Indonesia.

The data source was the secondary data from the neurology patient registry in the ER, which consisted of several clinical variables. For instance, the Glasgow Coma Scale (GCS) and all of the parameters required for calculating the NEWS score (level of consciousness, heart rate, systolic blood pressure, body temperature, respiratory rate, oxygen saturation, and supplemental oxygen) were documented during the initial ER assessment of each patient included in this study. After adding the clinical characteristics to the registry, all of the study participants were followed thoroughly until the end of their ER care. Then, the discharge status was recorded as follows: death, admission to a high/intensive care unit or general ward, no neurological emergency, referred to another hospital or discharged to home. The number of patients who died was compared to the total number of patients included in this study to determine the mortality rate. In addition, each patient's social and demographic data, such as gender, age, patient origin, and financing status were also collected.

Based on the data collected from the patient registry, a statistical analysis was performed using IBM SPSS Statistics for Windows version 20.0 (IBM Corp., Armonk, NY, USA). A univariate analysis was conducted to determine the frequency and central tendency values of each variable. A bivariate analysis, either the independent *t*-test or the Mann–Whitney U-test, was used to compare the means of the NEWS values between the two patient groups (died or alive). A receiver operating characteristic (ROC) curve was used to determine the NEWS cutoff points, as well as its specificity and sensitivity.

RESULTS

Subject characteristics

During the 6 months of this study, 1526 patients were admitted to the ER. Due to incomplete data, the number of patients (*n*) varied for each variable that was evaluated. Most of the patients were males (53.6%) with a median age of 49 years old. Although this study was held in a national referral hospital, half of the patients came without referrals (50.8%). Strokes, traumatic brain injuries, and intracranial infections were the top three diagnoses [Table 1].

In general, consciousness disorder was the most common reason for a patient to visit the ER (47.8%). However, GCS scores of 15

Table 1: Characteristics of the study subjects

Variable	<i>n</i> (%)
Gender (<i>n</i> =1507)	
Male	807 (53.6)
Female	700 (46.4)
Age (<i>n</i> =1479)	49* (16-87)**
Patient origin (<i>n</i> =1519)	
Referred from outside hospital	148 (9.7)
Other specialty consultation	596 (39.1)
Came without referral	775 (50.8)
Financing status (<i>n</i> =1508)	
National health coverage	1353 (89.7)
Personal	146 (9.7)
Others	9 (0.6)
Emergency type (<i>n</i> =1395)	
Coma and altered mental status	667 (47.8)
New onset of focal neurological deficit	265 (19.0)
Worsening of neurological deficit	58 (4.2)
Seizure(s)	133 (9.5)
Headache and/or other pain	219 (15.7)
Dizziness	35 (2.5)
False emergency	18 (1.3)
GCS (<i>n</i> =1428)	
3-8	129 (9.0)
9-12	287 (20.1)
13-14	190 (13.3)
15	822 (57.6)
NEWS category (<i>n</i> =907)	
Low	527 (58.1)
Medium	163 (18.0)
High	217 (23.9)
Diagnosis (<i>n</i> =1376)	
Stroke	351 (25.5)
Traumatic brain injury	208 (15.1)
Intracranial infection and demyelinating disease	139 (10.1)
Intracranial neoplasm	126 (9.2)
Spinal cord lesion	43 (3.1)
Neuromuscular disease	75 (5.5)
Acute seizure and status epilepticus	55 (4.0)
Headache and pain	60 (4.4)
Electrolyte imbalance	24 (1.7)
Uremic encephalopathy	24 (1.7)
Septic encephalopathy	79 (5.7)
Hepatic encephalopathy	18 (1.3)
Unspecified metabolic encephalopathy	95 (6.9)
Dizziness	27 (2.0)
Syncope	15 (1.1)
Hypoxia ischemic encephalopathy	31 (2.3)
Psychiatric disorders	6 (0.4)
Status of discharge (<i>n</i> =1421)	
Discharged to home	74 (5.2)
Referred to another hospital	7 (0.5)
No neurological emergency	307 (21.6)
General ward	799 (56.2)
High/intensive care unit	91 (6.4)
Died	143 (10.1)

*Median (minimum value - maximum value), GCS: Glasgow Coma Scale, NEWS: National Early Warning Score

were found in more than half of the study participants (57.6%). In terms of the NEWS, there was a fluctuating trend in the percentages, with the highest proportion (58.1%) in the low category. The medium category had the lowest proportion (18.0%), and the high category proportion fell between the low and medium percentages (23.9%). Overall, based on the complete data that was available, the mortality rate was 143/1421 patients (10.1%).

National Early Warning Score and emergency room mortality

The bivariate analysis showed that the NEWS was significantly related to mortality ($P < 0.001$). Moreover, the percentage of patients who died increased proportionally with the NEWS category (low, medium, and high) [Table 2]. Consequently, relative risk (RR) exhibited the same trend, with significantly increased scores of 6.466 (95% confidence interval [CI] = 2.466–16.957) and 20.238 (95% CI = 8.808–46.501) in the medium and high NEWS categories, respectively. To evaluate the NEWS accuracy for predicting the ER mortality, a ROC curve was generated, which showed that area under the ROC curve (area under the curve [AUC]) was 0.848 (95% CI = 0.805–0.892) [Figure 1]. Following this, there was a line intersection between points 5 and 6. At the first point (5), the sensitivity was 71.6% and the specificity was 85.3%, but at the other point (6), the sensitivity increased to 80.1% and the specificity decreased to 73.5% [Table 3].

DISCUSSION

Our results suggested that the NEWS could be applied as a predictor of mortality in the ER. With an AUC of nearly 90% (0.848, 95% CI = 0.805–0.892), the NEWS exhibited good accuracy as a determinant. Moreover, in this study, the line intersection was between points 5 and 6. If the cutoff point was >6 , the specificity was higher than the sensitivity. Conversely, if the cutoff point was >5.5 , the sensitivity was higher than the specificity. Overall, both cutoff points were

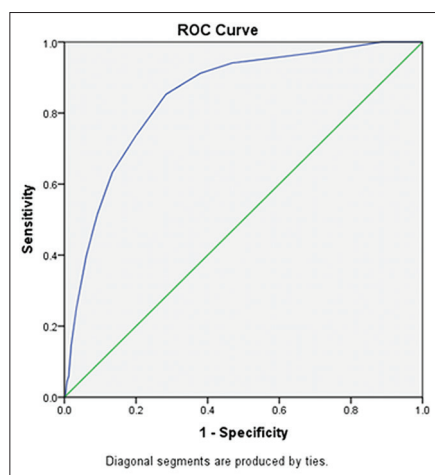


Figure 1: Receiver operating characteristic curve of the National Early Warning Score for predicting mortality in the emergency room

acceptable, and the NEWS could be applied as a screening or confirmation tool. The results of this study were similar to those of other studies.^[3,4] In acute stroke patients, the NEWS was validated as an excellent tool for predicting 30-day mortality, with an AUC of 0.856 (0.760–0.951). However, this study used a cutoff point of ≥ 5 instead of the cutoff of ≥ 7 that is usually applied.^[3] Another study that used the NEWS in traumatic brain injury cases reported that it was recommended for use during the triage stage to predict the 24-h mortality.^[4] Contrarily, some published papers have reported that the NEWS was not suitable for neurological cases.^[5,6] One of the most remarkable points was regarding the parameter used to assess consciousness for the NEWS. For the NEWS, the alert, voice, pain, unresponsive (AVPU) system, rather than a more quantitative scale, such as the GCS, was used to determine the level of consciousness. Moreover, there were only two options for a NEWS neurological score: 0 (alert) and 3 (voice, pain, unresponsive).^[1] That being said, one can assume that the NEWS is less sensitive for monitoring a coma or altered mental status. As a result, although performing an assessment using the AVPU system is easy during triage, the NEWS is inadequate for recognizing a slight decline, especially when monitoring the patients.^[1,2]

Table 2: The mortality rates of the National Early Warning Score categories

NEWS category	Mortality rate (%)	RR (95% CI)
Low	6/527 (1.1)	Reference
Medium	12/163 (7.4)	6.466 (2.466-16.957)
High	50/217 (23.0)	20.238 (8.808-46.501)

NEWS: National Early Warning Score, CI: Confidence interval, RR: Relative risk

Table 3: Sensitivity and specificity of the National Early Warning Score for predicting mortality in the emergency room

Cut-off point	Sensitivity	95% CI	Specificity	95% CI
≥ 0	100.00	94.7-100.0	0.00	0.0-0.4
> 0	100.00	94.7-100.0	11.32	9.3-13.7
> 1	97.06	89.8-99.6	29.68	26.6-32.9
> 2	95.59	87.6-99.1	41.12	37.8-44.5
> 3	94.12	85.6-98.4	53.16	49.7-56.6
> 4	91.18	81.8-96.7	62.10	58.7-65.4
> 5	85.29	74.6-92.7	71.63	68.5-74.7
> 6	73.53	61.4-83.5	80.10	77.2-82.7
> 7	63.24	50.7-74.6	86.65	84.2-88.9
> 8	51.47	39.0-63.8	90.82	88.7-92.7
> 9	39.71	28.0-52.3	93.92	92.1-95.4
> 10	25.00	15.3-37.0	96.66	95.2-97.8
> 11	14.71	7.3-25.4	98.09	96.9-98.9
> 12	5.88	1.6-14.4	98.81	97.8-99.4
> 13	4.41	0.9-12.4	99.28	98.4-99.7
> 14	0.00	0.0-5.3	99.76	99.1-100.0
> 16	0.00	0.0-5.3	100.00	99.6-100.0

CI: Confidence interval

In general, patients with acute life-threatening neurological conditions seem to have the same issues in the ER, such as airway, breathing, and circulation problems. In fact, their problems are different from those of other patients because an acute brain injury often leads to a consciousness disorder. This can affect the perspectives of the nurses and physicians who are dealing with these patients. Unfortunately, many patients with comas or altered mental statuses due to acute brain injuries are determined to have bad prognoses that are unsalvageable based on an initial ER assessment.^[7] However, based on our results regarding the RR increase across the NEWS categories, and the fact that there are care limitations, patients in the high category may require more consideration with regard to resource allocation and questions about the futility of treatment. The strengths of this study include the fact that it was a pioneer study in the field of neuroemergency that involved a large sample size across a spectrum of conditions. For instance, this study included various traumatic and nontraumatic cases, all of the NEWS categories, GCSs from 15 to 3, and intracranial structural lesions to metabolic derangements affecting the brain functions. In addition, when considering the limited evidence in this field and the statistically significant results of this study, our results do provide added value with regard to acute care improvement in Indonesia. Nonetheless, there were several limitations to this study. First, there was incomplete data on many of the study participants, but this is a common obstacle when conducting a retrospective study that does not use primary data. In addition, there was no specific time recorded for when the outcome event occurred, such as during the first 8 h, 24 h, or longer. Technically, patients should be discharged from the ER after maximum of 8 h of care. However, due to unforeseen circumstances, like a ward being full, this is not always the case. Therefore, the term “mortality in the ER” was chosen for convenience when describing an event that occurred while the patient was still in the ER.

CONCLUSION

The results of this study showed that the NEWS can be used as a significant predictor of patient mortality for neurological

emergencies in the ER. Therefore, this system should be routinely implemented by ER nurses and physicians for triage or the initial assessment. For future research, it would be useful to conduct a prospective cohort study with good data records and specific cases, such as strokes, traumatic brain injuries, or intracranial infections. In addition, several determinants, other than the NEWS, should be analyzed with regard to their ability to predict patient mortality.

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Conflicts of interest

There are no conflicts of interest.

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