

Abbreviated National Early Warning Score predicts the need for hospital admission and in-hospital mortality in elderly patients

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Abstract

The aim of this study was to evaluate the value of the Abbreviated National Early Warning Score (aNEWS) for predicting admissions and in-hospital mortality in elderly patients present to Emergency Department (ED). This retrospective, single-centred observational study was carried out in the ED of Minamitama Hospital, in Tokyo, Japan from 1 April 2018 to 30 April 2018. All of the patients aged 65 and older were included in this study. The aNEWS is based on six common physiological vital signs, including peripheral oxygen saturation, the presence of inhaled oxygen parameters, body temperature, systolic blood pressure, pulse rate, and the Alert, responds to Voice, responds to Pain, Unresponsive score. The scores range from 0 and 3 for each parameter. The aNEWS ranged from a score of 0 to a maximum of 17. The receiver operating characteristics (ROC) analysis was used to evaluate the predictive value of the aNEWS for admission and in-hospital mortality.

The median aNEWS of patients admitted to the hospital was significantly higher than that of patients discharged from the ED ($P < 0.001$). The median aNEWS of survivors was significantly higher than that of non-survivors ($P < 0.001$). The Areas under the

ROC Curve (AUC) for predicting admission was 0.773 [95% CI 0.7142 to 0.8317, $P < 0.001$] for the aNEWS. The AUC for predicting in-hospital mortality was 0.791 [95% CI 0.604 to 0.978, $P < 0.001$] for the aNEWS. Our single-centred study has demonstrated the utility of the aNEWS as a predictor of patient admission and in-hospital mortality in elderly patients.

Introduction

Life expectancy in Japan is the highest of all nations (83.7 years) because of improved health care.¹ In Japan, the proportion of people older than 65 years was 23.0% in 2010, and this is expected to reach 29.1% by 2020, which is the highest in the world.²

As the life expectancy rises, the number of patients older than 65 years that present in Emergency Departments (EDs) is also increasing proportionately. A previous study published in the US reported that elderly patients that presented in EDs comprise about 50% of all ED patients.³

The increasing number of elderly patients presenting in EDs is one of the major causes of overcrowding in EDs.^{4,6} Moreover, elderly patients need specific management in the ED because of their unique physiological responses to acute disease. Furthermore, elderly patients normally stay in EDs longer than younger patients.⁷ Therefore, the decision whether to admit patients is an important factor in managing EDs.

Several risk-scoring systems have been developed to predict the risk of catastrophic deterioration and death of hospital inpatients. The National Early Warning Score (NEWS) was developed in 2012 in the UK by the National Early Warning Score Development and Implementation Group on behalf of the Royal College of Physicians.⁸

Previous studies have explored the association between ED NEWS with in-hospital mortality or ICU admission, and these findings suggested that this risk score also could be used as a triage tool to identify patients requiring admission to hospital.⁹⁻¹¹ Several studies have reported the risk scoring systems for elderly patients who presented to ED, but they were not sufficiently effective for evaluating patients and none of them included calculations of NEWS.¹²⁻¹⁴

Because monitoring the respiratory rate is sometimes difficult, we proposed an Abbreviated National Early Warning Score (aNEWS) in order to make it easier to triage the patients and to increase the adherence of physicians.

The aim of this study was to evaluate the value of the aNEWS in predicting hospitalization and in-hospital mortality in patients older than 65 years who presented in the ED.

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Materials and Methods

Design and setting

This retrospective, single-centred observational study was conducted in the ED of Minamitama Hospital, an urban hospital in Tokyo, Japan. The hospital is a 122-beds facility providing general medicine, gastroenterological, cardiological, neurological, pulmonological, surgical, orthopaedic, urological, radiological, limited gynaecological, limited ophthalmological, and emergency medicine services to a population of approximately 560,000 people. This ED typically evaluates about 6,500 patients and accepts about 4,500 cases that present by ambulance annually.

Study population

This study was carried out between 1 April 2018 and 30 April 2018 at Minamitama Hospital, which is a secondary emergency medical institution. All of the patients aged 65 and older that presented to the ED for both surgical and non-surgical reasons during the study period were included in this study. Trauma patients were also included in this study but cardiopulmonary arrest (CPA) patients were excluded from this study.

Data sources and measurements

An emergency physician saw all the patients who presented in the ED, and he or she took over the patient's management and follow-up. During this process, all the data for each patient were recorded as electronic medical records by nurses. The patients were followed up until discharge, death or transfer to other hospitals. Data on each patient's discharge from the ED, admission to the hospital, and in-hospital mortality were recorded.

The aNEWS was calculated using the recorded physiological parameters for each patient. The aNEWS is derived from six common physiological vital signs, including peripheral oxygen saturation, the presence of oxygen supplementation, body temperature, systolic blood pressure, pulse rate, and the Alert, responds to Voice, responds to Pain, Unresponsive (AVPU) score. The scores range from 0 to 3 for each parameter. The aNEWS ranges from 0 to a maximum of 17 (Table 1). The AVPU was derived from the Glasgow Coma Score as follows: A=14-15, V=9-13, P=4-8, U=3.

Primary outcomes included hospitalization and in-hospital mortality. The patients were divided into two groups; Group 1 included those who were discharged from the ED. Group 2 included those who were admitted to the hospital. Patients who were transferred to another hospital were included in Group 2. To evaluate in-hospital mortality, the patients were divided into two groups: survivors and non-survivors.

Statistical analysis

The continuous variables were described as the medians and interquartile ranges, and they were compared using the Student's *t*-test and the Mann-Whitney *U*-test. The categorical variables were described as number (%), and compared using the Pearson's χ^2 test.

The receiver operating characteristics analysis was used to evaluate the predictive value of the aNEWS for admission and in-hospital mortality. The cut-off points for the aNEWS were determined for both the primary outcomes using Youden's Index (sensitivity + specificity-1). Using these determined cut-off points, the sensitivity, and specificity of aNEWS were calculated for the admissions and the in-hospital mortality.

Data were analysed using SPSS (version 16.0; SPSS Inc., Chicago, Illinois, USA). A *P* value less than 0.05 was considered to indicate statistically significance.

Results

During the study period, 304 elderly patients presented to our ED. Forty-six cases were excluded because of their missing data, three cases were excluded because of CPA and finally 255 cases were ultimately included in this study. The median age (interquartile range) of the patients was 82 (14.5) years, and 120 (47.1%) of the patients were men. Seventy-five (29.4%) patients arrived at the ED by ambulance. Fifty-six (22.0%) gastroenterology cases, 43 (16.9%) pulmonology cases, 38 (14.9%) orthopaedic cases and 51 (20.0%) miscellaneous cases were included, which accounted for 75% of all patients presenting in the ED. One-hundred thirty (51.0%) patients were discharged from the ED, and 125 (49.0%) patients were admitted including 17 cases that were transferred to another hospital. More than 75% of the patients did not need to receive oxygen, the consciousness of more than 75% of patients was clear, and fifty-six (22.0%) were gastroenterology cases (Table 2).

The median aNEWS of patients admitted to the hospital was significantly higher than the median aNEWS of patients discharged from the ED ($P<0.001$). The systolic blood pressure of patients admitted to the hospital was significantly lower ($P<0.05$) and the temperature of patients admitted to the hospital was higher ($P<0.001$) than those of patients discharged from the ED. In the admission group, the percentage of patients, who received oxygen and whose state of consciousness was not obvious, was significantly higher than in the discharged group. On the other hand, there was no significant difference in age, sex ratio, pulse rate or oxygen saturation between the groups (Table 3). The in-hospital mortality rate was 3.1% (8 cases). The median aNEWS of survivors was significantly higher than the median aNEWS of non-survivors

Table 1. Abbreviated National Early Warning Score (aNEWS).

	3	2	1	0	1	2	3
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219	–	–	≥220
Pulse rate (bpm)	≤40	–	41–50	51–90	91–110	111–130	≥131
Temperature (°C)	≤35.0	–	35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	–
Oxygen saturation (%)	≤91	92–93	94–95	≥96	–	–	–
Inhaled oxygen	–	Yes	–	No	–	–	–
Alert, responds to Voice, responds to Pain, Unresponsive (AVPU)	–	–	–	A	–	–	V, P, or U

A, alert; V, to voice; P, to pain; U, to unresponsive; bpm, beats or breaths per minute.

($P < 0.001$). The pulse rate of survivors was significantly lower ($P < 0.05$) than the pulse rate of non-survivors. In the non-survivors group, the percentage of patients, who received oxygen and whose state of consciousness was not obvious was significantly higher than those of the survivors group (Table 4).

The AUC for predicting admission was 0.773 [95% confidence interval (CI) 0.7142 to 0.8317, $P < 0.001$] for aNEWS (Figure 1). The cut-off values for the aNEWS was 3. The aNEWS of 3 or more had a sensitivity of 63.2 %, a specificity of 87.7 %, and an odds ratio of 12.24 for predicting admission. The AUC for predicting in-hospital mortality was 0.791 [95% confidence interval (CI) 0.604 to 0.978, $P < 0.001$] for aNEWS (Figure 2). The cut-off value for the aNEWS was 3. The aNEWS of 3 or more had a sensitivity of 87.5 %, a specificity of 64.4%, and an odds ratio of 12.65 for predicting in-hospital mortality.

Discussion

In this study, we demonstrated that the aNEWS has potential as triage tool that can be used to predict the admission rates of elderly patients presenting in EDs. In several studies, the effectiveness of

Table 2. Baseline characteristics of the study population.

	Median (interquartile range) (n=255)
Age, years	82 (14.5)
Sex [n (%)]	
Male	120 (47.1)
Female	135 (52.9)
Diagnostic Category [n (%)]	
Cardiology	29 (11.4)
Pulmonology	43 (16.9)
Neurology	16 (6.3)
Gastroenterology	56 (22.0)
Diabetes	3 (1.2)
Urology	19 (7.5)
Orthopedic	38 (14.9)
Others	51 (20.0)
Route of presentation [n (%)]	
Walk in	180 (70.6)
Ambulance	75 (29.4)
Disposition [n (%)]	
Discharge	130 (51.0)
Admission	125 (49.0)
Systolic blood pressure (mmHg)	142 (35.5)
Pulse rate (bpm)	82 (23)
Temperature (°C)	36.7 (0.8)
Oxygen saturation (%)	97 (3)
Inhaled oxygen [n (%)]	
Yes	63 (24.7)
No	192 (75.3)
AVPU [n (%)]	
A	197 (77.3)
Non-A	58 (22.7)
aNEWS	1 (4)

Data are presented as the median (interquartile range) for continuous variables and the number (%) for categorical variables. aNEWS, Abbreviated National Early Warning Score; bpm, beats or breaths per minute.

the NEWS for predicting admissions to a critical care unit has been evaluated, but there have been no studies evaluating the effectiveness of the NEWS for predicting admissions to hospitals or EDs. One study was carried out by Zerrin Defne *et al.*,¹⁵ which examined the predictive value of the VitalPac Early Warning Score (ViEWS). ViEWS is the basis of the NEWS, and it uses seven of the same vital signs, for admission, which were found to be moderate, yielding an AUC of 0.756. In contrast, the study carried out by Murray *et al.*¹⁶ demonstrated that the abbreviated ViEWS (in which mental state was excluded) is insufficient to predict the decision regarding hospital admission. In our study, we found that the aNEWS is moderately effective for predicting admission in elderly patients, and the AUC for admission was 0.773.

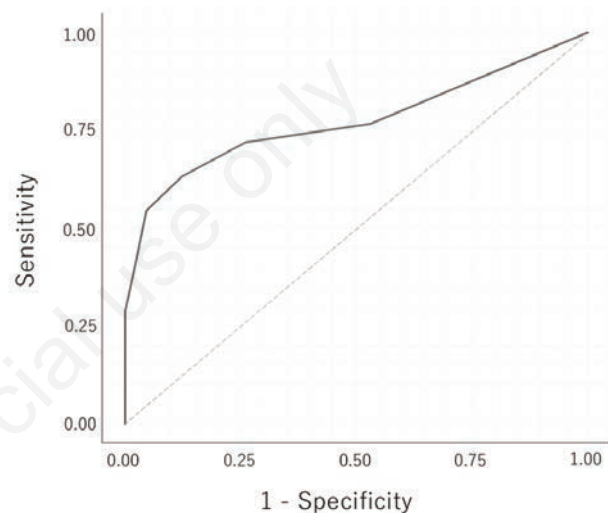


Figure 1. Receiver operator characteristics curves for the Abbreviated National Early Warning Score for admission.

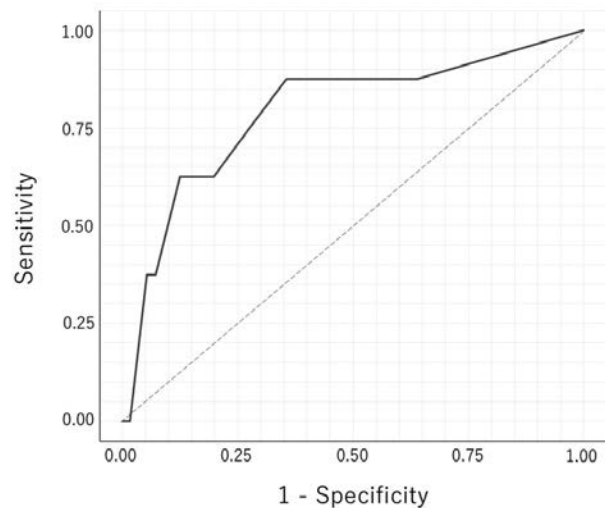


Figure 2. Receiver operator characteristics curves for the Abbreviated National Early Warning Score for in-hospital mortality.

In this study, we also showed that the aNEWS is an effective triage tool that can be used to predict the in-hospital mortality in elderly patients presenting at an ED. In the study carried out by Smith *et al.*,¹⁷ the predictive value of the NEWS for in-hospital mortality was found to be high, yielding an AUC of 0.894. In the study carried out by Kovacs *et al.*,¹⁸ the predictive value of the NEWS for predicting in-hospital mortality of different groups showed similar results. In the study carried out by Leandro *et al.*,¹⁹ the predictive value of the two kinds of short NEWS (which did not include temperature as a factor or temperature and systolic blood pressure) for predicting a patient's deterioration was extremely high, yielding AUCs of 0.965 and 0.903, respectively. Although several studies of the NEWS for in-hospital mortality were carried out, none of them were specific for elderly patients.

In our study, the predictive value of the aNEWS for in-hospital mortality in elderly patients was found to be moderate. The AUC for in-hospital mortality was 0.791. In a previous study carried out by Abbott *et al.*,²⁰ the mortality rate was 4.7% (15 patients out of 322). In our study, the in-hospital mortality rate was 3.1%, which is lower than this previous study.

This study has several limitations. Compared to previous studies, the cut-off values for the aNEWS in admission and in-hospital mortality were low in our study, and the condition of patients presenting in our ED was not severe. First, it was expected that the reason for this was that elderly patients were admitted not because of their physical severity, but because of social problems, such as a lack of families who care about the patients. Secondly, the patient's vital signs are often unchanged on presentation with prob-

Table 3. Comparison of parameters between the discharged group and the admitted group.

	Median (interquartile range)		P value
	Group 1 (discharged from ED) (n=130)	Group 2 (Admission to the hospital) (n=125)	
Age, years	81 (15)	82 (14)	0.27
Sex [n (%)]			
Male	59 (45.4)	61 (48.8)	0.585
Female	71 (54.6)	64 (51.2)	
Systolic blood pressure (mmHg)	148 (37.75)	137 (34)	<0.05
Pulse rate (bpm)	81.5 (25)	84 (22)	0.156
Temperature (°C)	36.6 (0.6)	37 (1.1)	<0.001
Oxygen saturation (%)	97 (2)	97 (4)	0.258
Inhaled oxygen [n (%)]			
Yes	1 (0.8)	62 (49.6)	<0.001
No	129 (99.2)	63 (50.4)	
AVPU [n (%)]			
A	126 (96.9)	71 (56.8)	<0.001
Non-A	4 (3.1)	54 (43.2)	
aNEWS	1 (2)	4 (5)	<0.001

Data are presented as the median (interquartile range) for continuous variables and the number (%) for categorical variables. aNEWS, Abbreviated National Early Warning Score; bpm, beats or breaths per minute.

Table 4. Comparison of parameters between survivors and non-survivors.

	Survivors (n=247)	Non-survivors (n=8)	P value
Age, years	82 (14.5)	87.5 (12)	0.398
Sex [n (%)]			
Male	116 (46.96)	4 (50.00)	0.866
Female	131 (53.04)	4 (50.00)	
Systolic blood pressure (mmHg)	143 (35.5)	130 (37)	0.423
Pulse rate (bpm)	82 (23.5)	90.5 (25)	< 0.05
Temperature (°C)	36.7 (0.8)	36.95 (0.725)	0.251
Oxygen saturation (%)	97 (3)	98.5 (4.25)	0.67
Inhaled oxygen [n (%)]			
Yes	58 (23.5)	5 (62.5)	<0.05
No	189 (76.5)	3 (37.5)	
AVPU [n (%)]			
A	195 (79.0)	2 (25.0)	<0.001
Non-A	52 (21.0)	6 (75.0)	
aNEWS	1 (4)	6 (4.25)	<0.001

Data are presented as the median (interquartile range) for continuous variables and the number (%) for categorical variables. aNEWS, Abbreviated National Early Warning Score; bpm, beats or breaths per minute.

lems such as limbs fracture, peripheral vertigo and intoxication. Because of the low severity of their physical illness, the number of non-survivors was very few. Therefore, several biases, such as the increase in false-negatives, would be statistically likely to occur. In our hospital, we lack several departments, such as the Resuscitation Unit, Neurosurgery, Cardiac Surgery and Trauma Surgery Department. Thus, we have to consider the selection bias during the pre-hospital phase. We researched the data for elderly patients presenting in the ED in April only, so there were seasonal variations and longer-term study will be needed to examine seasonal biases. Because ED physicians change daily, criteria for admission were different. Therefore, further study of a longer duration that includes larger numbers of patients will be needed.

Conclusions

Our single-centred study has demonstrated the utility of the aNEWS as a predictor of patient admission and in-hospital mortality in elderly patients. Further studies are required to evaluate the impact of aNEWS on more critically ill patients who come to the resuscitation centre. These studies should likewise evaluate whether aNEWS is useful in other geographical areas, including rural regions. Further studies are also needed to show whether aNEWS can be used to help manage the length of stay in EDs and, therefore, reduce ED crowding.

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