Predictive value of the National Early Warning Score–Lactate for mortality and the need for critical care among general emergency department patients☆,☆☆,★

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ARTICLE INFO

ABSTRACT

Study objectives: What is the predictive value of the National Early Warning Score–Lactate (NEWS-L) score for mortality and the need for critical care in general emergency department (ED) patients?

Methods: In this retrospective cohort study, we enrolled all adult patients who visited the ED of an urban academic tertiary-care university hospital in South Korea over 2 consecutive months. The primary outcome was 2-day mortality. The secondary outcomes were the need for critical care (advanced airway use, vasopressor or inotropic agent use, intensive care unit admission) during an ED stay; 2-day composite outcome (2-day mortality and the need for critical care); 7-day mortality; and in-hospital mortality.

Results: During the study period, 4624 adult patients visited the ED. Of these, 87 (1.9%) died within 2 days. In total, 481 patients (10.4%) required critical care during their ED stay. The 2-day composite outcome, 7-day mortality, and in-hospital mortality were 10.9% (503/4624), 2.5% (116/4624), and 3.9% (182/4624), respectively. The NEWS-L demonstrated excellent predictive value for 2-day mortality with an area under the receiver operating characteristic curve (AUROC) of 0.96 (95% confidence interval [CI], 0.94-0.98); this value was better than that of the NEWS alone (AUROC 0.94 [95% CI, 0.91-0.96], $P = .002$). The AUROC of the NEWS-L for the need for critical care was 0.83 (95% CI, 0.81-0.85); for the 2-day composite outcome, it was 0.84 (95% CI, 0.82-0.86); for 7-day mortality, it was 0.94 (95% CI, 0.92-0.96); and for in-hospital mortality, it was 0.87 (95% CI, 0.85-0.90). Logistic regression results confirmed that the ratio of the NEWS to the initial lactate level was 1:1. Similar results were obtained in the subgroup analyses (disease-infection, disease–vascular and heart, disease-others, and nondisease). The high-risk NEWS-L group (NEWS-L ≥ 7, 9.4% of all patients) had an adjusted odds ratio of 28.67 (12.66-64.92) for 2-day mortality in the logistic regression model adjusted for basic characteristics.

Conclusion: The NEWS-L can provide excellent discriminant value for predicting 2-day mortality in general ED patients, and it has the best discriminant value regarding the need for critical care and composite outcomes. The NEWS-L may be helpful in the early identification of at-risk general ED patients.

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1. Introduction

The early identification of at-risk patients and the initiation of timely treatment or intensive monitoring are important in emergency department (ED) practice. Although most EDs currently use triage tools, such as the Emergency Severity Index, the Manchester Triage Scale, the Australian Triage Scale, or the Canadian Triage Acuity Scale to prioritize patients for treatment [1-5], longitudinal monitoring after patients enter the ED is not guided by triage scales. Therefore, deteriorating patients who do not initially require timely treatment may be overlooked in a crowded ED. In addition to identifying patients who should be treated early, EDs should also identify patients who require monitoring.

However, there is no widely used score specifically designed to detect these at-risk patients.

To manage this issue, the practical and operational term *risk* should be defined, and a risk prediction model should be constructed. The National Early Warning Score (NEWS) seems to be a front-runner for this type of model. Among more than 30 000 ward patients, the NEWS demonstrated a fair to best predictive performance not only for death but also for cardiac arrest, unanticipated ICU admission, and other outcomes within 24 hours [6]. In addition, the NEWS was significantly associated with 30-day mortality and ICU admission among ED patients [7]. At present, the NEWS recommends specific level of monitoring for admitted patients in the United Kingdom [8] However, some important outcomes should be included in a new risk prediction model, such as advanced airway, vasopressor, or inotropic agent use, all of which require substantial ED resources. However, the NEWS has not been tested for these outcomes.

The modified early warning score using the initial serum lactate level (National Early Warning Score–Lactate or NEWS-L, formerly called the *ViEWS-L* score) was derived from medical ICU patients and tested on blunt trauma patients [9,10]. The NEWS-L comprises 2 main components: the physiologic component (NEWS) and the laboratory component (serum lactate level). Both the NEWS and the serum lactate level, which is rapidly obtained using point-of-care testing, can be determined soon after a patient arrives at the ED. Therefore, the NEWS-L can also be determined upon a patient's arrival, making it possible to initially use the NEWS-L score at the time of presentation of ED patients.

The aim of the present study was to evaluate the value of the NEWS-L for predicting mortality and the need for critical care among general ED patients. Furthermore, we explored the performance of the NEWS-L in subgroups based on the following admission diagnosis categories: disease-infection, disease–vascular and heart, disease-others, and nondisease, such as trauma or foreign body. In addition, the study aimed to determine the ratio of lactate to the NEWS. Finally, we recommend specific thresholds for the intensive monitoring of ED patients.

2. Methods

2.1. Study design and setting

We conducted a retrospective cohort study. The study was performed in one ED of an urban academic tertiary care university hospital in South Korea. The study hospital had 1200 beds, and the ED census was 35 000 patients per year. No patients were involved in setting the research question or outcome measures, nor were they involved in the study design and implementation. The present study was approved by the institutional review board of the study hospital, which waived the requirement for informed consent. This study complies with the Standards for Reproting of Diagnostic Accuracy statement [11].

2.2. Selection of participants

All patients 18 years or older who visited the study hospital over 2 consecutive months (from September 1 to October 31, 2014) were enrolled in the study. Multiple visits by the same patient were allowed. There were no exclusion criteria.

2.3. Methods and measurement

Age; sex; visit modality (direct visit, transfer from another facility, or transfer from an outpatient department [OPD]); emergency medical service (EMS) use; triage acuity (immediate, emergent, urgent, semiurgent, or nonurgent); disposition (discharge or admission to the ICU or ward); systolic blood pressure; diastolic blood pressure; pulse rate; respiratory rate; body temperature; mental status determined using the alert, verbal, painful, unresponsive scale; saturation determined by pulse oximetry (SpO_2); and the NEWS were extracted from the electronic medical records (EMRs) maintained by the study hospital. In addition, the date and time of ED arrival, ED discharge, hospital admission, and hospital discharge, as well as the survival status at discharge, were extracted. Since August 2014, the NEWS has been automatically recorded in the EMRs of the study hospital. Our trained researcher collected data related to advanced airway and vasopressor or inotropic agent use during the ED stay and initial blood lactate level. The initial blood lactate level was considered admissible when blood was sampled within 30 minutes of ED arrival. The admission diagnosis criteria were classified as disease-infection, disease–vascular and heart, disease-others, and nondisease. These processes followed the guidelines recommended by Gilbert et al [12]

The NEWS-L is the sum of the NEWS (physiologic component) and the serum lactate level (mmol/L; laboratory component) (Table 1) and is expressed as (x, y) = (NEWS, serum lactate level). If the serum lactate was not checked, a default value of 0.3 was used, which was the lower limit of the lactate level in the present study. For example, if a patient had a NEWS of 4 and a serum lactate level of 2.5 mmol/L, the NEWS-L was 6.5 and was expressed as (4, 2.5). If a patient had a NEWS of 2 and the serum lactate level was not checked, the NEWS-L was 2 and was expressed as (2, 0.3).

In the study hospital, serum lactate levels are generally measured using arterial blood, but venous blood lactate levels can also be used [13,14]. Lactate levels are measured using a Stat Profile Critical Care Xpress Analyzer (Nova Biomedical, Waltham, MA). The lactate measurement range of this machine is 0.3 to 20 mmol/L. This machine is periodically inspected by the manufacturer.

2.4. Outcomes

The primary outcome was 2-day (48-hour) mortality. The secondary outcomes were the need for critical care, the composite outcome of 2-day mortality and the need for critical care (2-day composite outcome), 7-day mortality, and in-hospital mortality. Critical care was defined as any of the following: ICU admission, advanced airway use in the ED, or vasopressor or inotropic agent use in the ED. Patients who were transferred from another facility while using an advanced airway, vasopressor, or inotropic agent were considered in need for critical care.

2.5. Analysis

Continuous data are presented as the mean and standard deviation (SD). Discrete data are presented as both counts and percentages. The logistic regression analysis results are presented as an odds ratio (OR) with a 95% confidence interval (95% CI).

Student *t* test for independent samples was used to compare the means of normally distributed variables. The Mann-Whitney *U* test was used for variables that were not normally distributed. For categorical data, the χ^2 test or χ^2 with Fisher exact test for 2 × 2 tables was used. The results were considered significant at a threshold of $P < .05$ (2-tailed).

An area under the receiver operating characteristic curve (AUROC) analysis was used to determine the predictive value of the NEWS and NEWS-L. The SEM and *P* values for the AUROC and comparisons between the NEWS-L and other risk scores were calculated using the method described by Hanley and McNeil [15]. Sensitivity and specificity analyses were also performed for various cutoff values of the NEWS-L score.

A multivariable logistic regression analysis was performed and adjusted according to the following basic characteristics: age, sex, visit modality (direct visit, transferred from another facility, or transferred from an OPD), EMS use, and triage acuity (immediate, emergent, urgent, semiurgent, or nonurgent).

All analyses were conducted using STATA 11.1 (StataCorp LP, College Station, TX) and SAS 9.1 (SAS Institute Inc, Cary, NC).