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National Early Warning Score (NEWS) at ICU discharge can predict early clinical deterioration after ICU transfer

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ABSTRACT

Objective: This study aims to determine the ability of the National Early Warning Score at ICU discharge ($NEWS_{dc}$) to predict the development of clinical deterioration within 24 h.
Methods: A prospective observational study was conducted. The NEWS was immediately recorded before discharge ($NEWS_{dc}$). The development of early clinical deterioration was defined as acute respiratory failure or circulatory shock within 24 h of ICU discharge. The discrimination of $NEWS_{dc}$ and the best cut off value of $NEWS_{dc}$ to predict the early clinical deterioration was determined.
Results: Data were collected from 440 patients. The incidence of early clinical deterioration after ICU discharge was 14.8%. $NEWS_{dc}$ was an independent predictor for early clinical deterioration after ICU discharge (OR 2.54; 95% CI 1.98–3.26; $P < 0.001$). The AUROC of $NEWS_{dc}$ was 0.92 ± 0.01 (95% CI 0.89–0.94, $P < 0.001$). A $NEWS_{dc} > 7$ showed a sensitivity of 93.6% and a specificity of 82.2% to detect an early clinical deterioration after ICU discharge.
Conclusion: Among critically ill patients who were discharged from ICU, a $NEWS_{dc} > 7$ showed the best sensitivity and specificity to detect early clinical deterioration 24 h after ICU discharge.

1. Introduction

Because of limited resources and the consideration for optimal resource allocation, appropriate ICU admission and discharge criteria may increase the benefits of patient care as well as to improve patient safety. Although the ICU admission criteria are clearly stated [1], the decision of ICU discharge may be difficult to determine. In addition, premature discharge from the ICU results in early ICU readmission and increased ICU mortality [2-6]. Several indices and clinical criteria have been proposed to identify the most appropriate patient to prevent premature ICU discharge [7-14]. Unfortunately, there are several limitations to apply these sophisticated criteria in clinical practice.

The National Early Warning Score (NEWS) is a simple aggregated weighted score based on the measurement of six vital signs and inspired gas breathed by the patient at the time. A higher NEWS indicates a greater severity of illness and risk of adverse outcomes [15,16]. Unfortunately, the use of NEWS values to select the appropriate patients for ICU discharge has never been tested.

The medical ICU at Songklanagarind Hospital is a level I ICU, which has 12 beds to care for mixed medical critically ill patients including acute respiratory failure, acute circulatory failure, and multiple organ failure. Because of high ICU requirements, most of the clinically stable patients are selected for discharge from the unit in order to receive new acute deteriorated patients from the ward or emergency department. The current ICU discharge criteria depend on the decision of the intensivist in charge of the patient. The NEWS was adopted in our unit for a period of time to monitor clinical deterioration of critically ill patients. In this study, we aimed to use the NEWS immediately before ICU discharge to predict early clinical deterioration, including acute respiratory failure or circulatory shock, in patients discharged from the ICU.

2. Methods

2.1. Patients

A prospective observation study was conducted. The study protocol was approved by the ethics committee (EC) at the Faculty of Medicine, Prince of Songkla University (EC number: 57-278-157). The data of 500 critically ill patients who were discharged from the medical ICU between December 2015 and October 2016 were recorded and followed

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up. A waiver of consent was approved and the investigators assigned a confidentiality term.

2.2. Data collection

All demographic data including age, gender, causes of ICU admission, Acute Physiologic and Chronic Health Evaluation (APACHE) II score, and types of ICU discharge were collected. The NEWS at the time of ICU discharge was also calculated and recorded immediately before transfer of the patients to the destination ward. The clinical conditions 24 h after ICU discharge were also monitored and recorded by the researchers (S.U., J.K.). The primary outcome was the development of early clinical deterioration, defined as acute respiratory failure or circulatory shock within 24 h of ICU discharge.

2.3. National Early Warning Score (NEWS)

The NEWS was introduced by the Royal College of Physicians of London (RCPL) in order to bring about a major change required in the assessment and response to acute illness. In this simple scoring system, a score is assigned according to the physiological measurements which are pragmatically recorded during hospitalization. There are seven parameters that comprise this scoring system: respiratory rate, oxygen saturation, oxygen requirement, body temperature, pulse rate, systolic blood pressure, and level of consciousness (Table 1). The higher scores indicate significant clinical deterioration and severity. The NEWS is categorized into 3 classes according to the composite score that includes low risk (NEWS 0–4), moderate risk (NEWS 5–6), and high risk (NEWS >6). Furthermore, the intensity of care was tailored regarding the level of the NEWS.

2.4. Definitions

In the current study, the causes of ICU admission were classified into septic shock, acute respiratory failure, acute renal failure, heart failure, cardiogenic shock, and post-cardiac arrest. The types of ICU discharge were categorized to planned ICU discharge, unplanned ICU discharge, and discharge for end-of-life care. The critically ill patients, who were fully evaluated by the intensivist in charge for the readiness of ICU discharge after daily morning ward rounds, were defined as planned ICU discharge. Unplanned ICU discharge was recorded if the patients were discharged for an immediate ICU bed requirement. Most of the unplanned ICU discharge patients were the most clinically stable patients which were decided by the intensivist in charge.

Early clinical deterioration in this study was defined as the development of acute respiratory failure or circulatory shock within 24 h after discharge from the ICU. Acute respiratory failure was defined as the need for intubation, invasive mechanical ventilation, non-invasive mechanical ventilation or high flow oxygen therapy. Hypotension that required vasopressors or inotropes was defined as circulatory shock. We did not record other types of organ system failure because a previous study showed that the major causes of ICU readmission were respiratory failure and a compromised circulatory system [17].

2.5. Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) or median with a minimum and a maximum dependent on the distribution of data and discrete variables that were expressed in percentages. The clinical characteristics between early clinical deterioration and non-deterioration were compared by the chi-squared test, Fisher's exact test, Mann-Whitey test, and independent samples *t*-test as appropriate.

We then used simple univariate and multivariate logistic regression to evaluate the correlation between the potential variables and primary outcome. The variables with $P < 0.1$ in univariate analysis were introduced into the multivariate logistic regression model. Collinearity between variables was excluded before modeling. All variables, odds ratios (ORs) and their 95% confidence intervals (CIs) were used to identify the independent predictors of early clinical deterioration.

Afterwards, a receiver operating characteristic (ROC) curve and a calculated corresponding area under the ROC curve (AUROC) of $NEWS_{dc}$ were constructed. The Youden index was introduced to select the best cut off value of $NEWS_{dc}$ with the best sensitivity, specificity, positive likelihood ratio (LR+) and negative likelihood ratio (LR−) to predict the primary outcomes. A P value <0.05 indicated statistical significance. All statistical analyses were computed by MedCalc® Statistical Software version 17.1 (MedCalc Software bvba, Ostend, Belgium).

3. Results

3.1. Patient characteristics

Sixty cases of ICU discharge for end-of-life care were excluded. Of the remaining 440 cases that were then analyzed, the median age of the patients was 61 (20,96) years old and 219 (49.8%) were male. The median APACHE II score was 25.5 (13,37). The median of the $NEWS_{dc}$ was 3 (0,13). Septic shock and acute respiratory failure were among the major reasons for ICU admission (27.0%, 24.5%, respectively). Approximately 53.2% of the cases were planned ICU discharge and 46.8% were unplanned ICU discharged.

3.2. Clinical characteristics between early clinical deterioration and non-deterioration

Of 440 patients, 65 patients (14.8%) developed early clinical deterioration. The demographic data, including mean age, gender, and median APACHE II, were comparable between the early clinical deterioration and non-deterioration group. Causes of ICU admission, types of ICU discharge, and $NEWS_{dc}$ were significantly different between the groups (Table 2). Most of unplanned ICU discharged patients developed early clinical deterioration. The median $NEWS_{dc}$ was significantly higher in the early clinical deterioration group: 10 (5,13) vs 3 (0,12) ($P < 0.001$).

3.3. Independent predictors of early clinical deterioration

Although unplanned ICU discharge was significantly higher in the early deterioration group, the univariate and multivariate analyses could not be determined due to the zero cell issue. In simple univariate

Table 1
National Early Warning Score.

Physiological parameters	3	2	1	0	1	2	3
Respiratory rate	≤8		9–11	12–20		21–24	≥25
Oxygen saturations	≤91	92–93	94–95	≥96			
Any oxygen supplement		Yes		No			
Temperature	≤35		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	
Systolic blood pressure	≤90	91–100	101–110	111–219			≥220
Heart rate	≤40		41–50	51–90	91–110	111–130	≥131
Level of consciousness[a]				A			V, P or U

[a] The AVPU scale for level of consciousness ="alertness, voice, pain, unresponsive".