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Original Article

NATIONAL EARLY WARNING SCORE 2 TO PREDICT ICU ADMISSION OF COVID-19 PATIENTS IN BANGLADESHI COHORT

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Abstract:

Objective: *To assess the predictive accuracy of the National Early Warning Score 2 (NEWS 2) for early prediction of clinical deterioration (ICU admission) of COVID-19-infected patients in Bangladesh.*

Methods: *Data from 244 patients with COVID-19 infection admitted from July 2021-September 2021, to the Aichi Hospital Ltd, Bangladesh, were retrospectively reviewed. Consecutive adult patients with laboratory-confirmed COVID-19 initially admitted to non-ICU wards were included. Categorical and quantitative variables were expressed as numbers (percentages) and median (interquartile range, IQR). We evaluated the predictive performance of NEWS2 to predict ICU admission by comparing the area under the receiver operating characteristics curve (AUROC) at thresholds 5 and 7 and assessed its association with ICU admission by performing multivariate logistic analyses. STATA conducted all the statistical analyses.*

Results: *Among the included 218 patients, 68 patients were transferred to ICU. The AUROC was 0.96 (Standard error 0.01, 95% confidence interval 0.93-0.98), revealing that NEWS2 at hospital admission was a good predictor of ICU admission. A NEWS2 threshold of 5 had higher sensitivity than a threshold of 7 (72.06% and 29.41%). A point of 7 also had high specificity (99.33% and 63.33%) and a high positive predictive value than a threshold of 5 (95.24% vs. 47.12%). The NEWS2 entries 5 and 7 were related to ICU admission found in multivariate logistic regression analysis.*

Conclusion: *Our results suggest that NEWS2 at hospital admission is a good predictor for ICU admission of COVID-19 patients in Bangladesh. Screening patients at admission with this tool may identify patients at risk of clinical deterioration and help in better management.*

Keywords:
COVID-19, National Early Warning Score 2 NEWS2, ICU, and Bangladesh

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Introduction

Coronavirus Disease 2019 (COVID-19); is a newly recognized respiratory illness that emerged in China in December 2019[1]. After that, COVID-19 rapidly spread through other regions of the world. The death toll of COVID-19 until now is approximately 200,000 globally[2].

The COVID-19 patient who hospitalized; many of them are required non-invasive pressure support, invasive ventilation, or critical care admission, and identifying these patients early is essential.[3] Simple and practical tools to identify deteriorating patients are needed. The NEWS2 is the latest version of NEWS, first produced in 2012 and updated in December 2017, which is commonly used in British hospitals to assess and respond to patients with a high risk of deterioration[4]. The updated NEWS2 is widely used to identify

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deteriorating hospitalized patients, particularly those requiring escalation to a higher level of care (from a general ward to a critical care setting).

The NEWS2 applies an aggregative weighted ordinal stratification to routinely measured physiological parameters, including heart rate, blood pressure, temperature, respiratory rate, oxygen saturation, and consciousness level to generate a score from o to 23. A threshold of NEWS2e"5 is used as a trigger for immediate clinical review, and has been validated in acute medical admissions and other settings.[5] Alternative rapid scoring systems have also been developed, notably the modified early warning score (MEWS) and quick sepsis related organ failure assessment (qSOFA) scores, which have been validated in the management of acute medical admissions and sepsis respectively.[6] No early warning score system has been validated for use in COVID-19.[3] To assess the severity of COVID-19-infected patients, an early assessment or predictive tool is a relevant need for the clinical courses of this highly contagious outbreak[7]. During this pandemic, we evaluated the predictive value of national early warning score 2 (NEWS 2) to identify high-risk, severely ill patients for intensive care unit (ICU) admission. Primarily, the NEWS2 was validated for death and intensive care needs in septic patients[4].

In this study, we provided the first report of the performance of NEWS2 to determine the predictive value at hospital admission of COVID-19 patients as a predictor of ICU admission among the Bangladeshi cohort.

Methods:

Patients and data retrieval

Consecutive adults with COVID-19 were admitted initially to the emergency department (ED) at Aichi Hospital Ltd, Bangladesh was recruited. During admission to the ED, we calculated the NEWS2 score for transferring the patients to the general ward (Non-ICU) and ICU. We retrospectively analyzed prospectively retrieved data of patients admitted with COVID-19 infection from July 2021 to September 2021. We included all adult patients (age e" 18 years) with a confirmed diagnosis of SARS-CoV-2 infection. All data were retrieved from the electronic medical records (EMR). We retrieved 244 COVID-19 patients' data, and they were analyzed anonymously.

Exclusion criteria were: pregnant mothers with positive COVID-19, patients that do not require ICU admission, patients who died within 48 hours of admission, patients with circulatory shock or positive pressure support on arrival to the ED, and patients lack of relevant data to calculate the NEWS2. The primary outcome was ICU admission following arrival at ED. The institutional ethics committee approved the study (Ethics Committee of East West Medical College & Hospital, a sister concern of Aichi Hospital Ltd, Bangladesh).

Statistical analysis

We assessed the potentials of NEWS2 thresholds of 5 and 7 during admission to the general ward (Non-ICU) and ICU. Since our primary outcome of this study is ICU admission, we intended to get prognostic accuracy of these two values for ICU admission by using sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio, and accuracy. Each value is reported with 95% confidence interval (CI)[8].

The prognostic accuracy of NEWS2 for ICU admission was evaluated by the receiver operating characteristic curve (ROC) analysis, describing the area under the receiver operating characteristic curve (AUROC) with 95% CI and comparing the null hypothesis (area=0.05). The probability value of the ROC curve was assessed using the Mann-Whitney-U test.

To assess if other variables might be correlated to ICU admission, multivariate logistic regression analysis was performed. Before multivariate analysis, univariate analysis was performed by applying Chi-square or Mann-Whitney-U tests as appropriate. Multivariate logistic regressions were performed for NEWS2 with thresholds of 5 and 7. The results of multivariate logistic regression are given as an odds ratio with 95% CI and *p*-value. Statistical analyses were performed using the software STATA. A *p*-value <0.05 was considered significant.

Results:

During the study period, 244 patients were admitted to the hospital for SARS-CoV-2 by confirming RT-PCR. As shown in Figure 1 twenty-six were excluded from the analysis. Ten patients were excluded due to insufficient data to calculate NEWS2 at admission. The other twelve patients, among them six patients were pregnant and the rest of the six patients got respiratory support before the first set of observations. In addition, four patients were <18 years old.

After exclusion, 218 patients were included in the analysis, and of them, 68 patients were admitted to ICU (31.11%) where they receive invasive respiratory support. The median time between hospitalization and ICU admission was 3.0 days (Interquartile range 1.5 – 5.5 days).

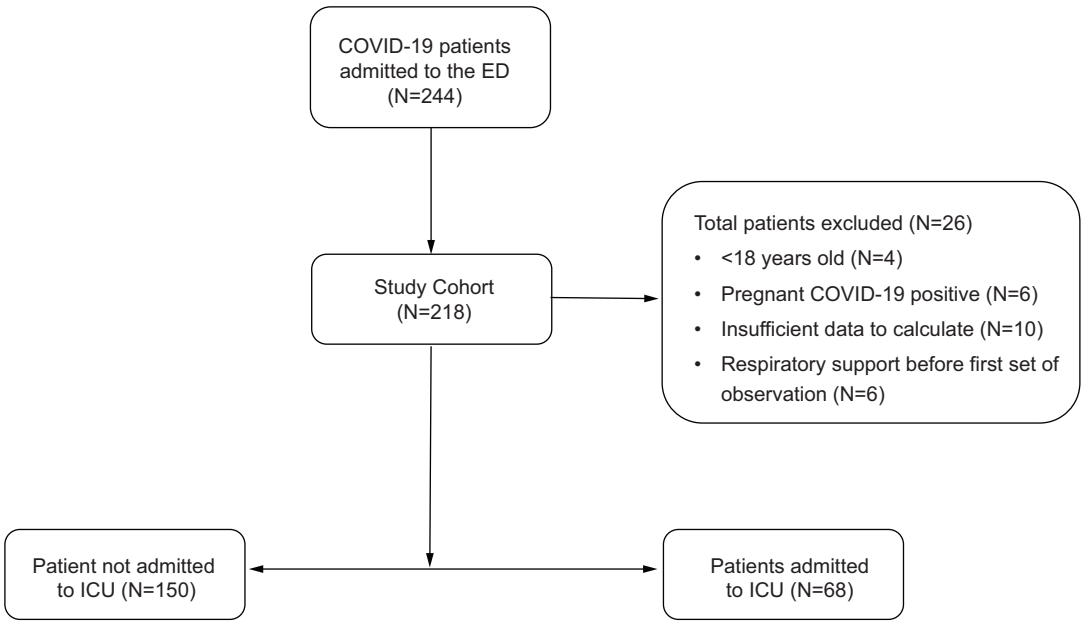

Figure 1: *Depicts Exclusion of Patients Prior to Analysis*

The baseline characteristics of the study population with COVID-19 are enlisted in Table I. The median age with IQR in ICU admission was 60 (50-70), and 47% were male. Diabetes mellitus, hypertension, and bronchial asthma were the most frequent comorbidities (67%, 61% and 33% respectively) among ICU admitted patients. NEWS 2 e"5 and NEWS2 e"7 patients were respectively 49 (72.0%) and 20 (29.4%) admitted to ICU.

Table-I

Baseline characteristics of the study population with COVID-19

	Total Population			NEWS 2 ≥ 5 (104)		NEWS2 ≥7 (20)	
	Total	ICU	Non-ICU	ICU	Non-ICU	ICU	Non-ICU
N	218	68	150	49	55	20	0
Age: Median, IQR	50 (35-65)	60 (50-70)	45 (33-60)	60 (50-70)	45 (34-60)	55 (42-68)	0
Sex:Male%	51	47	53	55	44	30	0
Diabetes Mellitus (%)	45	67	35	65	35	75	0
Hypertension (%)	37	61	26	61	92	65	0
Ischemic Heart Disease (%)	13	25	8	28	29	20	0
Bronchial Asthma (%)	16	33	8	42	25	10	0
Stroke (%)	4	7	3	6	12	10	0
Chronic Kidney Disease (%)	9	14	7	18	21	5	0

Table-II

Prognostic accuracy of NEWS2 for ICU admission using two different threshold values: 5 and 7 (N=68)

	NEWS 2 ≥5	NEWS 2 ≥7
Sensitivity % (95% CI)	72.06 (66.10-78.02)	29.41 (23.36-35.46)
Specificity % (95% CI)	63.33 (56.94-69.73)	99.33 (98.25-100.41)
Positive Predictive Value % (95% CI)	47.12 (40.49-53.74)	95.24 (92.41-98.07)
Negative Predictive Value % (95% CI)	83.33 (78.39-88.28)	75.63 (69.94-81.33)
Accuracy % (95% CI)	0.65 (0.59-0.71)	0.85 (0.79-0.90)
Positive Likelihood Ratio	1.94	29
Negative Likelihood Ratio	2.25	1.39

The prognostic accuracy of NEWS 2 for the prediction of ICU admission depicts in Table 2. Threshold 5 had higher sensitivity than a threshold of 7 (72% and 29% respectively). On the counterpart, a higher specificity was found in threshold 7 than in threshold 5 (99.33 and 63.33 respectively).

The threshold of 7 had a high positive likelihood ratio (29) and high positive predictive value (95%), while we using the threshold of 5 had 1.94 and 47%, respectively. The negative likelihood ratios were 2.25 and 1.39, and the negative predictive value was 83% and 75% for the threshold of 5 and 7, respectively. Accuracy was higher for threshold 7 (85% vs 65%). The ROC curve of NEWS2 for predicting ICU admission is in depicted Figure 3. The AUROC curve was 0.96, standard error (SE, 0.01, 95% CI 0.93-0.98; p<0.05)

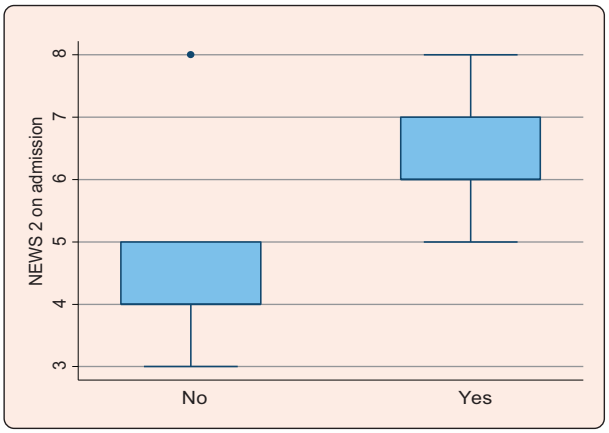

Figure 2: National Early Warning Score 2 (NEWS 2) of coronavirus disease 2019 (COVID-19) patients at hospital admission. Patients were divided into two groups: intensive care unit (ICU) patients, who required ICU admission and non-ICU patients, who did not require ICU admission.

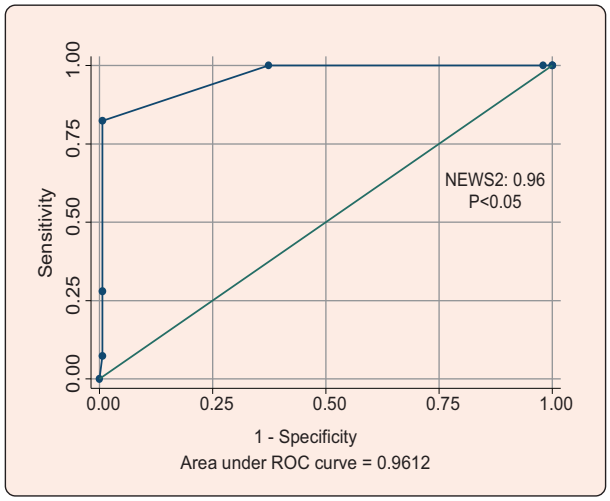

Figure 3: Receiver operating characteristic curve (ROC) for patients ICU admission using NEWS2 of COVID-19 patients at hospital admission. NEWS2 showed strong predictive ability with an area under the ROC (AUROC) curve of 0.96 (p<0.05).

Table 3 shows a multivariate logistic regression analysis. Only high NEWS2 was significantly related to ICU admission using both the threshold 5 (OR 18.05, 95% CI 4.80-92.86; p<0.05; Hosmer-Lemeshow test was not significant, p=0.43) and 7 (OR 77.8, 95% CI 12.3-1619; p=0.05; Hosmer-Lemeshow test was not significant, p=0.24).

n represents the total number of question- 'segments' in the Neuroanatomy portion of all the question papers of the universities analysed.

Table-III

Multivariate logistic regression analysis

Outcome: ICU admission	Multivariate analysis NEWS2 ≥5OR (95% CI, p)	Multivariate analysis NEWS2 ≥7OR (95% CI, p)
Diabetes Mellitus	0.9 (0.4-1.7, p = 0.77)	3.9 (1.1-13.2, p = 0.02)
Hypertension	0.7 (0.3-1.4, p = 0.40_	2.5 (0.8-7.4, p = 0.10)
Ischemic Heart Disease	1.2 (0.5-2.7, p = 0.64)	1.0 (0.3-3.6, p = 0.92)
Bronchial Asthma	2.6 (1.1-6.1, p = 0.02)	0.4 (0.1-1.7, p = 0.23)
Stroke	0.3 (0.08-1.6, p = 0.19)	4.5 (0.7-28.7, p = 0.10)
Chronic Kidney Disease	0.9 (0.3-2.6, p = 0.91)	0.4 (0.08-2.6, p = 0.39)
NEWS2	18.05 (4.8-92.9, p<0.05) HL = 8.1 (p=0.43)	77.8 (12.3-1619, p =0.05) HL =10.4 (p=0.24)

Discussion

The aim of this study was to determine whether the high NEWS2 can able to predict ICU admission of COVID-19 patients in Bangladesh. A NEWS2 showed a good predictive value for ICU admission (AUROC: 0.96). To the best of our knowledge, it is the first study in Bangladesh to evaluate the performance of NEWS2 in patients with COVID-19. Hu et al. recently find the importance of rapid scoring systems for the clinical evaluation of patients with COVID-19. They compared the Modified Early Warning Score (MEWS) and the Rapid Emergency Medicine Score (REMS) as a predictor of mortality in COVID-19 [9]. The primary outcome of our study was ICU admission, not mortality. The fact was based on: 1) the importance of identifying patients who may rapidly deteriorate and need resuscitation assessment; 2) the epidemic in Bangladesh, as yet, is in an earlier phase than in China, so most patients are hospitalized, and it was not possible to estimate the mortality in our cohort at that time.

We have chosen NEWS2 as it is easily and rapidly applicable and has shown high predictive capacity for mortality in other critically ill patients [10]. NEWS and NEWS2 can also be used in the prehospital setting to support ambulance clinician decision-making [11]. The potential benefit of NEWS2 for prehospital stratification of COVID-19 patients is presumable but not yet proven. Our results support the use of this score to evaluate the COVID-19 patients at hospital admission.

According to our results, NEWS2 could be useful in two ways:

- Using a threshold of 5 results in high sensitivity (72%), high negative predictive value (83%), and good negative likelihood ratio (2.25). It means that a patient with a score <5 has a low probability of ICU admission. We suggest monitoring patients with NEWS2 <5 every 4-6 hours or less, following the Royal College of Physicians' guidelines. We also recommend strict monitoring of patients with NEWS2 e" 5 because a considerable proportion may rapidly progress to severe respiratory failure.
- Using a threshold of 7 results in high specificity (99%), high positive predictive value (95%), and positive likelihood ratio (29). This means a probability of the need for later ICU admission. Based on our result, we propose rapid assessment of patients in a sub-intensive care unit with strict monitoring and preliminary evaluation by an intensive care specialist to discuss further treatment.

Our results in patients with COVID-19 are in line with the recent guidelines published by the Royal College of Physicians that recommend a greater urgency in the management of patients with NEWS2 e" 7 than in those with scores e" 5.

The main limitations of our study are the retrospective single-center study design and the small number of patients. The results need to be confirmed in multi-center studies and focus on laboratory parameters.

The main strength of this study is the well-characterized cohort with low missing data and the high predictive value of NEWS2 found in COVID-19 patients for ICU admission. Furthermore, we also individuated two different thresholds that could help clinicians to correctly classify these patients.

Conclusion:

In a pandemic like COVID-19, rapid assessment of the patient is essential. A fast and easily calculated score, such as NEWS2, could help clinicians manage acutely ill patients. The correlation between NEWS2 and ICU admission makes this scoring system useful in clinical practice to correctly and rapidly treat patients with severe diseases.

Acknowledgment

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Authors Contribution

MJI and NHN contributed conception and design of the study, MJI contributed analysis and interpretation of data, MJI wrote the first draft of the manuscript; MH, NHN, NSK, BB wrote sections of the manuscript. All authors contributed to critical manuscript revision, read and approved the submitted version.

Declaration of Competing Interest

The authors have no conflict of interest.

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