Utility of National Early Warning Score 2 to risk-stratify coronavirus disease of 2019 patients in the emergency department: A retrospective cohort study

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ABSTRACT

Background: The application of a risk stratification pathway is necessary for the emergency department (ED) to assess the severity of the disease and the need for escalation of therapy. We aimed to implement the National Early Warning Score 2 (NEWS2) pathway at triage to differentiate patients who are stable or critically ill with no invasive investigations at the time of admission during the coronavirus disease of 2019 (COVID-19) era in comparison to other clinical risk scores.

Methods: One hundred and four patients were collected from April 1, 2021, to June 1, 2021, during the second wave of the COVID-19 pandemic at an academic medical center in India. The NEWS2 scoring system and the quick sepsis-related organ failure assessment (qSOFA) score were introduced as part of the initial assessment in the triage area of the ED. Data were assessed using the area under the receiving operating characteristic (AUROC) curve for NEWS2 and qSOFA scores, respectively.

Results: In the study, NEWS2 classification indicated that 25% of patients required continuous monitoring, of which 12.7% subsequently deteriorated within 24 h of admission and 7% died. Both, NEWS2 (threshold 0; 1, AUROC 0.883; 95% confidence interval [CI] 0.8–0.966) and qSOFA (threshold 0; 1, AUROC 0.851; 95% CI 0.766–29 0.936) effectively identified COVID-19 patients in the ED at risk for clinical deterioration. There was no significant difference in the diagnostic performance of qSOFA and NEWS2 (DeLong’s test $P = 0.312$).

Conclusion: Both NEWS2 and qSOFA effectively-identified COVID-19 patients in the ED at risk for clinical deterioration with no significant statistical difference. However, a triage level risk stratification score can be developed with the inclusion of blood parameters on admission to further validate the practice.

Key Words: Coronavirus disease of 2019, National Early Warning Score 2, quick sepsis-related organ failure assessment, triage

INTRODUCTION

After the first wave of the severe acute respiratory syndrome coronavirus-2 pandemic in 2020, the second wave of the virus with its mutated variants was the much-anticipated peril for most countries, of which India capped the spot for the worst affected with 401,078 cases reported on a single day. The blanket of various symptoms and clinical
variations flooded the ED making it exigent to triage. The brunt of the overflowing surge capacity was faced by the various hospitals in the country, with many closing their doors to the public once the resources were drained.[2] In resource-limited settings, it is even more important to rapidly risk-stratify patients while sparing resources to identify those suspected and confirmed coronavirus disease 2019 (COVID-19) patients with a severe or critical illness as well as those at risk for clinical deterioration.

Traditional clinical risk stratification tools are widely used for continuous assessment of patients in the ED and intensive care units (ICU), but only a few studies have evaluated the use of these tools at triage during the COVID-19 pandemic in the ED.

National Early Warning Score 2 (NEWS2) is a standardized clinical scoring system developed for improved detection of deterioration in acutely ill patients [Figure 1].[3] The primary aim of the study was to determine if the application of the NEWS2 score at triage in the ED with COVID-19 patients (suspected or confirmed) was more effective in identifying patients with critical illness, clinical deterioration, or hospital mortality within 24 h of admission, as compared to the quick sepsis-related organ failure assessment (qSOFA) score.[4]

**METHODS**

A retrospective cohort study was conducted from April 1, 2021, to June 1, 2021, at an academic medical center in India. Before data collection, the study was approved by the institutional review board/ethics committee and informed consent was obtained on admission. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed for the study.

A convenience sample of patients above the age of 18 years; irrespective of their COVID-19 status at triage was abstracted from the paper hospital records. Missing or incomplete data were omitted from the study.

The ED is operationally divided by a three-tier triage system to which patients are directed based on their triage presentation: green (stable, does not require monitoring) and yellow (stable, requires monitoring) were admitted to the observation unit, and red (unstable, requires monitoring) to the emergency medicine ICU (EM ICU). In addition, the hospital had established an auxiliary care unit (fever clinic) for suspected and confirmed COVID-19 patients which may provide supplemental oxygen, monitors, and ventilator support (if needed) with online support for providers.

**Table 1: Summary of basic details**

| Basic details | Mean ± SD | Median (IQR) | Minimum-Maximum | Frequency (%) |
|---------------|-----------|--------------|-----------------|---------------|
| Age (years)   | 48.17 ± 18.79 | 47.00 (32.75-62.00) | 18.00-92.00 | 12 (11.5) |
| Gender, n (%) | Male | 74 (71.2) | 30 (28.8) |  |
| Age category  | 18-30 | 30 (28.8) | 74 (71.2) |  |
|               | 31-40 | 24 (23.1) | 10 (9.6) |  |
|               | 41-50 | 21 (20.2) | 8 (7.6) |  |
|               | 51-60 | 16 (15.4) | 5 (4.7) |  |
|               | 61-70 | 16 (15.4) | 10 (9.6) |  |
|               | > 70  | 12 (11.5) | 24 (23.1) |  |

**Table 2: Summary of COVID-19 status**

| COVID-19 status | Mean ± SD | Median (IQR) | Min-Max | Frequency (%) |
|-----------------|-----------|--------------|---------|---------------|
| COVID-19 status | 48.17 ± 18.79 | 47.00 (32.75-62.00) | 18.00-92.00 |  |
| Rapid antigen   | 10 (9.6) |  |
| negative        | 28 (26.9) |  |
| Unlikely        | 40 (38.5) |  |
| Suspected       | 26 (25.0) |  |
| Confirmed       | 31 (29.8) |  |
| Area of admission | 57 (54.8) |  |
| Fever clinic    | 15 (14.4) |  |
| Resuscitation room/ emergency ICU | 1 (1.0) |  |
| Observation room | 1 (1.0) |  |

SD: Standard deviation; IQR: Interquartile range

**Figure 1: National Early Warning Score 2**

**Figure 2: Severity of the clinical risks as per presentation for National Early Warning Score 2**

*Response by a clinician or team with competence in the assessment and treatment of acuity # patients and in recognising when the escalation of care to a critical care team is appropriate.

**The response team must also include staff with critical care skills, including emergency management.
NEWS2 [Figures 1 and 2] and qSOFA were calculated based on the triage presentation and had been integrated into the pro forma for assessment. qSOFA is a bedside tool that may identify patients with suspected infection at greater risk for a poor outcome outside the ICU. It assigns 1 point for each of the following criteria: low blood pressure (systolic blood pressure ≤100 mmHg), high respiratory rate (≥22 breaths/min), or altered mentation (Glasgow Coma Scale <15). A qSOFA score ≥2 has been associated with an increased risk of death or prolonged ICU stay.[4]

**Statistical analysis**
Data were coded and recorded using Microsoft Excel (Microsoft Corp., Redmond, USA) version 16.57. Statistical analyses were performed using IBM SPSS version 23 (IBM Corp., Armonk, USA). Descriptive statistics were elaborated in the form of means with standard deviations or medians with interquartile range for continuous variables, frequencies, and percentages for categorical variables. In case the expected frequency in the contingency tables was found to be <5 for >25% of the cells, Fisher’s Exact Test was used instead. Statistical significance was kept at $P < 0.05$ for the association between various parameters. Data were assessed using the Area Under the Receiver Operating Characteristics (AUROC) for NEWS2 (cutoff >8) and qSOFA (cutoff ≥2) scores, respectively.

**RESULTS**
One hundred and four patients were assessed in the triage area using the NEWS 2 score and qSOFA score. They were further segregated as per their clinical risk status of NEWS2 score of ≥9 and qSOFA score of ≥2. The primary finding in the study is that the NEWS2 score was found to be as effective as the qSOFA score for the suspected category despite a negative rapid antigen test on admission [Table 3]. As per presentation to the ED, 31 were admitted to the EM ICU, 57 in the fever clinic, and remaining in the observation room.

Twenty-five percent required continuous monitoring as per their clinical risk status of NEWS2 score of which 12.7% ($n = 13$) deteriorated, 12 from the high-risk group (three in fever clinic, nine in EM ICU), and one from the low risk within 24 h of admission accounting for 7% mortality [Table 4].

Table 5 shows the patient’s COVID-19 status and association with mortality. It was noted that five were rapid antigen negative.

**Strengths and limitations**
The study was limited by the availability of immediate COVID-19 RT-PCR-test and the small sample size. Furthermore, qSOFA has been validated for sepsis only; hence its parameters could not be justified for certain cases.

**DISCUSSION**
The primary finding in the study is that the NEWS2 score was found to be as effective as the qSOFA score for 7% mortality [Tables 6 and 7]. Although in comparison, there was no significant difference in the diagnostic performance of qSOFA and NEWS2 scores (DeLong’s test $P = 0.312$).

**Table 3: Association between COVID-19 status and parameters**

| Parameters                  | COVID-19 status       | $P$  |
|-----------------------------|-----------------------|------|
|                             | Rapid antigen negative| Likelihood | Suspected | Confirmed |
|                             | ($n = 10$), $n (%)$    | ($n = 28$), $n (%)$ | ($n = 40$), $n (%)$ | ($n = 26$), $n (%)$ |
| Age (years)                 | 48.40 ± 20.37         | 48.75 ± 16.33 | 51.25 ± 21.19 | 42.73 ± 16.42 | 0.428* |
| Age (years)                 |                       |                   |               |               |       |
| 18-30                       | 2 (20.0)              | 5 (17.9)          | 9 (22.5)      | 8 (30.8)      | 0.263* |
| 31-40                       | 1 (10.0)              | 4 (14.3)          | 6 (15.0)      | 4 (15.4)      |       |
| 41-50                       | 3 (30.0)              | 7 (25.0)          | 5 (12.5)      | 6 (23.1)      |       |
| 51-60                       | 2 (20.0)              | 6 (21.4)          | 6 (15.0)      | 2 (7.7)       |       |
| 61-70                       | 1 (10.0)              | 5 (17.9)          | 4 (10.0)      | 6 (23.1)      |       |
| > 70                        | 1 (10.0)              | 1 (3.6)           | 10 (25.0)     | 0             |       |
| Male                        | 7 (70.0)              | 19 (67.9)         | 25 (62.5)     | 23 (88.5)     | 0.144* |
| Female                      | 3 (30.0)              | 9 (32.1)          | 15 (37.5)     | 3 (11.5)      |       |
| Area of admission***        |                       |                   |               |               |       |
| Fever clinic                | 1 (10.0)              | 0                 | 31 (77.5)     | 25 (96.2)     | <0.001* |
| Resuscitation room/ICU      | 9 (90.0)              | 14 (50.0)         | 7 (17.5)      | 1 (3.8)       |       |
| Observation room            | 0                    | 13 (46.4)         | 2 (5.0)       | 0             |       |
| Triage                      | 0                    | 1 (3.6)           | 0             | 0             |       |

***Significant at $P < 0.05$; **Kruskal-Wallis test; *Chi-squared test, ICU: Intensive care unit
in differentiating patients at triage as per the clinical risks of deterioration. The study conducted in Norway by Stine Engebretsen et al.,[7] and Myrstad et al.,[8] shows that the NEWS2 score is adequate for the prediction of “ICU admission” and “critical care in ED,” which is similar to the result of our study. This also highlighted the need for different levels of monitoring intensity as per the risk groups. Whereas in a multicentric study, NEWS2 score was found to have poor to moderate outcome for the severity prediction of COVID-19, risk stratification was improved with added blood tests and the parameters on admission.[9] Even though the primary presenttions were mostly secondary to the respiratory insult, symptoms varying from altered sensorium, chest pain, loose stool, etc., were also found to be COVID-19-positive.[9] Twelve from the high risk and one from the low-risk groups deteriorated within 24 h of admission. It was also noted that five were rapid antigen-negative in the high-risk group. These various presentations or just the detection of the virus itself in a nonsuspect proved to be an admission conundrum. NEWS2 not only covered the hypoxemic parameter of the disease but also the others required for clinical risk stratification in comparison to qSOFA.

Despite the COVID-19 status of the patient, clinical risk stratification at triage will be a hallmark. It can control triage traffic and decrease the time required for admission, resources, and workforce utilization during a crisis. Perhaps a larger, multicentric study is required to validate the use of the NEWS2 score as a triaging tool or the development of a scoring system specific to the ED for clinical risk stratification irrespective of the COVID-19 status is the need of the hour.

Table 4: Association between deterioration of patient and other parameters

| Parameters                        | Deterioration of patient | P     |
|-----------------------------------|--------------------------|-------|
|                                   | Yes (n = 13), n (%)      | No (n = 89), n (%) |
| COVID-19 status ***              |                          |       |
| Rapid antigen negative           | 5 (38.5)                 | 5 (5.6)   | <0.001b |
| Unlikely                          | 0                        | 28 (31.5)|       |
| Suspected                         | 6 (46.2)                 | 33 (37.1)|       |
| Confirmed                         | 2 (15.4)                 | 23 (25.8)|       |
| Area of admission ***            |                          |       |
| Fever clinic                      | 4 (30.8)                 | 51 (57.3)| 0.011b |
| Resuscitation room/ emergency ICU| 9 (69.2)                 | 22 (24.7)|       |
| Observation room                  | 0                        | 15 (16.9)|       |
| Triage                            | 0                        | 1 (1.1)  |       |
| qSOFA score total ***            | 1.69 ± 0.63              | 0.69 ± 0.69| <0.001a |
| NEWS 2 score total ***           | 10.85 ± 3.02             | 4.64 ± 4.08| <0.001a |
| Clinical risk ***                |                          |       |
| Low risk                          | 1 (7.7)                  | 47 (52.8)| <0.001b |
| Medium risk                       | 0                        | 19 (21.3)|       |
| High risk                         | 12 (92.3)                | 23 (25.8)|       |
| Monitoring ***                   |                          |       |
| Continuous                        | 9 (69.2)                 | 16 (18.0)| <0.001b |
| 1-2 h                             | 3 (23.1)                 | 7 (7.9)  |       |
| 6 h                               | 1 (7.7)                  | 10 (11.2)|       |
| 12 h                              | 0                       | 56 (62.9)|       |
| Mortality (Yes) ***              | 7 (53.8)                 | 0       | <0.001b |

***Significant at P<0.05; aWilcoxon-Mann-Whitney U-test; bFisher’s exact test; ICU: Intensive care unit; qSOFA: Quick sepsis-related organ failure assessment; NEWS 2: National Early Warning Score

Table 5: Association between mortality and COVID-19 status (n = 104)

| COVID-19 status               | Mortality | Fisher’s exact test |
|-------------------------------|-----------|---------------------|
|                               | Yes, n (%)| No, n (%) | Total, n (%) | χ²  | P     |
| Rapid antigen negative        | 5 (71.4)  | 5 (5.2)  | 10 (9.6)  | 33.911 | <0.001 |
| Unlikely                      | 0 (28.6)  | 28 (92.4) | 28 (92.6)|       |
| Suspected                      | 2 (28.6)  | 38 (71.4) | 40 (75.8)|       |
| Confirmed                      | 0 (26.8)  | 26 (73.2) | 26 (25.0)|       |
| Total                          | 7 (100.0) | 97 (100.0)| 104 (100.0)|       |

Table 6: Performance of study parameters for predicting deterioration of patient

| Variable                      | Category(s) suggesting outcome present | Category(s) suggesting outcome absent | Total positives, n (%) | True positives, n (%) | True negatives, n (%) | False positives, n (%) | False negatives, n (%) | P     |
|-------------------------------|---------------------------------------|--------------------------------------|------------------------|-----------------------|-----------------------|------------------------|--------------------|-------|
| Deterioration of patient      | Yes                                   | No                                   | 13 (12.7)              | -                     | -                     | -                      | -                  |       |
| qSOFA score (Cutoff: 2 by ROC)| ≥ 2                                   | < 2                                  | 15 (14.7)              | 8 (8)                 | 82 (80)               | 7 (7)                  | 5 (5)              |       |
| NEWS 2 score total (Cutoff: 8 by ROC)| ≥ 8          | < 8                                  | 22 (21.6)              | 10 (10)               | 77 (75)               | 12 (12)                | 3 (3)              |       |

Primary diagnostic parameters

| Variable                      | Sensitivity | Specificity | PPV | NPV | Diagnostic accuracy |
|-------------------------------|-------------|-------------|-----|-----|---------------------|
| qSOFA score (Cutoff: 2 by ROC)| 81.5%       | 92.1%       | 53.3%| 53.3%| 88.2% (80-94)       |
| NEWS 2 score total (Cutoff: 8 by ROC)| 76.9%       | 86.5%       | 45.5%| 45.5%| 85.3% (77-92)       |

Other diagnostic parameters

| Variable                      | LR+         | LR−         | Yuden index | OR   | Kappa | P     |
|-------------------------------|-------------|-------------|-------------|------|-------|-------|
| qSOFA score (Cutoff: 2 by ROC)| 7.82 (3.41-17.96) | 0.42 (0.21-0.83) | 53.7 | 18.74 (4.82-72.88) | 0.5 | <0.001 |
| NEWS 2 score total (Cutoff: 8 by ROC)| 5.71 (3.12-10.44) | 0.27 (0.10-0.72) | 63.4 | 21.39 (5.14-89.06) | 0.49 | <0.001 |

Ranking of primary diagnostic parameters

| Variable                      | Sensitivity | Specificity | PPV | NPV | Diagnostic accuracy |
|-------------------------------|-------------|-------------|-----|-----|---------------------|
| qSOFA score (Cutoff: 2 by ROC)| 2           | 1           | 1   | 2   | 1                   |
| NEWS 2 score total (Cutoff: 8 by ROC)| 1          | 2           | 2   | 1   | 2                   |

qSOFA: Quick sepsis-related organ failure assessment; ROC: Receiving operating characteristic; NEWS 2: National Early Warning Score; OR: Odds ratio; PPV: Positive predictive value; NPV: Negative predictive value
Table 7: Comparison of the diagnostic performance of various predictors in predicting deterioration of the patient

| Predictor                  | AUROC  | 95% CI          | P     | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | DA (%) |
|----------------------------|--------|-----------------|-------|----------------|-----------------|---------|---------|--------|
| qSOFA score                | 0.851  | 0.766-0.936     | <0.001| 62             | 92              | 53      | 94      | 88     |
| NEWS 2 score total         | 0.883  | 0.8-0.966       | <0.001| 77             | 86              | 46      | 96      | 85     |

ROC: Receiving operating characteristic; AUROC: Area under ROC curve; CI: Confidence interval; PPV: Positive predictive value; NPV: Negative predictive value; DA: Diagnostic accuracy; qSOFA: Quick sepsis-related organ failure assessment; NEWS 2: National Early Warning Score

Trends

Best parameter in terms of AUROC: National Early Warning Score 2

Best parameter in terms of sensitivity: National Early Warning Score 2

Best parameter in terms of specificity: quick sepsis-related organ failure assessment (qSOFA) score

Best parameter in terms of positive predictive value: qSOFA score

Best parameter in terms of negative predictive value: National Early Warning Score 2

CONCLUSION

With the ever-evolving pathology and clinical characteristics of the COVID-19 virus, we are far away from the complete containment of the disease. The predicament of future waves of the virus edges the health-care system to hold the fort down with limited resources. NEWS2 is one of the clinical risk stratification tools that can triage patients but only with clinical parameters. The study of such a tool along with blood parameters could rectify the system and prevent future tribulation.

Research quality and ethics statement

This study was approved by the Institutional Review Board and Ethics Committee at Dr. D. Y. Patil Medical College, Vidyapeeth, Pune (Approval number: Med/20/10 on November 12, 2020). The authors followed the applicable EQUATOR network's STROBE guidelines during the conduct of this research project.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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