# A Modified Early Warning Score Predicts Decompensation in COVID-19 Patients

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## Background

- Over 30 million COVID-19 cases worldwide with 1 million deaths
- Of hospitalized patients (based on an early case series)
    - 5.0% require an ICU
    - 1.4% Mortality
- Due to limited availability of ICU beds and some COVID-19 treatments, we need a way to predict which patients will decompensate from COVID-19
- Duke developed a customized, institution-specific early warning score (EWS) but its applicability to COVID-19 patients is unknown
- Prior research in COVID-19 patients has looked at prediction based on data at time of admission for the whole encounter, rather than a regularly updated score
- Duke's EWS is updated at 12- and 24-hour intervals
- Planned comparison to the National Early Warning Score (NEWS), a broadly adopted risk model
- Decompensation =
    - Transfer to an ICU
    - Death

### Table 1: Variables Used in Duke EWS Model

| | | | |
|---|---|---|---|
| **Demographics** | | | |
| Age | Sex | Race | Time from Admission |
| **Vitals** | | | |
| Respiratory rate | Pulse | Temperature | SpO2 |
| Systolic BP | Diastolic BP | Level of Consciousness | Supplemental Oxygen |
| **Comorbidities** | | | |
| CKD | COPD | Diabetes | HIV |
| Malignancy | MI | Stroke | Transplant |
| **Labs** | | | |
| % bandemia | Albumin | ALT | Ammonia |
| Anion gap | AST | Blood Cultures | BUN |
| CK | CKMB | CRP | D-dimer |
| ESR | Fibrinogen | Hematocrit | INR |
| K | Lactate | LDH | Mg |
| PaCO2 (arterial) | PaCO2 (venous) | PaO2 (arterial) | pH (arterial) |
| pH (venous) | Platelets | Sodium | Total Bilirubin |
| Troponin | WBC | | |

## Hypothesis

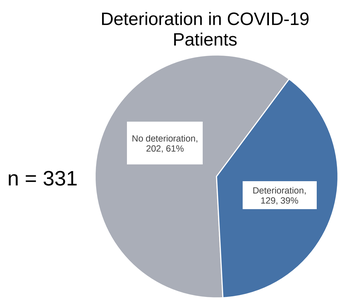
An institution-specific, frequently updated EWS will predict which patients deteriorate, i.e. transfer to an ICU or die, with superior performance compared to the NEWS.

## Methods

- Retrospective cohort analysis
- March 25, 2020 – August 6, 2020, Mondays - Fridays
- Inclusion Criteria
    - Age 18+
    - COVID-19 infection confirmed with laboratory test
    - Admitted to medical/surgical floor
- Exclusion Criteria
    - Directly admitted to an ICU
- Primary exposure
    - EWS prior to and closest to 8 AM and 8 PM daily
    - NEWS prior to and closest to 8 AM and 8 PM daily
- Primary outcome
    - Decompensation within 12 and 24 hours = composite of
        - Transfer to an ICU
        - Death
- Predictive Modeling
    - Compare performance of Duke EWS vs. NEWS using positive predictive value calculations
    - Calculate performance metrics of EWS and NEWS using risk thresholds

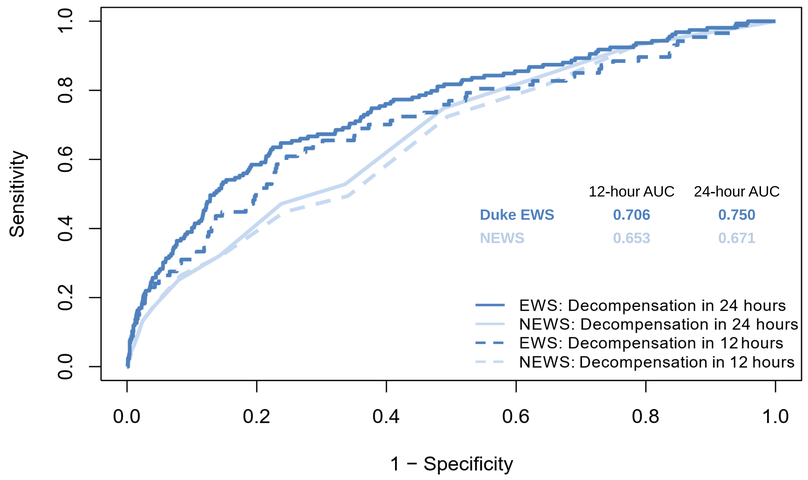
### Table 2: Risk Stratification and Associated Outcomes

| Outcome | Risk Group | Thresholds |
|---|---|---|
| Deterioration within 12 hours | Low risk | EWS < -6.16 |
| | Medium risk | -6.16 <= EWS < -4.77 |
| | High risk | EWS >= -4.77 |
| Deterioration within 24 hours | Low risk | EWS < -6.16 |
| | Medium risk | -6.16 <= EWS < -5.05 |
| | High risk | EWS >=-5.05 |
| Deterioration within 12/24 hours | Low risk | NEWS < 7 |
| | High risk | NEWS >=7 |

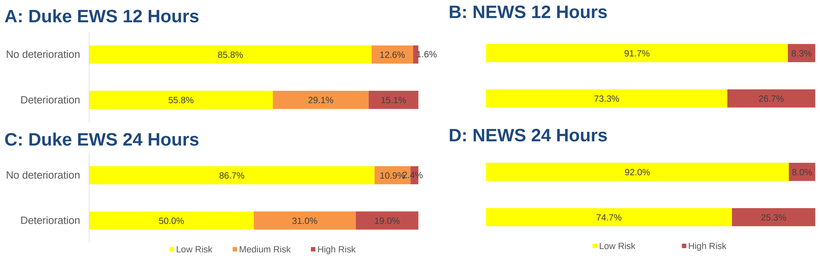



## Results

### Figure 2: ROC Curves



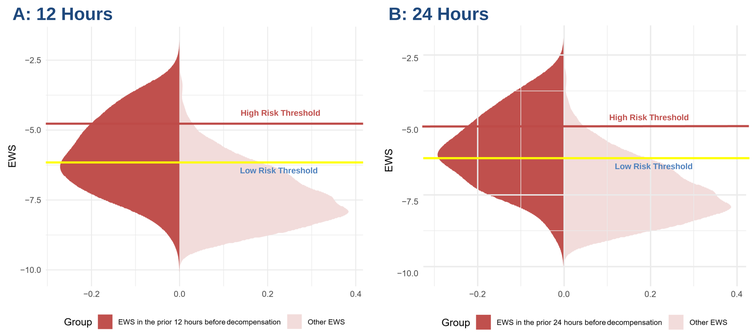

### Figure 1: Deterioration Events Based on Risk Stratification




### Table 4: Positive Predictive Value of Duke EWS versus NEWS

| | Duke NEWS | | | NEWS | |
|---|---|---|---|---|---|
| | Low Risk | Medium Risk | High Risk | Low Risk | High Risk |
| Decompensation in 12 hours | 1.5% | 5.2% | **17.8%** | 1.9% | **7.1%** |
| Decompensation in 24 hours | 2.5% | 11.2% | **25.9%** | 3.5% | **12.3%** |

### Figure 3: Violin Plots of Duke EWS Before Decompensation versus Other EWS




## Conclusions

1. A customized, institutional EWS predicts deterioration well in COVID-19 patients
2. Duke EWS outperforms NEWS in COVID-19 patients
3. During a pandemic, a risk-stratification score is necessary to allocate resources
    1. ICU beds
    2. Stepdown beds
    3. Limited availability treatments
4. The strength of the Duke EWS is its **actionability,** regularly polling patient data **every 12 hours** to give an updated, real time score of the patient's risk of deterioration. Other studies only look at risk based on data from time of admission.
5. Demonstrates opportunity for large health systems to leverage their data to build clinical decision support tools

**The Duke EWS provides an actionable, timely prediction for risk of death or transfer to an ICU in COVID-19 patients**

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