

COVID-19 Scientific Advisory Group Rapid Response Report

Key Research Question:

For patients with COVID-19 who are admitted to hospital, which risk prediction tool should be used to guide admission disposition and management decisions? [Updated June 8, 2020]

Context

- Risk prediction tools have been developed to guide the clinical decision-making process through the detection of physiologic changes that signal clinical deterioration of the patient.
- These tools are typically developed for use in the emergency department and intensive care unit settings, however they may help inform admission disposition decisions (ward versus ICU) as well as monitoring and management decisions for patients admitted to general wards during the COVID-19 pandemic.
- Tool selection for implementation in AHS facilities during the COVID-19 pandemic should consider 1) reported tool performance characteristics in patient populations comparable to those in Alberta; 2) feasibility of measured parameters; and 3) ease of use/interpretation by a broad group of health care providers.
- Since our initial review, the CURB-65 score is currently in use by Calgary Zone hospitals for inpatient disposition decisions, while the MEWS has been incorporated into ConnectCare at the University of Alberta Hospital for patients admitted to wards. The full extent of their use is uncertain.

Key Messages from the Evidence Summary

- Clinical risk prediction tools with acceptable performance have been identified for patients with various non-COVID respiratory conditions who were admitted to general hospital wards (i.e., non-ICU and non-ED patients). These tools were developed prior to the COVID-19 pandemic.
- There are several clinical risk prediction tools that have been developed in patients with COVID-19, as noted in a recent systematic review in BMJ. However, while the discriminative ability within a testing cohort was acceptable, the studies included in the review were rated at high risk of bias, either because of the way in which control patients were selected, because patients not experiencing the outcome were excluded, and because of model overfitting. As well, study reporting was of low quality, and the patient populations were not representative of the Alberta population.
- COVID-specific prediction tools developed since the publication of this systematic review are subject to similar criticisms, with most lacking evaluation of discrimination and calibration and lack of external validation. These tools are derived from areas outside of Canada (many in one country and some in one hospital) where patient populations and health system design/function are not comparable to Alberta.
- One COVID-19 risk prediction score has been both derived and validated in a Chinese population (Liang et al, 2020) with acceptable discrimination and precision for a composite outcome of ICU admission, mechanical ventilation or death. Generalizability to the Alberta population and healthcare setting is uncertain.
- COVID-specific risk prediction tools vary in their outputs. Most assess the risk for mortality or development of severe disease, and a few provide predictions for prolonged length of stay, recommendations for monitoring frequency and the need for critical care consultation.

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- No scores have been translated into a pathway with triggers for specific intensity of care (e.g. ward, step-down unit, ICU), nor have any care pathways been evaluated for safety or effectiveness.

Recommendations

1. There is insufficient evidence to recommend a specific risk prediction score for disposition and management of patients with COVID-19 disease. Hospitals that incorporate a risk prediction score in a clinical pathway should be aware of the limitations of that score.
2. Systematic use of a currently available COVID-19-specific risk prediction score should await testing and validation results from within a North American context.
3. If a hospital chooses to use a risk prediction score for patients with COVID-19 in the context of a clinical pathway, data on patient characteristics and outcomes should be collected in a consistent manner to enable researchers to test and validate the clinical utility of the tool.

Summary of Evidence

A literature search was conducted to identify clinical risk prediction tools that could feasibly be used to flag clinical deterioration in patients with COVID-19 admitted to Alberta hospitals. Only those publications that described developed tools in the forms of scores or nomograms were selected. Studies describing predictive models only that were not presented as a composite score or nomogram were excluded. The tools would be used to guide decisions for initial admission to general wards versus ICUs, and to aid in monitoring/management for general ward patients. For each identified tool, a search was conducted to determine the tool's performance among patients admitted to general wards (i.e., studies reporting on tool performance among patients in the ED or ICU were omitted). Further, the search was limited to studies which included, solely or in part, patients with respiratory conditions including COVID-19, SARS, MERS, CAP and ARDS.

A synopsis of twenty-seven (n=27) clinical risk prediction tools is presented below. Sixteen (n=16) tools were specifically developed for patients with COVID-19. The remaining eleven (n=11) tools were developed prior to the COVID-19 pandemic and were not specifically intended for use in patients with COVID-19.

The CURB-65 score is currently in use by Calgary Zone hospitals for inpatient disposition decisions, while the MEWS has been incorporated into ConnectCare at the University of Alberta Hospital for patients admitted to wards.

Review of Tool Performance Measures:

F₁ Score = measure of a test's accuracy; best value = 1 (perfect precision and recall); worst value = 0.

Receiver Operating Characteristic (ROC) curve =discrimination; how well the model discriminates between a patient who will live and one who will die; an area under the curve (AUC) value of 0.8 or greater is considered good.

Goodness of Fit (p-value) = calibration; how well the estimated probability of mortality generated by the tool correlates with actual mortality; a large p-value is sought (i.e., observed and expected are not statistically different).

Committee Discussion

There was general consensus among committee members that research evidence does not support the widespread adoption of any specific risk prediction tool for use in patients with COVID-19 admitted to hospital. No risk score has been empirically validated in COVID patients in a North American context, and clinical judgment is still required in the assignment of COVID patients to specific admitting services and inpatient units. Health care

providers should continue to use clinical judgement to guide decisions regarding management and the need to, and timing for, consult with critical care. If an AHS hospital/ward chooses to adopt a clinical risk prediction tool for use in patients with COVID-19, then the committee recommends that the score is used in a manner where validity of the tool can later be assessed. Users of the tool are encouraged to do so within a research protocol where appropriate outcome measures are recorded.

COVID-19 Specific Scores

BRESCIA COVID Respiratory Severity Scale (BCRSS)

<https://www.mdcalc.com/brescia-covid-respiratory-severity-scale-bcrss-algorithm>

Tool Assessment Population: Patients with COVID admitted to hospitals in Italy

Score Parameters: Wheezing/speaking ability, respiratory rate, PaO₂ or SpO₂, CXR

Output: Recommendations for management and medication suggestions

Reported Tool Performance: Not reported/tested

Tested in COVID Patients: Not formally, but derived from exclusive use in COVID patients

Validation: None

N.B. Not peer-reviewed, guideline/recommendation only based on clinical experience and expert opinion (source document written in Italian)

Reference: https://www.eahp.eu/sites/default/files/linee_guida_sulla_gestione_terapeutica_e_di_supporto_per_pazienti_con_infezione_da_coronavirus_covid-19.pdf

COVID-19 Critical Illness Prediction Tool (COVID-GRAM)

https://qxmd.com/calculate/calculator_750/covid-19-critical-illness-prediction-tool-covid-gram

Tool Assessment Population: Development cohort: n=1,590 patients with COVID admitted to 575 hospitals in China where 131 patients developed critical illness (including 50 deaths); validation cohort: n=710 patients with COVID admitted to hospitals in China where 87 developed critical illness (including 8 deaths); critical illness was defined as a composite endpoint of ICU admission, mechanical ventilation, or death.

Score Parameters: Age, conscious (yes/no), dyspnea (yes/no), hemoptysis (yes/no), hx of cancer (yes/no), number of comorbidities (from selection of COPD, hypertension, diabetes, cardiovascular disease, cerebrovascular disease, hepatitis B, malignancy, chronic kidney disease, immunodeficiency), abnormal chest image (yes/no), N/L ratio, LDH, direct bilirubin.

Output: Likelihood (with 95% CIs) that a hospitalized patient with COVID-19 will develop critical illness.

Tool Performance: Development cohort AUC = 0.88 (0.85-0.91 95% CI); Validation cohort: 0.88 (0.84-0.93 95% CI).

Tested in COVID Patients: Yes

Validation: Yes; cohort of patients with COVID admitted to hospital in China; patients were derived from hospitals that were not used for the development cohort.

N.B. CURB-6 scores were calculated and AUCs from the COVID-GRAM and CURB-6 were compared. The predictive value of COVID-GRAM was higher than the CURB-6 (AUC of 0.75 (95%CI, 0.70-0.80) for correct prediction of critical illness development (P < .001)).

Reference: Liang W, Liang H, Ou L, et al. Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients with COVID-19. JAMA Intern Med. 2020. Published online May 12, 2020. doi:10.1001/jamainternmed.2020.2033

COVID-19 Criticality Prediction

https://ebmcalc.com/COVID10_Yan.htm

Tool Assessment Population: Development cohort: 375 patients with COVID admitted to Tongji Hospital in Wuhan (China) where 174 died; validation cohort: 29 patients with COVID admitted to Tongji Hospital where 8 died.

Score Parameters: LDH, hsCRP, percent lymphocytes

Output: Mortality risk prediction

Tool Performance: Accuracy F_1 score = 0.93

Tested in COVID Patients: Yes

Validation: Validation cohort comprised of severe cases only, while development cohort included general, severe and critical cases.

N.B. Manuscript is in pre-print and not peer-reviewed

Reference: Pre-Print <https://doi.org/10.1101/2020.02.27.20028027>

COVID-19 Mortality Risk Estimation

https://ebmcalc.com/COVID19_Zhou.htm

Tool Assessment Population: 191 patients with COVID admitted to two hospitals in Wuhan (China) where 54 died.

Score Parameters: Age, coronary artery disease, SOFA score, lymphocyte count, D-dimer

Output: Mortality risk prediction

Tool Performance: Not reported

Tested in COVID Patients: Yes.

Validation: None.

N.B. Small sample; requires validation.

Reference: Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective study. *The Lancet*. 2020. 395(10229): 1054-1062.

[https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3)

COVID-19 Pneumonia Severity Estimate

Neutrophil/Lymphocyte ratio x C-Reactive Protein x D-dimer;

Tool Assessment Population: Development cohort: 250 patients with COVID admitted to a hospital in Wuhan (China) where 79 developed severe pneumonia; validation cohort: 89 patients with COVID admitted to the same hospital where 38 developed severe pneumonia; severe pneumonia defined as fever or suspected respiratory infection plus either a respiratory rate of greater than 30 breaths/min, severe respiratory distress, or SpO₂ of less than 90% on room air.

Score Parameters: Neut/lymph ratio, CRP, D-Dimer

Output: Severe/non-severe pneumonia; value < 5.32 classified as non-severe pneumonia

Tool Performance: Development cohort AUC = 0.91 (0.856–0.96 95%CI); validation cohort: AUC = 0.88 (0.84–0.92 95%CI).

Tested in COVID Patients: Yes

Validation: Yes; internal only.

N.B. Manuscript is in pre-print and not peer-reviewed

Reference: <https://www.medrxiv.org/content/10.1101/2020.03.24.20042119v1>

COVID-19 Prognostic Tool

https://qxmd.com/calculate/calculator_731/covid-19-prognostic-tool

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Tool Assessment Population: Patients with COVID admitted to hospitals in China (n=44,672; 1,023 deaths) and the USA (n=4,226; 44 deaths).

Score Parameters: Age, presence of (yes/no): cardiovascular disease, diabetes, chronic respiratory disease, hypertension, cancer, prior stroke, heart disease, and chronic kidney disease.

Output: Mortality risk prediction

Tool Performance: Not reported.

Tested in COVID Patients: Yes.

Validation: None.

N.B. This tool is based on data from the CDC Interim Clinical Guidance for Management of Patients with Confirmed Coronavirus Disease (COVID-19).

References: "Management of Patients with Confirmed 2019-NCoV." Centers for Disease Control and Prevention, 6 Apr. 2020, www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html.

CDC COVID-19 Response Team. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) – United States, February 12 – March 16, 2020. MMWR Morbidity and Mortality Weekly Report. 2020; 69 (12): 343-346.

Wu Z, McGoogan JM. Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72314 Cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020; 323 (13): 1239-1242.

Nomogram to Predict Severe COVID-19

Tool Assessment Population: Development cohort: n=189 patients with COVID admitted to Quanzhou Eighth People's Hospital (China) where 28 developed severe COVID; Validation cohort #1: n=165 patients with COVID admitted to Zhongnan Hospital (China) where 40 developed severe COVID; validation cohort #2: 18 patients with COVID admitted to Third Affiliated Hospital (China) where 4 developed severe COVID; severe COVID defined as having at least 1 of the following conditions: (1) shortness of breath (respiratory rate \geq 30 breaths per minute); (2) arterial oxygen saturation (resting status) \leq 93%; or (3) the ratio of partial pressure of oxygen to fraction of inspired oxygen (PaO₂/FiO₂) \leq 300 mm Hg.

Score Parameters: Nomogram that includes age, DBIL, RDW, BUN, CRP, LDH, ALB.

Output: Total points associated with probability of developing severe COVID

Tool Performance: Development cohort AUC= 0.91 (0.85-0.98 95%CI); Validation cohort #1 AUC = 0.85 (0.79-0.91 95% CI); due to limited sample size the AUC was not calculated for validation cohort #2 which had a sensitivity of 75% and specificity of 100%.

Tested in COVID Patients: Yes.

Validation: Yes; patients were derived from 2 hospitals that were not used for the development cohort.

N.B. Nomogram requires validation in a population outside of China.

Reference: Gong J, Ou J, Qiu X, et al. A tool to early predict severe corona virus disease 2019 (COVID-19): A multicenter study using the risk nomogram in Wuhan and Guangdong, China. Clinical Infectious Diseases. Published online April 15, 2020. doi:10.1093/cid/ciaa443

Prediction Nomogram for Prolonged Hospital Length of Stay

Tool Assessment Population: 75 patients with COVID admitted to a hospital in Zhejiang province (China) where 25 had a prolonged length of stay, defined as greater than 14 days (median LOS was 11 days for the total cohort).

Score Parameters: Nomogram that includes abnormal procalcitonin (yes/no), lymphocyte count less than $\times 10^9/L$ (yes/no), heart rate, cough (yes/no), epidemiologic history (contact with COVID patient, recent travel to Wuhan).

Output: Total points associated with probability of having a hospital stay for greater than 14 days.

Tool Performance: AUC=.85 (.75-.94 95% CI)

Tested in COVID Patients: Yes

Validation: None.

N.B. Epidemiologic history includes travel to Wuhan which may not be applicable to populations outside of China.

Reference: Hong Y, Wu X, Qu J, et al. Clinical characteristics of coronavirus disease 2019 and development of a prediction model for prolonged hospital length of stay. *Annals of Translational Medicine*, 8(7). doi:

<https://dx.doi.org/10.21037/atm.2020.03.147>

Prediction Nomograms for Disease Progression in Mild COVID-19

Tool Assessment Population: 344 patients with COVID admitted to a hospital in China; 45 manifested disease progression defined as requiring oxygen support.

Score Parameters: Nomogram that includes age, coronary heart disease (yes/no), temperature ≥ 38 C (yes/no), N/L ratio.

Output: Total points associated with risk of disease progression.

Tool Performance: AUC = 0.87 (95% CI not reported).

Tested in COVID Patients: Yes

Validation: None.

N.B. May be more useful for non-hospitalized patients given the mild disease of the development cohort.

Reference: Huang J, Cheng A, Lin S, et al. Individualized prediction nomograms for disease progression in mild COVID-19. *J. Med. Virol*, Retrieved from <https://dx.doi.org/10.1002/jmv.25969>

The CALL Score

Tool Assessment Population: 208 patients with COVID admitted to either of two hospitals in China where 40 developed severe disease, defined as at least one of: respiratory rate ≥ 30 breaths/min, resting oxygen saturation $\leq 93\%$, $\text{PaO}_2/\text{FiO}_2 \leq 300$ mmHg or requirement of mechanical ventilation.

Score Parameters: Nomogram that includes comorbidity (with/without; includes hypertension, diabetes, cardiovascular disease, chronic lung disease and HIV infection), age, lymphocyte count, LDH.

Output: Total score associated with probability of 5-day progression-free and probability of 10-day progression-free

Tool Performance: AUC = 0.91 (0.86-0.94 95% CI)

Tested in COVID Patients: Yes.

Validation: None.

N.B. Requires validation in a population outside of China.

Reference: Ji D, Zhang D, Xu J, et al. Prediction for progression risk in patients with COVID-19 pneumonia: The CALL score. *Clinical Infectious Diseases*. 2020. doi:10.1093/cid/ciaa414

The Age-LDH-CD4 Score

Tool Assessment Population: Development cohort: 322 patients (26 developed severe disease) with COVID admitted to a hospital in Shanghai (China) between Jan 20, 2020 and Feb 23, 2020; validation cohort: 317 patients (5 developed severe disease) with COVID admitted to the same hospital in Shanghai (China) between Feb 24, 2020 and May 1, 2020. Severe cases were defined as having at least one of the following: (1) respiratory distress, respiratory rates ≥ 30 /min; (2) pulse oxygen saturation $\leq 93\%$ in a resting state; (3) oxygenation index ($\text{PaO}_2/\text{FiO}_2$) ≤ 300 mmHg; (4) require mechanical ventilation; (5) shock; (6) combined with other organ failures and needed treatment in intensive care unit (ICU).

Score Parameters: age (years) x LDH (U/L) / CD4 (cell/ μl)

Output: Score of ≥ 82 has a sensitivity of 81% and specificity of 93% for the early detection of COVID progression.

Tool Performance: Development cohort: AUC=0.92 (0.81-0.89 95%CI); validation cohort: AUC=0.92 (0.89-0.95 95%CI)

Tested in COVID Patients: Yes.

Validation: Yes; cohort of patients with COVID admitted to the same hospital as the development cohort but at a later time period.

N.B. Single centre study.

Reference: Li Q, Zhang J, Ling Y, et al. A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency. *Infection*. 2020. doi:10.1007/s15010-020-01446-z

Neutrophil-to-Lymphocyte Ratio to Predict Critical Illness

Tool Assessment Population: Development cohort: 61 patients with COVID admitted to a single hospital in Beijing (China) from Jan 13, 2020 through Jan 31, 2020 where 17 developed critical illness; validation cohort: 54 patients admitted to the same hospital from Feb 1, 2020 through Feb 24, 2020 where 20 developed critical illness; critical illness was defined as at least one of the following: (1) respiratory failure occurs and requires mechanical ventilation; (2) Shock occurs; (3) ICU admission is required for combined organ failure.

Score Parameters: Nomogram in which the N/L ratio value is plotted.

Output: 7-day and 14-day probabilities of developing critical illness.

Tool Performance: AUC = 0.85 (0.70-0.99 95%CI).

Tested in COVID Patients: Yes.

Validation: Yes; cohort of patients with COVID admitted to the same hospital as the development cohort but at a later time period.

N.B. Derived and validated in a small sample size from a single centre.

Reference: Liu J, Liu Y, Xiang P, et al. Neutrophil-to-lymphocyte ratio predicts critical illness patients with 2019 coronavirus disease in the early stage. *Journal of Translational Medicine*. 2020. 18:206. doi:<https://dx.doi.org/10.1186/s12967-020-02374-0>

The ACP Index

Tool Assessment Population: 577 patients with COVID admitted to a single hospital in Wuhan (China) from Jan 21, 2020 through Feb 5, 2020 where 100 patients developed severe disease; severe disease was defined as meeting at least one of the following criteria: (1) presence of shortness of breath with a respiratory rate ≥ 30 breaths/minute; (2) an oxygen saturation (SpO₂) $\leq 93\%$ in the resting state; (3) hypoxemia defined as an arterial partial pressure of oxygen divided by the fraction of inspired oxygen (PaO₂/FiO₂ ratio) ≤ 300 mmHg; (4) presence of radiographic progression, defined as $\geq 50\%$ increase of target lesion within 24-48 hours.

Score Parameters: age ≥ 60 years, CRP ≥ 34 mg/L

Output: Three (3) categories of risk grade for 12 day mortality after admission; recommendation for place of isolation or treatment (i.e., general ward, ICU, mobile hospital)

Tool Performance: Not provided.

Tested in COVID Patients: Yes.

Validation: None.

N.B. Manuscript is in pre-print and not peer-reviewed; not all COVID patients were laboratory confirmed (i.e., suspected cases based on clinical presentation and epidemiological history).

Reference: <https://www.medrxiv.org/content/10.1101/2020.02.20.20025510v1.full.pdf>

Nomogram to Predict Mortality Among Patients with COVID-19

Tool Assessment Population: Development cohort: 299 patients with COVID admitted to Tongji Hospital (China) where 155 deaths were recorded; Validation cohort: 145 patients with COVID admitted to the Jinyintan hospital (69 deaths).

Score Parameters: Nomogram that includes SpO₂, lymphocyte count, age, LDH.

Output: Total points associated with probability for mortality.

Tool Performance: Development cohort: C-statistic = 0.89; validation cohort: C-statistic= 0.98.

Tested in COVID Patients: Yes.

Validation: Yes; validation cohort of patients was derived from a hospital that was not used for the development cohort.

N.B. Manuscript is in pre-print and not peer-reviewed.

Reference: <https://www.medrxiv.org/content/10.1101/2020.03.28.20045997v1.full.pdf>

Neutrophil/Lymphocyte/Platelet (NLP) Score for Disease Progression

Tool Assessment Population: 141 patients with COVID admitted to Taizhou Hospital (China); 29 developed severe disease defined as having one of the following criteria: (1) respiratory distress, respiratory rate ≥ 30 beats/min; (2) oxygen saturation $\leq 93\%$ in the resting state and (3) arterial blood oxygen partial pressure/oxygen concentration ≤ 300 mmHg (1 mmHg = 0.133 kPa).

Score Parameters: Nomogram that includes neutrophil count, lymphocyte count, and platelet count.

Output: Total points associated with 7-day, 14-day and 21 day probability of non-severe survival.

Tool Performance: C-index = 0.82 (0.75-0.90 95%CI)

Tested in COVID Patients: Yes.

Validation: None.

N.B. Single centre study that requires validation.

Reference: Zheng Y, Zhang Y, Chi H, et al. The hemocyte counts as a potential biomarker for predicting disease progression in COVID-19: A retrospective study. *Clinical Chemistry and Laboratory Medicine*. 2020. doi:10.1515/cclm-2020-0377

Nomogram for Predicting Risk of Severe COVID-19

Tool Assessment Population: 366 patients with COVID admitted to hospitals in 47 regions of Sichuan (China); 43 developed severe disease; severe cases defined as one major criterion (septic shock with need for vasopressors or respiratory failure requiring mechanical ventilation) or at least three minor criteria (respiratory rate ≥ 30 breaths per min, arterial partial oxygen pressure/fraction of inspired oxygen ≤ 250 mmHg, multilobar infiltrates, confusion/disorientation, uremia (blood urea nitrogen level ≥ 20 mg/dL), leukopenia (white blood cell count < 400 cells/ μ L), thrombocytopenia (platelet count $< 100,000/\mu$ L), hypothermia (core temperature $< 36^\circ\text{C}$), and hypotension requiring aggressive fluid resuscitation).

Score Parameters: Nomogram that includes temp (C), cough (yes/no), dyspnea (yes/no), hypertension (yes/no), CVD (yes/no), CLD (yes/no), CKD (yes/no).

Output: Total points associated with risk of disease severity.

Tool Performance: AUC=0.86

Tested in COVID Patients: Yes.

Validation: Internal validation conducted using bootstrapping.

N.B. Manuscript states in the figure text that oxygen saturation is included in the nomogram, but this variable is not included in the nomogram figure.

Reference: Zhou Y, He Y, Yang H, et al. Development and validation a nomogram for predicting the risk of severe COVID-19: A multi-center study in Sichuan, China. *PLoS ONE [Electronic Resource]*, 15(5), e0233328. <https://dx.doi.org/10.1371/journal.pone.0233328>

Existing Scores Developed Before the COVID-19 Pandemic

Acute Physiology and Chronic Health Evaluation (APACHE II)

<https://www.mdcalc.com/apache-ii-score>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: Hx of severe organ failure or immunocompromised status, age, temp, mean arterial pressure pH, HR or pulse, RR, sodium, potassium, creatinine, acute renal failure, hematocrit, WBC count, Glasgow Coma Scale, FiO₂.

Output: Mortality estimate

Tool Performance: AUC = 0.72 detected 0-12 hours before clinical deterioration; 0.66 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal for ward patients; internal and external for ICU patients

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. Critical Care. 2014;18R:132.

CRB-65

<https://medicalcriteria.com/web/pulcap/>

Tool Assessment Population: 11 studies with 397,211 patients admitted with CAP

Score Parameters: Confusion, RR, systolic BP or diastolic BP, age≥65

Output: Low/high risk for 30 day mortality

Tool Performance: ROC curve AUC=0.79

Tested in COVID Patients: No

Validation: Internal and external validation

N.B. Systematic review

Reference: Chalmers JD, Singanayagam A, Akram AR, et al. Severity assessment tools for predicting mortality in hospitalised patients with community-acquired pneumonia. Systematic review and meta-analysis. Thorax 2010;65:878-883.

CURB-65

<https://www.mdcalc.com/curb-65-score-pneumonia-severity>

Tool Assessment Population: 17 studies with 15,596 patients admitted with CAP

Score Parameters: Confusion, BUN, RR, systolic BP or diastolic BP, age≥65

Output: Low/high risk for 30 day mortality

Tool Performance: ROC curve AUC = 0.80

Tested in COVID Patients: Not formally tested, but has been used.

Validation: Internal and external validation

N.B. Systematic review

Reference: Chalmers JD, Singanayagam A, Akram AR, et al. Severity assessment tools for predicting mortality in hospitalised patients with community-acquired pneumonia. Systematic review and meta-analysis. Thorax 2010;65:878-883.

MEWS (Modified Early Warning Score)

<https://www.mdcalc.com/modified-early-warning-score-mews-clinical-deterioration>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: systolic BP, HR, RR, Temp, AVPU (alert, voice, pain, unresponsive) score

Output: % chance of ICU admission or death within 60 days

Tool Performance: AUC = 0.73 detected 0-12 hours before clinical deterioration; 0.66 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. Critical Care. 2014;18R.132.

National Early Warning Score (NEWS) 2

<https://www.mdcalc.com/national-early-warning-score-news-2>

Tool Assessment Population: All admissions at four hospitals in the UK; n=251,266 with 1,394 and 48,898 with documented and at risk type 2 respiratory failure; 47.5% male; mean age = 68 years.

Score Parameters: RR, hypercapnic respiratory failure, room air/supplemental O₂, Temp, systolic BP, pulse, consciousness

Output: risk level for in-hospital mortality, frequency of monitoring recommendations, recommendations for critical care intervention

Tool Performance: ROC Curve AUC = 0.84 for patients with documented type 2 respiratory failure.

Tested in COVID Patients: No

Validation: Internal

Reference: Pimentel MAF et al, A comparison of the ability of the National Early Warning Score and the National Early Warning Score 2 to identify patients at risk of in-hospital mortality: A multi-centre database study. Resuscitation. 2019;134 p. 147-156.

Pneumonia Severity Index

<https://www.mdcalc.com/psi-port-score-pneumonia-severity-index-cap>

Tool Assessment Population: Patients admitted to 78 American hospitals with community-acquired pneumonia; n=14,199 for test derivation and n=38,038 for validation.

Score Parameters: age, sex, nursing home resident, hx of comorbidities (neoplastic disease, liver disease, CHF, cerebrovascular disease, renal disease), altered mental status, respiratory rate, systolic blood pressure, temp, pulse, pH, BUN, sodium, glucose, hematocrit, partial pressure of oxygen, pleural effusion on x-ray

Output: Mortality risk

Tool Performance: ROC curve AUC = 0.83 for validation cohort

Tested in COVID Patients: No

Validation: Internal and external

Reference: Fine MJ. et al, A prediction rule to identify low-risk patients with community-acquired pneumonia. N Engl J Med. 1997 Jan 23; 336(4) 243-50.

Sequential Organ Failure Assessment (SOFA)

<https://www.mdcalc.com/sequential-organ-failure-assessment-sofa-score>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: PaO₂, FiO₂, mechanical ventilation, platelets, Glasgow Coma Scale, bilirubin, mean arterial pressure or administration of vasoactive agents required, creatinine.

Output: Mortality risk prediction

Tool Performance: AUC = 0.78 detected 0-12 hours before clinical deterioration; 0.68 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. Critical Care. 2014:18R.132.

Simple Clinical Score (SCS)

<https://mirmedical.wordpress.com/2010/12/26/simple-clinical-score-iphone-app/>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: Age, systolic BP, pulse rate > systolic BP, temp, RR, oxygen saturation, breathless on presentation, abnormal ECG, diabetes (T1 or T2), coma without intoxication or overdose, altered mental status without coma, intoxication or overdose & age >49 years, new stroke on presentation, unable to stand unaided or a nursing home resident, prior to current illness, spent some part of daytime in bed

Output: Predicted 30 day mortality, median length of hospital stay and 30 day readmission rate

Tool Performance: AUC = 0.74 detected 0-12 hours before clinical deterioration; 0.67 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. Critical Care. 2014:18R.132.

Simplified Acute Physiology Score (SAPS) II

<https://www.mdcalc.com/simplified-acute-physiology-score-saps-ii>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: age, HR, systolic BP, temp ≥ 39 C, Glasgow Coma Scale, PaO₂/FiO₂ if on mechanical ventilation or CPAP, BUN, urine output, sodium, potassium, bicarbonate, bilirubin, WBC, chronic disease history (metastatic cancer, hematologic malignancy, AIDS), type of admission (surg, med).

Output: Mortality risk prediction

Tool Performance: AUC = 0.73 detected 0-12 hours before clinical deterioration; 0.66 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. *Critical Care*. 2014;18R.132.

Standardized Early Warning Score (SEWS)

<http://library.nhsggc.org.uk/mediaAssets/Shock%20Team/SEWS%20Chart%202.pdf>

Tool Assessment Population: Patients admitted to acute medical wards of 2 UK hospitals with CAP; n=419; median age = 74; 47% male.

Score Parameters: RR, SaO₂, temperature, BP, HR, neurological response and urine output

Output: Recommendations for intensity of nursing observation and medical management

Tool Performance: ROC curve AUC = 0.64.

Tested in COVID Patients: No

Validation: Internal

N.B. complex tool to use.

Reference: Barlow G et al, The CURB65 pneumonia severity score outperforms generic sepsis and early warning scores in predicting mortality in community-acquired pneumonia. *Thorax*. 2007; 62:253-259.

VitalPAC Early Warning Score (ViEWS)

<https://www.evidencio.com/models/show/1006>

Tool Assessment Population: Patients with infection (pneumonia, urinary tract, skin/soft tissue, peritonitis) admitted to non-ICU wards in two US hospitals; n=328 cases with recorded clinical deterioration, ICU transfer, CC consult or death; n=328 matched controls who survived to hospital discharge without an ICU admission or CC consult; median age 64 for control and 67 for cases; 63% and 53% female for controls and cases.

Score Parameters: Pulse, systolic BP, temp, SaO₂, inspired O₂, level of consciousness

Output: Risk for clinical deterioration; recommendations for monitoring and critical care consultation

Tool Performance: AUC = 0.75 detected 0-12 hours before clinical deterioration; 0.67 for 12-24 hours before clinical deterioration

Tested in COVID Patients: No

Validation: Internal

Reference: Yu et al., Comparison of risk prediction scoring systems for ward patients: a retrospective nested case-control study. *Critical Care*. 2014;18R.132.

Date question received by advisory group: April 3, 2020

Date report submitted to committee: April 8, 2020

Date of first assessment: April 10, 2020

(If applicable) Date of re-assessment: June 8, 2020

Authorship & Committee Members

This review was written by Susan Jelinski and scientifically reviewed by Andrew McRae, Evan Minty (external reviewer), and Dan Zuege (external reviewer). The full Scientific Advisory Group was involved in discussion and

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COVID-19 Scientific Advisory Group Rapid Response Report

Appendix

List of Abbreviations

ALB	Albumin
ARDS	Acute Respiratory Distress Syndrome
AUC	Area Under the Curve
BP	Blood Pressure
BUN	Blood Urea Nitrogen
CAP	Community-Acquired Pneumonia
CC	Critical Care
CHF	Congestive Heart Failure
CKD	Chronic Kidney Disease
CLD	Chronic Liver Disease
COVID-19	Coronavirus Disease 2019; severe acute respiratory syndrome coronavirus 2
CRP	C-Reactive Protein
CXR	Chest X-Ray
CVD	Cardiovascular disease
DBIL	Direct Bilirubin
HR	Heart Rate
hsCRP	High Sensitivity C-Reactive Protein
Hx	History
ICU	Intensive Care Unit
LDH	Lactate Dehydrogenase
MERS	Middle East Respiratory Syndrome
RDW	Red Blood Cell Distribution Width
ROC	Receiver Operator Characteristic
RR	Respiratory Rate
SARS	Severe Acute Respiratory Syndrome
Temp	Temperature
WBC	White Blood Cell

Literature Search Details

- Search Terms: “COVID”, “coronavirus”, “SARS-COV-2”, “risk”, “prediction”, “tool”, “model” “score”, “algorithm” “calculator”, “track and trigger system”, “assessment”
- Inclusion Criteria: patients with COVID or respiratory disease (SARS, MERS, CAP, ARDS), patients admitted to general wards, studies that describe a composite score or nomogram (i.e., studies that include predictive models only with no scores/nomograms were excluded).
- Databases: Medline, CINAHL, PubMed, Google Scholar, Google.