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?

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.

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).
- There are several clinical risk prediction tools that have been tested in patients with COVID-19, as noted in a very recent systematic review in BMJ. However, while the discriminative ability within a testing cohort was acceptable, all studies 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.
- Clinical risk prediction tools vary in the utility of their outputs, from binary high/low risk for mortality results to recommendations for monitoring frequency and need for critical care consultation.

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. 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. These 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.

Three tools specific for patients with COVID-19 were identified, namely the Brescia COVID Respiratory Severity
Scale (BCRSS), the COVID-19 Criticality Prediction tool, and the COVID-19 Mortality Risk Estimation tool. None
of these three tools, however, have been validated.

The CURB-65 score is currently in use by Calgary Zone hospitals for inpatient disposition decisions.

A synopsis of fourteen (n=14) clinical risk prediction tools is presented below.

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 (C statistic and p-value)** = calibration; how well the estimated probability of mortality generated by
  the tool correlates with actual mortality; a large p-value is sought (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 one specific risk prediction tool for use in patients with COVID-19 admitted to hospital. No
risk score has been empirically validated in COVID patients, 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.

**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  

**BREScia COVID Respiratory Severity Scale (BCRSS)**  

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)  

**COVID-19 Criticality Prediction**  
https://ebmcalc.com/COVID10_Yan.htm  

Tool Assessment Population: Patients with COVID admitted to Tongji Hospital in Wuhan, China; n=520 (379 for tool build; 29 for tool testing); Mean age = 58 years; 59% male; 46% considered “critical” on admission.  
Score Parameters: LDH, hsCRP, percent lymphocytes  
Output: Mortality risk prediction  
Tool Performance: Accuracy F₁ score = 0.93  
Tested in COVID Patients: Yes  
Validation: Internal validation only  
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: Patients with COVID admitted to two hospitals in Wuhan, China; n=191; median age = 56 years; 62% male;  
Score Parameters: Age, coronary artery disease, SOFA score, lymphocyte count, D-dimer  
Output: Mortality risk prediction  
Tool Performance: Not reported  
Tested in COVID Patients: Not formally, but derived from use in COVID patients  
Validation: None.  
N.B. Created from a multivariable logistic regression model.  
**COVID-19 Pneumonia Severity Estimate**

Neutrophil/Lymphocyte ratio x C-Reactive Protein x D-dimer; value < 5.32 classified as non-severe pneumonia

**Tool Assessment Population:** Patients with COVID admitted to a hospital in Wuhan, China; n=377 (117 severe pneumonia and 260 non-severe pneumonia)

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

**Output:** Severe/non-severe pneumonia

**Tool Performance:** ROC curve AUC=0.88

**Tested in COVID Patients:** Yes

**Validation:** Internal validation

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

**Reference:** [https://www.medrxiv.org/content/10.1101/2020.03.24.20042119v1](https://www.medrxiv.org/content/10.1101/2020.03.24.20042119v1)

**CRB-65**

[https://medicalcriteria.com/web/pulcap/](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


**CURB-65**


**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


**MEWS (Modified Early Warning 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:** 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**


**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


**Pneumonia Severity Index**


**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


**Sequential Organ Failure Assessment (SOFA)**


**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
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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


**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


**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

**Standardized Early Warning Score (SEWS)**


**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.


**VitalPAC Early Warning Score (ViEWS)**

[https://www.evidencio.com/models/show/1006](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


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:

**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 revision of the document: Lynora Saxinger (co-chair), Braden Manns (co-chair), John Conly, Alexander

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### Appendix

#### List of Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ARDS</td>
<td>Acute Respiratory Distress Syndrome</td>
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<td>AUC</td>
<td>Area Under the Curve</td>
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<td>BP</td>
<td>Blood Pressure</td>
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<td>BUN</td>
<td>Blood Urea Nitrogen</td>
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<tr>
<td>CAP</td>
<td>Community-Acquired Pneumonia</td>
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<tr>
<td>CC</td>
<td>Critical Care</td>
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<tr>
<td>CHF</td>
<td>Congestive Heart Failure</td>
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<tr>
<td>COVID-19</td>
<td>Coronavirus Disease 2019; severe acute respiratory syndrome coronavirus 2</td>
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<tr>
<td>CXR</td>
<td>Chest X-Ray</td>
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<tr>
<td>HR</td>
<td>Heart Rate</td>
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<tr>
<td>hsCRP</td>
<td>High Sensitivity C-Reactive Protein</td>
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<td>Hx</td>
<td>History</td>
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<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<td>LDH</td>
<td>Lactate Dehydrogenase</td>
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<tr>
<td>MERS</td>
<td>Middle East Respiratory Syndrome</td>
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<tr>
<td>ROC</td>
<td>Receiver Operator Characteristic</td>
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<tr>
<td>RR</td>
<td>Respiratory Rate</td>
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<td>SARS</td>
<td>Severe Acute Respiratory Syndrome</td>
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<td>Temp</td>
<td>Temperature</td>
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<td>WBC</td>
<td>White Blood Cell</td>
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#### Literature Search Details

- Search Terms: “risk prediction tool”, “risk prediction score”, “risk prediction model”, “clinical decision algorithm”, “clinical decision tool”, “track and trigger system”, “assessment tool”,
- Inclusion Criteria: patients with COVID or respiratory disease (SARS, MERS, CAP, ARDS), patients admitted to general wards.
- Databases: Medline, CINAHL, PubMed, Google Scholar, Google.