COVID-19 Scientific Advisory Group Rapid Response Report

Key Research Questions:

1. For patients with suspected or confirmed COVID-19 who are assessed in the emergency department, are there clinical features that reliably indicate need for admission or safety for discharge?

1a. Is there a valid risk prediction tool, or if not, what are the strongest predictors of the need for admission?
1b. When and what laboratory and imaging investigations are indicated?
1c. Is there a role for an observation period for probable or confirmed COVID-19 patients who have mild hypoxia or require minimal (<2 LPM) oxygen?

Context

- This review was updated June 5, 2020. Information on three novel risk prediction tools for severe illness has been added. Systematic reviews on smoking and obesity as risk factors have been added. A new meta-analysis on comorbidities and severe COVID-19 illness has been added. Previous discussion on “walk tests” has been updated with discussion of exertion tests. One source on early management of patients in China (through facility based isolation of all COVID-19 patients) has been removed as it is not relevant to the Alberta context.
- The question and sub-questions come from emergency clinicians and are related to the work of the Emergency Strategic Clinical Network to create patient risk stratification guidelines and management information. The questions were reformulated for clarity.
- Anecdotally “walk tests” for oxygen saturation are being used internationally in emergency departments for risk prediction of COVID-19 patients.
- NEWS2, CURB-65 and Brescia Scales have been proposed for use as risk prediction tools in Alberta.
- The review is limited to adult, non-pregnant patients with confirmed/suspected COVID-19

Key Messages from the Evidence Summary

- No single laboratory investigation or imaging modality has independent prognostic value for COVID-19 disease. Chest radiographs and CT scans are discussed in the literature for prognosis of seriously ill COVID-19 patients, but lack sufficient specificity and sensitivity for screening. For otherwise healthy patients who are clinically stable, specific investigations may not be indicated in the ED.
- No risk stratification tools to guide admission decisions are validated for COVID-19. Published novel prognostic models and clinical pathways for COVID-19 outcomes are at high risk of bias

and may not be generalizable outside their population of origin, so would have to be locally validated.
- Admission decisions for COVID-19 patients will largely be driven by the need for supplemental oxygen. Medical comorbidities and advanced age are risk factors for higher severity of illness requiring hospital admission, or progression to mortality. These, and situational factors such as housing stability and available supports, should be considered in admission decisions.
- No literature on the utility of observation periods, or their optimal duration was identified.
- Both the AHS "COVID-19 Provincial Pandemic Flowsheet Admission to Acute Care" and the Emergency Strategic Clinical Network "Stratification of ED / UCC Patients Presenting with Symptoms Consistent with COVID-19" documents align with these key messages.

Committee Discussion

The committee reached consensus on the key messages and recommendations, specifically for the lack of current validated risk prediction tools for admission / emergency department discharge criteria. Admission decisions will be driven largely by the need for supplemental oxygen or factors that may put a patient with mild disease at risk for sudden deterioration out of hospital. The committee was in general agreement that no specific investigations are indicated for patients with mild disease. There are no laboratory or imaging findings that—by themselves—are reliable indicators for the need for admission.

Recommendations

1. SpO2 should be measured for clinical evaluation of patients with confirmed or suspected COVID-19 disease. Exertional oxygen monitoring may identify patients with latent hypoxemia, particularly in patients with underlying cardiopulmonary disease.
2. No laboratory investigations or diagnostic imaging are absolutely necessary or indicated for COVID-19 ED patients who are otherwise clinically well, unless required to exclude an alternative diagnosis.
3. While some laboratory or imaging findings are associated with poor outcomes, no single investigation or risk prediction tool should drive admission/discharge decisions.
4. In the absence of validated tools to identify patients requiring admission to hospital, patients who are not hypoxemic or exhibiting signs or symptoms of severe dyspnea, hemodynamic instability or cognitive impairment are likely suitable for discharge from the ED. Factors such as advanced age, frailty, cardiopulmonary or renal comorbidities, or lack of social supports/a stable home environment may be considered in admission/discharge decisions. Patients who are discharged home should be instructed to follow up with their primary care provider (virtually as feasible) to monitor for symptom progression, and should return to the ED should they experience new/worsened systemic or respiratory symptoms.
5. In the absence of existing evidence, it is reasonable to consider a short period of observation prior to admission/discharge decision, for ED patients with suspected COVID disease whose clinical stability is uncertain.

Research Gaps

There is a need for clinical risk prediction tools to estimate risk of serious outcomes in emergency department patients with suspected or confirmed COVID-19 disease. The development of these tools should follow accepted methodological standards for risk score development. Risk prediction tools should incorporate clinical features and investigations that are readily available at the bedside and have high-inter-rater reliability. Tools should be developed in an ED population and validated in populations

similar to those in which they would be applied, and provide individualized risk estimates that guide patients and clinicians to take specific disposition decisions.

Summary of Evidence

Question 1

No literature directly addressed clinical features indicating safety for discharge. Instead, studies commonly described features associated with poor outcomes. Studies proposing outcome prediction models were systematically reviewed by Wynants et al. (2020) and all found to be at high risk of bias. Wynants et al. note that much recently published COVID-19 characteristics and outcomes research is limited because controls are not similar to the general population, and studies commonly treat patients as if they will not progress to certain outcomes (e.g. ICU admission, death) when it is only fair to say that these patients do not have these outcomes during the study period.

Factors that published models use to predict hospital admission include “age, sex, previous hospital admissions, comorbidity data, and social determinants of health” (Wynants 2020). “Predictors included in more than one prognostic model were age (n=5), sex (n=2), features derived from CT scoring (n=5), C reactive protein (n=3), lactic dehydrogenase (n=3), and lymphocyte count (n=2…)” (Wynants 2020). One study of mortality probability that took steps to test calibration and reported a c index was found by Wynants et al. to produce “probabilities of mortality that were too high for low risk patients and too low for high risk patients” when applied prospectively. In addition to concerns outlined by Wynants (2020) readers should be cautious about risk prediction tools developed using administrative data as source data is not always reliable. Moreover, criteria for disposition decisions such as hospitalization and ICU admission vary between jurisdictions and studies. So, evidence on predictors of the need for hospitalization and ICU admission may not be generalizable to Alberta.

With the limitations of COVID-19 research in mind, comorbidities appear to be related to the risk of hospitalization and mortality. A large retrospective study of “1,590 laboratory-confirmed hospitalized patients [in] 575 hospitals” has found “COPD [hazards ratio (HR) 2.681, 95% confidence interval (95%CI) 1.424-5.048], diabetes (HR 1.59, 95%CI 1.03-2.45), hypertension (HR 1.58, 95%CI 1.07-2.32) and malignancy (HR 3.50, 95%CI 1.60-7.64)” to be associated with invasive ventilation, hospital admission and death. “The HR was 1.79 (95%CI 1.16-2.77) among patients with at least one comorbidity and 2.59 (95%CI 1.61-4.17) among patients with two or more comorbidities.” (Guan 2020). A meta-analysis of 46,248 Covid-19 patients has found that in “severe patients,” as categorized in included studies, “Compared with the Non-severe patient, the pooled odds ratio of hypertension, respiratory system disease, cardiovascular disease … were (OR 2.36, 95% CI: 1.46-3.83), (OR 2.46, 95% CI: 1.76-3.44) and (OR 3.42, 95% CI: 1.88-6.22) respectively” (Yang 2020).

Update: A meta-analysis by Wang et al. (2020) examined “1558 patients with COVID-19 in 6 studies…” and found “Hypertension (OR: 2.29, P<0.001), diabetes (OR: 2.47, P<0.001), chronic obstructive pulmonary disease (COPD) (OR: 5.97, P<0.001), cardiovascular disease (OR: 2.93, P<0.001), and cerebrovascular disease (OR:3.89, P=0.002) were independent risk factors associated with COVID-19 patients [progressing to severe illness]. The meta-analysis revealed no correlation between increased risk of COVID-19 and liver disease, malignancy, or renal disease.” This study is limited in that it relied on the categorizations of patients (as developing “severe’ illness or not) given in the studies relied on for the meta-analysis (and definitions of severe illness differed between studies). In addition, the authors did not conduct any quality assessment of the included studies.

A systematic review of smoking and COVID-19 risk by Vardavas and Nikitara (2020) has found "smoking is most likely associated with the negative progression and adverse outcomes of COVID-19" based on five included studies. However, the authors note that included studies did not adjust for confounding variables, and that further research is needed.

A systematic review by Tamara and Tahapary (2020) has found that "Obesity is an independent risk and prognostic factor for the disease severity and the requirement of advanced medical care in COVID-19" based on three retrospective cohort studies judged by the authors to be high quality.

Question 1a

Risk calculators may inform these decisions, but there is no clinical pathway or decision trigger that has been shown to be reliable or effective in guiding disposition decisions.

The Brescia Scale is available through MDCalc (MDCalc 2020a). This scale was developed and used in Italy but has not been validated. An interview with the creator indicates that the treatment recommendations that accompany it are for use in an environment of inadequate health care resources, which is not currently the case in Alberta (MDCalc 2020b). MDCalc also promotes other tools for use with COVID-19 patients (MDCalc 2020a). Some are not validated or are for specific purposes, e.g. assessing pneumonia, hypoxia, etc.

The CURB-65 scale is in clinical use in the Calgary Zone as applied to patients with non-COVID-related community acquired pneumonia. One included retrospective study applied this scale to COVID-19 patients. "On admission, the median CURB-65 was 1.9 (SD: 1.1; range: 0-5). Eight (9.4%) patients had a CURB-65 score of 0, 27 (31.8%) patients had a score of 1 and 25 (29.4%) patients had a score of 2. These were classified as mild according to the CURB-65 guidelines. Only 25 patients were classified as severe on admission, of whom 20 (23.5%) patients had a score of 3, 3 (3.5%) had a score of 4, and 2 (2.4%) had a score of 5" (Du 2020). The CURB-65 scale may not be adequately sensitive for use in predicting mortality, or need for admission.

One included retrospective study examined the Sequential Organ Failure Assessment (SOFA) scale (Zhou 2020) and found "odds of in-hospital death associated with older age (odds ratio 1·10, 95% CI 1·03–1·17, per year increase; p=0·0043), higher Sequential Organ Failure Assessment (SOFA) score (5·65, 2·61–12·23; p<0·0001), and d-dimer greater than 1 μg/mL (18·42, 2·64–128·55; p=0·0033) on admission."

A number of prognostic tools were tested in a prospective study by Alberta Emergency Medical Services prior to the emergence of COVID-19, including NEWS2, and been found to predict hospital mortality well but to have only moderate discrimination for emergency department disposition (Lane 2020).

The three minute walk test has been studied in emergency departments for risk stratification for some conditions unrelated to COVID-19. For instance, applicability of the test to congestive heart failure and Chronic Obstructive Pulmonary Disorder were evaluated using a convenience sample of 40 patients (Pan 2009). A prospective sample of 114 patients examined the three minute walk test for dyspnea (Amin 2015). The walk test is also used in prospectively studied risk scoring systems for heart failure (Stiell 2013) and chronic obstructive pulmonary disorder (Stiell 2018). While the metric of the test, hypoxemia or tachycardia with ambulation, has good face validity and is associated with poor outcomes, it has not been validated in COVID-19 patients.

Update: Liang et al. (2020) have developed a risk prediction tool for assessing patient risk of developing critical illness due to COVID-19, as defined by the Chinese Center for Disease Control and Prevention. All patients in the study were hospitalized with confirmed COVID-19 diagnosis, limiting the generalizability of the findings to patients who are not ill enough to warrant hospitalization or those awaiting COVID-19 test results.

Using logistic regression Liang et. al found “chest radiographic abnormality (OR, 3.39; 95% CI, 2.14-5.38), age [per year increase] (OR, 1.03; 95% CI, 1.01-1.05), hemoptysis (OR, 4.53; 95% CI, 1.36-15.15), dyspnea (OR, 1.88; 95% CI, 1.18-3.01), unconsciousness (OR, 4.71; 95% CI, 1.39-15.98), number of comorbidities (OR, 1.60; 95% CI, 1.27-2.00), cancer history (OR, 4.07; 95% CI, 1.23-13.43), neutrophil-to-lymphocyte ratio (OR, 1.06; 95% CI, 1.02-1.10), lactate dehydrogenase (OR, 1.002; 95% CI, 1.001-1.004) and direct bilirubin (OR, 1.15; 95% CI, 1.06-1.24)” to be predictive of critical illness. “The mean AUC in the development cohort was 0.88 (95% CI, 0.85-0.91) and the AUC in the validation cohort was 0.88 (95% CI, 0.84-0.93).” The authors note that their tool outperforms the CURB-6 “which had an AUC of 0.75 (95% CI, 0.70-0.80) for correct prediction of development of critical illness ($P < .001$).” The authors have made their risk tool available online (http://118.126.104.170/). These predictive factors are generally consistent with other published literature. However, several diagnostic tests (LDH, direct bilirubin) are not routinely ordered as part of the initial evaluation of patients with suspected COVID-19 disease, and may not be immediately available at the bedside for clinical decision-making. Given the population studied and the laboratory parameters included, it has limited utility in an ED population.

Williams and colleagues (2020) offer a pre-print publication on a model based on approximately 6.8 million influenza cases for outcomes that included hospitalization, need for intensive care, and death. The authors report that “43,061 COVID-19 patients were included for model validation [and the model] identified 7 predictors (history of cancer, chronic obstructive pulmonary disease, diabetes, heart disease, hypertension, hyperlipidemia, and kidney disease) which combined with age and sex could discriminate which patients would experience any of our three outcomes. The models achieved high performance in influenza. When applied to COVID-19 cohorts, the AUC ranges were, [Hospitalization]: 0.73-0.81, [Intensive Care]: 0.73-0.91, and [Death]: 0.82-0.90. Calibration was overall acceptable, with overestimated risk in the most elderly and highest risk strata.” The prediction tools for each outcome provide personalized risk estimates. But, these calculators do not provide actions or directions based on these risk estimates, and the impact of application to patient care is unknown.

A number of other risk scoring tools are summarized by Urwin et al. (2020). Generally, these are not validated and few are based on COVID-19 data. One that is validated using COVID-19 data and multivariate analysis found male sex, age of 50 or older and presence of hypertension to be associated with critical illness (Shi et al. 2020). However, validation work found only 42.9% of 66 patients who were admitted to hospital with mild illness and presence all three predictors went on to develop critical illness. As such, while the analysis suggests association of older age, male sex and hypertension with critical illness, scoring based on these three predictors alone is likely of limited clinical value.

The Centre for Evidence Based Medicine (CEBM) has reviewed the question “What is the efficacy and safety of rapid exercise tests for exertional desaturation in covid-19?” and concluded that these tests have a place in assessing O2 saturation and that “even a small desaturation on exercise should alert the clinician and a drop of 3% should be cause for serious concern, regardless of the amount of exercise needed to produce it” (Greenhalgh, Javid, Knight and Inada-Kim 2020) The CEBM authors reach this conclusion based on studies of such tests for evaluating outcomes in other illnesses.

Greenhalgh and colleagues note, in particular, the similarity between COVID-19 pneumonia and "pneumocystis carinii pneumonia (PCP) another acute infectious lung disease which presents with dry cough, silent hypoxia, exertional desaturation and similar CT scan changes."

The authors add that "Two tests have potential: the 1-minute sit-to-stand test (in which the patient goes from sit to stand as many times as they can in one minute) and the 40-step test (in which the patient takes 40 steps on a flat surface). The former correlates well with the validated 6-minute exercise test. The latter… does not appear to have been validated." The CEBM authors raise concerns about the safety of exertion tests. They recommend that tests involving stairs be avoided and that any test be discontinued if the patient experiences negative side effects (e.g. chest pain, dizziness).

Question 1b

Results of imaging of COVID-19 patients are reported in two systematic reviews. A systematic review of imaging results by Cao found bilateral pneumonia (75.7%, 0.639-0.871), and ground glass opacification (69.9%, 0.602-0.796) among COID-19 patients (Cao 2020). A systematic review by Saleh et al. notes "Known features of COVID-19 on initial CT include bilateral multilobar ground-glass opacification (GGO) with a peripheral or posterior distribution, mainly in the lower lobes and less frequently within the right middle lobe." A scoping review and meta-analysis by Borges (2020) had similar findings, and points out that the majority of clinical symptoms and laboratory findings of COVID-19 are non-specific.

No single investigation, including CT scanning, has sufficient sensitivity or specificity to be used to identify patients requiring admission. CT scans should not be ordered routinely in patients evaluated in the ED nor or in patients admitted to hospital.

Question 1c

No scientific literature on observation periods in emergency departments for COVID-19 was found.

Evidence from existing policies and guidelines

Question 1

United Kingdom National Institute for Health and Care Excellence (NICE) guidelines suggest clinicians should "Use the following symptoms and signs to help identify patients with more severe illness to help make decisions about hospital admission: severe shortness of breath at rest or difficulty breathing, coughing up blood, blue lips or face, feeling cold and clammy with pale or mottled skin, collapse or fainting (syncope), new confusion, becoming difficult to rouse, little or no urine output."

Public Health Agency of Canada guidelines suggest that those with mild symptoms do not require hospitalization "unless there is concern about rapid deterioration or inability to return promptly to hospital" (PHAC 2020).

"Older patients and those with comorbidities (e.g. cardiovascular disease, diabetes mellitus, pre-existing lung conditions) have increased risk of severe disease and mortality. While they may present with mild disease, they have a higher risk of deterioration and should be monitored closely." (PHAC 2020).

World Health Organization (WHO) (2020) guidelines are similar and cite Zhou 2020 above on the risk factors of COVID-19.

Update: Updated WHO guidelines note smoking as a risk factor for severe COVID-19 illness alongside "diabetes, hypertension, cardiac disease, chronic lung disease, cerebrovascular disease, chronic

kidney disease, immunosuppression and cancer." WHO guidelines also note "the presence of vulnerable persons in the household" as a consideration when deciding whether to admit a patient to hospital. These points were not noted when these WHO guidelines were previously reviewed.

Both the PHAC and WHO documents also suggest assessing for sepsis, pneumonia and acute respiratory distress syndrome in patients evaluated for COVID-19 disease. Canadian Association of Emergency Physicians (2020) guidelines note that particular care should be taken in discharging persons experiencing homelessness. They advise providers to:

"Contact the shelter to determine if there is the capability to provide isolation; Involve other providers early in the care process, where appropriate e.g., case worker, community outreach team, social worker, addictions services; Ensure that you have working contact information for the individual or service provider / delegate, as appropriate" and to avoid discharging without a transitional plan or after hours.

It would seem reasonable to consider household crowding (e.g. for low income populations) and transportation limitations (e.g. for rural persons, and persons without private vehicles), for any discharge decision. Statistics Canada reports a crowding rate (more than one person per room, not counting hallways and bathrooms) of 2.14% in Alberta Households (2017). Indigenous households have higher household crowding (e.g. "35% of on-reserve and 8% of off-reserve First Nations people in Alberta lived in crowded homes" in 2011 (Statistics Canada 2016)).

Question 1a

United Kingdom guidelines recommend caution in using the CURB-65 scale as it requires assessing blood pressure and this is thought to increase cross contamination risk. The guidelines do state that the NEWS2 scale "for predicting the risk of clinical deterioration may be useful" in community (NICE 2020).

The United Kingdom guidelines recommend utilizing the Medical Research Council (MRC) Dyspnoea scale / MRC Breathlessness scale to assess dyspnea (NICE 2020), but the Medical Research Council advises that this scale is for epidemiologic study only and should not be used on an individual basis (Medical Research Council 2020).

Question 1b

Chest imaging can aid the diagnosis of acute respiratory distress syndrome, and identify complications and other etiologies of hypoxemia in patients with severe disease. (PHAC 2020). PHAC makes no recommendation for imaging in patients with mild disease.

The American College of Respirology (2020) COVID-19 guidelines advise against chest CT for diagnosis of COVID-19. They state that, "A normal chest CT does not mean a person does not have COVID-19 infection - and an abnormal CT is not specific for COVID-19 diagnosis."

The Canadian Association of Radiologists (CAR) and the Canadian Society on Thoracic Radiology (CSTR) Recommendations on COVID-19 Management repeat the above point and state that "Imaging should only be conducted for those COVID-19 patients where imaging will impact management of the condition."

The use of point of care ultrasound has been described, however similar significant overlap between the appearance of COVID-19 and other viral infections is noted and point of care ultrasound is not recommended for clinical decision making at this time (Peng 2020).

Question 1c

Canadian (PHAC 2020) and WHO (2020) guidelines suggest patients with mild symptoms can be discharged home to recover. Standardized discharge instructions and follow up plan materials have been developed by AHS.

Italian National Institute for Infectious Diseases guidelines suggest ongoing clinical monitoring for even mild or asymptomatic cases, but offer no guidance on the duration, frequency or type of monitoring (Nicastri 2020).

Evolving Evidence

- New evidence will emerge on this topic.
- Rapid turnaround time afforded limited time to conduct a thorough search and review of the research and grey literature.
- Many relevant studies with small sample sizes could not be reviewed, assessed and compared in a timely manner.
- “Walk test” and related terms were not included in the librarian conducted search.

.

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 5, 2020

Authorship & Committee Members

This review was written by Patrick McLane and scientifically reviewed by Andrew McRae, Kerri Johansson (external reviewer), Evan Minty (external reviewer), Chris Fung (external reviewer), Finlay McAlister (external reviewer), Brian Holroyd (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 Doroshenko, Shelley Duggan, Nelson Lee, Andrew McRae, Jeremy Slobodan, James Talbot, Brandie Walker, and Nathan Zelyas.

COVID-19 Scientific Advisory Group Rapid Response Report

Appendix

List of Abbreviations

AUC – Area Under the Curve

CAR - Canadian Association of Radiologists

CSTR - Canadian Society on Thoracic Radiology

CURB-65 – Confusion, Blood Urea, Respiratory Rate, Blood Pressure, Age 65 or older - Tool

LPM - Litres per minute

NEWS2 – National Early Warning Scale 2

National Institute for Health and Care Excellence (NICE)

PHAC – Public Health Agency of Canada

SOFA – Sequential Organ Failure Assessment Scale

WHO- World Health Organization

Literature Search Details

Databases and search engines: OVID MEDLINE, EMBASE, LitCovid, CINAHL, TRIP PRO, BMJ Best Practice, WHO Global research on coronavirus (database), Google and Google Scholar.

Search Strategy

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to April 03, 2020 #	**Searches**	**Results**
1	exp Coronavirus/ or exp Coronavirus Infections/ or coronaviru*.mp. or "corona virus*".mp. or ncov*.mp. or n-cov*.mp. or COVID-19.mp. or COVID19.mp. or COVID-2019.mp. or COVID2019.mp. or SARS-COV-2.mp. or SARSCOV-2.mp. or SARSCOV2.mp. or	21048

	SARSCOV19.mp. or Sars-Cov-19.mp. or SarsCov-19.mp. or SARSCOV2019.mp. or Sars-Cov-2019.mp. or SarsCov-2019.mp. or "severe acute respiratory syndrome cov 2".mp. or "2019 ncov".mp. or "2019ncov".mp.	
2	hospitalization/ or patient admission/ or patient readmission/ or triage/	150915
3	(hospitali* or admission* or admit* or readmit* or readmission* or triage*).mp.	645728
4	2 or 3	645728
5	1 and 4	1077
6	limit 5 to (english language and yr="2020 -Current")	190
7	exp clinical laboratory techniques/ or exp diagnostic imaging/	4882177
8	(lab or labs or laborator* or imag* or CT scan*).mp.	3004694
9	7 or 8	6001034
10	Emergency Treatment/ or Emergency Medicine/ or emergency medical services/ or emergency service, hospital/ or trauma centers/ or triage/ or exp Evidence-Based Emergency Medicine/ or exp Emergency Nursing/ or Emergencies/ or emergicent*.mp. or casualty department*.mp. or ((emergenc* or ED) adj1 (room* or accident or ward or wards or unit or units or department* or physician* or doctor* or nurs* or treatment*or visit*)).mp. or (triage or critical care or (trauma adj1 (cent* or care))).mp. [mp=title, abstract, original title, name of	317728

	substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	
11	1 and 9 and 10	62
12	limit 11 to (english language and yr="2020 -Current")	10
13	Hypoxia/	63504
14	exp Oxygen/	181534
15	exp oxygen inhalation therapy/ or hyperbaric oxygenation/	25591
16	(hypoxia or hypoxemia or anoxemia or anoxia or oxygen deficienc* or oxygen*).mp.	822564
17	or/13-16	835282
18	1 and 17	291
19	limit 18 to (english language and yr="2020 -Current")	36
20	(CURB-65 or CURB criteria or NEWS2 or National Early Warning Score or (Brescia* adj7 (scale or algorithm))).mp.	709
21	1 and 20	5
22	exp risk assessment/ or risk factors/	997217
23	(risk adj3 (assess* or factor* or stratif* or tool*)).mp.	1361766
24	22 or 23	1364392
25	1 and 24	816
26	limit 25 to (english language and yr="2020 -Current")	101
27	Clinical Observation Units/	30
28	(clinical decision unit* or observation* unit* or observation* period* or observation* duration* or (clinical* adj3 observ*)).mp.	87162
29	27 or 28	87162
30	1 and 29	106

31	limit 30 to (english language and "humans only (removes records about animals)")	31
32	6 or 12 or 19 or 21 or 26 or 31	323

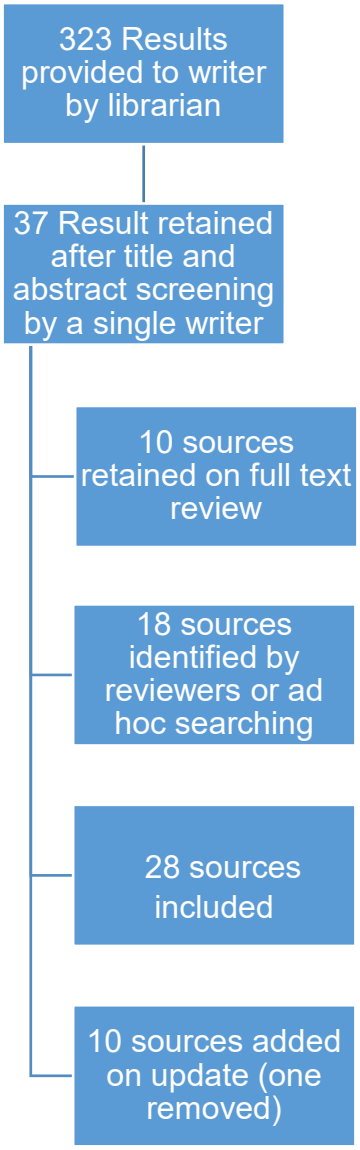
LitCovid
Search string 1: triage or admission or hospitali*
Search string 2: CURB-65 or "CURB criteria" or NEWS2 or "National Early Warning Score" or brescia
TRIP PRO / Google / Google Scholar
Search string 1: (hospitali* or admission* or admit* or readmit* or readmission* or triage*) AND (coronaviru* OR "corona virus" OR ncov* OR n-cov* OR COVID-19 OR COVID19 OR COVID-2019 OR COVID2019 OR SARS-COV-2 OR SARSCOV-2 OR SARSCOV2 OR SARSCOV19 OR SARS-COV-19 OR SARSCOV-19 OR SARSCOV2019 OR SARS-COV-2019 OR SARSCOV-2019 OR "severe acute respiratory syndrome cov 2" OR "severe acute respiratory syndrome coronavirus*" OR "2019 ncov" OR 2019ncov OR Hcov*) from:2020
Search string 2: risk* AND (emergency department* or ED or emergency room* or emergency ward* or emergency unit* or hospital emergency service*) AND (coronaviru* OR "corona virus" OR ncov* OR n-cov* OR COVID-19 OR COVID19 OR COVID-2019 OR COVID2019 OR SARS-COV-2 OR SARSCOV-2 OR SARSCOV2 OR SARSCOV19 OR SARS-COV-19 OR SARSCOV-19 OR SARSCOV2019 OR SARS-COV-2019 OR SARSCOV-2019 OR "severe acute respiratory syndrome cov 2" OR "severe acute respiratory syndrome coronavirus*" OR "2019 ncov" OR 2019ncov OR Hcov*) from:2020
Search string 3: (CURB-65 or "CURB criteria" or NEWS2 or "National Early Warning Score" or brescia) AND (coronaviru* OR "corona virus" OR ncov* OR n-cov* OR COVID-19 OR COVID19 OR COVID-2019 OR COVID2019 OR SARS-COV-2 OR SARSCOV-2 OR SARSCOV2 OR SARSCOV19 OR SARS-COV-19 OR SARSCOV-19 OR SARSCOV2019 OR SARS-COV-2019 OR SARSCOV-2019 OR "severe acute respiratory syndrome cov 2" OR "severe acute respiratory syndrome coronavirus*" OR "2019 ncov" OR 2019ncov OR Hcov*) from:2020
PubMed
Search string 1: ((hospitali* or admission* or admit* or readmit* or readmission* or triage*) AND (emergency department* or ED or emergency room* or emergency ward* or emergency unit* or hospital emergency service*)) AND (((wuhan[tw] AND (coronavirus[tw] OR corona virus[tw])) OR coronavirus*[ti] OR COVID*[tw] OR nCov[tw] OR 2019 ncov[tw] OR novel coronavirus[tw] OR novel corona virus[tw] OR covid-19[tw] OR SARS-COV-2[tw] OR Severe Acute Respiratory Syndrome Coronavirus 2[tw] OR coronavirus disease 2019[tw] OR corona virus disease 2019[tw] OR new coronavirus[tw] OR new corona virus[tw] OR new coronaviruses[all] OR novel coronaviruses[all] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[nm] OR 2019 ncov[tw] OR nCov 2019[tw] OR SARS Coronavirus 2[all]) AND (2019/12[dp]:2020[dp]))
Search string 2: (((wuhan[tw] AND (coronavirus[tw] OR corona virus[tw])) OR coronavirus*[ti] OR COVID*[tw] OR nCov[tw] OR 2019 ncov[tw] OR novel coronavirus[tw] OR novel corona virus[tw] OR covid-19[tw] OR SARS-COV-2[tw] OR Severe Acute Respiratory Syndrome Coronavirus 2[tw] OR coronavirus disease 2019[tw] OR corona virus disease 2019[tw] OR new coronavirus[tw] OR new corona virus[tw] OR new coronaviruses[all] OR novel coronaviruses[all] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[nm] OR 2019 ncov[tw] OR nCov 2019[tw] OR SARS Coronavirus 2[all]) AND (2019/12[dp]:2020[dp])) AND (CURB-65 or "CURB criteria" or NEWS2 or "National Early Warning Score" or Brescia)

Screening

Table 1. Inclusion and exclusion criteria for results of the literature search

Inclusion Criteria	Exclusion Criteria
- Guidelines and credible academic writing on emergency department management or hospital admission for COVID-19 patients. - Systematic reviews of Covid-19 clinical characteristics, imaging and outcomes. - Individual studies reporting on application of risk stratification tools to Covid-19 or similar patients. - Studies on “walk tests” in emergency departments.	- News articles. - Opinion pieces. - Cast studies or series. - Studies of unique populations (e.g. patients with cancer diagnoses, populations with high HIV rates, asymptomatic patients, seniors, children, pregnant persons). - Animal studies. - Studies proposing criteria for resource allocation when health a system is overwhelmed.

Figure 1: PRISMA Diagram



- PRISMA Citation:
  Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses:* The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Reference List

Alberta Health Services. (2020). COVID-19 Provincial Pandemic Flowsheet Admission to Acute Care. https://www.albertahealthservices.ca/assets/info/ppih/if-ppih-covid-19-provincial-pandemic-flowsheet.pdf

American College of Respirology. (2020). ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection. https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection

Amin, Q., Perry, J. J., Stiell, I. G., Mohapatra, S., Alsadoon, A., & Rodger, M. (2015). Ambulatory vital signs in the workup of pulmonary embolism using a standardized 3-minute walk test. CJEM, 17(3), 270–278. http://doi.org/10.1017/cem.2014.45

Borges do Nascimento IJ, Cacic N, Abdulazeem HM, et al. (2020). Novel Coronavirus Infection (COVID-19) in Humans: A Scoping Review and Meta-Analysis. *J Clin Med*. 9(4)

Canadian Association of Emergency Physicians. (2020). COVID-19 and Persons Experiencing Homelessness or Vulnerable Housing. https://caep.ca/wp-content/uploads/2020/03/COVID-19-and-homelessness-CAEP-updated-0321-1.pdf

Cao Y, Liu X, Xiong L, Cai K. (2020). Imaging and Clinical Features of Patients With 2019 Novel Coronavirus SARS-CoV-2: A systematic review and meta-analysis. J Med Virol.

CAR/CSTR (2020). The Canadian Association of Radiologists (CAR) and the Canadian Society on Thoracic Radiology (CSTR) Recommendations on COVID-19 Management in Imaging Departments. https://car.ca/wp-content/uploads/2020/03/The-Canadian-Association-of-Radiologists-CAR-and-the-Canadian-Society-on-Thoracic-Radiology-CSTR-Recommendations-on-COVID19-Management-in-Imaging-Departments-1.pdf

Deng Y, Liu W, Liu K, et al. (2020).Clinical characteristics of fatal and recovered cases of coronavirus disease 2019 (COVID-19) in Wuhan, China: a retrospective study. Chin Med J (Engl).

Du Y, Tu L, Zhu P, et al. (2020). Clinical Features of 85 Fatal Cases of COVID-19 from Wuhan: A Retrospective Observational Study. Am J Respir Crit Care Med. doi:https://dx.doi.org/10.1164/rccm.202003-0543OC

Emergency Strategic Clinical Network, Alberta Health Services. (2020). "Stratification of ED / UCC Patients Presenting with Symptoms Consistent with COVID-19." https://insite.albertahealthservices.ca/Main/assets/tls/ep/tls-ep-covid-19-stratification-patients-presenting-covid-symptoms.pdf

Greenhalgh T, Javid B, Knight M, Inada-Kim M. What is the efficacy and safety of rapid exercise tests for exertional desaturation in covid-19? April 21, 2020. Centre for Evidence-Based Medicine. https://www.cebm.net/covid-19/what-is-the-efficacy-and-safety-of-rapid-exercise-tests-for-exertional-desaturation-in-covid-19/

Guan W-J, Liang W-H, Zhao Y, et al. (2020).Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. Eur Respir J.

Lane DJ., Wunsch H, Saskin R, Cheskes S, Lin S, Morrison LJ. & Scales DC. (2020) Assessing Severity of Illness in Patients Transported to Hospital by Paramedics: External Validation of 3 Prognostic Scores, Prehospital Emergency Care, 24:2, 273-281, DOI: 10.1080/10903127.2019.1632998

National Institute for Clinical Excellence. (2020). COVID-19 rapid guideline: managing suspected or confirmed pneumonia in adults in the community. https://www.nice.org.uk/guidance/ng165/chapter/3-Diagnosis-and-assessment

Nicastri E, Petrosillo N, Bartoli TA, et al. (2020). National Institute for the Infectious Diseases "L. Spallanzani", IRCCS. Recommendations for COVID-19 clinical management. Infect Dis Rep. 12(1):8543. doi:https://dx.doi.org/10.4081/idr.2020.8543

Liang W, Liang H, Ou L, et al. (2020). Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19 [published online ahead of print, 2020 May 12]. JAMA Intern Med.;e202033. doi:10.1001/jamainternmed.2020.2033

MDCalc. (2020a). COVID-19 Resource Center. https://www.mdcalc.com/covid-19

MDCalc (2020b). Interview with Italian Intensivist Dr. Simone Piva, Discussing the Brescia-COVID Respiratory Severity Score (BCRSS). https://www.mdcalc.com/covid-19/brescia-covid-respiratory-severity-scale-bcrss-interview

Medical Research Council (2020). MRC Dyspnoea scale / MRC Breathlessness scale. https://mrc.ukri.org/research/facilities-and-resources-for-researchers/mrc-scales/mrc-dyspnoea-scale-mrc-breathlessness-scale/

Pan AM, Stiell IG, Clement CM, et al Feasibility of a structured 3-minute walk test as a clinical decision tool for patients presenting to the emergency department with acute dyspnea. Emergency Medicine Journal 2009;26:278-282.

Peng QY et al. Chinese Critical Care Ultrasound Study Group (CCUSG). Findings of lung ultrasonography of novel corona virus pneumonia during the 2019-2020 epidemic. Intensive Care Med 2020. Mar 12. Doi: 10.1007/s00134-020-05996-6

Public Health Agency of Canada. (2020). Clinical Management of Patients with Moderate to Severe COVID-19 - Interim Guidance. https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/clinical-management-covid-19.html

Williams RD, Markus AF, Yang C, Salles TD, Falconer T, Jonnagaddala J, et al. (2020) SEEK COVER: Development and validation of a personalized risk calculator for COVID-19 outcomes in an international network. medRxiv 2020.05.26.20112649; doi: https://doi.org/10.1101/2020.05.26.20112649

Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. (2020). Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. Am J Roentgenol. 1-7. doi:10.2214/AJR.20.23034 https://doi.org/10.2214/AJR.20.23034" https://doi.org/10.2214/AJR.20.23034

Shi Y, Yu X, Zhao H, Wang H, Zhao R, Sheng J. Host susceptibility to severe COVID-19 and establishment of a host risk score: findings of 487 cases outside Wuhan. Critical Care. 2020;24:1-4.

Statistics Canada. 2016. Aboriginal Peoples: Fact Sheet for Alberta. https://www150.statcan.gc.ca/n1/pub/89-656-x/89-656-x2016010-eng.htm

Statistics Canada. 2017. *Alberta [Province] and Canada [Country]* (table). *Census Profile*. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E (accessed April 9, 2020).

Stiell, I.G., Clement, C.M., Brison, R.J., Rowe, B.H., Borgundvaag, B., Aaron, S.D., Lang, E., Calder, L.A., Perry, J.J., Forster, A.J. and Wells, G.A. (2013), A Risk Scoring System to Identify Emergency Department Patients With Heart Failure at High Risk for Serious Adverse Events. Acad Emerg Med, 20: 17-26. doi:10.1111/acem.12056

Stiell, I.G., Perry J.G., Clement C.M., Brison R.J., Rowe B.H., Aaron S.D., McRae A.D., Borgundvaag B.,Calder L.A., Forster A.J., Brinkhurst J., Wells, G.A. 2018. Clinical validation of a risk scale for serious outcomes among patients with chronic obstructive pulmonary disease managed in the emergency departments. CMAJ, 190 (48) E1406-E1413; DOI: 10.1503/cmaj.180232

Stiell I.G., Wells G.A. 1999. Methodologic standards for the development of clinical decision rules in emergency medicine. Ann Emerg Med; 33:437–47

Tamara, A, Tahapary, D. (2020). Obesity as a predictor for a poor prognosis of COVID-19: A systematic review. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 14. 10.1016/j.dsx.2020.05.020.

Urwin SG, Kandola G, Graziadio S. 2020. What prognostic clinical risk prediction scores for COVID-19 are currently available for use in the community setting? Centre for Evidence Based Medicine.

Vardavas, C. I., & Nikitara, K. (2020). COVID-19 and smoking: A systematic review of the evidence. Tobacco induced diseases, 18, 20. https://doi.org/10.18332/tid/119324

Wang B, Li R, Lu Z, Huang Y. (2020). Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. Aging (Albany NY) [Internet]. 12(7):6049–57.

Wells. (2018). Clinical validation of a risk scale for serious outcomes among patients with chronic obstructive pulmonary disease managed in the emergency department. CMAJ. 190 (48) E1406-E1413; DOI: 10.1503/cmaj.180232

World Health Organization (2020). Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim guidance. https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected

Wynants Laure, Van Calster Ben, Bonten Marc M J, Collins Gary S, Debray Thomas P A, De Vos Maarten et al. (2020). Prediction models for diagnosis and prognosis of covid-19 infection: systematic review and critical appraisal BMJ; 369 :m1328

Yang J, Zheng Y, Gou X, et al. (2020). Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis. Int J Infect Dis.

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 cohort study. *Lancet (London, England)*.