Emergency Department COVID-19 Management Tool

American College of Emergency Physicians®
ADVANCING EMERGENCY CARE

Fall 2023

This tool was developed to provide a pragmatic framework to assist with severity classification, diagnostic workup, disposition, and treatment of patients with suspected or confirmed SARS-CoV-2 (COVID-19) in the emergency department.

- It is designed to assist with the management of adult patients (≥18 years old) with symptomatic infection.
- For information on pediatric MIS-C protocols (**CHOP**, **Minnesota**, and **Yale**)
- **This tool is not intended to represent a legal standard of care for emergency physicians. Recommendations offered in this tool are not intended to represent the only diagnostic or management options available to the emergency physician. Individual physicians' judgment and consideration of patient resources/preferences is essential.**
- This tool is not exhaustive in regards to diagnostic and treatment recommendations. Patients may present with particular conditions (MI, PE, stroke) that could be manifestations of severe or critical COVID-19. These conditions may require additional specific diagnostic and therapeutic interventions not discussed in this tool.
- Evidence on this topic (including differences in severity that may occur with evolving variants) is changing quickly and may alter recommendations.
- A digitized version of this tool can now be found at **MDCalc.**

Step 1 - Severity Classification - Assess the patient's severity of disease utilizing NIH criteria.

MILD	MODERATE	SEVERE	CRITICAL
Individuals who have various signs and symptoms of COVID-19 (ANY): ☐ Fever ☐ Cough ☐ Sore throat ☐ Malaise ☐ Headache ☐ Muscle pain ☐ Nausea, vomiting, diarrhea ☐ Loss of taste and smell **BUT who do NOT have (ANY):** ☐ Shortness of breath ☐ Dyspnea ☐ Abnormal chest imaging (if obtained)	**Individuals who show evidence of lower respiratory disease during (ANY):** ☐ Clinical assessment ☐ Imaging **AND who have:** ☐ SpO2 ≥94% on room air at sea level (in those with normal baseline SpO2 at rest)	**Individuals who have (ANY):** ☐ SpO2 <94% on room air at sea level (in those with normal baseline SpO2 at rest) ☐ Ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mm Hg (if ABG obtained) ☐ RR >30 breaths/min ☐ Lung infiltrates >50%	**Individuals with (ANY):** ☐ Respiratory failure ☐ Septic shock ☐ Multiorgan dysfunction or failure

Consider Risk Prognostication and Assessment (see Page 3)

Step 2 - Diagnostic Testing

The following imaging and lab tests should be considered based on your patients severity and risk for disease progression. Diagnosing acute SARS-CoV-2 infection solely on the basis of serologic test results is not recommended by NIH. Antigen Testing Algorithm for Community Settings

MILD	MODERATE	SEVERE	CRITICAL
Based on clinician's judgement, diagnostic testing may not be necessary in patients with (ALL): ☐ Mild Severity ☐ PRIEST score ≤4 (See Page 3) ☐ 1 or less Risk Factors **Exertional SpO2 may have limited ability to identify adverse outcomes in otherwise well-appearing patients:** ☐ <3% change in SpO2	**Imaging**: the optimal imaging technique has not yet been defined for people with symptomatic COVID-19. Initial evaluation for these patients may include: ☐ Chest X-ray ☐ Pulmonary Ultrasound ☐ CT Chest (if indicated) **ECG**: should be performed if indicated ☐ ECG **Labs**: ☐ CBC w/ differential ☐ CMP **It is recommended to utilize ACEP's COVID-19 Field Guide section on Laboratory Abnormalities to review lab results.**		**Additional tests to consider include:** ☐ ABG ☐ Coagulation screen - (d-dimer, PT/PTT, fibrin degradation products) ☐ Inflammatory markers - (procalcitonin / c-reactive protein) ☐ Ferritin ☐ LDH ☐ CK, CK-MB ☐ Troponin ☐ Blood and sputum cultures

Step 3 - Disposition

The following represents a pragmatic approach for disposition of patients depending on their disease severity. Clinicians may want to consider a patient's risk for progression of disease based on PRIEST Score / Risk Assessment (see Page 3), imaging, and labs in their disposition decision. See Steps 4 and 5 on the next page for treatment guidance.

MILD	MODERATE	SEVERE	CRITICAL
☐ **Discharge Home** ☐ Supply patient with educational materials on precautions and items to be monitorinag at home **In patients with PRIEST Score ≥5 and/or multiple Risk Factors** ☐ Clinicians should consider early follow-up with primary care physician or other health system access points. ☐ Patient should be educated on their increased risk for severe disease and precautions to return to the ED.	☐ **Discharge Home, consider if ALL:** ☐ PRIEST Score ≤4 ☐ 1 (or less) Risk Factors ☐ No concerning Imaging or Lab results ☐ Capability and resources to care for self at home ☐ No other condition that warrants admission ☐ **Admission, consider if ANY:** ☐ PRIEST Score ≥5 ☐ Multiple Risk Factors ☐ Concerning Imaging or Lab results ☐ Does NOT have the capability or resources to care for self at home **Admission Location:** Based on clinician's judgement ☐ Observation ☐ Inpatient Floor ☐ Intermediate	**Admission Location:** based on clinician's judgement ☐ Floor Bed ☐ Intermediate ☐ ICU ☐ **Transfer** ☐ Consider transfer if your facility does not have the resources or capacity to care for a severe COVID patient that could deteriorate.	**Admission** ☐ ICU ☐ **Transfer** ☐ Consider transfer if your facility does not have the resources or capacity to care for a critically ill COVID patient. ☐ Consider transfer to an ECMO facility for patients who may benefit from this after consultation with receiving facility.

CDC Patient Educational Materials • SAEM Patient Toolkit

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Step 4 - Non-Pharmacologic Treatment

The following treatments should be considered based on your patient's severity and risk of disease progression.

MILD / MODERATE	SEVERE	CRITICAL
☐ Consider home oxygen therapy (for those who may benefit) ☐ Monitor home 02 saturation with portable monitor ☐ Progressive ambulation as tolerated (if no contraindication) ☐ Resting in the prone position if dyspneic ☐ Adequate rest/sleep ☐ Balanced diet ☐ Adequate hydration **COVID-19 vaccination is recommended for everyone 6 months of age and older, regardless of a history of symptomatic or asymptomatic SARS-CoV-2 infection.** - People who recently had SARS-CoV-2 infection may consider delaying their next COVID-19 vaccination dose by 3 months from symptom onset or positive test (if infection was asymptomatic). - Additional information HERE and Vaccination FAQs	☐ Oxygen support-nasal cannula, titrate up to 6L with an oxygenation goal of >92% ☐ High-Flow Nasal Cannula (HFNC) or high-velocity therapy (titrated up to a flow of 60L and FiO2 up to 100%) are recommended over NIPPV [42,43]. This intervention may reduce need for mechanical, ventilation but has not been demonstrated to reduce mortality. (AII) ☐ Non-Invasive Postive Pressure Ventilation (NIPPV) if HFNC not available ☐ Consider trial of awake prone positioning if patient can be monitored or can self rescue. Awake proning is contraindicated in patients in respiratory distress. ☐ Insufficient data recommend for or against use Nitric Oxide[38]. ☐ Recommend against routine use of Heliox; may be considered in croup-like pediatric presentations[39].	☐ Intubation is recommended for severe respiratory failure: ☐ Oxygenation goal for ventilated patients should be 92-96%. ☐ Consider low tidal volume (VT) ventilation (VT 4–8 mL/kg of predicted body weight) over higher VT ventilation (VT >8 mL/kg) (AI). ☐ Target plateau pressures of <30 cm H2O (AII). ☐ A higher positive end-expiratory pressure (PEEP) strategy is recommended over a lower PEEP strategy (BII). ☐ For mechanically ventilated adults with refractory hypoxemia despite optimized ventilation, consider prone ventilation for 12 to 16 hours per day over no prone ventilation. ☐ Consider using a conservative fluid strategy over a liberal fluid strategy (BII). ☐ Venovenous ECMO appears to be an effective intervention in selected patients with COVID-19-related ARDS (AII)[41] ☐ Insufficent Data to recommend for or against ECMO in these patients. ☐ Against the routine use of inhaled nitric oxide (AI). May improve oxygenation in severe persistent hypoxia (BII)[38].

Step 5 - Pharmacologic Treatment

The following medications should be considered for treatment based on the patient's severity and risk of disease progression.
Pharmacologic recommendations for patients with COVID-19 continue to evolve.

- For the latest updates and details visit the NIH or IDSA Guidelines.
- For the latest information on local availability of therapies for COVID, check your State Health Department.
- For tips and tricks on how to talk with patients about COVID treatment options see the SAEM Provider Toolkit.

DISCHARGED FROM EMERGENCY DEPARTMENT

All patients should be offered symptom management (AIII).

Based upon the emergence of the Omicron Variant of Concern (VOC), and its subvariants, the following are the current recommendations for treatment of patients with a HIGH risk of disease progression.

Preferred Therapies: Use 1 of the following (listed in order of preference).

1. **Nirmatrelvir 300 mg with ritonavir 100 mg (Paxlovid)** orally twice daily for 5 days, initiated as soon as possible and within 5 days of symptom onset in those aged ≥12 years and weighing ≥40 kg (AIIa). **See Caution note, below and in the Footnote Section before prescribing**.
2. **Remdesivir 200 mg** IV on Day 1, followed by remdesivir 100 mg IV daily on Days 2 and 3, initiated as soon as possible and within 7 days of symptom onset in those aged ≥12 years and weighing ≥40 kg (BIIa). (off label use)

Alternative therapy - For use when neither of the preferred therapies are available, feasible to use, or clinically appropriate:

- **Molnupiravir 800 mg** orally twice daily for 5 days, initiated as soon as possible and within 5 days of symptom onset in those aged ≥18 years ONLY when none of the above options can be used (CIIa). Molnupiravir is not recommended for pregnant or lactating females (See Footnote Section). Women who could become pregnant should use contraception during treatment and for 4 days after the last dose. Men should use contraception during treatment and for at least 3 months after the last dose. See molnupiravir-us.com/patients/
- **Bevtelovimap** no longer authorized by the FDA (See Footnote Section)

Providers should have **CAUTION** when prescribing Paxlovid due to the ritonavir component, which has significant and complex drug-drug interactions. Please see the Footnotes section for links to more information on these.

- See the Footnotes page for links to the EUA FDA fact sheets for these drugs

ADMITTED TO HOSPITAL

Hospitalized for reasons other than COVID-19, but with COVID-19:
☐ See left column "Discharged from ED" for treatment recommendations.

Hospitalized but does not require supplemental 02:
☐ Do not use dexamethasone (AIIa) or other corticosteroids (AIII)
☐ For patients at high risk of disease progression: Remdesivir (BIII)

Hospitalized and requires supplemental 02:
☐ For pts only requiring minimal supplemental 02: Remdesivir (BIIa)
☐ For most patients: Dexamethasone plus remdesivir (BIIa)
☐ If remdesivir is not available: Dexamethasone (BIIa)
☐ For patients on dexamethasone with rapidly increasing oxygen needs and systemic inflammation: Add baricitinib or tocilizumab to one of the above 3 options (BIIa)

Hospitalized and requires 02 through hi-flow device or noninvasive ventilation:
☐ For most patients: One of the following: Dexamethasone plus baricitinib (AI) or dexamethasone plus tocilizumab (BIIa)
☐ If neither baricitinib/tofacitinib nor tocilizumab/sarilumab can be procured: Dexamethasone (AI)
☐ Optional: Add remdesivir to any 1 of the above selections (CIIa)

Hospitalized and requires mechanical ventilation or ECMO:
☐ Upon initiation of MV or ECMO, if not already initiated: One of the following: Dexamethasone plus baricitinib (BIIa) or dexamethasone plus tocilizumab (BIIa)
☐ If neither baricitinib/tofacitinib nor tocilizumab/sarilumab can be procured: Dexamethasone (AI)

PO tofacitinib can be used instead of PO baricitinib (BIIa) and IV sarilumab can be used instead of IV tocilizumab (BIIa).
If dexamethasone is NOT available: Alternative corticosteroids such as prednisone, methylprednisolone, or hydrocortisone can be used (BIII).
Additional details on these options can be found at the NIH Inpt Treatment Page

Steroids: Dexamethasone (or other corticosteroids) should NOT be initiated in these patients in the absence of another indication. ((AIIb)

☐ **Anticoagulation:** Unless contraindicated, anticoagulation is recommended for admitted COVID-19 patients. The recommendations and evidence for therapeutic vs. prophylactic anticoagulation are rapidly evolving. The latest information can be found at the NIH Anticoagulation Page

Insufficient Evidence: At this time there is insufficient data to recommend either for or against the following medications for SARS-CoV-2 (COVID-19):

- Fluvoxamine
- Herbal medications - Vitamin C
- Vitamin D

DO NOT USE - The following are recommended AGAINST for the treatment of SARS-CoV-2 (COVID-19) at the time of publication of this tool.

- Anti-interluken-6 receptor monoclonal antibodies (except tocilizumab) or anti-IL-6 monoclonal antibody (siltuximab), except in a clinical trial (BIII).
- Azithromycin alone (AI)
- Budesonide
- Chloroquine or hydroxychloroquine with or without azithromycin (AI)
- Colchicine (InPt-AI) (OutPt-BIIa)
- Famotidine
- Interferons: None in hon-hospitalized patients (AIIa); in hospitalized: do not use beta (AI), alpha (AIIa), or lambda (AIIa)
- Ivermectin
- Lopinavir/ritonavir (AI) or other HIV protease inhibitors (AIII) except in a clinical trial
- Metformin
- Nitazoxanide (BIIa)
- Zinc supplementation above the recommended daily dietary allowance for the prevention of COVID-19, except in a clinical trial (BIII)

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Supplement - Risk Prognostication and Assessment

Providers may choose to additionally utilize a risk prognostication tool and/or assess patients risk factors for complicated illness.
The COVID PRECISE Consortium living systematic review of COVID prognostic scores identifies the highest quality prognostic models as:

- The PRIEST model to predict whether patients with COVID-19 will have an adverse outcome, such as death. This model can be used to triage patients with COVID-19 that go to the ED.
- The 4C Mortality Score for COVID-19, the Carr model[36] and the Xie model[37], to predict whether patients hospitalized with COVID-19 will have an adverse outcome, such as death, critical care or ventilatory support.
- These models could guide physicians to make the best possible decisions for individual patients regarding, for example, intensive care support.

Optional - Risk Prognostication

Patients with **MILD** and **MODERATE** Severity should be further assessed to determine their risk of disease progression.
The **PRIEST Score** is a validated tool to predict a patient's risk for end organ failure and/or mortality using readily available data on initial presentation to the ED.

The ACEP working group recognizes that there are other risk prognostication calculators that have been published. The PRIEST Score is included here as it offers a pragmatic approach with variables that don't require diagnostic testing and don't overlap with medical conditions that are within the separate risk assessment section.

Variable		1 Point	2 Points	3 Points	4 Points
Respiratory rate (per minute)	☐ 12-20	☐ 9-11	☐ 21-24	☐ <9 or >24	
Oxygen saturation (%) See Footnote	☐ >95	☐ 94-95	☐ 92-93	☐ <92	
Heart rate (per minute)	☐ 51-90	☐ 41-50 or 91-110	☐ 111-130	☐ <41 or >130	
Systolic BP (mmHg)	☐ 111-219	☐ 101-110	☐ 91-100	☐ <91 or >219	
Temperature (°C)	☐ 36.1-38.0	☐ 35.1-36.0 or 38.1-39.0	☐ >39.0	☐ <35.1	
Alertness	☐ Alert			☐ Confused	
Inspired oxygen	☐ Room Air		☐ Supplemental Oxygen		
Sex	☐ Female	☐ Male			
Age (years)	☐ 16-49		☐ 50-65	☐ 66-80	☐ >80
Performance status	☐ Unrestricted Normal Activity	☐ Limited strenuous activity, can do light activity	☐ Limited activity, can self-care	☐ Limited self-care	☐ Bed/chair bound, no self-care
Total number of boxes checked in each column	_____ x 0 =	_____ x 1 =	_____ x 2 =	_____ x 3 =	_____ x 4 =
Add Subtotals	0 +	+	+	+	+

= Total Score																	
Score	0-1	2-3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+	
Risk %	**1%**	**2%**	**3%**	**9%**	**15%**	**18%**	**22%**	**26%**	**29%**	**34%**	**38%**	**47%**	**48%**	**50%**	**55%**	**66%**	

Optional - Risk Assessment

The CDC maintains a list of **underlying medical conditions associated with higher risk of severe COVID-19**.
If your patient has one (or especially multiple) risk factors, you may want to consider in the approach taken in subsequent steps for diagnostic testing, disposition, and treatment.

The **CDC** notes that patient race/ethnicity, socioeconomic status, and healthcare resources may effect clinical outcomes and advise consideration in clinical risk assessment.

Higher Risk (conclusive)

- ☐ Asthma
- ☐ Cancer (hematologic malignancies)
- ☐ Cerebrovascular disease
- ☐ Chronic kidney disease (receiving dialysis)
- ☐ Chronic lung diseases
  - ☐ Bronchiectasis
  - ☐ COPD
  - ☐ Interstitial lung disease
  - ☐ Pulmonary embolism
  - ☐ Pulmonary hypertension
- ☐ Chronic liver disease
  - ☐ Cirrhosis
  - ☐ Non-alcoholic fatty liver disease
  - ☐ Alcoholic liver disease
  - ☐ Autoimmune hepatitis
- ☐ Cystic fibrosis
- ☐ Diabetes mellitus (type 1 and 2)
- ☐ Disabilities (including Down syndrome)
- ☐ Heart conditions
  - ☐ Heart failure
  - ☐ Coronary artery disease
  - ☐ Cardiomyopathies
- ☐ HIV
- ☐ Mental health conditions (mood/ schizophrenia)
- ☐ Neurologic conditions limited to dementia
- ☐ Obesity (BMI ≥30 kg/m^2)
- ☐ Physical inactivity
- ☐ Pregnancy and recent pregnancy
- ☐ Primary immunodeficiencies
- ☐ Smoking (current and former)
- ☐ Solid organ and blood stem cell transplantation
- ☐ Tuberculosis
- ☐ Use of corticosteroids or other immunosuppresive medications

Suggestive Higher Risk

- ☐ Children with certain underlying conditions
- ☐ Overweight (BMI ≥25 kg/m2 but <30 kg/m2)
- ☐ Sickle cell disease
- ☐ Substance use disorders

Mixed Evidence

- ☐ Alpha 1 antitrypsin deficiency
- ☐ Bronchopulmonary dysplasia
- ☐ Hepatitits B / C
- ☐ Hypertension
- ☐ Thalassemia

FOOTNOTES

Step 1- Severity Classification

- All severity classifications are outlined by the NIH. The NIH COVID-19 Treatment Guidelines Panel is a multi-disciplinary team of experts that meets routinely to discuss the impact of new evidence on best practices in addition to providing a standardized system for classifying clinical severity.[6]

Step 2 - Diagnostic Testing

- **Exertional SpO2**: post-exertional SpO2 may provide modest prognostic information of adverse outcome at 30 days[5, 13, 21]
  - Optimal time interval is not established.
  - Some have suggested 1-2 minutes and a sit-stand option in the patient's room (due to COVID restrictions)[5]
  - A 3% drop has been used in several studies[21, 13]
  - Another study used a quick walk test of 6 minutes. Decrease in ≥3% or ≥5% (conservative cutoff or postexercise ≤90% suggest poor outcome (need for mechanical ventilation) with LR+=3.5 and LR-=0.22[21]
- **Diagnostic Testing**: ACEP maintains a section on Laboratory Abnormalities in the COVID-19 Field Guide.

Step 3 - Disposition

Discharge of select COVID patients with Home Oxygen has been shown to be associated with low rates of mortality and return admission.[32,33,34]

The CDC maintains Patient Educational Materials.

SAEM Patient Toolkit has materials for patients to understand more about COVID.

Helpful links from JAMA include:

- What does this mean for families?
  - https://jamanetwork.com/journals/jamapediatrics/fullarticle/2763176
- Masks
  - https://jamanetwork.com/journals/jama/fullarticle/2764955
- Stopping the spread
  - https://jamanetwork.com/journals/jama/fullarticle/2763533
- What is herd immunity?
  - https://jamanetwork.com/journals/jama/fullarticle/2772168

Step 4 - Non-Pharmacologic Treatment

Home Supplemental O2

Discharge of select COVID patients with Home Oxygen has been shown to be associated with low rates of mortality and return admission[32]

Studies in COVID and other viral illnesses[20], have shown the benefit of:

- Rest[16]
- Healthy diet[17]
- Adequate sleep[18]
- Exercise[19]

Issues with SpO2 measurements

- If sending patients home with instructions for pulse oximetry, be mindful that SpO2 readings should always be considered an estimate of oxygen saturation. The FDA has just issued precautions on SpO2 devices.[26]
- Although pulse oximetry is useful for estimating blood oxygen levels, pulse oximeters may not accurately detect hypoxemia under certain circumstances. Pulse oximetry results can be affected by skin pigmentation, thickness, or temperature. In fact, an SpO2 reading of 90% may represent a range of SaO2 from 86% to 94%. Clinicians should keep this limitation in mind when making patient decisions.[25]

Vaccination

- Additional information on current vaccinations recommendations, can be found HERE and Vaccination FAQs
  - SMART Phrases from ACEP for patients can be found HERE

Treatment of Severe and Critical patients

- Recommendations for respiratory support, IV fluids, and other interventions are maintained by the NIH HERE.

Step 5 - Pharmacologic Treatment

Medications - recommendations are maintained by the NIH and IDSA.

Recommendations for the treatment of patients discharged home, but who have a HIGH risk for disease progression is evolving quickly due to the Omicron Variant of Concern (VOC).

- Guidance can be found on the NIH Outpatient Treatment Page
- Paxlovid EU A Fact Sheet: www.fda.gov/media/155050/download
- Molnupiravir EUA Fact Sheet: www.fda.gov/media/155054/download
- The SAEM Provider Toolkit offers tip and tricks on how to communicate with patients about COVID treatment options.
- Bevtelovimap no longer authorized by the FDA due to high prevalence of BQ1, BQ.1.1 and XBB variants: www.fda.gov/drugs/drug-safety-and-availability/fda-announces-bebtelovimab-not-currently-authorized-any-us-region

CAUTION with prescribing Paxlovid

- Ritonavir-boosted nirmatrelvir (Paxlovid) has significant and complex drug-drug interactions, primarily due to the ritonavir component of the combination. Before prescribing, clinicians should carefully review the patient's concomitant medications, including over-the-counter medications and herbal supplements, to evaluate potential drug-drug interactions.
  - Clinicians who are not experienced in prescribing ritonavir-boosted drugs should refer to resources such as the NIH Paxlovid Drug-Drug Interactions page, the Ontario COVID-19 Science Advisory Table, the EUA fact sheet for ritonavir-boosted nirmatrelvir (Paxlovid) or the Liverpool COVID-19 Drug Interactions website for additional guidance.
  - Consultation with an expert (e.g., clinical pharmacist, HIV specialist, and/or the patient's specialist provider[s], if applicable) should also be considered.
- Molnupiravir is not recommended for pregnant females unless there are no other options and therapy is clearly indicated (AIII). Feeding breastmilk should be avoided during molnupiravir use and for 4 days after the last dose of the drug (AIII).
- For patients with a eGFR of 30-60 ml/min, the FDA recommends nirmatrelvir 150 mg (one 150-mg tablet) with ritonavir 100 mg (one 100-mg tablet) twice daily for 5 days

Optional - Risk Prognostication

- The PRIEST Score: is a validated tool to predict a patient's risk for end organ failure and/or mortality.[14,35]
- The PRIEST Score can be accessed on MDCalc.
- See notes about pulse oximetry within Section 4 footnotes.
  - 4C Mortality Score for COVID-19 is available on MDCalc.
  - The Carr model(36) and the Xie model (37) have also been validated for risk stratification of COVID-19 patients.

Optional - Risk Assessment

The CDC maintains a reference for medical conditions associated with high risk for severe COVID-19.

- **Race/Ethnicity and access to healthcare**: the CDC has more information on how race, ethnicity, and access to health care resources may affect outcomes[7]
- **Economic Disparity**: has been shown to be an independent variable of risk[11]
- **Pregnancy**: has been shown to have increased hospitalization (OR 3.5).[2]
  - Severe cases have been shown to have pre-term labor 45.4% compared to 6.9% of mild and recovered cases.[9]

NIH

Rating of Recommendations

- A = Strong
- B = Moderate
- C = Weak

Rating of Evidence

- I = One or more randomized trials without major limitations
- IIa = Other randomized trials or subgroup analyses of randomized trials
- IIb = Nonrandomized trials or observational cohort studies
- III = expert opinion

CITATIONS

1 Haimovich AD et al. Development and Validation of the Quick COVID-19 Severity Index: A Prognostic Tool for Early Clinical Decompensation. Ann Emerg Med. 2020;76(4):442-453.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7373004/

2 *Citation Removed*

3 Ebinger JE et al. Pre-existing traits associated with Covid-19 illness severity. PLoS One. 2020;15(7):e0236240.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7377468/

4 Toussie D et al. Clinical and Chest Radiography Features Determine Patient Outcomes in Young and Middle-aged Adults with COVID-19. Radiology. 2020;297(1):E197-E206.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7507999/

5 Greenhalgh T et al. 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/

6 COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines. National Institutes of Health.
https://www.covid19treatmentguidelines.nih.gov/

7 COVID-19 Hospitalization and Death by Race/Ethnicity. Centers for Disease Control and Prevention.
https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html

8 Giannakoulis VG et al. Effect of Cancer on Clinical Outcomes of Patients With COVID-19: A Meta-Analysis of Patient Data. JCO Glob Oncol. 2020;6:799-808.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7328119/

9 Lokken EM et al. Disease Severity, Pregnancy Outcomes and Maternal Deaths among Pregnant Patients with SARS-CoV-2 Infection in Washington State [published online ahead of print, 2021 Jan 19]. Am J Obstet Gynecol. 2021;S0002-9378(21)00033-8.
https://www.ajog.org/article/S0002-9378(21)00033-8/fulltext

10 Strausz S et al. Sleep apnoea is a risk factor for severe COVID-19. BMJ Open Respir Res. 2021;8(1):e000845.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7804843/

11 Williamson EJ et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584(7821):430-436.
https://www.nature.com/articles/s41586-020-2521-4

12 Tartof SY et al. Obesity and Mortality Among Patients Diagnosed With COVID-19: Results From an Integrated Health Care Organization. Ann Intern Med. 2020;173(10):773-781.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7429998/

13 Goodacre S et al. Post-exertion oxygen saturation as a prognostic factor for adverse outcome in patients attending the emergency department with suspected COVID-19: a substudy of the PRIEST observational cohort study. Emergency medicine journal:emermed-2020-210528.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7716294/

14 Goodacre S, Thomas B, Sutton L, Burnsall M, Lee E, Bradburn M, et al. (2021) Derivation and validation of a clinical severity score for acutely ill adults with suspected COVID-19: The PRIEST observational cohort study. PLoS ONE 16(1): e0245840.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7822515/

15 Clift AK et al. COVID-19 Mortality Risk in Down Syndrome: Results From a Cohort Study Of 8 Million Adults. Annals of internal medicine, M20-4986. 21 Oct. 2020.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7592804/

16 Putative contributions of circadian clock and sleep in the context of SARS-CoV-2 infection. Meira E Cruz M, Miyazawa M, Gozal D.Meira E Cruz M, et al. Eur Respir J. 2020 Jun 4;55(6):2001023. doi: 10.1183/13993003.01023-2020. Print 2020 Jun.
http://www.ncbi.nlm.nih.gov/pmc/articles/pmc7191115

17 Pecora F, Persico F, Argentiero A, Neglia C, Esposito S. The Role of Micronutrients in Support of the Immune Response against Viral Infections. Nutrients. 2020 Oct 20;12(10):3198. doi: 10.3390/nu12103198.
https://pubmed.ncbi.nlm.nih.gov/33092041/

18 Arjona A, Sarkar DK. Evidence supporting a circadian control of natural killer cell function. Brain Behav Immun. 2006 Sep;20(5):469-76. doi: 10.1016/j.bbi.2005.10.002. Epub 2005 Nov 23.
https://pubmed.ncbi.nlm.nih.gov/16309885/

19 Campbell J.P., Turner J.E. Debunking the myth of exercise-induced immune suppression: Redefining the impact of exercise on immunological health across the lifespan. Front Immunol. 2018;9:648.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5911985/

20 Patchett D, Yang J, Northern J, Salinas M, Bauer BA. Viral Respiratory Infections: An Ounce of Prevention Is Worth a Pound of Cure. Mayo Clin Proc Innov Qual Outcomes. 2021 Feb 6.
https://pubmed.ncbi.nlm.nih.gov/16155285

21 Paglia S, Nattino G, Occhipinti F, et al. The Quick Walk Test: A Noninvasive Test to Assess the Risk of Mechanical Ventilation During COVID-19 Outbreaks. Acad Emerg Med. 2020 Dec 15.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7753836/#acem14180-sup-0001

22 Ghosh S, Deshwal H, Bin Saeedan M, et al. Imaging algorithm for COVID-19: A practical approach. Clin Imaging. 2021 Apr; 72: 22–30.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7655027/

23 Rubin GD, Ryerson CJ, Haramati LB, et al. The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society. Radiology (296) 1.
https://pubs.rsna.org/doi/full/10.1148/radiol.2020201365

24 Kameda T, Mizuma Y, Taniguchi H. Point-of-care lung ultrasound for the assessment of pneumonia: a narrative review in the COVID-19 era. Journal of Medical Ultrasonics volume 48, pages31–43(2021).
https://link.springer.com/article/10.1007/s10396-020-01074-y

25 Sjoding MW, Dickson RP, Iwashyna TJ, et al. Racial Bias in Pulse Oximetry Measurement. N Engl J Med 2020; 383:2477-2478
https://www.nejm.org/doi/full/10.1056/NEJMc2029240

26 Pulse Oximeter Accuracy and Limitations: FDA Safety Communication. Date Issued: February 19, 2021.
https://www.fda.gov/medical-devices/safety-communications/pulse-oximeter-accuracy-and-limitations-fda-safety-communication

27 Guan X, Zhang B, Fu M, et al. Clinical and inflammatory features based machine learning model for fatal risk prediction of hospitalized COVID-19 patients: results from a retrospective cohort study. Ann Med 2021 Dec;53(1):257-266.
https://pubmed.ncbi.nlm.nih.gov/33410720/

28 Tjendra Y, Al Mana AF, Esejo AP. Predicting Disease Severity and Outcome in COVID-19 Patients: A Review of Multiple Biomarkers. Arch Pathol Lab Med 2020 Dec 1;144(12):1465-1474.
https://pubmed.ncbi.nlm.nih.gov/32818235/

29 Hahm CR, Lee YK, Oh DH, et al. Factors associated with worsening oxygenation in patient with non-severe COVID-19 pneumonia. Tuberc Respir Dis (Seoul) 2021 Jan 5.
https://pubmed.ncbi.nlm.nih.gov/33401345/

30 Chow DS, Glavis-Bloom J, Soun JE, et al. Development and external validation of a prognostic tool for COVID-19 critical disease. PLoS One 2020 Dec 9;15(12):e0242953.
https://pubmed.ncbi.nlm.nih.gov/33296357/

31 Payan-Pernia S, Perez LG, Sevilla AFR, et al. Absolute Lymphocytes, Ferritin, C-Reactive Protein, and Lactate Dehydrogenase Predict Early Invasive Ventilation in Patients With COVID-19. Lab Med 2020 Dec 18.
https://pubmed.ncbi.nlm.nih.gov/33336243/

32 Banerjee J, Canamar CP, Voyageur C, et al. Mortality and Readmission Rates Among Patients With COVID-19 After Discharge From Acute Care Setting With Supplemental Oxygen. JAMA Network Open 2021 Apr 1;4(4).
https://pubmed.ncbi.nlm.nih.gov/33792728/

33. Steel PA, Siegal J, Zhang Y, et al. Telehealth follow up in emergency department patients discharged with COVID-like illness and exertional hypoxia. Am J Emerg Med. 2021 Mar 1
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7919584/

34. Suh EH, Bodnar DJ, Melville LD, et al. Crisis clinical pathway for COVID-19. Emerg Med J. 2020 Nov;37(11):700-704.
https://pubmed.ncbi.nlm.nih.gov/32912930/

35. Suh EH, Lang KJ, Zerihun LM. Modified PRIEST Score for Identification of Very Low-Risk COVID Patients. Am J Emerg Med. 2021 Sep; 47: 213–216.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8062911/

(continued on next page)

CITATIONS (continued)

36 Carr E, Bendayan R, Bean D, et al. Evaluation and improvement of the National Early Warning Score (NEWS2) for COVID-19: a multi-hospital study. BMC Med2021;19:23.
https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01893-3

37 Xie J, Hungerford D, Chen H, et al. Development and external validation of a prognostic multivariable model on admission for hospitalized patients with covid-19.
https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2764293

38 Alqahtani JS, Aldhahir AM, Al Ghamdi SS, et al. Inhaled Nitric Oxide for Clinical Management of COVID-19: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2022 Oct 6;19(19):12803.
https://pubmed.ncbi.nlm.nih.gov/36232100/

39 Manuilov VM, Suvorov AV, Kurkin SV, et al. Evaluation of the Efficiency of Oxygen-Helium Therapy for Patients with Covid-19-Associated Pneumonia. Hum Physiol. 2022;48(7):863-870.
https://pubmed.ncbi.nlm.nih.gov/36713087/

40 NUOVA F.I.O. (Italian Oxygen-Ozone Federation); Marini S, Maggiorotti M, Dardes N, et al. Oxygen-ozone therapy as adjuvant in the current emergency in SARS-COV-2 infection: a clinical study. J Biol Regul Homeost Agents. 2020 May-Jun;34(3):757-766.
https://pubmed.ncbi.nlm.nih.gov/32462858/

41 Ramanathan K, Shekar K, Ling RR, et al. Extracorporeal membrane oxygenation for COVID-19: a systematic review and meta-analysis. Crit Care. 2021 Jun 14;25(1):211.
https://pubmed.ncbi.nlm.nih.gov/34127027/

42 Frat JP, Quenot JP, Badie J, et al; SOHO-COVID Study Group and the REVA Network. Effect of High-Flow Nasal Cannula Oxygen vs Standard Oxygen Therapy on Mortality in Patients With Respiratory Failure Due to COVID-19: The SOHO-COVID Randomized Clinical Trial. JAMA. 2022 Sep 27;328(12):1212-1222.
https://pubmed.ncbi.nlm.nih.gov/36166027/

43 Ospina-Tascón GA, Calderón-Tapia LE, García AF, et al; HiFLo-Covid Investigators. Effect of High-Flow Oxygen Therapy vs Conventional Oxygen Therapy on Invasive Mechanical Ventilation and Clinical Recovery in Patients With Severe COVID-19: A Randomized Clinical Trial. JAMA. 2021 Dec 7;326(21):2161-2171.
https://pubmed.ncbi.nlm.nih.gov/34874419/

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