



INPATIENT GUIDANCE FOR TREATMENT OF COVID-19 IN ADULTS AND CHILDREN

Patient population:

Adult and pediatric patients with COVID-19 infection, who are admitted on an inpatient floor or to the intensive care unit.

Key points:

Details regarding isolation/precautions, personal protective equipment, patient movement, family/visitor policy, and cleaning/disinfection can be found [here](#).

Clinical symptoms:

Range from uncomplicated upper respiratory tract viral infection to pneumonia, acute respiratory distress syndrome (ARDS), sepsis, and septic shock ([Table 1](#))

Diagnosis:

See current [COVID-19 testing recommendations](#).

Recommended Labs:

Labs recommended on admission:

- COVID-19 testing and RPAN
- CBC with differential (lymphopenia often prominent)
- Comprehensive metabolic panel (assess for AKI and elevated AST/ALT)
- D-dimer (often elevated, consider evaluation for DVT if very high)
- Ferritin
- CRP
- Procalcitonin (can be elevated even without infection but helpful for baseline if you become concerned for bacterial super-infection later)
- Hs-troponin (often elevated but helpful as baseline if worsening cardiac symptoms later)
- Respiratory cultures do not need to be obtained unless there is HIGH suspicion for bacterial pneumonia

Daily labs:

- Only recommended as needed clinically, please be judicious as we attempt to conserve PPE
- CRP likely best to trend for prognosis if needed in addition to clinical improvement

Treatment:

The current body of literature and local experience does not support the routine use of any specific treatment regimen, including hydroxychloroquine, for patients with confirmed COVID-19 infection.

Michigan Medicine is committed to participation in randomized controlled clinical trials to facilitate the generation of robust evidence concerning the effectiveness of products in treating COVID-19 and to appropriately delineate risk-vs-benefit assessments for various treatment strategies. Infectious Diseases will review every case for trial eligibility and continue to make treatment decisions that are most optimal for each individual patient.

Supportive care:

Appropriate treatment of concomitant pneumonia, respiratory failure, ARDS, sepsis, septic shock.

Concomitant use of NSAIDs and/or ACE-I/ARBs:

There are conflicting theories regarding the risk and benefit of non-steroidal anti-inflammatory drugs (NSAIDs) or angiotensin converting enzyme inhibitors/ angiotensin II receptor blockers (ACE-I/ARBs) in patients with COVID-19 infection. Currently, there are no robust data demonstrating beneficial or adverse outcomes with use of these drugs in COVID-19 infections or specifically in COVID-19 infected patients taking these medications for cardiovascular disease. The American Heart Association, American College of Cardiology, and Heart Failure Society of America do not recommend stopping ACE-I or ARBs in COVID-19 infected patients. In addition, a clinical trial (NCT04312009) is investigating whether adjunctive ARB therapy can improve outcomes in COVID-19 patients. Pending this data, we do not endorse stopping or starting such therapies solely because of COVID-19 infection.

Limited evidence supporting routine use of corticosteroids:

Prior studies assessing outcomes in patients receiving systemic corticosteroids for infections due to closely related viruses (SARS-CoV and MERS-CoV) found a lack of effectiveness and possible harm. However, early published and unpublished observations from China suggest that corticosteroids may reduce mortality in COVID-19 infected patients with ARDS and evidence of progression. If steroids are contemplated, it is recommended to use moderate doses of methylprednisolone (1-2 mg/kg) for 3-5 days.

Further details regarding the clinical syndrome and management of COVID-19 infections can be found in the below reference: World Health Organization. Clinical management of severe acute respiratory infection when novel coronavirus (2019-nCoV) infection is suspected. Interim guidance. Jan 28th 2020. <https://www.who.int/docs/default-source/coronaviruse/clinical-management-of-novel-cov.pdf>

Table 1. Clinical syndromes associated with COVID-19 infection

Uncomplicated illness	Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, cough, sore throat, nasal congestion, malaise, headache, muscle pain or malaise. The elderly and immunosuppressed may present with atypical symptoms. These patients do not have any signs of dehydration, sepsis or shortness of breath.
Mild pneumonia	Patient with pneumonia and no signs of severe pneumonia. Child with non-severe pneumonia has cough or difficulty breathing + fast breathing: fast breathing (in breaths/min): <2 months, ≥60; 2–11 months, ≥50; 1–5 years, ≥40 and no signs of severe pneumonia.
Severe pneumonia	Adolescent or adult: fever or suspected respiratory infection, plus one of respiratory rate >30 breaths/min, severe respiratory distress, or SpO ₂ <90% on room air (adapted from [1]). Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or SpO ₂ <90%; severe respiratory distress (e.g. grunting, very severe chest indrawing); signs of pneumonia with a general danger sign: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions. Other signs of pneumonia may be present: chest indrawing, fast breathing (in breaths/min): <2 months, ≥60; 2–11 months, ≥50; 1–5 years, ≥40. ² The diagnosis is clinical; chest imaging can exclude complications.
Acute Respiratory Distress Syndrome⁷⁻⁹	Onset: new or worsening respiratory symptoms within one week of known clinical insult. Chest imaging (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by effusions, lobar or lung collapse, or nodules. Origin of oedema: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of oedema if no risk factor present. Oxygenation (adults): <ul style="list-style-type: none"> Mild ARDS: 200 mmHg < PaO₂/FiO₂ ≤ 300 mmHg (with PEEP or CPAP ≥5 cmH₂O,⁷ or non-ventilated⁸) Moderate ARDS: 100 mmHg < PaO₂/FiO₂ ≤ 200 mmHg with PEEP ≥5 cmH₂O,⁷ or non-ventilated⁸) Severe ARDS: PaO₂/FiO₂ ≤ 100 mmHg with PEEP ≥5 cmH₂O,⁷ or non-ventilated⁸) When PaO₂ is not available, SpO₂/FiO₂ ≤ 315 suggests ARDS (including in non-ventilated patients) Oxygenation (children; note OI = Oxygenation Index and OSI = Oxygenation Index using SpO₂): <ul style="list-style-type: none"> Bilevel NIV or CPAP ≥5 cmH₂O via full face mask: PaO₂/FiO₂ ≤ 300 mmHg or SpO₂/FiO₂ ≤ 264 Mild ARDS (invasively ventilated): 4 ≤ OI < 8 or 5 ≤ OSI < 7.5 Moderate ARDS (invasively ventilated): 8 ≤ OI < 16 or 7.5 ≤ OSI < 12.3 Severe ARDS (invasively ventilated): OI ≥ 16 or OSI ≥ 12.3
Sepsis^{10,11}	Adults: life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection, with organ dysfunction*. Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output, fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate or hyperbilirubinemia. Children: suspected or proven infection and ≥2 SIRS criteria, of which one must be abnormal temperature or white blood cell count.
Septic shock^{10,12}	Adults: persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP ≥65 mmHg and serum lactate level >2 mmol/L. Children (based on [12]): any hypotension (SBP <5 th centile or >2 SD below normal for age) or 2-3 of the following: altered mental state; tachycardia or bradycardia (HR <90 bpm or >160 bpm in infants and HR <70 bpm or >150 bpm in children); prolonged capillary refill (>2 sec) or warm vasodilation with bounding pulses; tachypnea; mottled skin or petechial or purpuric rash; increased lactate; oliguria; hyperthermia or hypothermia.

Abbreviations: ARI, acute respiratory infection; BP, blood pressure; bpm, beats/minute; CPAP, continuous positive airway pressure; FiO₂, fraction of inspired oxygen; MAP, mean arterial pressure; NIV, noninvasive ventilation; OI, Oxygenation Index; OSI, Oxygenation Index using SpO₂; PaO₂, partial pressure of oxygen; PEEP, positive end-expiratory pressure; SBP, systolic blood pressure; SD, standard deviation; SIRS, systemic inflammatory response syndrome; SpO₂, oxygen saturation. *If altitude is higher than 1000m, then correction factor should be calculated as follows: PaO₂/FiO₂ x Barometric pressure/760.

⁷ The SOFA score ranges from 0 to 24 and includes points related to 6 organ systems: respiratory (hypoxemia defined by low PaO₂/FiO₂), coagulation (low platelets), liver (high bilirubin), cardiovascular (hypotension), central nervous system (low level of consciousness defined by Glasgow Coma Scale), and renal (low urine output or high creatinine). Sepsis is defined by an increase in the Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score¹³ of ≥2 points. Assume the baseline score is zero if data are not available

Source: World Health Organization

Table 2: Agents under investigation for treatment of COVID-19

NOTE: Routine treatment with investigational therapies is not endorsed outside clinical trials. Infectious Diseases will review every case for potential benefit and screen COVID-19 infected patients for eligibility in trials (see "Treatment" on Page 1). The below provides information regarding investigational therapies that may be recommended by ID.

Antiviral therapy	Dosing & Duration	Comments
<p>Hydroxychloroquine</p> <p><i>The current body of literature and local experience does not support the routine use of hydroxychloroquine for patients with confirmed COVID-19 infection.</i></p> <p>Please see Appendix A for review of existing data.</p>	<p><u>Per Future Research Protocol</u></p>	<p><u>Adverse events:</u></p> <p>Retinopathy rash, nausea, glucose fluctuations, and diarrhea. GI symptoms can be mitigated by taking hydroxychloroquine with food.</p> <ul style="list-style-type: none"> • Use with caution in diabetic patients; hypoglycemia may occur. Insulin requirements may decrease. • Use with caution in patient at risk for QT prolongation. • Recommend obtaining G6PD test. Post-marketing studies suggest the risk of hemolysis is very low. It is reasonable to start hydroxychloroquine in most patients while awaiting G6PD testing. • Recommend avoid taking hydroxychloroquine with antacids. Separate administration by at least 4 hours. • Hydroxychloroquine can be crushed. <p><u>Contraindications:</u></p> <ul style="list-style-type: none"> • Porphyria <p><u>Pregnant and Nursing Mothers:</u></p> <ul style="list-style-type: none"> • Maternal-Fetal Medicine at Michigan Medicine has endorsed the use of hydroxychloroquine in pregnancy. • Hydroxychloroquine is excreted into breast milk in minute amounts. Thorough evaluation of the risk:benefit should be discussed with the patient prior to starting therapy. The American Academy of Pediatrics considers hydroxychloroquine compatible with breastfeeding.

Antiviral therapy	Dosing & Duration	Comments
Remdesivir	<p><u>Adult dosing:</u> 200 mg IV load, then 100 mg IV q24h</p> <p><u>Pediatric dosing*:</u> <40 kg: 5 mg/kg IV load, then 2.5 mg/kg q24h ≥40 kg: 200 mg IV load, then 100 mg IV q24h</p> <p><u>Duration:</u> Per protocol</p>	<p>UM is enrolling patients in 2 clinical trials with remdesivir. These trials currently exclude children (<12 years and/or <40 kg) and pregnant patients.</p> <p>Remdesivir may be available for excluded <i>children and pregnant women</i> with moderate-severe COVID-19 infection through Gilead with approved investigational new drug (IND) application.</p> <p>To start the request for remdesivir through Gilead's expanded access program, please send an email to the UMHS Expanded Access Group at (UM-Expanded-Access-Request@med.umich.edu). Email this group regardless of hour, but the expanded access program typically responds M-F during daytime hours. For urgent weekend and evening/over-night requests, please contact the research pharmacy on-call pager at 2944. After contacting the expanded access program, a request can be initiated via this portal: https://rdvcu.gilead.com/</p> <p><u>Adverse events:</u> Increased liver enzymes.</p> <p>*pediatric dosing of remdesivir is taken from the WHO recommendations for treatment of Ebola virus, as no specific dosing recommendations exist for COVID-19.</p>

Antiviral therapy	Dosing & Duration	Comments
<p>Tocilizumab <i>ID APPROVAL NEEDED</i></p> <p>Consider for patient meeting all criteria (#1-#5) below and is not eligible for the sarilumab trial or cannot receive sarilumab in a timely fashion.</p> <ol style="list-style-type: none"> COVID-19 positive All of the following respiratory findings: <ol style="list-style-type: none"> Abnormal chest imaging consistent with COVID-19 Rapidly worsening gas exchange requiring ≥ 6 L/min O_2 Absence of systemic bacterial or fungal co-infection High clinical suspicion for cytokine release syndrome supported by elevated inflammatory markers (e.g. ferritin >600 ug/mL; D-dimer >1.0 mg/L) and clinical decline. Does not have a poor prognosis where they are unlikely to survive >48 hours 	<p>** Dose rounding currently built into Epic order. Doses should be rounded to nearest available full vial (80 mg, 200 mg, 400 mg vials)**</p> <p><u>Adult Dosing (≥ 18 years):</u> 8 mg/kg (max: 800 mg/dose)</p> <p><u>Pediatric Dosing (<18 years):</u> <30 kg: 12 mg/kg ≥ 30 kg: 8 mg/kg (max: 800 mg/dose)</p> <p><u>Duration:</u> One dose</p> <p>There is no data to inform risk vs benefit of a second dose 48-72 hours later. Based on local experience a second dose is rarely needed and administration of a second dose should not be routine practice. *Patients receiving tocilizumab often do not show an immediate response. Improvement generally BEGINS 48-72 hours after administration with cessation of fevers and stabilization or improvement in oxygenation. In the absence of fevers, worsening oxygenation alone is not an indication for redosing tocilizumab. It is also important to exclude concomitant bacterial infection when patients do not improve or worsen.</p>	<p>Adjunct therapy with interleukin-6 inhibitors, like tocilizumab, may improve oxygenation and time to symptom resolution in patients with cytokine storm.</p> <p>Laboratory Parameters also supportive of cytokine storm:</p> <ul style="list-style-type: none"> Ferritin >300 ug/L (or surrogate) with doubling within 24 hours Ferritin >600 ug/L at presentation and LDH >250 U/L Elevated D-dimer (>1 mg/L) <p><u>Pregnancy and Nursing Mothers:</u></p> <ul style="list-style-type: none"> Maternal-Fetal Medicine at Michigan Medicine has endorsed the use of tocilizumab in pregnancy Tocilizumab may be harmful to newborns, and mothers should stop breastfeeding if receiving tocilizumab but may resume after discontinuation and discussion with provider <p><u>Serious adverse events:</u></p> <ul style="list-style-type: none"> Gastrointestinal perforation Anemia Hepatitis Infusion reaction Neutropenia

Do not use (therapies without any supportive evidence and/or associated with potential harm): lopinavir/ritonavir, nitazoxanide, oseltamivir, baloxavir, interferon, ribavirin, IVIG

Recommend against the use of azithromycin for COVID-19 treatment:

Preliminary data evaluating the combination of hydroxychloroquine and azithromycin for treatment of COVID-19 were recently published (Gautret et al.). The authors of this study conclude that combination therapy (only in 6 patients) led to greater viral load reduction compared to monotherapy with hydroxychloroquine. However, more patients receiving hydroxychloroquine monotherapy had higher baseline viral burden (estimated by cycle threshold values). When limiting the analysis to those with comparable baseline cycle threshold values, combination therapy with hydroxychloroquine and azithromycin led to a similar proportion of negative testing by day 6 compared to hydroxychloroquine monotherapy. Furthermore, the study does not report the clinical outcomes of these patients, and it is unknown if reductions in viral load correlate with improvements in clinical outcomes. A subsequent study, which has not been peer-reviewed, suffers from only including patients with very mild illness and a lack of a control group. Thus, based on this limited and weak evidence and concern for harm, we recommend against the use of azithromycin for the treatment of COVID-19 at this time. Azithromycin can still be used if patients require antibiotic therapy for legionella or as part of an empiric regimen for community acquired pneumonia.

Antibiotic Management for Pneumonia in PUI and Confirmed COVID-19 Patients

Recommendations:

1. In patients admitted with suspected COVID-19 pneumonia (testing pending), decisions whether to initiate antibiotic therapy should be based on guidance provided in the institutional pneumonia treatment and procalcitonin usage guidelines.
2. Continuation/initiation of antibiotic therapy *solely* due to confirmation of COVID-19 pneumonia is not indicated as described below.
3. In patients with confirmed COVID-19 pneumonia, secondary bacterial infection is uncommon, even in critically ill patients, and elevated procalcitonin levels are not reliably associated with bacterial infection, especially in the setting of concomitant renal dysfunction. Empiric antibiotic therapy should generally be discontinued once a patient is confirmed COVID-19 positive, but may be indicated in patients with leukocytosis and/or hemodynamic instability. De-escalation/discontinuation of antibiotics should be considered based on clinical and microbiological data. Note that an extended duration of fevers is typical in COVID-19 patients.
4. In patients who test negative for COVID-19 pneumonia, antibiotic therapy should be based on guidance provided in the institutional pneumonia treatment and procalcitonin usage guidelines.

Reports thus far have not identified unusual associations between COVID-19 infection and bacterial co-infection. Additionally, no unique association with resistant pathogens, including MRSA or *Pseudomonas*, has been made.

In a study of 24 critically-ill patients in Seattle-area hospitals:

- 75% required mechanical ventilation and 71% needed vasopressors. Pulmonary secretions were generally characterized as moderate or thick and purulent, and all chest radiographs showed bilateral pulmonary opacities
- Coexisting bacterial infection was not identified in any patient (blood and sputum cultures drawn in 20 and 15 patients, respectively)

In the study of adult patients by Zhou et al.:

- 15% of hospitalized COVID-19 patients developed a secondary bacterial infection (definition: clinical symptoms or signs of pneumonia or bacteremia with a positive culture).
- The median time to secondary bacterial infection was 17 days (13 to 19 days).
- Of all COVID-19 patients in their cohort, 79% had a WBC <10.
- Only 1% of survivors developed a secondary bacterial infection, yet the median duration of fever in survivors was 12 days and cough persisted for 19 days. Thus, 'just in case' treatment of bacterial infection can result in prolonged durations of therapy.

Data in pediatric patients are limited, but one small study (Xia et al.) suggests that procalcitonin may be higher in children with COVID-19, regardless of suspected bacterial superinfection. Decisions about antibiotic management for children should continue to be guided by clinical judgment.

Adult pneumonia treatment guidelines are summarized here, and adult and pediatric pneumonia treatment guidelines are available in their entirety at:

- [Pneumonia Treatment \(Adult\)](#)
- [Community-Acquired Pneumonia Treatment \(Pediatrics\)](#)
- [Procalcitonin Use Guidelines](#)

Procalcitonin

- Although PCT levels should not be used in isolation to decide whether to initiate antibiotics in patients with suspected bacterial pneumonia, **bacterial co-infection is unlikely in a confirmed COVID-19 patient with a low procalcitonin (<0.25), and antibiotics can be safely withheld. In addition, PCT levels >0.25 are not uncommon in patients with COVID-19 pneumonia, and do not appear to be a reliable marker of bacterial superinfection. Importantly, patients with CKD and AKI have falsely elevated PCT levels, and as such PCT is not reliable in such settings.** Procalcitonin should also NOT be routinely used to *extend* treatment duration.

Adult Pneumonia Treatment Summary Recommendations

Indication	1 st Line Empiric Therapy (see guidelines for alternatives)	Duration of Therapy
Pathway A – Inpatient community-acquired with no risk factors	Ampicillin-sulbactam 3 g IV q6h + Azithromycin 500 mg IV/PO x1 day, then 250 mg q24h x4 days	<u>Uncomplicated pneumonia:</u> 5 days for patients who defervesce within 72 hours and have no more than 1 sign of CAP instability at the time of antibiotic discontinuation
Pathway B – Inpatient pneumonia with risk factors as defined below	Piperacillin-azobactam 4.5 g IV q6h (+ Tobramycin IV if admitted to ICU) + Vancomycin* IV (see Standard Dosing Guideline) *Discontinue vancomycin if no evidence of MRSA colonization/infection (negative MRSA nasal swab or respiratory culture).	<u>Uncomplicated pneumonia:</u> 7 days

PATHWAY B RISK FACTORS

Healthcare Exposure:

- HAP (hospitalization ≥72h); VAP; Prior hospitalization ≥48h within previous 90 days; Current resident from LTCF, nursing home, ECF, SNF with at least partial functional dependence in ADLs (transfer, feeding, bathing, dressing, toileting, and continence)

Disease Severity:

- Septic shock requiring ICU admission

Antibiotic Exposure:

- Fluoroquinolone, linezolid or any intravenous antibiotic use within previous 90 days

Immunosuppression:

- AIDS, neutropenia (ANC <1000), or active malignancy undergoing intravenous chemotherapy; Kidney or liver transplant recipient within 1 year; Lung transplant recipient; Autologous stem cell transplant within 6 months; Allogeneic stem cell transplant within 1 year of transplant date or those with chronic GVHD

Other:

- Tube feeding; History of infection or colonization with *Pseudomonas* spp., MRSA, or other MDR pathogens within previous 12 months; Cystic fibrosis, chronic obstructive pulmonary disease (FEV1 <35% predicted, multiple antibiotic prescriptions in last year, multiple hospital admissions in last year), or chronic bronchiectasis

References:

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7. Committee on Drugs, American Academy of Pediatrics. The transfer of drugs and other chemicals into human milk. [Pediatrics 2001;108:776–89](#).
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Revision History: 3/16: Removed testing recommendations - added link to testing document 3/17: Added tocilizumab, adjusted pediatric hydroxychloroquine dosing 3/19: Revised tocilizumab criteria, added pneumonia guidance 3/20: Revised tocilizumab dosing to weight based due to changes in Epic dose rounding capabilities, added limited data for corticosteroids in ARDS 3/24: Added guidance on azithromycin, revised tocilizumab dosing, added clinical study enrollment appendix 3/25: Revised criteria for HCQ use. 3/26: Revised tocilizumab criteria & included sarilumab study caveat 3/27: Removed study flow diagram 3/31: Removed recommendation for routine HCQ, removed nitazoxanide and lopinavir/ritonavir options, revised ACE/ARB/NSAID recommendations, recommendations re: combination HCQ/Azithromycin, revised pregnancy/breastfeeding recommendations and Remdesivir compassionate use criteria, deleted Tocilizumab re-dosing 4/2: Added suggested labs, revised remdesivir clinical trial information 4/3: Added hyperlink to Appendix A - review of HCQ data 4/6: Revised testing guidance hyperlink 4/7: Revised tocilizumab criteria	

The recommendations in this guide are meant to serve as treatment guidelines for use at Michigan Medicine facilities. If you are an individual experiencing a medical emergency, call 911 immediately. These guidelines should not replace a provider's professional medical advice based on clinical judgment, or be used in lieu of an Infectious Diseases consultation when necessary. As a result of ongoing research, practice guidelines may from time to time change. The authors of these guidelines have made all attempts to ensure the accuracy based on current information, however, due to ongoing research, users of these guidelines are strongly encouraged to confirm the information contained within them through an independent source.

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