LITERATURE REVIEW SARS-CoV 2 Treatment

By: Keerthi Thallapureddy, Roma Ahuja, Derrick Draeger, Aditi Sharma, Jeffrey Xia, Sabi Shrestha, Theodora Winter, Elise Lasker, Cory Nunn, Anjali Prasad, Brian Seegmiller, Michelle Sutanto, and Saraaga Tamirisa; Peer reviewed by: Dr. Kristi Traugott and Dr. Elizabeth Hand

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SUPPORTIVE CARE

IMMUNOSUPRESSANTS

- Long duration and excessive doses of steroids may adversely affect recovery due to the inhibition of antiviral immunity and may also result in other side effects related to steroids.
- Discontinuation of immunosuppressants and steroid treatment might help faster recovery from COVID-19 pneumonia.
- The risks and benefits of continuing or discontinuing immunosuppressants should be weighed for each individual case.
  - A lower than standard dose of immunosuppressants could be tried in patients requiring immunosuppressants to facilitate and shorten duration of disease with COVID-19.
- However, steroids are still considered standard of care in the management of patients who progress to ARDS

VENTILATION

- Though mostly anecdotal, there is some evidence on the ventilator settings and differing characteristic of COVID-19 associated ARDS. Ventilator setting recommendations include:
  - Low TV, less than or equal to 4-8 mL/kg ideal body weight
  - Plateau pressures <30 cm H2O
  - PEEP >10 cm H2O
  - Oxygen administration at an SpO2 < 90% - 96%
  - Starting RR of 16 breaths/min.
  - Early prone positioning
    - If prone positioning fails, use recruitment maneuvers and high PEEP strategies, pulmonary vasodilators, neuromuscular blocking agents, and/or ECMO.
- The most experienced team member should perform intubation with as few assistants as possible to reduce exposure. Bag-mask ventilation generates aerosols and should be minimized by performing prolonged pre-oxygenation. Rapid sequence induction with muscle relaxants will reduce coughing.
- In patients who develop hypercapnia, increase VT to ~7.7.
- For timing of intubation:
  - If a patient is on nasal high-flow oxygen therapy, the ROX index [SpO2/(FiO2 x RR)] can be used. If after 12 hours, patients have a ROX index of <3.85, initiate intubation.
  - For NCP patients, if PaO2/FiO2 is <150 mmHg (1mmHg = 0.133 kPa), initiate intubation if receiving more than 2 hours of nasal high-flow therapy or non-invasive ventilation.
- Two recent studies found that self-proning improved oxygenation parameters in adults with COVID-19 with noninvasive ventilation
  - Some patients may be unable to tolerate this or sustain higher oxygenation parameters upon returning to the supine position.
- Among the noninvasive modalities recent data suggests HFNC is superior to NIV. The preference for HFNC is based upon limited and inconsistent data, which, on balance, favors HFNC compared with NIV in patients with non-COVID-19-related acute hypoxemic respiratory failure.

ANTICOAGULATION

- D-dimer and FDP levels may progressively increase with COVID-19 exacerbation, resulting in acro-ischemia
- Prophylactic anticoagulation with LMWH (preferred) or UFH (CrCl <15ml/min or RRT) is recommended for all inpatient adults with COVID-19
- Therapeutic anticoagulation with rivaroxaban and other DOACs did not improve clinical outcomes and increased bleeding risk [ACTION trial]
- Fondaparinux may be used for HIT
- Antiplatelet agent Dipyridamole has been found to suppress SARS-CoV-2 replication in vitro. A proof of concept trial involving 31 patients with COVID-19 found that dipyridamole supplementation was associated with decreased D-Dimer concentration, improved platelet and lymphocyte counts, and improved clinical outcomes compared to control patients.

ECMO

- ECMO should be considered if mortality rate approaches 50%, initiate if 80%.
- ECMO should be considered if one following criteria are met:
  1. PaO2/FiO2<100mmHg
  2. P(A-a) O2>600mmHg
  3. pH<7.2 and plateau pressure >30 cmH2O with respiratory rate > 35 breaths per minute
  4. <65 years old
  5. NO contraindications
  6. Severe air leak syndrome
  7. Complicated by cardiogenic shock or cardiac arrest
- Contraindications include: obesity, multi-organ failure, contraindication to anticoagulation, high mechanical vent for more than 7 days

OUTPATIENT MANAGEMENT OF COVID-19

FIRST STEPS

- Advise for methods to reduce COVID-19 transmission
- Advise patients on when to seek health care provider and treatment
- Triage patients with COVID-19 symptoms via tele-health visits prior to receiving in-person care
- Purchasing a pulse oximeter is not recommended, but if the patient already owns an oximeter, advise on proper usage and consider the oximetry data with overall clinical picture

Therapy for Mild-Moderate COVID-19

Timing: Administer within 7 days of symptom onset

- **Casirivmmab-Imdevimab (600-600 mg) (REGEN-COV)**
- **Sotrovimab (500 mg)***

Supportive care: hydration, acetaminophen (fever, myalgia), OTC cough meds (cough disturbing sleep), ambulation/activity as tolerated

*Sotrovimab approved per EUA but not fully recommended due to clinical trial results currently unavailable
Note: *Bamlanivimab-Etesevimab (700-1400 mg) distribution suspended on 06/25/21 due to likely resistance in variants*

EVALUATION OF DYSPNEA

- Home observation*: no dyspnea, no dyspnea + risk factors for severe disease; mild dyspnea without risk factors for severe disease
- Clinic evaluation*: mild dyspnea + O2 sat 91-94%; mild dyspnea + risk factors for severe disease; moderate dyspnea in any patient
- ED evaluation: severe dyspnea, O2 sat ≤90%, concerning altered mental status, other signs of hypoxia

*Telehealth follow-up mostly scheduled on days 4, 7, 10. If high concern for exacerbation, follow-up within 24 hours.

THERAPIES NOT APPROVED FOR OUTPATIENT MANAGEMENT OF COVID-19

- Bamlanivimab 700 mg + Etesevimab 1,400 mg [resistance]
- High-titer convalescent plasma [remains investigational for outpatient use]
- Chloroquine/Hydroxychloroquine +/- Azithromycin
- Systemic glucocorticoids in the absence of other indications [no efficacy]
- Antimicrobial therapy (e.g. azithromycin, doxycycline, ivermectin) in the absence of other indications [lack of evidence]
- Fluvoxamine [lack of evidence]
- Anticoagulants and antiplatelet therapy should not be initiated for prophylaxis in outpatient setting unless patient has other indications for therapy

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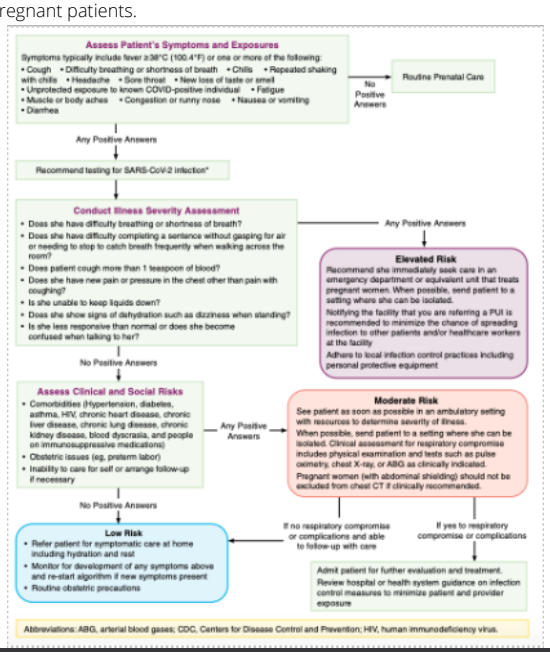
COVID-19 MANAGEMENT IN SPECIAL POPULATIONS

PREGNANCY

- The American College of Obstetricians and Gynecologists (ACOG) has developed an algorithm in the outpatient management of COVID-19 in pregnant women
- ACOG recommends that pregnant individuals have access to COVID-19 vaccines.
- COVID-19 vaccines should be offered to lactating individuals similar to non-lactating individuals.
- A study that used data from three vaccine safety reporting systems in the United States reported that the frequency of adverse events among 35,691 vaccine recipients who identified as pregnant was similar to the frequency observed among non-pregnant patients.
- Local injection site pain, nausea, and vomiting were reported slightly more frequently in pregnant people than in non-pregnant people.
- Other systemic reactions were reported more frequently among non-pregnant vaccine recipients, but the overall reactogenicity profile was similar for pregnant and non-pregnant patients.



CHILDREN

- Most children with mild or moderate COVID-19, even with risk factors, will recover without specific therapy
- Bamlanivimab plus etesevimab or casirivimab plus imdevimab may be considered on a case-by-case basis for nonhospitalized children who meet the EUA criteria, especially those who meet more than one criterion or are aged ≥16 years
- Remdesivir is recommended for
  - Hospitalized children aged ≥12 years with COVID-19 who have risk factors for severe disease and have an emergent or increasing need for supplemental oxygen
  - Hospitalized children aged ≥16 years with COVID-19 who have an emergent or increasing need for supplemental oxygen regardless of whether they have risks factors for severe disease
- Dexamethasone for hospitalized children with COVID-19 is recommended for those who require high-flow oxygen, noninvasive ventilation, invasive mechanical ventilation, or extracorporeal membrane oxygenation
- Convalescent plasma is recommended against for hospitalized children with COVID-19 who do not require mechanical ventilation, except in clinical trial
- Sarilumab is recommended against for hospitalized children with COVID-19 or MIS-C, except in clinical trial
- IVIG and/or corticosteroids are the first-line therapies for children with MIS-C
  - Interleukin-1 antagonist has been used for refractory cases
- After an explicit, evidence-based review of all available data, the Advisory Committee on Immunization Practices (ACIP) has issued interim recommendations for use of the:
  - Pfizer-BioNTech COVID-19 vaccine in persons aged ≥12 years for the prevention of COVID-19
  - Moderna-1273 COVID-19 vaccine in persons aged ≥ 18 years
  - Janssen (Johnson & Johnson) COVID-19 vaccine in persons aged ≥ 18 years.
- There is insufficient evidence for the Panel to recommend either for or against the use of tocilizumab in hospitalized children with COVID-19 or MIS-C.

MEDICAL AGENTS

DIRECT ACTING ANTIVIRALS

REMDESIVIR (Veklury)

- Remdesivir is the only FDA approved COVID treatment as of 10/26/2020
- Remdesivir shows promise for improved clinical outcomes in one compassionate-use cohort study. Study limitations: lack of control group, lack of uniformity of supportive care, small sample size (n=53).
- In a preliminary report of a multinational trial of >1000 patients of patients with COVID-19 and pulmonary involvement, remdesivir resulted in faster recovery time.
- Preliminary results from randomized control trial (ACTT-1, n = 1063) show 31% faster median recovery (11 vs 15 days) and improved mortality (8% vs 11.6%). Use is recommended in hospitalized patients requiring supplemental oxygen. Benefit is most evident in patients who were hypoxic but not yet intubated.
- The current dose regimen for remdesivir is an IV loading dose of 200mg on the first day of treatment, followed by IV maintenance doses of 100mg for 4 days. However, one study found that this would not achieve adequate plasma concentrations. It is suggested that a combination of IV and pulmonary delivery regimen may be more effective.
- A study comparing the efficacy of 5 days of remdesivir treatment vs. 10 days demonstrated no benefit in a longer treatment duration. Therefore, the current recommended dosing regimen is 5 days.
- Adverse events occur more commonly in ventilated patients. Most common adverse events: increased hepatic enzymes, diarrhea, rash, renal impairment, hypotension.
- On March 5, 2021, the COVID-19 Treatment Panel updated its recommendations on the use of remdesivir and dexamethasone in hospitalized patients requiring conventional oxygen therapy.
- They recommend using one of the following options: remdesivir, dexamethasone + remdesivir, or dexamethasone alone

IVERMECTIN

- According to the COVID-19 Treatment Panel, There is insufficient evidence and more clinical trials are needed to understand the role of ivermectin in the treatment of COVID-19
- ·Ivermectin has been shown to inhibit replication of the SARS-CoV-2 virus

NONSPECIFIC ANTI-INFLAMMATORIES

DEXAMETHASONE

- ·The RECOVERY trial (n=2104) has shown that dexamethasone reduces mortality in ventilated patients by one-third and in patients solely on oxygen by one-fifth.
  - 6 mg PO or IV QD dexamethasone was given to all patients (n=2104) for 10 days and compared to a randomized control group (n=4321) receiving usual care. The compared treatment arms were Lopinavir-Ritonavir, Hydroxychloroquine (discontinued), Azithromycin, Tocilizumab, and Convalescent plasma.
- Dexamethasone has not shown reduction in mortality of patients not using respiratory support
- Preliminary results of the RECOVERY trial have been released, but the study has not been published as of 6/18/20.
- ·The primary short-term adverse effect of corticosteroids are hypoglycemia
- ·Adverse events associated with prolonged use include glaucoma, cataracts, fluid retention, hypertension, psychological effects, weight gain, or increased risk of infections and osteoporosis
- ·Dexamethasone has shown to be a moderate inducer of CYP3A4 and thus its use must be monitored for drug interactions
- According to the NIH recommendations released on April 21, 2021, dexamethasone is not recommended for outpatient management of COVID-19
- Low-dose dexamethasone for ICU patients with COVID-19 who require oxygen supplementation or mechanical ventilation is recommended based on accumulating evidence that glucocorticoids reduce mortality in such patients. The dose of dexamethasone is 6 mg daily for 10 days or until discharge, if sooner.

METHYLPREDNISONE

- ·A Brazilian study evaluated the use of short-term methylprednisone as adjunct therapy for hospitalized patients, over the course of 28-days. (Prado Jeronimo, C.M. et al, 2020)
- ·Methyprednisone was given to one group (n=194), dosed for 5 days with twice-daily 0.5 mg/kg IV, and then compared to a randomized control group (n=199). Mortality was not different at day 28 between the two groups; however, mortality among patients over the age of 60 was decreased in the MP group.
- ·As a caution, insulin should be monitored in patients receiving MP.

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MEDICAL AGENTS CONTINUED

COLCHICINE

- ·A press release from the Montreal Heart Institute announced on Jan. 22, 2021 the preliminary results of a clinical trial using Colchicine to treat COVID-19. The results showed that Colchicine reduced the risk of death or hospitalizations by 21% compared to placebo. The colchicine was effective at preventing the cytokine storm.
  - The trial (n=4488) included people who had tested positive via naso-pharyngeal PCR, and randomly assigned them to colchicine or placebo cohorts. The colchicine was shown to reduce hospitalizations by 25%, the need for ventilation by 50%, and deaths by 44%.
  - This would be a good candidate for an oral treatment for non-hospitalized patients.
  - As of July 8th, 2021 the Panel officially recommends against the use of colchicine for the treatment of hospitalized patients with COVID-19.

FLUVOXAMINE

- An SSRI approved by FDA for treatment of Obsessive-Compulsive Disorder (OCD) and used for depression therapy
- Research has shown the anti-inflammatory effect of fluvoxamine in its ability to bind to the sigma-1 receptor in immune cells, resulting in decreased inflammatory cytokine production
- There is insufficient evidence to recommend either for or against use of fluvoxamine in COVID-19 treatment

BUDESONE

- Based on available clinical trial data, the Panel has determined that there is currently insufficient evidence to recommend either for or against the use of inhaled budesonide for the treatment of COVID-19.

MONOCLONAL ANTIBODIES

BAMLANIVUMAB + ETESIVIMAB

- On February 23, 2021, Emergency Use Authorization was given for the use of Bamlanivimab 700 mg and Etesevimab 1,400 mg combo for outpatient treatment of patients with mild to moderate COVID-19 infection who are at high risk of progressing to severe disease and/or hospitalization
  - They recommend against the use of this combination treatment in hospitalized COVID-19 patients, with exceptions for those in clinical trial
- On March 2021, the Panel recommended AGAINST the use of Bamlanivumab monotherapy
- Bamlanivimab and etesevimab are not authorized for use in patients:
  - who are hospitalized due to COVID-19, OR
  - who require oxygen therapy due to COVID-19, OR
  - who require an increase in baseline oxygen flow rate due to COVID-19 in those on chronic oxygen therapy due to underlying non-COVID-19 related comorbidity.
- Treatment with bamlanivimab and etesevimab has not been studied in patients hospitalized due to COVID-19. Monoclonal antibodies, such as bamlanivimab and etesevimab, may be associated with worse clinical outcomes when administered to hospitalized patients with COVID-19 requiring high flow oxygen or mechanical ventilation
- On April 16, 2021 the U.S. Food and Drug Administration revoked the emergency use authorization (EUA) that allowed for the investigational monoclonal antibody therapy bamlanivimab, when administered alone, to be used for the treatment of mild-to-moderate COVID-19 in adults and certain pediatric patients.
- On June 25, 2021 the FDA paused distribution of bamlanivimab and etesevimab until further notice.

REGEN-COV ANTIBODY COCKTAIL

- ·The REACH Trial (COVPN 3502/REGN 2069) is testing the ability to prevent the acquisition of SARS-COV-2 through the combination treatment of casirivimab and imdevimab antibody cocktail.
- This cocktail is designed to bind the SARS-COV-2 virus and prevent the virus from entering into healthy cells
- Study enrollment consists of ~3,500 adults and adolescents who share a household with a person who recently tested positive for COVID-19
- Preliminary results from Regeneron show decreased viral loads and decreased disease burden, measured by fewer weeks of viral shedding, fewer weeks of high viral load shedding, and fewer total symptomatic weeks.
- As of July 30, 2021 the authorized dosage is 600 mg of casirivimab and 600 mg of imdevimab administered together as a single intravenous infusion or by subcutaneous injection as soon as possible after positive SARS-CoV-2 viral testing and within 10 days of symptom onset.

SOTROVIMAB

- On May 26, 2021, the FDA issued an EUA for the anti-SARS-CoV-2 monoclonal antibody sotrovimab for the treatment of non-hospitalized patients with mild to moderate COVID-19 who are at high risk of progression to

TOCILIZUMAB

- A study reviewing clinical trials in China and by the FDA suggest that Tocilizumab may be indicated in patients with cytokine release syndrome (CRS) and diffuse lung injury. The clinical trial found reduction in lung lesions, improvements in oxygen level and respiratory function, and reduction in fever to normal temperature.
  - Study limitations: small sample size (n = 14), all patients treated with methylprednisolone concomitantly
- ·A multicenter study (n = 63) in showed significant improvement in COVID patients with a pro-thrombotic, pro-inflammatory profile (classified as having 3 of the following: Ferritin >1000 ng/mL, CRP, D-Dimer 10x normal, LDH 2x normal). Administration of TCZ within 6 days of admission was associated with a higher chance of survival. (Sciascia et al. 05/26/2020)
  - TCZ was administered either IV (8 mg/kg) or SC (324 mg), with a 2nd dose in 52 out of 63 patients.
- ·Another retrospective study by the University of Maryland confirmed similar improvements in COVID patients with CRS due to Tocilizumab treatment combined with lopinavir, methylprednisolone, and oxygen therapy.
  - Both studies reviewed 1-hour infusion of tocilizumab up to 800 mg (max dosage) with some adverse effects including gastrointestinal perforations in patients with diverticulitis and concomitant high dosage corticosteroid use.
- ·Tocilizumab should not be used in pregnant patients and has not been found to be hepatotoxic or nephrotoxic thus far.
- ·According to COVID-19 treatment guidelines, patients who require ICU-level care are recommended against the use of tocilizumab or sarilumab for the treatment of COVID-19, except for clinical trials
- ·On February 2021, a New England Journal of Medicine paper revealed that the use of tocilizumab did not result in significantly better clinical status or lower mortality.
- ·On March 5, 2021, the COVID-19 Treatment Panel updated its recommendations on the use of tocilizumab:
  - They recommend the use of tocilizumab + dexamethasone in certain hospitalized COVID patients who are in rapid respiratory decompensation. These patients include:
    - ICU patients admitted within 24 hours and require respiratory support
    - Recently hospitalized patients (not ICU) with increasing oxygen requirements and have significantly increased markers of inflammation
- On May 27, 2021, the COVID-19 Treatment Panel recommended the use of tocilizumab in combination with dexamethasone alone or dexamethasone plus remdesivir for the treatment of COVID-19 in hospitalized patients on high-flow oxygen or noninvasive ventilation who have evidence of clinical progression or increased markers of inflammation
- On June 24, 2021 the U.S. Food and Drug Administration issued an emergency use authorization (EUA) for the drug Actemra (tocilizumab) for the treatment of hospitalized adults and pediatric patients (2 years of age and older) who are receiving systemic corticosteroids and require supplemental oxygen, non-invasive or invasive mechanical ventilation, or extracorporeal membrane oxygenation (ECMO).
- As of August 23, 2021 there is insufficient evidence for the Panel to recommend either for or against the use of tocilizumab in hospitalized children with COVID-19 or MIS-C.

KINASE INHIBITORS

BARICITINIB

- Baricitinib has received EUA approval for treatment of COVID-19 in patients 2 years of age or older as of 11/23/2020
  - The ACTT-2 trial was published on Dec. 11,2020, which showed that Baricitinib in combination with Remdesvir was more effective in reducing recovery time and accelerating recovery time than Remdesvir alone. The trial group (n=1033) compared using a 4-mg dose of Baricitinib in combination with Remdesivir, versus Remdesivir alone. Investigators found a 1-day reduction in median time overall in recovery. They defined recovery as either coming off supplemental oxygen or being discharged.
- Patients receiving combination therapy on high-flow oxygen or non-invasive ventilation at enrollment recovered faster (within 10 days versus 18 for control) and there were fewer serious adverse events and infections in the combo cohort. The 28-day mortality was 5.1% in the combination cohort and 7.8 in the control.Baricitinib received EUA for a 4-mg dose for COVID patients.
- On May 27, 2021, the COVID-19 Treatment Panel recommended the use of baricitinib in combination with dexamethasone alone or dexamethasone plus remdesivir for the treatment of COVID-19 in hospitalized patients on high-flow oxygen or noninvasive ventilation who have evidence of clinical progression or increased markers of inflammation
- In circumstances when corticosteroids cannot be used, the Panel recommends the use of baricitinib in combination with remdesivir for COVID-19 hospitalized, nonintubated patients who require oxygen supplementation
- As of July 8th, 2021 the Panel recommends against the use of baricitinib in combination with tocilizumab.

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DIRECT ACTING AGENTS CONTINUED

ADVANCED THERAPY MEDICINAL PRODUCTS (ATMP)

CONVALESCENT PLASMA

- Convalescent plasma is FDA approved for use in clinical trials, patients with severe or immediately life-threatening laboratory confirmed COVID-19, and single patient emergency IND approval (FDA 5/1/2020)
- A study performed at Houston Methodist hospitals (n = 25) found that 36% of patients improved from baseline after 7 days and 76% improved after 14 days after 300 mL convalescent plasma obtained from 9 healthy donors who had recovered from COVID-19 was transfused (Salazar et al 5/27/2020)
  - Study limitations: n = 25, no control group, all patients were treated with HQ +azithromycin, 2 patients were treated with remdesvir, some with ribavarin, and some with tocilizumab and methylprednisone
  - Overall decrease in CRP and no increase in LFTs; 20 out of 25 patients were discharged, all but 2 patients on ventilation and ECMO were weaned off
  - Further study is needed to assess efficacy of convalescent plasma as a stand-alone treatment
  - No adverse effects related to transfusion were observed in the study
- Another randomized clinical trial from 7 medical centers in Wuhan, China compared a standard treatment group (n = 51) to a standard treatment plus convalescent plasma group (n=52)
  - 98.3% of patients in the experimental group with severe disease recovered within 28 days compared to the control group (68.2%)
  - There was no statistical difference for recovery within 28 days between the control and experimental group for patients with life-threatening disease
  - No statistically significant decrease in time to clinical improvement between the experimental and control groups

OTILIMAB AND LENZILUMAB

- As of July 8th, 2021 the Panel has determined that there is insufficient evidence to recommend either for or against the use of GM-CSF inhibitors for the treatment of hospitalized patients with COVID-19.

NIH RECOMMENDATIONS


Figure 1. Pharmacologic Management of Patients with COVID-19 Based on Disease Severity
Doses and durations are listed in the footnotes.

DISEASE SEVERITY | PANEL'S RECOMMENDATIONS

Not Hospitalized, Mild to Moderate COVID-19

For patients who are not at high risk for disease progression, provide supportive care and symptomatic management (AIII).

For patients who are at high risk of disease progression (as defined by the FDA EUA criteria for treatment with anti-SARS-CoV-2 monoclonal antibodies), use one of the following combinations:
- Bamlanivimab plus etesevimab (AIIa)
- Casirivimab plus imdevimab (AIIa)

Hospitalized but Does Not Require Supplemental Oxygen

There are insufficient data to recommend either for or against the routine use of remdesivir. For patients at high risk of disease progression, the use of remdesivir may be appropriate.

Hospitalized and Requires Supplemental Oxygen

Use one of the following options:
- Remdesivir[aaa] (e.g., for patients who require minimal supplemental oxygen) (BIIa)
- Dexamethasone[c] plus remdesivir[aaa] (e.g., for patients who require increasing amounts of supplemental oxygen) (BIII)[ccc]
- Dexamethasone[c] (e.g., when combination therapy with remdesivir cannot be used or is not available) (BI)

Hospitalized and Requires Oxygen Delivery Through a High-Flow Device or Noninvasive Ventilation

Use one of the following options:
- Dexamethasone[c] (AI)[f]
- Dexamethasone[c] plus remdesivir[aaa] (BIII)[ccc]

For patients who were recently hospitalized[d] with rapidly increasing oxygen needs and systemic inflammation:
- Add tocilizumab[e] to one of the two options above (BIIa)

Hospitalized and Requires Invasive Mechanical Ventilation or ECMO

- Dexamethasone[c] (AI)[f]

For patients who are within 24 hours of admission to the ICU:
- Dexamethasone[c] plus tocilizumab[e] (BIIa)

Rating of Recommendations: A = Strong; B = Moderate; C = Optional
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

[aaa] The remdesivir dose is 200 mg IV for one dose, followed by remdesivir 100 mg IV once daily for 4 days or until hospital discharge (unless the patient is in a health care setting that can provide acute care but is similar to inpatient hospital care). Treatment duration may be extended to up to 10 days if there is no substantial clinical improvement by Day 5.

[c] For patients who are receiving remdesivir but progress to requiring oxygen through a high-flow device, noninvasive ventilation, invasive mechanical ventilation, or ECMO, remdesivir should be continued until the treatment course is completed.

[f] The combination of dexamethasone and remdesivir has not been studied in clinical trials. Dexamethasone is not available, equivalent doses of other corticosteroids (e.g., prednisone, methylprednisolone, hydrocortisone) may be used. See the Corticosteroids section for more information.

[d] The combination of dexamethasone and remdesivir has not been studied in clinical trials.

[e] In the rare circumstances where corticosteroids cannot be used, baricitinib plus remdesivir can be used (BIIa). The FDA has issued an EUA for baricitinib use in combination with remdesivir. The dose for baricitinib is 4 mg PO once daily for 14 days or until hospital discharge.

[ccc] The Panel recommends against the use of remdesivir monotherapy in these patients.

Key: ECMO = extracorporeal membrane oxygenation; EUA = Emergency Use Authorization; FDA = Food and Drug Administration; ICU = intensive care unit; IV = intravenous; the Panel = the COVID-19 Treatment Guidelines Panel; PO = orally

AGENTS NO LONGER RECOMMENDED FOR USE

HYDROXYCHLOROQUINE
CHLOROQUINE
COLCHICINE
IVERMECTIN
TENOFOVIR
BAMLANIVIMAB MONOTHERAPY
BARICITINIB + TOCILIZUMAB

VACCINE DEVELOPMENT

AUTHORIZED AND RECOMMENDED COVID-19 VACCINES

Vaccine*	Number of Doses	FDA Status	Efficacy	Age	Side Effects	Allergies
Pfizer Vaccine	2 shots 21days apart+	In use	95%	12+	Pain, swelling, redness at injection site, chills, tiredness, headaches, fever, chills, symptomatic acute myocarditis in adolescents, multisystem inflammatory syndrome in children, anaphylaxis	Polyethylene glycol
Moderna Vaccine	2 shots 28 days apart+	In use	94.1%	18+	Pain, swelling, redness at injection site, chills, tiredness, headaches, fever, anaphylaxis	Polysorbate, Polyethylene glycol
Johnson& Johnson Vaccine	1 shot	In use	66.3%	18+	Rare blood clot in women younger than 50, pain, swelling, redness at injection site, chills, tiredness, headaches, fever, anaphylaxis	Polysorbate

*** All vaccines should not be given until 90 days after monoclonal antibody administration.**
+ Patients that are moderately or severely immunocompromised should receive a third shot

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VACCINE DEVELOPMENT

AUTHORIZED AND RECOMMENDED COVID-19 VACCINES

PFIZER VACCINE

- BioNTech, Pfizer, and Fosun Pharma have developed a two-dose mRNA vaccine that has recently expanded to include people of 12 years old and up. They have also reported results stating that individuals who received the first dose experienced mostly mild to moderate side effects.
- 12/11/2020 -- FDA gave the Pfizer vaccine EUA in the United States.
- 08/12/2021 -- FDA announced that moderate to severely immunocompromised individuals should receive a third dose of the Pfizer vaccine a minimum of 28 days after the second dose was administered to produce a sufficient immune response.
  - A list of conditions that qualify for needing a third shot is on the CDC website
  - The FDA and CDC state that the timing of the third dose should be determined by physicians based on the timing of their patient's immunosuppressive therapy.
- Adverse effects of the vaccine have been mild to moderate, and start within 1-2 weeks after getting the vaccine, but should go away in a few days. Most common side effects reported include pain, swelling, and redness in the injection site and chills, tiredness, and headaches. Side effects such as fevers, chills, tiredness, and headaches are more common after the 2nd dose of the vaccine.
- The vaccine is reported by the NIH to be 95% effective in preventing symptomatic COVID-19.
- 04/01/2021 -- an analysis performed on 927 symptomatic COVID-19 cases found the vaccine to be 91.3% effective against COVID-19 from seven days to six months after the second dose. New data suggests the vaccine is 87-89.5% effective at preventing disease with the B.1.1.7/UK variant and 72.1-75% effective at preventing disease with the B.1.135/South African variant in people that were at least two weeks past their second dose. Overall, the vaccine is 100% effective at preventing severe, critical, or fatal disease cause by the UK and South African variants.
- A study is currently underway to test the efficacy of a third dose of the Pfizer vaccine as a booster shot.
- A study published by the New England Journal of Medicine found the Pfizer vaccine to be 88% effective against the delta variant and 93.7% effective against the alpha variant.
- In their latest executive report, the company explained that several individuals have waned immunity 8+ months after completed vaccination, warranting a booster. Currently, the booster is just a third shot identical to the first and second with the anticipation that circulating antibodies will be produced and increase protection of individuals. Current trials showed that the booster increases the amount of Delta variant antibodies fivefold in 18-to-55-year-olds and 11-fold in 65–85-year-olds. Studies began in August regarding an updated booster with the potential to confer added resistance against more novel strains. Boosters are on target to be distributed to the public as early as September 20th.

MODERNA VACCINE

- Moderna has developed a two-dose mRNA-based vaccine for individuals 18 years and older, and a phase 3 study determined the vaccine is 94.1% effective in preventing symptomatic COVID-19.
- 02/18/2020 -- FDA gave the Moderna vaccine EUA in the United States
- 08/12/2021 -- the FDA and CDC are recommending moderate to severely immunocompromised individuals should receive a third dose of the mRNA vaccine. The third dose should be given a minimum of 28 days after the second dose. Physicians should work with their patients to decide the best time for the third dosed based on their individual immunosuppressive treatment regimen. A full list of conditions that qualify for a third dose are located on the CDC website.
- Adverse effects have been mild to moderate and more common after the 2nd dose. Most common side effects reported include pain, swelling, and redness in the injection site, and chills, tiredness, and headaches. People who are allergic to polyethylene glycol or polysorbate should not get this vaccine
- A study performed by the CDC tracked front-line workers, first responders, and essential workers who had completed their second dose over 13 weeks found the vaccine to be 90% effective against protecting from COVID-19 in current conditions
- 06/29/2021 Moderna announced in a press release that their vaccine was protective against the delta variant based on studies they performed. The Moderna vaccine has been found to be protective against all the variant strains
- 09/01/21 -- Moderna announced submission of data to the FDA in support for its 50 mcg booster dose of their mRNA-1273 COVID-19 vaccine. Preliminary release of data showed that in n=344 participants, neutralizing antibody titers against SARS-CoV-2 significantly declined at 6 months from their second dose. Participants who received a booster dose demonstrated a 32-fold increased geometric mean titer for Beta variant, and 42.3-fold increased geometric mean titer for Gamma and Delta variants.
- 09/05/21 -- Moderna's data regarding boosters is lagging and will not meet the September 20th deadline set by the Biden Administration.

LITERATURE REVIEW SARS-CoV 2 Treatment

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updated 09/12/2021

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VACCINE DEVELOPMENT

AUTHORIZED AND RECOMMENDED COVID-19 VACCINES

JOHNSON&JOHNSON VACCINE

- 02/27/2021 -- the FDA announced the EUA of the single-dose COVID-19 vaccine developed by Johnson&Johnson. The vaccine is recommended for people aged 18 years and older. The vaccine was 66.3% effective in clinical trials. People had most protection 2 weeks after getting the vaccine. This vaccine had high efficacy in preventing hospitalizations and death in people who did not get sick. This vaccine may provide protection against asymptomatic infection.
- 04/13/2021 -- The FDA and CDC have temporarily paused the use of Johnson&Johnson vaccines due to a small percentage of women receiving the vaccine developing severe and rare blood clots. The blood clot has been found in fifteen women and over 6.8 million doses of the vaccine have been given thus far. The blood clot occurred in women between the ages of 18 and 59. They reported that their symptoms began 6-15 days after vaccination
- 04/23/2021 -- The CDC and FDA lifted the pause on Johnson&Johnson vaccines. Now, women under the age of 50 must be notified of the potential risk for blood clots and be made aware of other COVID-19 vaccines available.
- There is currently conflicting data on the effectiveness of the J&J vaccine against the delta variant. A new study indicates that this vaccine is less effective than the others at protecting against the variant strain, however this data is not peer-reviewed nor published. However, peer-reviewed study showed that Johnson&Johnson demonstrated that the vaccine was as effective as the Pfizer vaccine against the delta variant. Several health officials have begun recommending a booster shot and advise that the most vulnerable populations are prioritized. Although there have been concerns over possibly needing a different vaccine to confer immunity with the new Delta variant, health officials do not recommend mixing vaccines due to the nature of the J&J vaccine being an adenovirus vector vaccine while Pfizer and Moderna are vector vaccines. There is currently no FDA approval regarding mixing vaccines.
- 09/02/21 -- J&J published a correspondence in NEJM to release interim phase 1/2a data about their Ad26.COV2.S vaccine. In n=20 participants who received either 1 or 2 doses of the J&J vaccine, compared to n=5 who received placebo, at 8 months after the single-shot regimen and 6 months after the two-shot regimen, participants who received vaccine demonstrated durable humoral and immune response.

VACCINE EFFICACY AGAINST VARIANT COVID-19 STRAINS

Vaccine	Delta Variant	Alpha Variant
Pfizer	88%	93.7%
Moderna	-	-
Johnson&Johnson	-	-

(-) There is not enough published information at this time.

COVID-19 VACCINES IN PHASE 3 CLINICAL TRIALS

Vaccine	Number of Doses	FDA Status	Efficacy	Age	Side Effects	Allergies
Vaxzevria (AstraZeneca)	2 shots 4-12 weeks apart	Not in use	82%	18+	Vomiting, diarrhea, swelling, redness at the injection site and low levels of blood platelets occurred in less than 1 in 10 people.	Polysorbate
Novavax *	2 shots 1month apart	Not in use	- *	18+	- *	- *

***Novavax is currently still being studied.**

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VACCINE DEVELOPMENT

VAXZEVRIA (ASTRAZENECA) VACCINE

- AstraZeneca and the University of Oxford have developed a vaccine called ChAdOx1
- 10/23/2021 -- After halting global trials in September due to a volunteer who had developed transverse myelitis, the FDA authorized the restart of the trial
- Analysis of the phase III US trials demonstrated a 76% efficacy against symptomatic COVID-19 after the first dose and 82% efficacy after the second. It has been 100% effective against development of severe COVID-19 symptoms and hospitalizations. In participants 65 and older, the vaccine has been found to be 85% effective. The AstraZeneca vaccine has been found to produce a rare form of blood clot in a small percentage of those vaccinated
- 04/04/2021 -- there were 222 cases out of the 34 million vaccinated with this formula in the European Union and United Kingdom
- 04/14/2021 -- the Pharmacovigilance Risk Assessment Committee (PRAC) concluded that a causal relationship between vaccination with Vaxzevria and very rare cases of thrombosis together with thrombocytopenia, sometimes accompanied by bleeding, is plausible. Although rare, the cases of cerebral venous sinus thrombosis, splanchnic vein thrombosis and arterial thrombosis exceed what is observed in the general population. Most of these cases occurred 14 days after vaccination and mostly in women under 60 years of age. PRAC agreed that the product information for Vaxzevria should be updated with this assessment and specify thrombocytopenia as a new common side effect (occurring in less than 1 in 10 persons) and thrombosis in combination with thrombocytopenia as a new very rare side effect (occurring in less than 1 in 10,000 persons)
- June 2021 – The estimated risk of TTS from a single dose of the Astrazeneca vaccine was published. The age group with highest risk are <50 years old with 3.1 estimated cases per 100,000 first doses of Vaxzevria. All other age groups had lower estimated risk.
- A study published by the New England Journal of Medicine found the vaccine to be 67% effective against the delta variant and 74.5% effective against the alpha variant.

NOVAVAX VACCINE

- Novavax is a vaccine based on the genetic sequence of the SARS-CoV-2 and does not contain any live or inactivated virus. It was created using Novavax's nanoparticle technology and contains a patented adjuvant (Matrix-MTM) for immune boosting and neutralizing antibody stimulation, allowing a stronger immune response at a lower vaccine dose
- Nov 2020 -- Novavax started Phase 3 trials in adults 18 years and older in the United States and Mexico. The trial has also been opened at UT Health Antonio, and study participants will be followed for 2 years
- An analysis of the United Kingdom and South African trials showed the vaccine was effective in providing protection against variant strains. In the UK, the vaccine proved to be 96.4% effective against the original COVID-19 strain, 100% effective against the severe strain, and 86.3% against the UK variant. In South Africa, the vaccine in trial Phase 2b and has been found to be 100% protective against severe disease and 48.6% effective against the South African variant
- 06/14/21 -- Results from the phase 3 clinical trial (PREVENT-19) showed 90.4% efficacy of the Novavax vaccine in preventing symptomatic COVID-19 disease. Safety data showed the vaccine is generally well tolerated – primarily mild-moderate injection site tenderness, fatigue, headache lasting around 2 days

NOVOVAX INFLUENZA + COVID 19 COMBINATION VACCINE

- In May 2021, Novavax announced that in the preclinical trials, the NanoFlu/NVX-CoV2373 combination vaccine demonstrated positive immune responses to both influenza and SARS-CoV-2 31/2021.

INTERNATIONAL COVID-19 VACCINE STUDIES

- The Murdoch Children's Research Institute is conducting a Phase 3 trial in Australia to see if the BCG vaccine partly protects against COVID-19.
- CanSinoBIO, the Gamaleya Research Institute, Bektop, Sinovac, Sinopharm, and the Wuhan Institute of Biological Products have developed vaccines that are approved for limited use in international countries. None are approved in the U.S. as of 5/31/2021.