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Select entries were updated on 3/27/2020; these can be identified by the date that appears in the Drug(s) column.

### ANTVIRAL AGENTS

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<thead>
<tr>
<th>Drug(s)</th>
<th>AHFS Class</th>
<th>Rationale</th>
<th>Trials or Clinical Experience</th>
<th>Dosage⁹</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Baloxavir</td>
<td>8:18.92</td>
<td>Antiviral active against influenza viruses</td>
<td>Currently no known published clinical trial data regarding efficacy or safety in the treatment of COVID-19 China: Two randomized clinical trials registered, but not yet recruiting. Chinese Clinical Trial Registry links: ChICTR2000029544 CHICCTR20000029548</td>
<td>Protocol in one registered Chinese trial (2000029548) specifies a baloxavir marboxil dosage of 80 mg orally on day 1, 80 mg orally on day 4, and 80 mg orally on day 7 as needed, not to exceed 3 total doses.¹</td>
<td>No data to date support use in the treatment of COVID-19</td>
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<tr>
<td>Chloroquine Phosphate</td>
<td>8:30.08</td>
<td>Antimalarial</td>
<td>In vitro activity against various viruses, including coronaviruses ¹⁻³, ¹³, ¹⁴ In vitro activity against SARS-CoV-2 in infected Vero E6 cells reported; some evidence it may block infection in Vero E6 cells exposed to SARS-CoV-2 ¹⁻⁴, ¹² Active in vitro against SARS-CoV-1 and MERS-CoV ²⁻⁵, ⁹ Only limited clinical trial data available to date to evaluate use of chloroquine for treatment or prevention of COVID-19 Multiple clinical trials initiated using various dosages in pts with COVID-19 in China and other countries ⁴⁻¹⁰ Clinical experience in pts with COVID-19 accumulating; reports of possible clinical benefits, including decrease in viral load and duration of illness; only limited data available to date to support efficacy and identify possible safety concerns in pts with COVID-19 ¹⁻⁶</td>
<td>Various dosages recommended or being investigated Oral chloroquine phosphate: 500 mg twice daily for 10 days ⁴ Oral chloroquine phosphate: 500 mg twice daily for 7 days (adults 18-65 years weighing &gt;50 kg); 500 mg twice daily on days 1 and 2, then 500 mg once daily on days 3-7 (adults weighing &lt;50 kg) ¹¹ Oral chloroquine phosphate: Initial dose of 600 mg (of chloroquine)</td>
<td>Efficacy of chloroquine for treatment or prevention of COVID-19 not established Additional data needed to determine whether in vitro activity against SARS-CoV-2 corresponds with clinical efficacy for treatment or prevention of COVID-19 Additional data needed to substantiate initial reports of efficacy and identify optimal dose and duration Data needed regarding toxicity profile when used in patients with COVID-19</td>
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<td>Drug(s)</td>
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<tr>
<td>Hydroxychloroquine (Plaquenil®)</td>
<td>8:30.08 Antimalarial</td>
<td>In vitro activity against various viruses, including coronaviruses 5, 8, 12-14</td>
<td>Only limited clinical trial data available to date to evaluate use of hydroxychloroquine for treatment or prevention of COVID-19</td>
<td>Various dosages recommended or being investigated</td>
<td>Efficacy of hydroxychloroquine for treatment or prevention of COVID-19 not established Additional data needed to determine whether in vitro activity against SARS-CoV-2 corresponds with clinical efficacy for treatment or prevention of COVID-19 Additional data needed to substantiate initial reports of efficacy and identify optimal dose and duration Data needed regarding toxicity profile when used in patients with COVID-19 Hydroxychloroquine suggested as possible option and included in some guidelines for treatment of COVID-19</td>
</tr>
<tr>
<td>Hydroxychloroquine</td>
<td>Antimalarial</td>
<td>In vitro activity against SARS-CoV-2 in infected Vero 6 cells reported; may be more potent than chloroquine in vitro, but some data are conflicting and additional study needed 8, 12</td>
<td>Multiple clinical trials initiated using various dosages in pts with COVID-19 in China and other countries 4, 10</td>
<td>Oral hydroxychloroquine sulfate: 400 mg twice daily on day 1, then 200 mg twice daily on days 2-5 8, 20</td>
<td>Chloroquine suggested as possible option and included in some guidelines for treatment of COVID-19</td>
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<tr>
<td>Hydroxychloroquine</td>
<td>Antimalarial</td>
<td>Has immunomodulatory activity that theoretically could contribute to an anti-inflammatory response in patients with viral infections 1-3, 13, 15-16</td>
<td>Clinical experience in pts with COVID-19 accumulating; only limited data available to date to support efficacy and identify possible safety concerns in pts with COVID-19 7, 16</td>
<td>Oral hydroxychloroquine sulfate: 400 mg once or twice daily for 5-10 days 10, 18</td>
<td>Chloroquine phosphate is equivalent to 300 mg of chloroquine base 17</td>
</tr>
<tr>
<td>Hydroxychloroquine</td>
<td>Antimalarial</td>
<td>Known pharmacokinetics and toxicity profile</td>
<td>Hydroxychloroquine small pilot study conducted in China: 30 treatment-naïve pts were randomized 1:1 to receive hydroxychloroquine sulfate (400 mg daily for 5 days) with conventional treatment or conventional treatment alone; primary end point was negative conversion in pharyngeal swabs on day 7. Negative conversion reported at day 7 in 13 pts (86.7%) treated with hydroxychloroquine and 14 pts (93.3%) not treated with the drug (data unclear for 3 pts); median duration from hospitalization to negative conversion and to temperature normalization were similar in both groups; evidence of radiologic progression on CT in 5 pts treated with the drug and 7 pts not treated with the drug (all pts showed improvement at follow-up).</td>
<td>Oral hydroxychloroquine sulfate: 600 mg twice daily on day 1, then 400 mg daily on days 2-5 20</td>
<td>Chloroquine suggested as possible option and included in some guidelines for treatment of COVID-19</td>
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<td>Oral hydroxychloroquine sulfate: 100-200 mg twice daily for 5-14 days 4 Oral hydroxychloroquine sulfate: 200 mg 3 times daily for 10 days 7</td>
<td>Chloroquine suggested as possible option and included in some guidelines for treatment of COVID-19</td>
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Hydroxychloroquine sulfate: 400 mg once or twice daily for 5-10 days 10, 18

Hydroxychloroquine sulfate: 600 mg twice daily on day 1, then 400 mg daily on days 2-5 20

Hydroxychloroquine sulfate: 100-200 mg twice daily for 5-14 days 4

Hydroxychloroquine sulfate: 200 mg 3 times daily for 10 days 7
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<tr>
<th>Drug(s)</th>
<th>AHFS Class</th>
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<th>Trials or Clinical Experience</th>
<th>Dosage(^a)</th>
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<tbody>
<tr>
<td><strong>Hydroxychloroquine with Azithromycin:</strong> Preliminary data from an ongoing study in France in hospitalized pts with confirmed COVID-19 was used to assess efficacy of hydroxychloroquine used alone or with azithromycin; untreated pts were used as a negative control. The primary end point was negative PCR results in nasopharyngeal samples at day 6. Data from 14 pts treated with hydroxychloroquine (200 mg 3 times daily for 10 days), 6 pts treated with hydroxychloroquine and azithromycin (500 mg on day 1, then 250 mg daily on days 2-5), and 16 pts in the control group were analyzed. At day 6, 8/14 (57%) in the hydroxychloroquine group, 6/6 (100%) in the hydroxychloroquine and azithromycin group, and 2/16 (12.5%) in the control group had negative PCR results. At day 8, a positive PCR was reported in a pt treated with both drugs who had tested negative at day 6. This was a small nonrandomized study that didn’t appear to be designed to compare hydroxychloroquine vs hydroxychloroquine and azithromycin (pts received antibiotics to prevent bacterial superinfection based on clinical judgment). Data on disease severity was unclear (some asymptomatic pts were included when study initiated) and information on disease progression and clinical outcomes was not presented. Although it provides some evidence of the effects of hydroxychloroquine in pts with COVID-19, additional data needed before any conclusions can be made regarding possible benefits of using hydroxychloroquine with azithromycin. (See Azithromycin in this Evidence Table.)**</td>
<td><strong>Efficacy measures:</strong> Initial studies evaluating hydroxychloroquine based efficacy of the drug on negative conversion in nasopharyngeal samples at day 6 or 7. RT-PCR tests using upper and lower respiratory specimens (including nasopharyngeal and oropharyngeal swabs) are recommended.</td>
<td>** (a)**</td>
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| Lopinavir and Ritonavir (LPV/RTV; Kaletra<sup>®</sup>) | 8:18.08.08 | Antiretroviral with in vitro activity against SARS-CoV and MERS-CoV<sup>1 </sup><sup>3</sup><sup>5</sup><sup>7</sup><sup>9</sup><sup>11</sup>; some evidence of benefit in animal studies for treatment of MERS-CoV<sup>2</sup><sup>4</sup> | **COVID-19 Randomized, open-label trial** in hospitalized adults with severe COVID-19 compared LPV/RTV in conjunction with standard of care (99 pts) vs standard of care alone (100 pts). Primary end point: time to clinical improvement (time from randomization to improvement of two points on a seven-category ordinal scale or hospital discharge, whichever came first). In ITT population, time to clinical improvement was not shorter with LPV/RTV compared with standard of care (median time to clinical improvement 16 days in both groups); in modified ITT population, median time to clinical improvement 15 days in LPV/RTV group and 16 days in standard of care only group. The 28-day mortality rate was numerically lower in LPV/RTV group (19.2% vs 25% in ITT population; 16.7% vs 25% in modified ITT population). Some evidence that LPV/RTV initiation within 12 days after symptom onset is associated with shorter time to clinical improvement. **No significant differences in reduction of viral RNA load, duration of viral RNA detectability, duration of oxygen therapy, duration of hospitalization, or time from randomization to death.** LPV/RTV stopped early in 13 pts because of adverse effects. | **COVID-19:** LPV 400 mg/RTV 100 mg orally twice daily for 14 days<sup>3</sup>  
**COVID-19:** LPV 400 mg/RTV 100 mg orally twice daily with or without arbidol (200 mg every 8 hours) for up to 21 days<sup>6</sup>  
**COVID-19:** LPV 400 mg/RTV 100 mg orally with or without interferon (5 million units of interferon-α or equivalent twice daily given in 2 mL of sterile water by nebulization) and with or without ribavirin for up to 10 days<sup>5</sup><sup>13</sup>  
**SARS:** LPV 400 mg/RTV 100 mg orally twice daily for 14 days with ribavirin (4-g oral loading dose, then 1.2 g orally every 8 hours or 8 mg/kg IV every 8 hours)<sup>1</sup>  
**MERS:** LPV 400 mg/RTV 100 mg orally twice daily with ribavirin (various regimens) and/or interferon-α; LPV 400 mg/RTV 100 mg orally twice daily with interferon β1b (0.25 mg/mL sub-Q on alternate days) for 14 days<sup>1</sup><sup>4</sup><sup>6</sup><sup>8</sup> | Efficacy for treatment of COVID-19 not definitely established  
Additional study needed to evaluate possible clinical benefits of early use of LPV/RTV in COVID-19  
Additional study needed to evaluate benefits of concomitant use of LPV/RTV with other antivirals for COVID-19; usually used in conjunction with other antivirals (e.g., ribavirin with or without an interferon) for SARS and MERS |
<table>
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<tr>
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<th>Trials or Clinical Experience</th>
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<tbody>
<tr>
<td>Neuraminidase inhibitors (e.g., oseltamivir)</td>
<td>8:18.28</td>
<td>Antivirals active against influenza viruses</td>
<td>In a retrospective case series of 99 patients with COVID-19 at single center in Wuhan from 1/1/20 to 1/20/20, 76% of patients received antiviral treatment, including oseltamivir (75 mg orally every 12 hours). At the time of evaluation, 58% of patients remained hospitalized, 31% had been discharged, and 11% had died. ¹ While oseltamivir is noted to have been widely used for confirmed or suspected COVID-19 cases in hospitals in China, there has been no exact evidence to date that oseltamivir is effective in the treatment of COVID-19. ² Neither oseltamivir nor zanamivir has demonstrated inhibition of cytopathic effect against SARS-CoV in in vitro cell culture. ⁴</td>
<td>Dosage of oseltamivir in the case series of 99 patients was 75 mg orally every 12 hours. ¹ Dosages of oseltamivir from registered trials (either recruiting, or not yet recruiting) vary, but include 300 mg orally daily, 75 mg orally once or twice daily, and 4–6 mg/kg orally (frequency not specified). ⁵</td>
<td>No data to date support use in the treatment of COVID-19</td>
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1. COVID-19 trials at Clinicaltrials.gov that include LPV/RTV 15: NCT04307693 (LPV/RTV vs hydroxychloroquine in pts with mild disease) NCT04276688 (LPV/RTV with ribavirin and interferon β-1B vs LPV/RTV alone)

2. COVID-19 Clinical Experience: Data accumulating on LPV/RTV used with or without interferon in pts with COVID-19 outside of clinical trials. 5, 12, 14

3. SARS and MERS Clinical Experience: Evidence of some clinical benefit when used in conjunction with ribavirin and/or interferon. 1, 8, 9, 10, 11

4. Neuraminidase inhibitors (e.g., oseltamivir) 8:18.28 Antivirals active against influenza viruses In a retrospective case series of 99 patients with COVID-19 at single center in Wuhan from 1/1/20 to 1/20/20, 76% of patients received antiviral treatment, including oseltamivir (75 mg orally every 12 hours). At the time of evaluation, 58% of patients remained hospitalized, 31% had been discharged, and 11% had died. ¹ While oseltamivir is noted to have been widely used for confirmed or suspected COVID-19 cases in hospitals in China, there has been no exact evidence to date that oseltamivir is effective in the treatment of COVID-19. ² Neither oseltamivir nor zanamivir has demonstrated inhibition of cytopathic effect against SARS-CoV in in vitro cell culture. ⁴ Clinicaltrials.gov trials for COVID-19 that include oseltamivir²: NCT04303299 (not yet recruiting) NCT04261270 (recruiting) NCT04255017 (recruiting) | Dosage of oseltamivir in the case series of 99 patients was 75 mg orally every 12 hours. ¹ Dosages of oseltamivir from registered trials (either recruiting, or not yet recruiting) vary, but include 300 mg orally daily, 75 mg orally once or twice daily, and 4–6 mg/kg orally (frequency not specified). ⁵ | No data to date support use in the treatment of COVID-19 |
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</tr>
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<tbody>
<tr>
<td>Remdesivir</td>
<td>8:18.92</td>
<td>Antivirals, Miscellaneous</td>
<td>Broad-spectrum antiviral with activity against coronaviruses</td>
<td>Phase 3 randomized, open-label trial (NCT04292899) initiated by the manufacturer (Gilead) to evaluate safety and antiviral activity of 5- and 10-day regimens of Remdesivir in conjunction with standard of care in pts with severe COVID-19 (^9)</td>
<td>Not commercially available; most promising antiviral currently being investigated for COVID-19 Safety and efficacy not established; additional data needed</td>
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<td>Phase 3 randomized, open-label trial (NCT04292730) initiated by the manufacturer (Gilead) to evaluate safety and antiviral activity of 5- or 10-day regimens of remdesivir in conjunction with standard of care in pts with moderate COVID-19 compared with standard of care alone (^11)</td>
<td>Phase 3 trial protocol (severe COVID-19): 200 mg IV on day 1, then 100 mg IV daily on days 2-5 (arm 1) or 200 mg IV on day 1, then 100 mg IV daily on days 2-10 (arm 2) (^10)</td>
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<td>Phase 2 randomized, placebo-controlled trial (NCT04280705) sponsored by NIAID initiated to evaluate safety and efficacy of remdesivir in hospitalized pts with laboratory-confirmed COVID-19 (^13)</td>
<td>Phase 3 trial protocol (moderate COVID-19): 200 mg IV on day 1, then 100 mg IV on days 2-5 (arm 1) or 200 mg IV on day 1, then 100 mg IV daily on days 2-10 (arm 2) (^11)</td>
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<td>Expanded access and compassionate use access: The manufacturer (Gilead) is transitioning from individual compassionate use requests to an expanded access program for emergency access to the drug for severely ill pts with confirmed COVID-19. During this transition, new individual compassionate use requests cannot be accepted, with the possible exception of requests for pregnant women and children &lt;18 years of age with confirmed infections and severe manifestations of the disease. (^15) <a href="https://rdvcu.gilead.com/">https://rdvcu.gilead.com/</a></td>
<td>NIAID study protocol: 200 mg IV on day 1, then 100 mg IV for duration of hospitalization up to 10 days total (^13)</td>
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<td>Compassionate use access (NCT04302766): May be available for DoD personnel through treatment IND protocol sponsored by US Army Medical Research and Development Command (^12)</td>
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\(^{a}\) Phase 3 randomized, open-label trial (NCT04292899) initiated by the manufacturer (Gilead) to evaluate safety and antiviral activity of 5- and 10-day regimens of Remdesivir in conjunction with standard of care in pts with severe COVID-19.

\(^{b}\) Phase 3 randomized, open-label trial (NCT04292730) initiated by the manufacturer (Gilead) to evaluate safety and antiviral activity of 5- or 10-day regimens of remdesivir in conjunction with standard of care in pts with moderate COVID-19 compared with standard of care alone.

\(^{c}\) Phase 2 randomized, placebo-controlled trial (NCT04280705) sponsored by NIAID initiated to evaluate safety and efficacy of remdesivir in hospitalized pts with laboratory-confirmed COVID-19.

\(^{d}\) Expanded access and compassionate use access: The manufacturer (Gilead) is transitioning from individual compassionate use requests to an expanded access program for emergency access to the drug for severely ill pts with confirmed COVID-19. During this transition, new individual compassionate use requests cannot be accepted, with the possible exception of requests for pregnant women and children <18 years of age with confirmed infections and severe manifestations of the disease.

\(^{e}\) Compassionate use access (NCT04302766): May be available for DoD personnel through treatment IND protocol sponsored by US Army Medical Research and Development Command.
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<tr>
<td>Ascorbic acid</td>
<td>88:12 (Vitamin C)</td>
<td>Antioxidant and cofactor for numerous physiologic reactions; may support host defenses against infection and protect host cells against infection-induced oxidative stress</td>
<td>Phase 2 randomized, placebo-controlled trial (NCT04264533) initiated in China to evaluate high-dose IV ascorbic acid in ICU patients with severe COVID-19-associated pneumonia</td>
<td>Phase 2 trial protocol (NCT04264533): Ascorbic acid 12 g IV every 12 hours for 7 days (12 g of drug diluted in sterile water for injection to total volume of 50 mL and infused IV at rate of 12 mL/hour)</td>
<td>Current data not specific to COVID-19; additional study needed</td>
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<td>Azithromycin</td>
<td>8:12.12 Macrolides</td>
<td>Antibacterial with some in vitro activity against some viruses (e.g., influenza A H1N1, Zika)</td>
<td>Adjunctive therapy in certain respiratory viral infections: Although contradictory results reported, some evidence of beneficial immunomodulatory or anti-inflammatory effects when used in pts with some viral infections (e.g., influenza). However, in a retrospective cohort study in critically ill pts with laboratory-confirmed MERS, there was no statistically significant difference in 90-day mortality rates or clearance of MERS-CoV RNA between those who received macrolide therapy and those who did not. Adjunctive therapy in certain respiratory conditions: Some evidence of beneficial immunomodulatory or anti-inflammatory effects when used in pts with certain viral infections: 500 mg once daily has been used</td>
<td>Adjunctive treatment in certain viral infections: 500 mg once daily has been used</td>
<td>Current data insufficient to establish pros and cons of adjunctive use of azithromycin in management of COVID-19. Additional data needed before any conclusions can be made regarding possible benefits of using a combined regimen of hydroxychloroquine and azithromycin in pts with COVID-19. Because both azithromycin and hydroxychloroquine are associated with QT prolongation, caution is advised if considering use of both drugs in pts who have chronic medical conditions (e.g., renal failure, hepatic disease) or are receiving other drugs that cause arrhythmias.</td>
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<td>Corticosteroids (general)</td>
<td>68:04 Adrenals</td>
<td>Potent anti-inflammatory and antifibrotic properties; low doses of corticosteroids may prevent an extended cytokine response and may accelerate resolution of pulmonary and systemic inflammation in pneumonia.</td>
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<td>Respiratory conditions (e.g., ARDS). In a retrospective cohort study in pts with moderate or severe ARDS, a statistically significant improvement in 90-day survival was reported in those who received adjunctive azithromycin.</td>
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<td>Clinical experience in pts with COVID-19: Has been used for antibacterial coverage in hospitalized pts with COVID-19. Use in conjunction with hydroxychloroquine in pts with COVID-19: In a small nonrandomized study evaluating use of hydroxychloroquine, 6 study pts received azithromycin (500 mg on day 1, then 250 mg daily on days 2-5) in addition to the 10-day regimen of hydroxychloroquine. Although preliminary results indicated that all 6 of these pts had negative PCR results in nasopharyngeal samples at day 6 (a higher percentage than those receiving hydroxychloroquine alone), data presented to date are insufficient to evaluate possible clinical benefits of azithromycin in pts with COVID-19. (See Hydroxychloroquine in this Evidence Table.)</td>
<td>Adjunctive treatment in certain viral infections: 500 mg once daily has been used.</td>
<td>Current data insufficient to establish pros and cons of adjunctive use of azithromycin in management of COVID-19. Additional data needed before any conclusions can be made regarding possible benefits of using a combined regimen of hydroxychloroquine and azithromycin in pts with COVID-19. Because both azithromycin and hydroxychloroquine are associated with QT prolongation, caution is advised if considering use of both drugs in pts who have chronic medical conditions (e.g., renal failure, hepatic disease) or are receiving other drugs that cause arrhythmias.</td>
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<td>Observational studies: Evidence suggests that corticosteroids in patients with SARS and MERS showed no survival benefit and possible harm (e.g., delayed viral clearance, avascular necrosis, psychosis, diabetes). Systemic corticosteroid therapy (e.g., dexamethasone) has been studied for the treatment of acute respiratory distress syndrome (ARDS). Conflicting results reported for use of corticosteroids (e.g., hydrocortisone) for treatment of sepsis.</td>
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<td>WHO and CDC recommend that corticosteroids not be routinely used in patients with COVID-19 for treatment of viral pneumonia or ARDS unless indicated for another reason (e.g., asthma or COPD exacerbation, septic shock). Existing evidence is inconclusive for treatment of COVID-19 patients. Prudent use with low-to-moderate doses and short courses of treatment advised. WHO and expert consensus statement from Chinese Thoracic Society: Basic principles should be followed when using corticosteroids: (1) benefits and risks should be carefully weighed.</td>
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before using corticosteroids
(2) corticosteroids
should be used prudently in
critically ill patients with 2019-nCoV
pneumonia; (3) for patients with hypox-
emia due to underlying diseases or who
regularly use corticosteroids for chronic
diseases, further use of corticosteroids
should be cautious and (4) dosage
should be low to moderate (≤ 0.5–1 mg/
kg daily of methylprednisolone or equiv-
alent) and duration should be short (≤7
days). 1,7 Chinese health authority
states that corticosteroids can be used
in patients with COVID-19 who experi-
ence progressive deterioration for a
short period of time (3–5 days) and at
dosages not exceeding methylpredniso-
lone 1–2 mg/kg daily or equivalent. 10

International clinical practice guidelines
make a weak recommendation for use
of corticosteroids in patients with sep-
sis. 4 Recommendation applies to all
patients with sepsis with no meaningful
difference in efficacy of corticosteroids
in different patient populations, includ-
ing those with septic shock, pneumonia,
or ARDS. 4 For treatment of sepsis, clini-
cians considering corticosteroids for
patients with COVID-19 should balance
the potential small reduction in mortal-
ity with potential effects of prolonged
coronavirus shedding. 7 If corticoster-
oids prescribed, monitor and treat ad-
verse effects including hyperglycemia,
hypernatremia, and hypokalemia. 1,4
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<th>Drug(s)</th>
<th>AHFS Class</th>
<th>Rationale</th>
<th>Trials or Clinical Experience</th>
<th>Dosage&lt;sup&gt;a&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Methylprednisolone (DEPO-Medrol®, SOLU-Medrol&lt;sup&gt;®&lt;/sup&gt;)</td>
<td>68:04 Adrenal</td>
<td>Potent anti-inflammatory and antifibrotic properties; low doses of corticosteroids may prevent an extended cytokine response and may accelerate resolution of pulmonary and systemic inflammation in pneumonia&lt;sup&gt;1,9&lt;/sup&gt;</td>
<td><strong>Retrospective, observational, single-center study:</strong> In 201 patients with confirmed COVID-19 pneumonia who developed ARDS, methylprednisolone appeared to reduce the risk of death.&lt;sup&gt;6&lt;/sup&gt; Among patients with ARDS, of those who received methylprednisolone treatment, 23 of 50 (46%) patients died, while of those who did not receive methylprednisolone, 21 of 34 (61.8%) died.&lt;sup&gt;6&lt;/sup&gt; Dosage used in this retrospective study not provided.&lt;sup&gt;6&lt;/sup&gt; Based on expert consensus statement from Chinese Thoracic Society, dosage of methylprednisolone should be low to moderate (i.e., ≤0.5 to 1 mg/kg daily or equivalent).&lt;sup&gt;7&lt;/sup&gt; Regimens used in China were typically methylprednisolone 40-80 mg IV daily for a course of 3-6 days.&lt;sup&gt;8&lt;/sup&gt;</td>
<td>Findings suggest that for patients with COVID-19 pneumonia who progressed to ARDS, methylprednisolone treatment may be beneficial. Results should be interpreted with caution because of potential bias (drug used in sickest patients) and small sample size. Randomized controlled studies are needed.&lt;sup&gt;6&lt;/sup&gt;</td>
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<td>Nitric oxide (inhaled)</td>
<td>48:48 Vasodilating agent</td>
<td>Selective pulmonary vasodilator; may be useful in the treatment of acute respiratory distress syndrome (ARDS), a potential complication of COVID-19&lt;sup&gt;2,3,9&lt;/sup&gt;</td>
<td>In a small pilot study conducted in China during the 2003 SARS-CoV outbreak, treatment with inhaled nitric oxide reversed pulmonary hypertension, improved severe hypoxia, and shortened the duration of ventilatory support&lt;sup&gt;2,3&lt;/sup&gt; Randomized controlled studies of inhaled nitric oxide in ARDS patients generally demonstrated modest improvements in oxygenation, but no effect on mortality and possible harm (e.g., renal impairment)&lt;sup&gt;4,5,6&lt;/sup&gt;.</td>
<td>Inhaled nitric oxide therapy was given for 3 days (30 ppm on day 1, followed by 20 and 10 ppm on days 2 and 3, respectively, then weaned on day 4; therapy was resumed at 10 ppm if deteriorating oxygenation occurred) in a pilot study in SARS-CoV patients&lt;sup&gt;2&lt;/sup&gt; Therapeutic guidelines state that inhaled nitric oxide may be considered in ARDS patients with severe hypoxemia; however, routine use not recommended&lt;sup&gt;4,5,6,9&lt;/sup&gt;. Although no data specifically on treatment of COVID-19, a clinical trial evaluating inhaled nitric oxide as a potential treatment for mild/moderate COVID-19 is underway (NCT04305457)&lt;sup&gt;3,7&lt;/sup&gt;. On March 20&lt;sup&gt;th&lt;/sup&gt;, 2020, Bellerophon Therapeutics announced that the FDA granted emergency expanded access allowing its inhaled nitric oxide delivery system (INOpulse&lt;sup&gt;®&lt;/sup&gt;) to be immediately used for the treatment of COVID-19&lt;sup&gt;8&lt;/sup&gt;.</td>
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<td>Sarilumab (Kefzara®)</td>
<td>92:36 Disease-modifying Anti-rheumatic Drug</td>
<td>Recombinant humanized monoclonal antibody specific for the interleukin-6 (IL-6) receptor; may potentially combat cytokine release syndrome (CRS) and pulmonary symptoms in severely ill patients&lt;sup&gt;1,2,5&lt;/sup&gt;</td>
<td>Currently no known published clinical trial evidence supporting efficacy or safety against Coronavirus. However, based on encouraging results in China with a similar drug, tocilizumab, a U.S.-based, phase 2/3, randomized, double-blind, placebo-controlled study evaluating efficacy and safety of sarilumab in patients hospitalized with severe COVID-19 is currently under way&lt;sup&gt;3,4&lt;/sup&gt;.</td>
<td>Not available (see Trials or Clinical Experience)</td>
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<td><strong>Sirolimus</strong>&lt;br&gt;&lt;sub&gt;92:44 Immunosuppressive agent (mTOR inhibitor)&lt;/sub&gt;</td>
<td>92:44</td>
<td>mTOR complex 1 (mTORC1) is involved in the replication of various viruses, including coronavirus&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>In vitro studies demonstrated inhibitory activity against MER-CoV infection&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Dosage of sirolimus in the open-label trial was 2 mg daily orally, administered in conjunction with oral prednisolone 20 mg daily for 14 days; patients also received oseltamivir 75 mg twice daily for 10 days&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Although possible clinical application, current data not specific to 2019-nCoV/SARS-CoV2-2; additional study needed&lt;sup&gt;5&lt;/sup&gt;</td>
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<td><strong>Tocilizumab</strong>&lt;br&gt;&lt;sub&gt;(Actemra®) Updated 3/24/20&lt;/sub&gt;</td>
<td>92:36</td>
<td>Recombinant humanized monoclonal antibody specific for the interleukin-6 (IL-6) receptor; may potentially combat cytokine release syndrome (CRS) symptoms (e.g., fever, organ failure, death) in severely ill patients&lt;sup&gt;1,2,3&lt;/sup&gt;</td>
<td>Case study/series describing use of tocilizumab in patients with COVID-19 reported from various areas of the world&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>IV infusion: <strong>China</strong> recommends an initial dose of 4–8 mg/kg infused over more than 60 minutes. If initial dose not effective, may administer second dose (in same dosage as initial dose) after 12 hours. No more than 2 doses should be given; maximum single dose is 800 mg&lt;sup&gt;2&lt;/sup&gt;</td>
<td><strong>In China</strong>, tocilizumab can be used to treat severely or critically ill COVID-19 patients with extensive lung lesions and high IL-6 levels&lt;sup&gt;2&lt;/sup&gt; Published data to support use currently are limited&lt;sup&gt;1&lt;/sup&gt;</td>
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### Drug(s) | AHFS Class | Rationale | Trials or Clinical Experience | Dosage* | Comments
---|---|---|---|---|---

| **Trials or Clinical Experience** |  
Currently no other known clinical trial evidence supporting efficacy and safety of tocilizumab against Coronavirus. 

**China**: Randomized, multicenter, controlled clinical trial evaluating efficacy & safety in 188 patients with COVID-19 underway through 5/10/20. **Results not yet available.**


### OTHER

| Drug(s) | AHFS Class | Rationale | Trials or Clinical Experience | Dosage* | Comments
---|---|---|---|---|---

| **ACE Inhibitors, Angiotensin II Receptor Blockers (ARBs)** |  
24:32 Renin-Angiotensin-Aldosterone System Inhibitor | **Hypothetical harm**: Human pathogenic coronaviruses bind to their target cells through angiotensin-converting enzyme 2 (ACE2). Expression of ACE2 is increased in patients treated with ACE inhibitors or ARBs. Increased expression of ACE2 may potentially facilitate COVID-19 infections. 

**Hypothetical benefit**: ACE inhibitors or ARBs may have a protective effect against lung damage or may have paradoxical effect in terms of virus binding. | Data are lacking; no evidence of harm or benefit with regards to COVID-19 infection. 

Clinical trial underway: Initiation of losartan in adult patients with COVID-19 requiring hospitalization; primary outcome measure: sequential organ failure assessment (SOFA) respiratory score. (NCT04312009) |  
American Heart Association (AHA), American College of Cardiology (ACC), Heart Failure Society of America (HFSA), European Society of Cardiology (ESC) recommend to continue treatment with renin-angiotensin-aldosterone system (RAAS) antagonists in those patients who are currently prescribed such agents. 

Patients with cardiovascular disease are at an increased risk of serious COVID-19 infections. |
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| Ibuprofen | 28:08.04 Nonsteroidal Anti-inflammatory Agent (NSAIA) | Speculative link between ibuprofen and increased ACE2 expression **leading to worse outcomes** in COVID-19 patients, and should NOT be used in patients with COVID-19 | None; anecdotal | A letter published in The Lancet Respir Med [1] stated that increased expression of ACE2 could facilitate infection with COVID-19. The letter states that thiazolidinediones and ibuprofen can increase ACE2. **No sources have been cited for this.**

A statement attributed to WHO spokesperson Christian Lindmeier recommending paracetamol and avoiding ibuprofen as a self-medication was widely circulated in the media; however, such a position could not be found on the WHO website or other official sources. WHO has stated “after a rapid review of the literature, is not aware of published clinical or population-based data on this topic.” As of 3/18/20 (via Twitter) “WHO does not recommend against the use of ibuprofen.” [https://twitter.com/WHO/status/1240409217997189128](https://twitter.com/WHO/status/1240409217997189128)

In addition, there have been unsubstantiated reports of younger, healthy patients who took ibuprofen and suffered severe outcomes with COVID-19. Official case reports are lacking.

On March 19, 2020, FDA issued a statement that it is not aware of scientific evidence connecting the use of NSAIAAs, such as ibuprofen, with worsening COVID-19 symptoms. FDA stated that it is investigating this issue further and will communicate publicly when more information is available. FDA also noted that all prescription NSAIA labels warn that by reducing inflammation, and possibly fever, these drugs may diminish the utility of diagnostic signs in detecting infections. [https://www.fda.gov/drugs/drug-safety-and-availability/fda-advises-patients-use-non-steroidal-anti-inflammatory-drugs-nsaids-covid-19](https://www.fda.gov/drugs/drug-safety-and-availability/fda-advises-patients-use-non-steroidal-anti-inflammatory-drugs-nsaids-covid-19) |
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<td>Indomethacin</td>
<td>28:08.04 Nonsteroidal Anti-inflammatory Agents (NSAIA)</td>
<td>Possible antiviral activity against other coronavirus- es SARS-CoV &amp; CanineCoV (interferes with viral RNA synthesis)</td>
<td>Speculative; one in vitro &amp; animal model study with other coronaviruses SARS-CoV &amp; CanineCoV</td>
<td></td>
<td>Therefore, currently no compelling evidence to support an association between ibuprofen and negative outcomes in patients with COVID-19.</td>
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<td>Nebulized drugs</td>
<td></td>
<td>Potential harm: Concern that use of nebulized drugs (e.g., albuterol) for the management of respiratory conditions in patients with COVID-19 infection may distribute the virus into the air and expose close contacts.</td>
<td>Nebulizer treatment used in clinical practice to treat influenza and other respiratory infections is thought to generate droplets or aerosols. In one study, nebulized saline delivered droplets in the small- and medium-size aerosol/droplet range. These results may have infection control implications for airborne infections, including severe acute respiratory syndrome and pandemic influenza infection.</td>
<td></td>
<td>American College of Allergy, Asthma &amp; Immunology (ACAAI) recommends that nebulized albuterol should be administered in a location that minimizes exposure to close contacts who do not have COVID-19 infection. In the home, choose a location where air is not recirculated (e.g., porch, patio, or garage) or areas where surfaces can be cleaned easily or may not need cleaning.</td>
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<td>Niclosamide</td>
<td>8:08 Anthelmintic</td>
<td>Broad antiviral activity In vitro evidence of activity against SARS-CoV and MERS-CoV</td>
<td>Currently no known published clinical trial data regarding efficacy or safety in the treatment of COVID-19 In drug repurposing screens, was found to inhibit replication and antigen synthesis of SARS-CoV; did not interfere with virion’s attachment into cells</td>
<td></td>
<td>Not commercially available in the US No data to date support use in treatment of COVID-19</td>
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<sup>a</sup> See US prescribing information for additional information on dosage and administration of drugs commercially available in the US for other labeled indications.
ACE Inhibitors and Angiotensin II Receptor Blockers (ARBs)


Ascorbic acid:


Azithromycin:


Baloxavir:


Chloroquine and Hydroxychloroquine:


**Corticosteroids, including methylprednisolone:**


**Ibuprofen:**


**Indomethacin:**


**Lopinavir and Ritonavir:**


**Nebulized drugs:**


Neuraminidase Inhibitors (e.g., oseltamivir):

Niclosamide:

Nitric Oxide (inhaled):


Remdesivir:


**Sarilumab:**


**Sirolimus:**


**Tocilizumab:**

