



Northwestern Medicine ASP Evidence Review for Inpatient Treatment Options for COVID-19

The listed agents represent potential treatments for inpatient cases of COVID-19 largely based on limited evidence, few proven effective to date.

Careful clinical consideration should be applied when deciding to use the agents listed in this select evidence review.

*This document should not be used as empiric or definitive treatment guidelines. **Clinical pathways** [available here](#).*

Evidence is continuing to evolve, as such this document will be updated accordingly.

AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Remdesivir (Veklury®)				
<p>Antiviral with activity against Ebola, MERS, SARS</p> <p><i>Prodrug nucleotide analog of adenosine triphosphate; incorporates into nascent viral RNA chains and results in premature termination.</i></p> <p>Gilead</p>	<p>Dose: 200mg IV x1 on day 1 then 100mg IV daily for the duration of the hospital course up to 10 days total</p> <p>Duration:</p> <ul style="list-style-type: none"> • 5 days for most patients • Consideration of up to 10 days for patients who do not show clinical improvement by day 5 or those who progress to require invasive mechanical ventilation and/or ECMO • Clinical trial: 5 or 10 days (determined by PI) 	<p>FDA approved for the treatment of hospitalized patients with COVID-19 (>12 years old)</p> <ul style="list-style-type: none"> • EUA use for children <12yrs, weighing <40kg <p>NMH recommended use criteria (as of 11/2):</p> <p>1. Hospitalized patients with suspected or confirmed COVID-19 and meets one or more of the following:</p> <ol style="list-style-type: none"> a. Hypoxemic with SpO₂ ≤94% on room air or requiring supplemental oxygen c. Immunosuppressed* b. ID consult recommended remdesivir use <p>*Immunosuppression defined as pts with any of the following:</p> <ol style="list-style-type: none"> i. ≥20 mg/day prednisone (or equivalent) for at least 2 weeks ii. Organ transplant receiving immunosuppressive medications iii. Cancer patients on chemotherapy or those with hematological malignancies <p><u>Patients must have ALT < 10x ULN for use</u></p>	<p>FDA Prescribing Information</p> <p>Patient Education Sheet</p>	<p>Monitoring: Perform hepatic lab monitoring, eGFR, and prothrombin time testing prior to initiating remdesivir and during use as clinically appropriate.</p> <p>AE: Abnormal LFTs, hepatotoxicity, abnormal INR, PT & PTT, reversible kidney injury, nausea, vomiting, diarrhea, headache, rash</p> <p>Contraindications/Precautions: Contraindicated in patients with ALT >10x ULN. Caution in patients with eGFR <30 mL/min as IV formulation contains cyclodextrin, although use can be considered with risk-benefit assessment. Should not be co-administered with HCQ or CQ due to antagonistic effects</p>

NMH is enrolled as study site for remdesivir use in Adaptive COVID-19 clinical trial (ACTT-IV)

Evidence

- ACTT-2: double-blind RCT comparing remdesivir plus baricitinib (treatment, n=515) versus remdesivir plus placebo (control, n=518) in hospitalized patients with COVID-19. Similar exclusion criteria to ACTT-1 with addition of patients receiving prednisone ≥20mg/d x14d (or equiv) or monoclonal antibodies in prev 4 weeks. Post-hoc analysis compared moderate (no or low flow oxygen) v severe (hi-flow oxygen, NIMV, MV). Patients receiving baricitinib had a shorter median time to recovery compared to placebo (7d v 8d, RR 1.16, P=0.03). Patients receiving high-flow or non-invasive oxygen (ordinal category 6) demonstrated most benefit for time to recovery (10d v 18d, RR 1.51, CI 1.1-2.1) despite more patients in the control arm receiving steroids (21.2% v 11.7%). Minimal benefit seen in any other ordinal group. Numerically lower mortality was seen in patients treated with combination therapy (5.1% v 7.8%, HR 0.65, CI 0.39-1.09). (Kalil)
- ACTT-1: double-blind RCT comparing remdesivir (n=541) versus placebo (n=521) in hospitalized patients with COVID-19 and at least one of the following criteria: infiltrates on chest imaging, SpO₂ ≤94% on room air, or supplemental oxygen requirement including mechanical ventilation. Pts were excluded if eGFR < 30ml/min, LFTs > 5x ULN, pregnant, or breastfeeding. Among 1063 patients, those treated with remdesivir had a shortened median time to recovery (11d v 15d) compared with placebo. Significant clinical status improvement at day 15, measured by 8-point ordinal scale, was seen with remdesivir compared to placebo (59.2% v 49.5%, OR 1.5; CI 1.2-1.9). No significant difference was found for mortality at 28 days although it was numerically lower with remdesivir (11.4% v 15.2%). Serious adverse events were experienced in 24.6% of patients receiving remdesivir compared to 31.6% in those receiving placebo. Common adverse events in remdesivir treated patients were anemia or decreased hemoglobin (7.9%), reduced eGFR or CrCl (7.4%), hyperglycemia (4.1%), and LFT increases (4.1%). AKI per group: remdesivir 1.3% v placebo 2.3%. (Beigel)
- SOLIDARITY interim results: multicenter international clinical trial (n=11,330) evaluating the effect of 4 treatments [remdesivir (n=2750), hydroxychloroquine (n=954), lopinavir/ritonavir (n=1411), interferon (n=2063), no trial drug (n=4088)] in hospitalized patients with COVID-19. In patients receiving remdesivir compared to standard of care, there was no significant difference in the primary endpoint of in-hospital mortality [RR=0.95 (0.81-1.11, p=0.50; 301/2743 remdesivir vs 303/2708 control). Of note, 47.8% and 47.6% of patients receiving remdesivir or standard of care also received corticosteroids. Remdesivir did not reduce initiation of ventilation (remdesivir 295 vs 284 control) or rate of hospitalization on day 7 (remdesivir 69% vs 59% control). Among patients receiving low-flow or high-flow oxygen there were numerically fewer deaths at 28-day (12.2% v 13.8, RR 0.85, 95% CI 0.66-1.09). (Pan, WHO)
- Randomized open-label, phase 3 trial of 397 hospitalized patients with COVID-19 who received remdesivir for a duration of 5 days v 10 days in 55 hospitals across US, Europe, and Asia. Patients had SpO₂ ≤94% on room air, infiltrates on chest imaging, and a positive SARS-CoV-2 PCR within 4 days of enrollment. Patients on mechanical ventilation were excluded. Supportive care was also administered. At baseline patients in 10-day group had significantly worse clinical status (p=0.02) compared to 5-day group. Patients were treated for a median duration of 5 days and 9 days in each group. At day 14, clinical improvement by 2 points, based on 7-point ordinal scale, occurred in 64% of patients treated for 5 days and 54% in those who received 10 days of remdesivir. Median duration of hospitalization among those discharged on or before day 14 was shorter in 5 day group compared to 10 day group (7d v 8d) with more patients being discharged in 5 day group (60% v 52%). Mortality was numerically lower in 5 day group (8% v 11%). Common adverse events were nausea (9%), worsening respiratory failure (8%), elevated ALT (7%), and constipation (7%). (Goldman)

References

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| <ul style="list-style-type: none"> • Kalil AC et al. NEJM 11 December 2020. DOI: 10.1056/NEJMoa2031994 • Pan et al. WHO. NEJM. 2 December 2020. DOI: 10.1056/NEJMoa2023184 | <ul style="list-style-type: none"> • Goldman JD et al. NEJM. 27 May 2020. DOI: 10.1056/NEJMoa2015301 • Wang Y et al. Lancet. 29 April 2020. DOI: 10.1016/S0140-6736(20)31022-9 • Beigel JH et al. NEJM. 8 October 2020. DOI: 10.1056/NEJMoa2007764 |
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AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Dexamethasone (Decadron®)				
<p>Systemic corticosteroid</p> <p><i>Decreases inflammation and production of inflammatory mediators to suppress immune response and pro-inflammatory cytokines associated with COVID-19</i></p>	<p>Various dosing regimens have been reported</p> <p>6 mg PO or IV q24hr for up to 10 days</p> <p><i>Recommended by NIH guidelines for patients on mechanical ventilation or ECMO (AI) or supplemental oxygen (BIII)</i></p>	<p>NMH Recommended use criteria (as of 12/23):</p> <ul style="list-style-type: none"> Consider in ICU patients requiring mechanical ventilation or supplemental oxygen Consider in non-ICU patients on supplemental oxygen <p><u>Not recommended in patients:</u></p> <ul style="list-style-type: none"> not requiring oxygen ARDS >14 days from symptom onset 	<p>Dexamethasone is 4-5 times more potent than prednisone and has long lasting half-life of 36-54 hours, allowing for self-tapering</p> <p>PO tablet should be given with food to prevent GI upset</p> <p>IV formulation can be given as IV push over 3-5min with concentration of 4-10mg/ml</p>	<p>AE: Immunosuppression, metabolic disturbances, hyperglycemia, hypertension, psychiatric disturbances, GI toxicity</p> <p>Contraindications/Precautions: risk of secondary infections, activation of latent infections, exacerbation of viral infections due to delayed viral clearance, anaphylaxis</p>
NMH is enrolled as study site for remdesivir use in Adaptive COVID-19 clinical trial (ACTT-IV)				
<p>Evidence</p> <ul style="list-style-type: none"> RECOVERY: Preliminary report of an open label adaptive RCT of hospitalized patients with suspected COVID (89% SARS-CoV-2 positive) in the UK. Patients were randomized in 2:1 ratio to receive either standard of care (SOC) alone (n=4321) or dexamethasone plus SOC (n=2014). Patients received IV or PO dexamethasone 6 mg daily for up to 10 days (median duration 6 days). Patients were stratified by respiratory support received (none, oxygen only, invasive mechanical ventilation) and duration of symptoms (≤ 7d v > 7d). The mean age was 66.1 years and 36% were females. At randomization 16% were on mechanical ventilation or ECMO, 60% were on supplemental oxygen, and 24% were not on oxygen. At least 56% had one coexisting condition. Mortality rate at 28 days was significantly lower with dexamethasone plus usual care (22.9% vs 25.7%, RR 0.83; 95% CI 0.75 to 0.93; $P < 0.001$). Greatest mortality benefit was among patients on mechanical ventilation (n=1007) (29.3% vs 41.4%; RR, 0.64; 95% CI 0.51 to 0.81) and those receiving oxygen (17.8% v 14.0%, RR 0.82, 95% CI 0.72-0.94), with no clear benefit and possibility of harm in those who did not require oxygen (17.8% vs. 14.0%; RR, 1.19; 95% CI 0.91 to 1.55). Patients with longer duration since symptoms onset (> 7 days) had greater mortality benefit with dexamethasone (RR 0.69, CR 0.59-0.80). Patients in the dexamethasone group had a shorter LOS (median 12 days vs 13 days) and were more likely to be discharged alive within 28 days (67.2% vs 63.5%, RR 1.10 (1.03-1.17)). Among those patients requiring oxygen at randomization, fewer progressed to invasive mechanical ventilation or death (28.1% vs 32.0%, RR 0.87, 95% CI 0.79-0.96). Less patients in the dexamethasone arm progressed to mechanical ventilation (RR 0.92; 95% CI, 0.84 to 1.01) than in the usual care group. The trial provides evidence supporting the use of dexamethasone in patients requiring oxygen support after 7-14 days of symptoms onset. (RECOVERY) CoDex study was a multicenter, randomized, open-label clinical trial of 299 patients in Brazil. COVID-19 patients with moderate to severe disease were randomized (1:1) to receive dexamethasone 20 mg IV daily x5 days, 10 mg of dexamethasone daily for 5 days or until discharge plus standard of care (n=151), or standard of care alone (n=148). Use of dexamethasone resulted in statistically significant increase in the number of ventilator-free days (days alive and free of MV) over 28 days when compared to standard of care alone (6.6 days vs 4.0 days). (Tomazini) <p>Evidence of other glucocorticoids in COVID-19</p> <ul style="list-style-type: none"> Meta-analysis of 7 randomized trials (n=1703) to evaluate the association between systemic steroids and mortality among critically ill COVID-19 patients. There was minimal heterogeneity between trial results. The larger number of patients were from the recovery trial (n=1007). The greatest benefit was seen among patients who received dexamethasone [OR was 0.64 (95% CI, 0.50-0.82; $P < .001$)]. Administration of systemic corticosteroids, compared with usual care or placebo, was associated with significant reduction in 28-day all-cause mortality (OR 0.66) compared to usual care or placebo. (REACT) Randomized clinical trial of 149 ICU patients with acute COVID in France to determine the effect of hydrocortisone on 21-day treatment failure (defined as death or being on mechanical ventilation). The trial was terminated early due failure of hydrocortisone to demonstrate any benefit by day 21 when compared to placebo (42.1% vs 50.7%; $P=0.29$). (Dequin) METCOVID was a parallel, double-blind, placebo-controlled, randomized, phase IIb clinical trial evaluating the efficacy of methylprednisolone (MP) among adult hospitalized patients with suspected COVID-19 in Brazil. 416 patients were randomized, and 393 analyzed as mITT (MP=194, placebo=199). Patients in the MP arm received methylprednisolone (0.5 mg/kg) twice daily x5 days. Only 81.3% of patients had PCR confirmed COVID-19. Third (33.8%) were on mechanical ventilation at baseline. Overall 28-day mortality was 37.7%. None of the patients received anti-IL-6, remdesivir or convalescent plasma. The median duration of therapy was 4 days. The rate of 7, 14, and 28-day mortality was similar between groups (placebo 38.2% vs MP 37.1%; $P=0.629$). Decrease in 28-day mortality was seen in elderly patients > 60 yo with high CRP (HR0.634). Increased mortality was observed in patients < 60 yo. Patients in the MP arm experienced hyperglycemia requiring more insulin. MP did not affect viral clearance by day 7. (Jeronimo) 				
<p>Clinical Trials</p> <ul style="list-style-type: none"> Short term corticosteroids in SARS-CoV2 patient (US). NCT04445506 Dexamethasone and Oxygen support strategies in ICU with COVID-19 PNA (COVIDCUS) (France). NCT04344730 				
<p>References</p> <ul style="list-style-type: none"> The RECOVERY group. NEJM. 17 July 2020. DOI: 10.1056/NEJMoa2021436 Tomazini et al. JAMA. 2 September 2020. doi:10.1001/jama.2020.17021 Meta-analysis. JAMA. Published online September 02, 2020. doi:10.1001/jama.2020.17023Jeronimo et al. Clinical Infectious Diseases. 12 August 2020. https://doi.org/10.1093/cid/ciaa1177 Dequin et al. JAMA. 2 September 2020. doi:10.1001/jama.2020.16761 Fadel R et al. CID. 19 May 2020. DOI: 10.1093/cid/ciaa601/5840526 Fernandez Cruz A et al. AAC. 22 June 2020. DOI: 10.1128/AAC.01168-20 				

AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Baricitinib (Olumiant®)				
<p>Janus Kinase Inhibitor</p> <p>Proposed MOA: <i>Inhibition of JAK1/2 to mediate cytokine signaling involved in inflammation; Inhibition of cyclin G-associated kinase to regulate endocytosis; interrupt viral entry and viral particle assembly via disruption of AP2-associated protein kinase 1 (AAK1)</i></p>	<p>The recommended dose under the EUA: -Adults and pediatrics 9 years and older: 4 mg once daily -Pediatrics 2-9 years: 2 mg once daily</p> <p>Renal dose adjustment based on eGFR_(ml/min/1.73 m²): - ≥60: no dose adjustment -30 to <60: 2 mg once daily -15 to <30: 1 mg once daily - <15: not recommended</p> <p>Duration: up to 14 days or until hospital discharge, do not continue as outpatient</p>	<p>EUA granted for use in combination with remdesivir for the treatment of suspected of confirmed COVID for patients requiring supplemental oxygen, including patients on mechanical ventilation and those on ECMO</p> <p>Consider use in patients who require hi-flow oxygen or NIMV who cannot receive dexamethasone or equivalent steroid therapy</p> <p>Eligible patients should be considered for enrollment in clinical trial – Contact ID COVID study team</p>	<p>FDA Emergency use authorization document</p> <p>EUA Fact Sheet for Healthcare Providers</p> <p>EUA Fact Sheet for Patients</p> <p>EUA use requires non-formulary request and approval</p> <p>Oral tablets are to be taken orally or can be crushed, dispersed in water, and given via gastrostomy tube</p> <p>In hospitalized patients with COVID-19, prophylaxis for venous thromboembolism (VTE) is recommended unless contraindicated</p>	<p>AE: serious infections, thrombosis including pulmonary embolism, and hypersensitivity reactions</p> <p>Contraindications/Precautions: Monitor hepatic and renal function, CBC. Interruption of therapy or dose adjustments may be required</p> <ul style="list-style-type: none"> Interrupt therapy if AST/ALT elevation attributed to suspected drug-induced liver injury (DILI) Dose adjustment is recommended if Absolute Lymphocyte Count (ALC)<200 or Absolute Neutrophil Count (ANC) <500
NMH is enrolled as study site for remdesivir use in Adaptive COVID-19 clinical trial (ACTT-IV)				
<p>Evidence</p> <ul style="list-style-type: none"> ACTT-2: double blind, randomized, placebo-controlled trial evaluating baricitinib and remdesivir (B+R) in hospitalized adults with Covid-19. All the patients received remdesivir (≤10 days) and either baricitinib (≤14 days) or placebo (control). The primary outcome was the time to recovery. The key secondary outcome was clinical status at day 15. A total of 1033 patient were randomized 1:1 to receive combination of baricitinib plus remdesivir or placebo. Patients randomized to treatment had a reduced recovery time compared to placebo (7 vs 8 days), and 30% higher odds of improvement in clinical status (OR 1.3). Notably, patients receiving high flow oxygen or noninvasive ventilation had the greatest benefit, with time to recovery of 10 days compared to 18 days with control. Serious adverse events including infections were less frequent in the treatment group. The results of this randomized, double-blind, placebo-controlled trial show that combination treatment with the antiinflammatory drug baricitinib and the antiviral drug remdesivir was safe and superior to remdesivir alone for the treatment of hospitalized patients with Covid-19 pneumonia. (Kalil) Controlled, observational study of 83 patients who received baricitinib and a matched cohort of 83 patients in Europe from the Albecta hospital (Spain) and the University of Pisa (Italy). Both arms were well matched. The average age of the population from the University of Pisa was 65 yo, and 80 years old for patients from Albecta hospital (n=92). Most patients in the study received concomitant “antiviral therapy” with hydroxychloroquine, lopinavir/ritonavir, antibiotics, corticosteroids and low molecular weight heparin. The composite endpoint of death or mechanical ventilation was 14 in the active arm (16.9%) versus 29 (34.9%) in the control arm [RR 52%, p=0.001]. Significant reduction in primary outcome was also noted in the older subpopulation from the Albecta hospital. (Stebbing) 				
<p>Clinical Trials</p> <ul style="list-style-type: none"> (COV-BARRIER): NCT04421027 				
<p>References:</p> <ul style="list-style-type: none"> Kalil et al. 11 December 2020. NEJM. DOI: 10.1056/NEJMoa2031994 Stebbing et al. 12 November 2020. Science Advances. DOI: 10.1126/sciadv.abe4724 				

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Convalescent Plasma				
Plasma, blood product <i>Plasma derived from recovered donors which has developed humoral immunity, may neutralize SARS-CoV-2 in infected patients</i>	Managed by individual blood banks 1-2 units once (200-250ml per unit) Order 2 units for patients who weigh >100kg If a second unit of convalescent plasma is transfused, should be given within 12 hours of completion of first unit administration	Available as Emergency Use Authorization Consider use early in course of disease (≤3 days from diagnosis) Recent RCT demonstrated the use of convalescent plasma did not result in reduction in mortality or progression to severe disease	Ordering process across NM: 1. Obtain signed informed consent using NM convalescent plasma consent form below and blood product transfusion consent 2. Scan signed consent into Epic media tab 3. Ensure patient has an active type and screen 4. Place Convalescent Plasma order in Epic FDA Investigational Consent Form	AE: Allergic reactions, viral infections, antibody-mediated enhancement of infection Precautions: Transfusion reactions including transfusion-associated acute lung injury or circulatory overload
Evidence				
<ul style="list-style-type: none"> PlasmAr: a double-blind, placebo-controlled, multicenter trial conducted at 12 clinical sites in Argentina. A total of 228 hospitalized patients with severe COVID were randomized 2:1 to receive convalescent plasma or placebo. The primary outcome was the patient’s clinical status at 30 days, as measured on a six-point ordinal scale ranging from total recovery to death. The median time from symptom onset to trial enrollment is 8 days. Hypoxemia was the most frequent criterion for enrollment. The infused convalescent plasma had a median titer of 1:3200 of total SARS-CoV-2 antibodies. At day 30, there was no significant difference between groups in clinical outcomes according to ordinal scale [OR 0.83; P=0.046]. Overall mortality and adverse events were similar in the two groups. (Ventura) PLACID: an open label, multicenter, randomized, clinical trial of hospitalized patients with moderate COVID-19 in India. A total of 464 patients were randomized to convalescent plasma (2 doses of 200 mL) with standard of care, or standard care alone. Nearly 64% of donors had a titer of more than 1:20, with a median titer of 1:40. The primary outcome was a composite of progression to severe disease or all-cause mortality at 28 days. The primary outcome occurred in 44 (19%) of patients who received CP vs 41 (18%) who received standard care [RR 1.04]. Mortality was recorded in 34 (15%) patients in the intervention arm and 31 (14%) patients in the control arm. A higher proportion of patients that received CP showed resolution of shortness of breath and fatigue at day 7. Over all, administration of CP did not result in reduction in 28-day mortality or progression to severe disease. (Agarwal) Observational, open-label study of convalescent plasma expanded access program (EAP) by Mayo Clinic that included 35,322 hospitalized patients with/at risk of severe COVID-19 at 2,807 acute care facilities. Patients received at least one unit of human convalescent plasma donated by COVID-19 survivors. The primary outcome was 7 and 30-day mortality. Half the patients (52.3%) were critically ill, & 27.5% were on mechanical ventilation at baseline. The mortality rate was significantly lower in patients transfused within 3 days of diagnosis when compared to patients transfused 4 days or later. The rate of 7-day mortality was (early transfusion 8.7% vs late 11.9%; P<0.001) and 30-day mortality was (21.6% vs. 26.7%, P<0.0001). Patients who received high IgG plasma had the lowest rate of mortality (8.9%) when compared to medium IgG plasma (11.6%), and low IgG plasma (13.7%), (p=0.048). Reduced mortality was noted with early transfusion and high IgG antibody level transfusion. (Joyner) Open-label, multicenter, randomized, controlled trial of 103 patients with confirmed COVID-19 who received convalescent plasma with standard of care (SOC, n=52) compared to SOC alone (n=51) in Wuhan, China. Included patients had severe (respiratory distress and/or hypoxemia) or life-threatening (shock, organ failure, or mechanical ventilation) COVID-19. Clinical improvement within 28 days, noted as patient being discharged from hospital alive or an observed reduction of 2 points in 6-point disease severity scale was not significantly different among convalescent plasma group compared to SOC (51.9% v 43.1%, p=0.26). Among those with severe disease, significant clinical improvement seen in patients receiving convalescent plasma (91.3% v 68.2%, p=0.03). No significant difference observed in 28-day mortality among patients in each group (15.7% v 24.0%) or a significant difference in time to discharge. Improved negative conversion rate of viral PCR at 72 hrs among those receiving convalescent plasma compared to SOC (87% v 38%, P<0.001). (Li) 				
Clinical Trials				
<ul style="list-style-type: none"> Convalescent Plasma in the Treatment of COVID 19 (US). NCT04343261 Convalescent Plasma for the Treatment of COVID-19 (US). NCT04389710 			<ul style="list-style-type: none"> Convalescent Plasma in ICU Patients with COVID-19 induced Respiratory Failure (US). NCT04353206 Safety in Convalescent Plasma Transfusion to COVID-19 (Mexico). NCT04333355 	
References:				
<ul style="list-style-type: none"> Ventura et al. 24 November 2020. DOI: 10.1056/NEJMoa2031304 Agarwal et al. 3 November 2020. BMJ. doi: https://doi.org/10.1136/bmj.m4232 Pre-print: Joyner et al. 12 August 2020. Effect of Convalescent Plasma on Mortality among Hospitalized Patients with COVID-19: Initial Three-Month Experience. 2020. doi:10.1101/2020.08.12.20169359 Li L et al. Effect of convalescent Plasma Therapy on Time to Clinical Improvement in Patients with Severe and Life-threatening COVID-19. JAMA. 3 June 2020. DOI:10.1001/jama.2020.10044 Zeng QL et al. Effect of convalescent plasma on viral shedding and survival in patients with coronavirus disease 2019. JID. 28 April 2020. DOI: 10.1093/infdis/jiaa228 Shen C et al. Treatment of 5 critically ill patients with COVID-19 with convalescent plasma. JAMA. 27 March 2020. DOI:10.1001/jama.2020.4783 				

AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Tocilizumab (Actemra®)				
<p>IL-6 receptor antagonist; Humanized monoclonal antibody</p> <p><i>Binds to soluble membrane-bound IL-6 receptors to inhibit IL-6 mediated pro-inflammatory response</i></p>	<p>Various dosing regimens have been reported 400mg IV once OR 8mg/kg* IV once, up to 800mg</p> <p>Consider re-dosing 8-24hr after initial dose if no or partial clinical response – up to 2 additional doses *Weight-based Dose rounding:</p> <ul style="list-style-type: none"> • 50-60 kg: 400mg • >60-85 kg: 600mg • >85 kg: 800 mg <p>Dosing adjustments for hepatic impairment</p>	<p>Not recommended outside of investigational use due to varying evidence in clinical trials</p> <p>IL-6 receptor antagonists have unclear place in therapy in light of recent sarilumab RCT results demonstrating no significant clinical benefit and potential risk for adverse events</p>	<p>Consider checking inflammatory markers (D-dimer, CRP, ESR, ferritin, fibrinogen) prior to administration</p> <p>Consider checking for history or evidence of tuberculosis prior to initiation</p>	<p>AE: Increased ALT/AST, neutropenia, thrombocytopenia, injection site reaction, Upper respiratory tract infections, nasopharyngitis, headache, hypertension</p> <p>Contraindications/Precautions: risk of serious and fatal infections, including tuberculosis, invasive fungal infections, viral infections, and PJP. Increased risk of gastric perforation, hepatic injury</p>
Evidence				
<ul style="list-style-type: none"> • EMPACTA: RCT of hospitalized patients not receiving mechanical ventilation receiving standard of care plus one or two tocilizumab (n=249) doses (8mg/kg) or placebo (n=128). Tocilizumab plus standard of care resulted in fewer patients who progressed to mechanical ventilation or death compared to placebo (12.0% v 19.3%, HR 0.56, 95% CI 0.33-0.93). Progression to ICU including requirement of mechanical ventilation or ECMO were similar (3.2% v 4.7%). The difference in time to hospital discharge (6 vs 7.5 days, HR 1.16, 95% CI 0.91-1.48) or time to improvement in clinical status (6 vs 7 days, HR 1.15, 95% CI 0.90-1.48) was not significant. Serious adverse events were similar in each group (15.2% v 19.7%) with similar rates of secondary infections (5.2% v 7.1%). (Salama) • Randomized, double-blind, placebo-controlled trial involving patients with confirmed COVID-19 infection, hyperinflammatory state, and one of the following signs: fever, pulmonary infiltrates, or the need for supplemental O2. 243 patients randomized 2:1 to receive standard care plus a single dose of tocilizumab (8 mg/kg) or placebo. The primary outcome was intubation or death at 28 days, which was numerically reduced with tocilizumab (10.6% v 12.5%, HR 0.83 P=0.64). Overall, tocilizumab was not effective in preventing death or mechanical ventilation amongst moderately ill COVID-19 patients. However, because the confidence interval is wide, potential harm or benefit cannot be ruled out completely. (Stone) • Prospective, open-label, randomized clinical trial of 126 patients in Italy with confirmed COVID-19 and Pao₂/Fio₂ ratio between 200 and 300 mm Hg and elevated CRP (≥10 or more than x2 increase). Patients were excluded if they had advanced age or multiple comorbidities, or if the treating physician deemed the patient wouldn't receive ICU care. 60 patients were randomized to tocilizumab (8 mg/kg up to a maximum of 800 mg administered within 8 hours of administration, and followed by a second dose 12 hours later); 63 randomized to the control group. Seventeen patients of 60 (28.3%) in the tocilizumab arm and 17 of 63 (27.0%) in the standard care group showed clinical worsening within 14 days since randomization (rate ratio, 1.05; 95% CI, 0.59-1.86). The administration of tocilizumab did not reduce the risk of clinical worsening. (Salvarani) • Multicenter cohort evaluating the efficacy of tocilizumab in critically ill patients with COVID-19 (n=3,924). Eleven-percent of patients received tocilizumab in the first 2 days of ICU admission. More patients who received tocilizumab were on mechanical ventilation (paO₂/FIO₂ <200 mmHg) (toci 47.3% vs 37.9% control). Among the well-balanced group (n=1,544) 28.9% treated with toci died vs 40.6% control. In the primary analysis, patients treated with tocilizumab had a lower risk of death during a median follow-up of 27 days (HR, 0.71; 95% CI, 0.56-0.92). The estimated 30-day mortality rate was lower in patients who received toci in the first 2 days of ICU admission compared to control (toci 27.5% vs 37.1% control). These findings are susceptible to bias due to unblinded nature of the study. (Gupta) • Meta-analysis of 10 observational studies (n=1358) showed that mortality was 12% lower for COVID-19 patients treated with tocilizumab compared to control. The suggested number needed to treat was 11. There was no mortality benefit in patients who received tocilizumab + steroids. These results carry a high risk of bias driven by heterogenic observational studies with unmatched cohorts. Results must be interpreted with caution. (Malgie) • Pre-print: COVACTA study was a phase III randomized, double-blind, placebo controlled study investigating the efficacy and safety of tocilizumab compared to placebo in hospitalized patients with severe COVID. The primary endpoint was measured using 7-category ordinal scale of clinical status based on need for supplemental oxygen at day 28. 452 hospitalized patients were randomized (2:1) to tocilizumab (8 mg/kg) (n=294) and placebo (n=144). There was no difference in primary endpoint of improved clinical status (OR 1.19; P 0.36), or secondary end point of difference in patient mortality at week four (Toci 19.7% vs placebo 19.4%; P=0.941). However, hospital discharge was 8 days shorter with tocilizumab (20 days) than placebo (28 days); P=0.037. Serious adverse events occurred in 34.9% of patients in the tocilizumab arm and 38.5% of patients in the placebo arm. Rate of infections were similar (Toci 38.3% vs. placebo 40.6%). (Rosas) 				
References			<ul style="list-style-type: none"> • Biran et al. 14 August 2020. Lancet Rheumatology. DOI:https://doi.org/10.1016/S2665-9913(20)30277-0 • Somers et al. Clinical Infectious Diseases. 11 July 2020. DOI: 10.1093/cid/ciaa954 • Martinez-Sanz J et al. Pre-print medRxiv. 9 June 2020. DOI: 10.1101/2020.06/08/20125245 • Zhang C et al. Int Jour of Antimicrobial Agents, March 29, 2020. DOI: 10.1016/j.ijantimicag.2020.105954 • Xu Xialong et al. PNAS. May 19 2020. DOI: 10.1073/pnas.2005615117 • Roumier M et al. medRxiv Pre-print. April 22, 2020: https://doi.org/10.1101/2020.04.20.20061861 	

OUTPATIENT USE ONLY				
AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Bamlanivimab (LY-CoV555)				
Recombinant, neutralizing human IgG1 monoclonal antibody (mAb) <i>Consists of two antibodies directed against the spike protein of SARS-CoV-2. It is designed to block viral attachment and entry into human cells, thus neutralizing the virus, potentially treating COVID-19.</i> Lilly	Dose: single IV infusion of 700 mg administered over 60 minutes as soon as possible after positive viral test for SARS-CoV2 and within 10 days of symptom onset	FDA authorized under emergency use authorization (EUA) for the treatment of mild to moderate COVID-19 in adults and pediatric patients 12 years and older with a positive COVID-19 test, who are at high risk for progressing to severe COVID-19 and/or hospitalization	For eligibility criteria, please see: NM Outpatient Protocol EUA Fact sheet for Health Care Providers EUA Fact Sheet for Patients	AE: infusion related reactions and hypersensitivity including anaphylaxis Administration in patients hospitalized due to COVID may be associated with worse clinical outcomes Patients treated with bamlanivimab should continue to self-isolate and use infection control measures
Evidence <ul style="list-style-type: none"> BLAZE-1: a randomized, ongoing, double-blind, placebo-controlled Phase 2 study involving outpatients with recently diagnosed mild to moderate COVID-19. In this study, 452 patients were randomly assigned to receive single IV infusion of bamlanivimab (700, 2800, or 7000 mg) or placebo. The primary outcome was change in viral load at day 11. Patients treated with 2,800 mg dose of bamlanivimab showed the greatest reduction in viral load (-3.5 vs -3.47 with placebo; P=0.02). Smaller differences were observed among patients who received the 700 mg dose (-0.2; P 0.38] or the 7000 mg dose [0.09; P=0.7]. Patients who received bamlanivimab had a slightly lower severity of symptoms, and less COVID related hospitalizations (1.6% vs 6.3%) Frequency and types of adverse events were similar between bamlanivimab and placebo, with the majority being mild to moderate in severity. Infusion reactions and other allergic hypersensitivity events have been reported in the study. (Chen) ACTIV-3: comparing bamlanivimab and remdesivir against placebo and remdesivir in hospitalized COVID patients. Study enrollment was halted by the safety committee due to lack of efficacy. (press release) 				
Clinical Trials <ul style="list-style-type: none"> ACTIV-3: comparing bamlanivimab and remdesivir against placebo and remdesivir in hospitalized COVID patients. Enrollment was halted by the safety committee due to lack of efficacy 				
References: <ul style="list-style-type: none"> Chen et al. 28 October 2020. NEJM. DOI: 10.1056/NEJMoa2029849 				

PREVIOUSLY INVESTIGATED AGENTS				
AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
<p>Sarilumab (Kevzara®)</p> <p>IL-6 receptor antagonist; Humanized monoclonal antibody</p> <p><i>Binds to soluble membrane-bound IL-6 receptors to inhibit IL-6 mediated pro-inflammatory response</i></p> <p>Sanofi-Regeneron</p>	<p>Trial Regimens:</p> <ul style="list-style-type: none"> Sarilumab 400 mg IV once Placebo IV once 	<p>Investigational – US clinical trial stopped in light of recent sarilumab RCT results demonstrating no significant clinical benefit and potential risk for adverse events</p> <p>Hospitalized patients on mechanical ventilation with critical COVID-19</p>	<p>Consider checking inflammatory markers (D-dimer, CRP, ESR, ferritin, fibrinogen) prior to administration</p> <p>Consider checking for history or evidence of tuberculosis prior to initiation</p>	<p>AE: increased serum ALT and AST, antibody development, local injection site reaction, neutropenia</p> <p>Contraindications/Precautions: GI perforation, neutropenia, thrombocytopenia, hepatotoxicity, hyperlipidemia, infusion reactions, infection, tuberculosis</p>
<p>Clinical trial no longer active in US based on preliminary results which did not demonstrate significant reduction in CRP nor clinical improvement compared to supportive care</p>				
<p>Evidence</p> <ul style="list-style-type: none"> Press Release from Sanofi-Regeneron – Compared to placebo, sarilumab 400mg use among mechanically ventilated patients with critical COVID-19 did not meet its primary endpoint of significant reduction in CRP levels nor key secondary endpoints including 1-point clinical improvement based on 7-point ordinal severity scale. This was in combination with supportive care. Adverse events were experienced at high rates, 80% in sarilumab arm & 77% among those receiving placebo, including serious AE such as multiorgan dysfunction syndrome (6% sarilumab, 5% placebo) and hypotension (4% sarilumab, 3% placebo). Based on these results, the trial has been stopped in the US, including a secondary cohort of patients receiving sarilumab 800mg. (Sanofi-Regeneron) Preliminary analysis of phase II trial comparing sarilumab 200mg v 400mg v placebo in COVID-19 patients with baseline categorization of severe (dyspnea, hypoxia, or >50% lung involvement on imaging), critical (respiratory failure, shock, or multi-organ failure), or multi-system organ dysfunction. Among 358 patients included in the trial, administration of sarilumab was associated with drastic reduction in CRP levels from highest baseline (-79% with 400mg dose, -77% with 200mg, -21% with placebo). In an exploratory analysis, sarilumab had no notable benefit when combining severe and critical subgroups, due to negative trends seen within the severe group. In the critical subgroup all exploratory outcomes were positive, with notable benefit in the 400mg dose compared to placebo (endpoints: died or on a ventilator 32% v 55%, 2-point clinical improvement on 7-point ordinal scale 59% v 41%, off oxygenation 58% v 41%, discharged 53% v 41%). As a result, the phase III trial will explore use of sarilumab 400mg dose v placebo in the critical study population. <p>Clinical Trials</p> <ul style="list-style-type: none"> Evaluation of the Efficacy and Safety of Sarilumab in Hospitalized Patients With COVID-19. NCT04315298 (NMH) - stopped Study of Immune Modulatory Drugs and Other Treatments in COVID-19 Patients: Sarilumab, Azithromycin, Hydroxychloroquine Trial - CORIMUNO-19 - VIRO. NCT04341870 Sarilumab COVID-19. NCT04327388 Anti-IL6 Treatment of Serious COVID-19 Disease With Threatening Respiratory Failure. NCT04322773 Randomized, Embedded, Multifactorial Adaptive Platform Trial for Community- Acquired Pneumonia. NCT02735707 				
<p>References:</p> <ul style="list-style-type: none"> Press: Sanofi and Regeneron – Clinical Trial Stop (Announcement 7/2/20) 			<ul style="list-style-type: none"> Press: Sanofi and Regeneron Update (Announcement 3/16/20 & Announcement 4/27) Kevzara [Package Insert] 	

AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Interferon β-1a (Rebif®)				
<p>Biological Response Modulator</p> <p><i>It interferes with viral replication via the interferon-stimulated genes (ISG) and modulates the body's immune response to SARS-CoV-2 infection by increasing the expression of CD-73 protein. It can also reduce ARDS by improving vascular leakage</i></p> <p>EMD Serono</p>	<p>Trial regimen: -Interferon beta- 1a: 44 mcg subcutaneous injection every other day for a total of 4 doses (day 1, 3, 5, and 7 while hospitalized)</p>	<p>Investigational – enrollment in clinical trial-ACCT-III (NMH only): Currently OPEN (remdesivir + interferon beta-1a vs. remdesivir + placebo)</p> <p>Per NIH guidelines: Not recommended for the treatment of severe COVID outside of clinical trials due to lack of benefit and significant toxicities</p>	<p>Monitor CBC, liver function tests, and thyroid function for patients with pre-existing abnormalities.</p> <p>SubQ administration: injection site reactions can occur with subcutaneous administration. Monitor patients closely when administering the first injection; doses should be at least 48 hours apart; rotate injection site; do not inject into an area where skin is irritated, red, bruised, or scarred.</p>	<p>AE: flu-like symptoms, nausea, fatigue, weight loss, hematological toxicities (leukopenia), hepatotoxicity, and psychiatric symptoms.</p> <p>Precautions: use in caution in patients with autoimmune disorders, history of depression, cardiovascular history, or if patients are on chemotherapy and other immunomodulators.</p>
Evidence				
<ul style="list-style-type: none"> Pre-print: randomized, open-label, controlled trial evaluating the efficacy of IFN β-1a in patients with severe COVID in Iran (n=81). 42 patients were randomized to receive IFN β-1a and 39 patients were in the control group. The mean age in the study was 52 years old. Fifty-two (64.19%) patients had positive nasopharyngeal real-time PCR (RT-PCR) for SARS-CoV-2, and 29 (35.81%) patients were diagnosed according to the clinical signs/symptoms along with the imaging findings. Median time from symptom onset to IFN administration was 10 days. Forty-percent of patients were on mechanical ventilation at randomization. Almost all patients (79/81) were on hydroxychloroquine. Lopinavir-ritonavir or atazanavir-ritonavir were added to (36/81) for 10 days for patients with severe disease. Corticosteroids were administered to 61.9% of patients in the IFN group and 43.6% of patients in the control group. Corticosteroid dose was equivalent to 250 mg of methylprednisolone for 3 days. In addition, more patients in the IFN group (35.7%) than in the control group (25.6%) received IVIG. As for the primary outcome, time to clinical response was not statistically different between the IFN and control groups (9.7 vs 8.3 days; P 0.95). The six-category ordinal scale was assessed on day 0, 7, 14, and 28 of therapy. On day 7, 19% of patients in the IFN group were discharged with no deaths, but 28% of patients in the control were group were discharged and 25% died. On day 14, discharge rate was statistically higher with IFN (IFN 66.7% vs. control 43.6%; OR, 2.5; 95% CI, 1.05 to 6.37). The 28-day mortality was significantly lower with IFN (19% vs. 43.6%; P=0.0015). Analysis showed that early administration of IFN had significantly reduced mortality (OR, 13.5; 95% CI, 1.5 to 118). Injection related side effects happened in 19% of IFN patients, and 4 patients experiences neuropsychiatric problems (agitation and depression). (Davoudi-Monfared). 				
Interferon Beta -1b:				
<ul style="list-style-type: none"> An open-label, Phase 2 clinical trial randomized 127 participants (2:1) to combination antiviral therapy or lopinavir/ritonavir. In the combination antiviral therapy group, the treatment regimen differed by time from symptom onset to hospital admission. Participants hospitalized within 7 days of symptom onset (n = 76) were randomized to triple drug therapy (interferon beta-1b 8 million units administered subcutaneously every other day for up to 7 days total, lopinavir/ritonavir, and ribavirin); those hospitalized ≥7 days after symptom onset (n = 51) were randomized to double therapy (lopinavir/ritonavir and ribavirin) because of concerns regarding potential inflammatory effects of interferon. Patients in the control group received lopinavir/ritonavir alone regardless of the time from symptom onset to hospitalization. The study participants were patients in Hong Kong with confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection who were hospitalized until they had two negative nasopharyngeal (NP) swab tests. The time to a negative result on PCR SARS-CoV-2 test on an NP swab (the primary endpoint) was shorter in the combination therapy group than in the control group (median of 7 days vs. 12 days; P = 0.001). The combination group had more rapid clinical improvement as assessed by the National Early Warning Score (NEWS) 2 and Sequential Organ Failure Assessment (SOFA) score and a shorter hospital stay (median of 9 days for the combination group vs. 14.5 days for the control group; P = 0.016). There was no difference in oxygen use between the groups. The antiviral and clinical effect was more pronounced in the patients hospitalized within 7 days of symptom onset, suggesting that interferon beta-1b with or without ribavirin was the critical component of the combination antiviral therapy. The study provides no information about the effect of interferon beta-1b when administered ≥7 days after symptom onset. (Hung) 				
Clinical Trials				
<ul style="list-style-type: none"> Adaptive COVID-19 Treatment Trial 3 (ACTT-3). NCT04492475 Click for more ongoing clinical trials for interferon and COVID-19 				
References:				
<ul style="list-style-type: none"> Davoudi-Monfared et al. Antimicrob Agents Chemother. 13 July 2020. DOI: 10.1128/AAC.01061-20 Hung et al. Lancet. 8 May 2020. https://doi.org/10.1016/S0140-6736(20)31042-4 				

AGENTS	RECOMMENDED DOSE	PLACE IN THERAPY	OPERATIONS	CONTRAINDICATIONS/ADVERSE EVENTS
Canakinumab (Ilaris®)				
<p>IL-1β receptor antagonist; Monoclonal antibody</p> <p><i>Binds to IL-1β to block interaction between IL-1β and IL-1 receptor, leading to inhibition of IL-1β induced gene activation and production of downstream inflammatory mediators including IL-6 and CRP and potentially preventing inflammatory damage associated with ARDS</i></p> <p>Novartis</p>	<p>Trial Regimens:</p> <ul style="list-style-type: none"> • Canakinumab dosed based on pt’s body weight • 40-59.9kg: 450mg • 60-80kg: 600mg • >80kg: 750mg • Placebo 	<p>Investigational – enrollment in clinical trial is currently closed</p>	<p>Recommended for patients to have up to date immunizations including pneumococcal and influenza vaccines before initiating therapy. Avoid administration of live vaccines in patients receiving concurrent therapy.</p>	<p>AE: increased risk of infections, particularly upper respiratory tract infections, nasopharyngitis, ALT/AST elevations, GI toxicity including diarrhea, abdominal pain, nausea, headache, weight gain</p> <p>Contraindications/Precautions: Neutropenia, thrombocytopenia, infections, Macrophage activation syndrome, malignancy, tuberculosis, hypersensitivity, infusion reactions</p>
Clinical trial enrollment is currently closed				
<p>Evidence</p> <ul style="list-style-type: none"> • No evidence currently available – clinical trials pending <p>Clinical Trials</p> <ul style="list-style-type: none"> • Study of Efficacy and Safety of Canakinumab Treatment for CRS in participants with COVID-19 induced pneumonia (US – NMH). NCT04362813 • Observation Study, Use of Canakinumab administered subcutaneously in the treatment of COVID-19 pneumonia (Italy). NCT04348448 • Canakinumab to reduce deterioration of cardiac and respiratory function due to COVID-19 (US). NCT04365153 				
<p>References:</p> <ul style="list-style-type: none"> • Ridker PM et al. NEJM. 21 September 2017. • Ilaris [Package Insert] 				