CLINICAL BEST PRACTICE ADVICE FOR HEPATOLOGY AND LIVER TRANSPLANT PROVIDERS DURING THE COVID-19 PANDEMIC: AASLD EXPERT PANEL CONSENSUS STATEMENT

This is a “living” document that will continue to evolve and will be updated as new information becomes available.

Table 1. Diagnostic Methods for SARS-CoV-2 Detection

| Figure 1. Approach to the Patient with COVID-19 and Elevated Serum Liver Biochemistries |
| Figure 2. Approach to Liver Transplant Organ Offers |
| Figure 3. Approach to the Liver Transplant Recipient with COVID-19 |
Disclaimer
This document represents the collective opinion of its authors and approval of the AASLD Governing Board as of the date of publication. Its use is voluntary, and it is presented primarily for the purpose of providing information to hepatology and liver transplant care providers. This document is not a practice guideline and has not been subject to the methodical rigor of a practice guideline. There has not been a systematic evidence review as defined by the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine (formerly the Institute of Medicine), nor is the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach utilized. This document does not define a standard of practice or a standard of care. It should not be considered as inclusive of all proper treatments or methods of care, nor is it intended to substitute for the independent professional judgment of the treating provider. Hospitals, clinics and private practices should take into account local standards, practices and environment.

Overview and Rationale
Coronavirus disease 2019 (COVID-19), the illness caused by the SARS-CoV-2 virus, continues to spread rapidly throughout the world.1 In many parts of the United States, hospitals and healthcare providers at the front lines continue to manage critically ill patients with limited information about this new disease. Nonetheless, we all must do our part to implement the drastic changes necessary to mitigate the spread of SARS-CoV-2 to keep our healthcare system from becoming overwhelmed.2 These changes have resulted in a backlog of routine procedures and clinic visits that could have long-lasting effects on the health of patients with liver disease.3 Nevertheless, we must continue to manage the care of our patients with liver disease and our liver transplant recipients despite unique logistical and pharmacological issues. Patients with chronic liver disease including cirrhosis may be at higher risk of death from COVID-19, but clinical risk factors in specific liver diseases, such as autoimmune hepatitis or liver cancer, or in transplant recipients, are not clearly defined.4 Although many risks factors of severe COVID-19 are now known, it is unclear if patients on immunosuppressive medications are at increased risk for severe COVID-19. Given the extraordinary amount of rapidly emerging data on COVID-19, it is difficult for any single clinician to stay abreast of the latest information. The goals of this document are to provide data on what is currently known about COVID-19, and how it may impact hepatologists, liver transplant providers, and their patients. Our aim is to provide a template for the development of clinical recommendations and policies to mitigate the impact of the COVID-19 pandemic on liver patients and healthcare providers. As some communities begin a gradual return toward a pre-pandemic state, we must adjust to the “new normal” and find ways to achieve optimal care and safety in response to changes in our work and surrounding environment. Considering that SARS-CoV-2 can be transmitted from asymptomatic individuals, including children, and it can be detected in stool after viral clearance from pharyngeal samples,5–8 these recommendations have been created to protect our patients, communities, and healthcare workers. Data from Italy indicate that up to 20% of healthcare workers who are taking care of patients with COVID-19 may become infected.9 The Centers for Disease Control and Prevention (CDC) has reported over 9200 COVID-19 cases in US healthcare workers, including some with severe outcomes including death.10 We must continue to work to contain the spread of SARS-CoV-2 to ensure the health of our patients with liver disease and the healthcare workers who must care for them.
Effects of SARS-CoV-2 on the Liver and Evaluation of COVID-19 Patients with Elevated Liver Biochemistries

What we know

• The novel coronavirus SARS-CoV-2 is most similar to the beta-coronaviruses, SARS-CoV and MERS-CoV, the causative agents of the SARS outbreak in 2002-2003 and the MERS outbreak beginning in 2012, respectively.
• SARS-CoV-2 is a single, positive-stranded RNA virus that replicates using a virally-encoded RNA-dependent RNA polymerase.
• SARS-CoV-2 binds to and is internalized into target cells through angiotensin-converting enzyme 2 (ACE2), which acts as a functional receptor.\(^{11,12}\)
• ACE2 is present in biliary and liver epithelial cells; therefore, the liver is a potential target for infection.\(^{13}\)
• The incidence of elevated serum liver biochemistries in hospitalized patients with COVID-19 ranges from 14% to 53%.\(^{1,14-19}\)
  o Primarily elevated AST and ALT 1-2 times the upper limit of normal (ULN) and normal to modestly elevated total bilirubin early in the disease process.\(^{19,20}\)
  o Liver injury occurs more commonly in severe COVID-19 cases than in mild cases.\(^{18}\)
  o Rare cases of severe acute hepatitis have been described in patients with COVID-19.\(^{14,19,21}\)
  o Liver injury in mild COVID-19 cases is usually transient and does not require specific treatment beyond supportive care.\(^{18}\)
• Low serum albumin on hospital admission is a marker of COVID-19 severity.\(^{17,22,23}\)
• Severe liver injury in COVID-19 is uncommon in children; in the rare cases of severe pediatric COVID-19, increases in ALT or AST, when present, are usually mild (<2x ULN).\(^{24,25}\)
• COVID-19 has recently been reported as possibly linked with a pediatric multisystem inflammatory syndrome disease with overlapping features of Kawasaki disease and positive COVID-19 antibody testing suggesting a post-infectious entity.
• Liver histologic assessment has been limited but thus far is nonspecific and ranges from moderate microvesicular steatosis with mild, mixed lobular and portal activity to focal necrosis.\(^{26,27}\)
• An Italian autopsy series described focal portal and lobular lymphocytic infiltrates and changes suggestive of hepatic vascular involvement.\(^{28}\)
• Elevated liver biochemistries may reflect a direct virus-induced cytopathic effect and/or immune damage from the provoked inflammatory response and cytokine release syndrome.\(^{15,29}\)
• Therapeutic agents used to manage symptomatic COVID-19 may be hepatotoxic but rarely lead to treatment discontinuation.\(^{18}\) These include remdesivir and tocilizumab.
• Less common causes of elevated liver biochemistries include chloroquine, hydroxychloroquine, and azithromycin.
• It is unknown whether patients with chronic liver disease, especially viral hepatitis B and/or C, may be more susceptible to liver damage from SARS-CoV-2, as was the case with SARS-CoV.\(^{17,30}\)
• It is also unknown whether SARS-CoV-2 infection exacerbates cholestasis in those with underlying cholestatic liver disease such as primary biliary cholangitis or primary sclerosing cholangitis or with underlying cirrhosis.\(^{18}\)
• Patients with chronic lung disease including those with alpha-1 antitrypsin deficiency may be at increased risk of severe COVID-19.
• Emerging data demonstrate that COVID-19 may predispose patients to thromboembolic disease and anticoagulation may improve outcomes in hospitalized patients.\(^{31,32}\)
An Italian autopsy series described diffuse intrahepatic vascular abnormalities, including partial or complete acute portal and sinusoidal thrombosis and chronic fibrous endothelial thickening, findings that may have contributed to liver injury in these patients.28

An awareness of the high rate of thrombotic events in COVID-19 is necessary as this could potentially adversely impact the outcomes in those with chronic liver disease.

- The impact of nonalcoholic fatty liver disease (NAFLD) on COVID-19 is controversial but metabolic risk factors such as obesity, diabetes mellitus, and hypertension are associated with COVID-19 severity.33,34
- It will be difficult to differentiate whether increases in liver biochemistries are due to SARS-CoV-2 infection itself; its complications, including myositis (particularly with AST>ALT), cytokine release syndrome, ischemia/hypotension; or a drug-induced liver injury.18,26
- An approach to evaluating the patient with COVID-19 and elevated liver biochemistries is shown in Figure 1.

Recommendations

- Patients with cirrhosis, autoimmune hepatitis on immunosuppressive medications, liver cancer, and posttransplant patients on immunosuppressant therapy are potentially at increased risk for severe COVID-19. Until further data become available, there should be a low threshold for testing these patients for SARS-CoV-2 if symptomatic.
- Consider etiologies unrelated to COVID-19, including other viruses such as hepatitis A, B and C, and drug-induced liver injury when assessing patients with COVID-19 and elevated liver biochemistries.
- To limit unnecessary transport of patients with COVID-19, ultrasound or other advanced imaging (e.g., MRI/MRCP) should be avoided unless it is likely to change management, e.g., clinical suspicion for biliary obstruction or hepatic/portal venous thrombosis.
- Consider other causes of elevated liver biochemistries, including myositis (particularly when AST>ALT), cardiac injury, ischemia, drug-induced liver injury, and cytokine release syndrome.
- The presence of abnormal liver biochemistries should not be a contraindication to using investigational or off-label therapeutics for COVID-19 (e.g., remdesivir, tocilizumab, chloroquine, hydroxychloroquine), although AST or ALT levels >5x ULN may exclude patients from consideration of some investigational agents.
- Regular monitoring of liver biochemistries should be performed in all hospitalized COVID-19 patients, particularly those treated with remdesivir or tocilizumab, regardless of baseline values.
- In patients with autoimmune hepatitis or liver transplant recipients with active COVID-19 and elevated liver biochemistries, do not presume disease flare or acute cellular rejection without biopsy confirmation.
- Evaluate all children with elevated AST or ALT for underlying liver diseases and coexisting infections as COVID-19 is not commonly associated with abnormal liver biochemistries in children.24
- Follow guidance in your clinical study protocol and/or by the Food and Drug Administration (FDA) for monitoring of liver biochemistries and discontinuation of study drug used to treat COVID-19.
Diagnosis of SARS-CoV-2 Infection

**What we know**

- Routine labs including a complete blood count (CBC) with differential and platelets and comprehensive metabolic panel (CMP) can provide useful indirect evidence of infection.
  - Lymphopenia, thrombocytopenia, hypoalbuminemia are associated with a poorer prognosis (Table 1).
- Inflammatory markers including D-dimer, C-reactive protein, creatine phosphokinase, and ferritin are frequently elevated in hospitalized patients and may be followed over time.
- A chest computed tomography (CT) scan with bilateral ground glass opacities is highly sensitive for the detection of pneumonia due to COVID-19 but is non-specific.35
  - The American College of Radiology recommends that chest CT should not be used as a first line screening test but rather to confirm the presence of pneumonia in selected hospitalized patients.36–38
- Accurate real-time quantitative polymerase chain reaction (RT-PCR) testing for SARS-CoV-2 relies on sufficient amounts of replicating virus, optimal collection procedures and the collection site (i.e., nasopharyngeal vs. oropharyngeal vs. lower respiratory tract).39
- Nasopharyngeal swabs are more sensitive (63%) than oropharyngeal swabs (32%) while bronchoalveolar lavage (BAL) fluid specimens are the most sensitive (93%) using RT-PCR-based methods, although BAL poses a more significant risk of aerosolizing the virus.40
- In early studies, saliva may be more sensitive and reliable for SARS-CoV-2 detection than nasopharyngeal samples in hospitalized patients and asymptomatic healthcare workers.41
- Qualitative, isothermal, non-PCR nucleic acid amplification methods can deliver SARS-CoV-2 test results from a nasal or nasopharyngeal swab in <15 minutes but with higher concern for false negatives.42
- Testing samples from multiple sites from the patient or repeated testing from one patient site may improve sensitivity and reduce false negative results.
- SARS-CoV-2 viral load may be low at early stages of disease but higher viral loads are detected soon after symptom onset and decline during the second week of illness.39
- Serological tests (antibody and antigen) have now been developed, which hold promise as non-invasive, rapid, and convenient means of testing for current or past SARS-CoV-2 infection.43,44
  - SARS-CoV-2 antigen testing is less sensitive than PCR but with the advantage of more rapid results and potentially lower cost.44
  - Antibody testing may complement PCR testing to improve detection (IgM), detect subclinical infection (IgM or IgG) and identify individuals who have recovered (IgG).39
  - Antibody testing may also prove valuable in epidemiological studies, identification of convalescent plasma donors, and in the ongoing development of SARS-CoV-2 vaccines and antiviral treatments.
  - Potential drawbacks of serological testing include false negative results early in the disease course, false positive results particularly with IgM testing and potential cross-reactivity with common cold coronaviruses.45
  - There is no direct evidence that SARS-CoV-2 IgG confers protective immunity against reinfection. Per the Infectious Diseases Society of America (IDSA), antibody results should not be used to make staffing decision or decisions regarding the need for personal protective equipment (PPE) until more evidence is available.45
**Recommendations**

- Check CBC with differential and platelets and CMP in all hospitalized patients with symptoms suggestive of COVID-19 as part of their initial evaluation, with the understanding that it is common for patients with chronic liver disease to have baseline leukopenia, thrombocytopenia, and hypoalbuminemia.
- Monitoring systemic inflammatory markers may be useful in the assessment of the severity and response to treatment of COVID-19 in hospitalized patients.\(^4^6\)
- Test all patients with suspected COVID-19 with nasopharyngeal swab testing (or saliva if available) using RT-PCR or non-PCR methods.
- Consider retesting patients with a high clinical suspicion for COVID-19 and negative initial test results, as resources permit.
- Point-of-care oropharyngeal swabs can also be used to screen for and diagnose COVID-19, although this is not preferred due to low sensitivity.
- Reserve testing of BAL samples for intubated patients with high clinical suspicion for COVID-19 despite negative nasopharyngeal, oropharyngeal, or sputum testing.
- CT should not be used to screen for or as a first line test to diagnose COVID-19 due to its lower specificity compared to nasal swabs.\(^3^8,4^7\)
- Antibody testing should not be used for the diagnosis of SARS-CoV-2 infection.
- Antibody testing results should not be used as the sole information necessary to make staffing decisions or decisions regarding the need for PPE.

**Stable Outpatients with Liver Disease and/or Hepatocellular Carcinoma**

**What we know**

- Information is accumulating regarding the effects of SARS-CoV-2 infection in patients with chronic liver disease.
- Preliminary data from the CDC on 122,653 COVID-19 cases, including 7,162 (5.8%) with data on underlying conditions, showed that 1/3 of these patients (37.6%) had at least one underlying condition or risk factor for severe disease and poor outcomes.\(^4^8\) Among these patients with underlying conditions, only 41 patients (0.6%) had chronic liver disease, including 7 who required ICU admission.\(^4^8\)
  - These data are limited by small numbers and missing data (only 5.8% had available data on underlying conditions). Based on the known prevalence of NAFLD in the US population, the estimated prevalence of chronic liver disease in this study is likely underestimated.
- In a large cohort study of electronic health record data from over 17 million patients (>114,000 with chronic liver disease) in the United Kingdom, chronic liver disease was a risk factor for in-hospital death from COVID-19 (HR 1.61, 95% CI 1.33-1.95).\(^4\)
- Chronic liver disease was associated with significantly higher mortality (RR 2.8, 95% CI 1.9-4.0) in a cohort of 2780 US patients with COVID-19.\(^3^0\)
  - The mortality risk was higher in patients with cirrhosis (RR 4.6, 95% CI 2.6-8.3).
  - Fatty liver disease and nonalcoholic steatohepatitis were the most common etiologies in the liver disease group and the mortality risk was independent of risk factors such as body mass index, hypertension, and diabetes.
- Both immunocompetent and immunosuppressed patients can contribute to SARS-CoV-2 spread even if they are asymptomatic.\(^4^9\)
• Children are less likely to become ill from SARS-CoV-2 infection but can still contribute to spread of the virus.24
• There is no evidence that patients with stable chronic liver disease without advanced fibrosis/cirrhosis due to hepatitis B and/or C, or cholestatic syndromes such as primary biliary cholangitis or primary sclerosing cholangitis have increased susceptibility to SARS-CoV-2 infection.18
• It is unknown whether patients with hepatocellular carcinoma (HCC) are at increased risk for severe COVID-19 by virtue of their malignancy or treatments.
  o A case series reported an association between worse COVID-19 outcomes and a history of non-hepatic types of cancer.50
  o Those who underwent recent chemotherapy had an even higher risk of severe COVID-19, but the series also included those without recent chemotherapy.50
• The slow median doubling time of HCC supports a rationale of a short delay in radiological surveillance given the challenges many centers are currently facing with COVID-19.51

Recommendations
• When COVID-19 is prevalent in the community, severely limit outpatient visits to only patients who must be seen in person, even in areas without significant COVID-19 community spread. (See CDC Interim Guidance for Healthcare Facilities.)
  o Consider seeing in person only new adult and pediatric patients with urgent issues and clinically significant liver disease (e.g., jaundice, elevated ALT or AST >500 U/L, recent onset of hepatic decompensation, selected patients with liver cancer, and selected patients for liver transplant evaluation).
  o Follow CDC recommendations for PPE. If PPE is unavailable keep a distance of at least 6 feet from the patient.
  o Patients, caregivers, and providers should wear masks while in the clinic. Masks should be provided and/or homemade cloth masks should be permitted.
  o Stagger patient arrival times, and if possible, room patients immediately on arrival to clinic to avoid patients congregating in the waiting area. If patients or caregivers are in the waiting area, appropriate distancing and decontamination of the waiting area should be practiced.
  o Limit the number of family members/friends who accompany patients to their visits. Have these persons wait outside the clinic unless their presence is required for clinical decision making. Enable critical caregivers to participate in the visit by phone or video if possible.
  o Strongly consider phone visits or telemedicine as appropriate and available to replace in-person visits.
• Screen all patients for symptoms of COVID-19 or recent exposure (i.e., fever, cough, shortness of breath, sore throat, diarrhea, myalgias, new loss of sense of taste or smell,20,52,53 contact with known COVID-19 patients, history of recent travel) before entry into the clinical space (e.g., phone call 24 hours prior to scheduled visit), and again at registration or as they enter the clinic.
• Check each patient’s temperature and ask about symptoms when they arrive to the clinic or registration desk.
  o Patients with fever (>38 °C) or symptoms should be referred to the hospital’s protocol for symptomatic patients.
• Consider evaluating patients with COVID-19 symptoms or known exposure in an outpatient clinic or a site dedicated for this purpose. PPE should be prioritized to that site. Patients with
COVID-19 symptoms or known exposure should not be evaluated in the hepatology/liver transplant clinic.

- Follow CDC recommendations for cleaning and disinfecting rooms or areas visited by individuals with suspected or confirmed COVID-19.
- Continue treatment for hepatitis B and hepatitis C if already on treatment.
- There is no contraindication to initiating treatment of hepatitis B and C in patients without COVID-19 as clinically warranted.
- Initiating treatment of hepatitis B in a patient with COVID-19 is not contraindicated and should be considered if there is clinical suspicion of a hepatitis B flare or when initiating immunosuppressive therapy.
- Initiating treatment of hepatitis C in a patient with COVID-19 is not routinely warranted and can be deferred until recovered from COVID-19.
- Continue monitoring in those on or off therapy for HCC and continue surveillance in those at risk for HCC (cirrhosis, chronic hepatitis B) as close to schedule as circumstances allow, although an arbitrary delay of 2 months is reasonable.
  - Discuss the risks and benefits of delaying surveillance with the patient and document the discussion.
  - These patients should be prioritized for imaging studies as outpatient facilities start to re-open.
- Review images of new referrals for patients with liver masses in tumor board or with expert radiologists in virtual multidisciplinary conference prior to scheduling an in-person visit.
- Consider virtual visits to discuss diagnosis and management of HCC and other liver tumors.
- Proceed with liver cancer treatments or surgical resection when able rather than delaying them due to the pandemic.

Patients with Decompensated Cirrhosis, Liver Transplant Evaluations, and Patients on the Liver Transplant Waiting List

**What we know**

- Information is growing regarding the effects of SARS-CoV-2 infection in patients with decompensated cirrhosis or those awaiting liver transplantation.
- Mortality due to COVID-19 appears higher in patients with more advanced liver disease.4
- The complex decision making involved in whether or not to proceed with transplantation is now significantly more challenging due to the COVID-19 pandemic.
- It is essential that transplant centers continuously assess their local situation and its impact on patients awaiting transplantation.
- Some transplant centers may decide that individual candidates should not receive organ offers at this time.5\textsuperscript{4}
- Special consideration could be given to wait-listed patients with high Model for End-stage Liver Disease (MELD) scores or HCC based on their risk of drop-out and disease progression.
- A reduction in organ recovery has already occurred because of COVID-19-related limitations on institutional resources and staff involved in organ recovery and our evolving understanding of the risk of donor-derived disease transmission.
- These factors have had a significant impact on the transplant waiting list.
- Risk stratification is important to identify patients who need to be evaluated for transplantation or complete their evaluation during the COVID-19 pandemic, including patients with high MELD scores, risk of decompensation, or tumor progression.
**Recommendations**

**Outpatient management**

- Limit the number of patients coming to clinic for transplant evaluations.
  - Consider evaluating only patients with HCC or those patients with severe disease and high MELD scores who are likely to benefit from immediate liver transplant listing.
  - Telemedicine can be used to evaluate less urgent patients.
- Develop a policy to decide which listed patients need to be seen in person.
- Consider telemedicine alternatives in place of outreach clinics.
- Obtain labs and imaging only as clinically necessary.
  - Patients should not be asked to update labs or imaging simply to update or maintain their MELD score. Recent Organ Procurement and Transplantation Network (OPTN) policy changes provide guidance on how to maintain candidate MELD when updated clinical data are not obtained.
- Ensure that patients have refills available for essential medications. Provide prescriptions for 90-day supplies instead of 30-day supplies. Many insurance companies are waiving early medication refill limits.
- Consider instructing patients to avoid attending in-person community recovery support meetings such as Alcoholics Anonymous and provide alternative telephone or online resources.
- Advise patients not to travel during the COVID-19 pandemic.
- Consider providing documentation to patients, providers, and organ procurement teams to ease essential travel where travel restriction policies are in place.
- Have a low threshold for admitting patients on the transplant waiting list who are diagnosed with COVID-19.
- Consider using specific screening facilities and a “COVID-19-free” path through the hospital for transplantation candidates.
  - Recognizing the current limitations with testing of patients and staff, these pathways might be described as “COVID-19-minimal” rather than “COVID-19-free”.

**Patient transplant education and consultations**

- Conduct patient transplant education and social work, dietitian, and financial consultations by video conference, telemedicine, or telephone whenever possible.
- Avoid multiple patients in one room for patient education.
  - Consider developing internet-based education sessions for patients and family members that can be deployed either by in-room computers or at home prior to patient evaluation.

**Liver Transplantation, Resource Utilization, and Ethical Considerations**

**What we know**

- Resource utilization and ethical considerations are inherently tied to liver transplantation. This is a critical and challenging area for which protocols and policies need to be carefully considered and developed. There is no over-arching policy that can or should be applied to every transplant center; these issues will need to be discussed and developed locally.
- Although the Centers for Medicare and Medicaid Services (CMS) recommended limiting all non-essential planned surgeries and procedures, they specifically excluded transplant surgery from this recommendation and categorize transplant surgery as Tier 3b (“do not postpone”).
The status of medical and surgical procedures is changing as state executive orders are expiring.

- Most Organ Procurement Organizations are testing donors for SARS-CoV-2 RNA, and those who test positive are medically ineligible for organ donation.
- The capacity to test all recipients shortly before proceeding with transplant may be limited but is strongly recommended.
- There is a significant false negative testing rate and transplant programs should consider symptoms of COVID-19 in a potential donor or recipient to be strongly suggestive of infection despite negative testing.
  - Additional data including chest imaging and inflammatory markers (e.g., C-reactive protein, ferritin, IL-6) should be considered.
- Transplantation in SARS-CoV-2-positive transplant candidates is currently not recommended.

**Recommendations**

- Develop a hospital-specific policy for organ acceptance.
  - Ensure hospital administrators are aware of the CMS Tier 3b designation for transplant surgery (“Do not postpone”).
  - Consider recipient age and comorbidities prior to organ acceptance.
  - Consider resource utilization including ICU beds, ventilators, PPE and supply of blood products (especially platelets and type-specific packed red cells) in the decision to proceed with liver transplantation.
  - Account for local COVID-19 prevalence data when considering suspension of transplantation.
- Consider notifying patients that the COVID-19 pandemic may impact their waiting time on the transplant list.
- Notify patients that family and visitor access to them during their hospital stay may be limited or prohibited.
- Screen potential donors for exposure and clinical symptoms/fever compatible with COVID-19 (regardless of test results or availability).55
  - Alternatives to PCR-based testing such as chest radiography may also be considered.
- Screen potential recipients with an acceptable organ offer for COVID-19 symptoms/fever before they are called in from home for transplantation.
- Consider accepting only grafts with a low risk of delayed graft function to minimize complications and prolonged ICU and hospital lengths of stay.
- Test all recipients and donors for SARS-CoV-2 before transplantation, if testing is available.
  - Consider the risk of false negatives, disease prevalence, and testing turnaround time in your area.
  - Review as much donor history as possible for fever, respiratory symptoms and radiographic findings.
- Consider having backup transplant recipients wait at home or away from the transplant center.
- Consider suspending living donor liver transplant programs during the pandemic, except for pediatric patients with acute liver failure.55
- SARS-CoV-2-positive transplant candidates may be considered for transplantation at least 14-21 days after symptom resolution and 1 or 2 negative SARS-CoV-2 diagnostic tests.
- See the latest updates regarding COVID-19 related OPTN policy changes.
- An approach to liver transplant organ offers is shown in Figure 2.
Challenging Issues in Liver Transplantation During the COVID-19 Pandemic

- Should we decide who is more in need of limited resources, i.e., COVID-19 patients vs. patients in urgent need of liver transplantation? It is impossible to weigh the value of the life of a patient with COVID-19 against that of a patient in need of life-saving liver transplantation. We should not compound the pandemic by risking the lives of patients in need of liver transplantation and our goal should be to ensure that an appropriately staffed ICU bed is available for every patient who requires one.
- An argument that has been advanced to justify deferring some transplants is a concern about immunosuppressing patients during the COVID-19 pandemic. However, it is possible that immunosuppressed patients may not be at increased risk for severe COVID-19. Nevertheless, immunosuppressed patients have higher viral titers and may be more infectious than immunocompetent individuals.
- CMS has clarified that transplants fall into Tier 3b and should not be postponed.
- Other issues to consider in hospitals with a high prevalence of COVID-19 include the risk of nosocomial transmission during the transplant admission, difficulty obtaining procedures or other resources when complications arise, and limitations on family/caregiver visitation for a postoperative period that often relies on the engagement of caregivers.
- Is there a point at which we need to ration who will receive a liver transplant? If so, we may need to prioritize patients who are most likely to die on the waitlist and defer those who can wait longer.
- These issues are likely to arise in many transplant programs and predominantly center on the need for limited ICU beds, ventilators, and blood products. Each program will need to establish its institutional capacity to perform liver transplantation and a process for determining whether or not to proceed when an organ is available.
- These decisions should ideally be made in consultation with local medical ethics committees.

Post-Liver-Transplant Patients and Management of Patients on Immunosuppressive Agents

What we know

- Data suggest that the immune response may be the main driver for pulmonary injury due to COVID-19 and that immunosuppression may be protective.
  - Rapid pulmonary deterioration in COVID-19 is due to a systemic/pulmonary inflammatory response associated with increased serum IL-6, IL-8 and TNF-α levels.
- Posttransplant immunosuppression was not a risk factor for mortality associated with SARS (2002-2003) or MERS (2012-present).
- The effects of immunosuppression on COVID-19 are not well established.
- Immunosuppression may prolong viral shedding in posttransplant patients with COVID-19.
- A retrospective report described the outcomes of 90 solid organ transplant recipients with COVID-19 treated as outpatients or inpatients in New York City.
The report included 13 liver transplant recipients (9 with mild/moderate COVID-19 and 4 with severe disease).

Nosocomial transmission was suspected in 3 patients including 1 liver transplant recipient who was undergoing inpatient treatment for refractory rejection.

Immunosuppressive medications were reduced in most hospitalized patients: Antimetabolite decreased or held in 88%, steroids decreased or held in 7%, and calcineurin inhibitor decreased or held in 18%.

34% required ICU admission, 35% required mechanical ventilation, 24% died (52% of the ICU patients), and 54% were discharged at the time of publication.

There was no reported acute cellular rejection.

- The World Health Organization recommends avoiding corticosteroids for treatment of COVID-19 unless indicated for another therapeutic purpose.57
- The NIH recommends against the routine use of systemic corticosteroids for the treatment of COVID-19 in hospitalized patients, unless they are in the intensive care unit.58
  - The NIH recommends against the routine use of systemic corticosteroids for the treatment of mechanically ventilated patients with COVID-19 without ARDS. There is insufficient evidence to recommend for or against the use of systemic corticosteroids for mechanically ventilated patients with ARDS.58
- Anti-IL-6 therapeutics have not been shown to increase the risk of acute cellular rejection.
- It is too early to know if posttransplant patients are at greater risk for more severe COVID-19.
- Reducing the dosage or stopping immunosuppressants may cause a flare in a patient with autoimmune hepatitis or precipitate acute rejection in a liver transplant recipient.

**Recommendations**

- In post-transplant patients without COVID-19:
  - Do not make anticipatory adjustments to current immunosuppressive drugs or dosages.
  - Emphasize prevention measures posttransplant patients already know well: frequent hand washing, cleaning frequently touched surfaces, staying away from large crowds, staying away from individuals who are ill, etc.
  - Advise patients not to travel during the COVID-19 pandemic.55
  - Minimize in-person visits for posttransplant patients by maximizing use of telemedicine.
  - Consider advocating for telework options, appropriate excuses from work or leaves of absence for posttransplant patients and their primary caregivers.

- In post-transplant patients with COVID-19:
  - Consider minimizing the dosage of high-dose prednisone but maintain a sufficient dosage to avoid adrenal insufficiency.
  - Consider reducing azathioprine or mycophenolate dosages, especially in the setting of lymphopenia, fever, or worsening pneumonia attributed to COVID-19.
  - Consider reducing but not stopping daily calcineurin inhibitor dosage, especially in the setting of lymphopenia, fever, or worsening pulmonary status attributed to COVID-19.
  - An approach to managing liver transplant recipients with COVID-19 is shown in Figure 3.

- In patients with autoimmune hepatitis on immunosuppression without COVID-19:
  - Do not make anticipatory adjustments to current immunosuppressive drugs or dosages.

- In patients with autoimmune hepatitis on immunosuppression with COVID-19:
  - Consider minimizing the dosage of high-dose prednisone but maintain a sufficient dosage to avoid adrenal insufficiency.
Consider reducing azathioprine or mycophenolate dosages, especially in the setting of lymphopenia, fever, or worsening pneumonia attributed to COVID-19.

- Initiate immunosuppressive therapy in patients with liver disease with or without COVID-19 who have strong indications for treatment (e.g., autoimmune hepatitis, graft rejection).
- In patients with COVID-19, use caution in initiating prednisone, prednisolone, or other immunosuppressive therapy where the potential benefit might be outweighed by the risks (e.g., alcohol-associated hepatitis).

**Inpatients**

*What we know*

- Healthcare workers and other hospital staff are at risk for COVID-19.9
- Healthcare workers with SARS-CoV-2 may spread the virus to patients and to each other, and should remain away from in-person work until approved to return by local health authorities.
- Minimizing interactions among healthcare workers and between healthcare workers and patients is critical to reducing the spread of SARS-CoV-2.
- Minimizing the transport of patients within and between healthcare facilities could reduce the spread of SARS-CoV-2.

**Recommendations**

- Consider cohorting of inpatients with COVID-19 from other non-infected patients in the hospital.
- Consider equipping patient rooms with telemedicine equipment (e.g., tablet) to enable remote consultation and monitoring.
- Conduct medical and surgical transplant rounds with the minimum number of personnel needed to provide care at a given time.
- Limit the number of team members who enter a patient’s room for patient examinations and encounters.
  - The same rule applies to inpatient consultations involving other medical or surgical services for the care of patients with liver disease or transplant evaluation. Limit the personnel permitted to enter patient rooms to the minimum needed for the performance of consultative care.
  - Consider conducting virtual visits for updates not requiring direct examination. This will reduce contact risks as well as unnecessary utilization of PPE thereby preserving hospital supplies for essential needs.
- Discourage in-person multidisciplinary rounds with dietary, pharmacy, social work, and care coordination staff.
  - Consider the use of virtual conferencing to reduce direct staff interactions.
- Consider restricting the direct patient care of providers at higher risk (age >65 years, serious underlying medical conditions, immunocompromised).
- Limit or even prohibit the presence of non-essential team members in the hospital (e.g., students, observers, research staff) to minimize exposure risk and prioritize the use of PPE.
- Consider use of telephone or virtual language translation services as needed to reduce contact with patients.
- Patients and visitors (if permitted) should wear masks while in the hospital. Masks should be provided and/or homemade cloth masks should be permitted.
- Limit the number of visitors who may see inpatients.
Ideally, no visitors should be permitted in patient rooms except in specific, institutionally-defined circumstances (e.g., hospice care, pediatrics, a patient being discharged following transplantation).

- Immediately identify caregivers and legal representatives (and collect their emergency contact information) to provide informed consent if a patient is impaired, and to enable provision of regular status updates to them while visitors are not permitted in patient rooms.
- Carefully consider and minimize all requests for imaging and procedures on patients, including blood draws. Order only studies essential for care to reduce institutional resource utilization, including patient transport between hospital locations.
- Consider developing a policy for review and triage of hospital inpatient transfers. For example, consider accepting for transfer only patients with acute liver failure or those in need of urgent liver transplant evaluation during their hospital stay.
  - Consider accepting for transfer only other liver patients with a unique need for inpatient interventions at the transplant center.
  - Screen and test all patients for SARS-CoV-2 prior to transfer or upon arrival if testing is not available at the transferring facility.
  - Avoid direct hospital admission for patients with fever and respiratory symptoms, particularly admission to a transplant unit.
- Consider evaluating patients with liver disease for COVID-19 if they develop new onset encephalopathy or other acute decompensation.
- Have a low threshold for aggressive airway management in COVID-19 patients with underlying pulmonary diseases such as hepatic hydrothorax, portopulmonary hypertension, or hepatopulmonary syndrome.
- Perform a needs assessment prior to patient discharge to determine whether the patient can have follow-up encounters by phone or telemedicine, and encourage early monitoring by these means to reduce early postdischarge, in-person visits.
  - Consider home health or visiting nurse services for frequent blood draws needed after posttransplant hospital discharge.
- Coordinate with outpatient services for admission and discharge planning to prevent unnecessary admissions and reduce unplanned re-admissions after discharge.
- Patients with active viral shedding on discharge should remain in isolation at home and appropriate precautions should be taken for caregivers or family members who live with the patient.
- Consider the capacity of local rehabilitation centers to accept complex patients as beds in those facilities may become limited during the COVID-19 pandemic.
  - Patients should have a negative SARS-CoV-2 test prior to discharge to a rehabilitation or skilled nursing facility.
  - Review the possibility of enhanced home services during the admission to expedite discharge.

Medication Management of Patients with COVID-19 and Potential Drug-Drug Interactions

**What we know**

- There currently are no FDA-approved therapies to prevent or treat COVID-19 infection.
- The frequency of discontinuation of investigational or off-label therapeutics for COVID-19 due to hepatotoxicity is low (Table 2).
• Remdesivir is a nucleotide analogue with demonstrated activity against SARS-CoV and MERS-CoV in cultured cells, mice and non-human primates, and more recently against SARS-CoV-2 in human cell lines.\textsuperscript{59,60}

• Remdesivir is being tested in hospitalized patients with moderate to severe COVID-19 in randomized controlled trials.\textsuperscript{61} Early data from compassionate use were encouraging.\textsuperscript{62,63}
  - On May 1, 2020, the FDA issued an Emergency Use Authorization (EUA) for remdesivir for the treatment of hospitalized patients with severe COVID-19, which will allow patients to be treated while further studies are being conducted.
  - Interim analysis of the NIH-sponsored Adaptive COVID-19 Treatment Trial (ACTT) showed that remdesivir significantly accelerates time to recovery to hospital discharge or return to normal activity level compared to placebo (mean of 11 days vs. 15 days, \(P<.001\)).
    - Remdesivir may also have a survival benefit compared to placebo (mortality rate of 8\% vs. 11.6\%, \(P=.059\)).
  - A recently completed Phase 3 trial of remdesivir showed similar improvement in clinical status for 5- and 10-day courses (OR 0.75, 95\% CI 0.51-1.12).
    - Grade 3 or higher ALT elevations occurred in 7.3\% of subjects leading to discontinuation of remdesivir in 3\%.
  - An under-enrolled, randomized, double-blind, placebo-controlled trial of remdesivir from Wuhan, China showed no significant difference in time to clinical improvement (median 21 days vs 23 days) or 28-day mortality (14\% vs 13\%).\textsuperscript{64}
    - Remdesivir was stopped early in 12\% or subjects due to adverse events.
  - Elevated liver biochemistries have been commonly observed in the remdesivir clinical development program, rarely including elevations up to 10 times baseline values.

• Drugs that target the IL-6 receptor (e.g., tocilizumab) are being tested only in hospitalized patients with moderate to severe COVID-19.
  - The IDSA recommends using tocilizumab only in the context of a clinical trial.\textsuperscript{65}

• Hydroxychloroquine (an analogue of chloroquine with a better safety profile) has been shown to have anti-SARS-CoV-2 activity \textit{in vitro}.\textsuperscript{66}
  - The NIH recommends against the use of hydroxychloroquine plus azithromycin except in the context of a clinical trial due to the risk of QT prolongation.\textsuperscript{58}
  - A single-arm study from France of 20 patients with COVID-19 who were treated with hydroxychloroquine with or without azithromycin compared to 16 nonrandomized controls reported negative nasopharyngeal swabs for SARS-CoV-2 PCR in 70\% of the treated group compared to 12.5\% of the controls.\textsuperscript{57}
  - A separate study from France reported that the combination of hydroxychloroquine and azithromycin was not associated with clinical recovery or viral clearance and 4 of the 11 patients discontinued therapy due to prolonged QT interval.\textsuperscript{68}
  - A large observational study from New York City showed no association between hydroxychloroquine and risk of intubation or death (HR 1.04, 95\% CI 0.82-1.32), suggesting that hydroxychloroquine should not be used outside of randomized controlled trials.\textsuperscript{69}
  - The CDC recently issued a \textit{warning} about the danger of using nonpharmaceutical chloroquine phosphate, a commercially available chemical for aquarium use, to treat or prevent COVID-19. One individual died after using nonpharmaceutical chloroquine and another became critically ill with gastrointestinal symptoms and cardiac conduction abnormalities.
• Convalescent plasma transfusion is under investigation for treating critically ill patients with COVID-19.  
  o The FDA is facilitating access to convalescent plasma for patients with serious COVID-19 through its emergency Investigational New Drug application process.
• The NIH recommends against the use of lopinavir-ritonavir for the treatment of COVID-19, except in the context of a clinical trial.
  o An open-label, randomized, controlled trial of lopinavir-ritonavir vs. standard of care in adults hospitalized with severe COVID-19 showed no clinical benefit. Treatment was stopped early in some patients taking lopinavir-ritonavir due to adverse events.
  o Lopinavir-ritonavir combined with ribavirin and interferon-beta-1b showed more rapid viral clearance by nasopharyngeal swab compared to lopinavir-ritonavir alone in a phase 2, open-label, randomized trial.
  o Ritonavir is a potent inhibitor of CYP3A4, which is involved in the metabolism of calcineurin inhibitors, sirolimus, and everolimus.
  o The use of ritonavir requires a reduction in the tacrolimus dosage to 1/20-1/50 of baseline due to this drug-drug interaction.
• Treatment with ACE inhibitors (ACEIs) and angiotensin receptor blockers (ARBs) results in upregulation of ACE2, the target for SARS-CoV-2 entry into cells.
  o Increased ACE2 expression theoretically facilitates infection with SARS-CoV-2.
  o Animal studies suggest that ACEIs and ARBs may protect against serious lung complications from SARS-CoV-2, but to date there are no data in SARS-CoV-2 or in humans.
  o Multiple US and European cardiology societies and the NIH have highlighted the lack of evidence demonstrating harmful effects of ACEIs and ARBs in the setting of COVID-19 and recommend that patients should continue with their usual antihypertensive therapy, including ACEIs and ARBs.

**Recommendations**
• Monitor studies of antiviral and immunomodulatory approaches to COVID-19 at NIH’s clinicaltrials.gov.
• Consider remdesivir for the treatment of hospitalized patients with severe COVID-19 under the FDA’s EUA.
  o According to the FDA, liver biochemistries should be checked in all patients prior to starting remdesivir and daily while receiving remdesivir.
  o Remdesivir should not be initiated in patients with ALT ≥5x ULN at baseline.
  o Remdesivir should be discontinued in patients who develop ALT ≥5x ULN during treatment or ALT elevation accompanied by signs or symptoms of liver inflammation or increasing conjugated bilirubin, alkaline phosphatase, or INR.
  o Remdesivir may be restarted when ALT is <5x ULN.
• The available evidence does not currently support the use of lopinavir-ritonavir for the treatment of COVID-19.
• Hydroxychloroquine with or without azithromycin is not routinely recommended and may be associated with serious adverse events such as prolongation of the QT interval.
• Patients receiving ACEIs and ARBs should remain on them even in the setting of COVID-19.
• Acetaminophen at a daily dosage of ≤2 g/d is the preferred analgesic and anti-pyretic for patients with known or suspected COVID-19.
• NSAIDS may also be used or continued as needed.
Consult the University of Liverpool Drug Interactions Group document on Interactions with Experimental COVID-19 Therapies.

**Procedures**

*What we know*

- There is potential for fecal-oral SARS-CoV-2 transmission,\(^{1,5,29,63}\) and the virus is detected in saliva.\(^{1,29,41,77}\)
- Multiple societies strongly recommended rescheduling non-urgent procedures.
- The Joint Gastroenterology Societies recommend to “strongly consider rescheduling non-urgent endoscopic procedures.”
- CMS, the US Surgeon General and the American College of Surgeons recommend postponing elective surgeries.
- Endoscopic procedures should be considered aerosol-generating.\(^{78}\)
- Non-urgent endoscopic procedures should be rescheduled to reduce the risk of disease transmission from asymptomatic patients, reduce the use of PPE, and reduce hospital admissions.\(^{78}\)
- To limit disease transmission, the Joint Gastroenterology Societies and the American Gastroenterological Association recommend healthcare workers involved with endoscopy wear a full set of PPE, including N95 masks and double gloves.\(^{79}\)

**Recommendations**

- Continue to defer elective/non-urgent procedures (e.g., endoscopy, liver biopsy, transient elastography) in patients with COVID-19.
- Consult ASGE and AGA, state-specific guidelines, and local conditions for guidance on proceeding with elective/non-urgent procedures in COVID-19-negative patients.\(^{78}\)
- Consider categorizing endoscopic procedures based on medical indication (e.g., perform always, postpone always, high or low priority case-by-case management).\(^{80}\)
- Consider, in the interim, primary prophylaxis with beta blocker therapy instead of screening endoscopy in patients with clinically significant portal hypertension or high risk of decompensation.
- Some procedures may need to be performed, e.g., liver biopsy to rule out rejection or diagnose autoimmune hepatitis, therapeutic paracentesis, transjugular intrahepatic portosystemic shunt and/or endoscopy for variceal bleeding, follow-up band ligation in those with recent variceal bleeding, urgent biliary procedures for symptomatic disease such as cholangitis and sepsis (interventional radiology or endoscopic).
- Consult state guidelines as hospitals and endoscopy units begin to schedule non-urgent procedures.
- N95 masks (as opposed to surgical masks) and double gloves should be worn during upper and lower endoscopic procedures.\(^{79}\)
  - N95 masks may need to be reused depending on the local situation.
  - Hats may be worn for the entire day unless visibly soiled.
  - Eyewear (personal or disposable) should be cleaned with an alcohol wipe between cases.
  - Disposable eyewear should be disposed of at the end of the day unless visibly soiled, in which case it should be immediately discarded.
• Consider limiting the involvement of fellows in endoscopies and other procedures to conserve PPE.78
• Follow CDC recommendations for cleaning and disinfecting rooms or areas visited by individuals with suspected or confirmed COVID-19.

Research

What we know
• Due to quarantine-related travel restrictions and potential supply chain interruptions, the FDA and NIH have posted guidance documents for the conduct of clinical trials during the COVID-19 pandemic.
• As the FDA states, protocol deviations may be necessary and will depend on many context-dependent factors related to the nature of the study, the patient population, and environmental circumstances.
• Patient safety is of utmost importance and should be used to guide decisions impacting the trial, including recruitment, continuation decisions, patient monitoring, delayed assessments, and investigational product dispensing.
• Evaluation of alternative visits, including virtual, phone, or remote contact, may be warranted if safety of the patient can be assured with the alternative approach.
• Protocol changes that reduce immediate danger or protect the well-being of the research participants may be implemented before Institutional Review Board (IRB) approval but must be subsequently reported.
• The NIH encourages grant recipients to discuss changes that prioritize patient and staff safety, including limiting study visits or conducting them virtually, suspending unnecessary travel, and increasing flexibility for laboratory testing and imaging with both the institution and the IRB.
• In an effort to ensure patient safety and maintain trial integrity, sponsors, investigators, and IRBs should document all such contingency measures and reasons for protocol deviations.

Recommendations
• Limit clinical trial activity to essential clinical trials, defined as those that enroll or follow patients with life-threatening or serious conditions for which participation in the clinical trial holds out the clear prospect of directly benefiting the patient. Patients already enrolled in clinical trials who are undergoing safety and efficacy assessments fall within this definition.
  o Continue in-person research visits for participants already enrolled in essential clinical trials if required for patient safety and/or participation in the clinical trial is an integral part of the patient’s treatment plan.
  o The study physician – in consultation with the study team, the patient’s physician, the patient, and the patient’s family – should carefully assess the necessity and risks of an in-person visit.
• Do not initiate new clinical trials at this time unless meeting the definition of an essential clinical trial.
• Strongly consider not enrolling new research participants into existing clinical trials unless meeting the definition of an essential clinical trial.
  o Postpone all other in-person clinical research visits.
• Research staff should make efforts to use alternative methods to conduct research visits or perform testing such as check-ins with participants by phone and/or performing research-related lab testing at lab testing centers if feasible.
• Research staff should work remotely, unless their presence is required for the safe conduct of the trial.
• Discuss options for conducting telehealth study visits with clinical research organizations and study sponsors.
• Principal investigators should notify commercial sponsors that opening new nonessential clinical trials and enrolling subjects into ongoing “non-essential” clinical trials should be temporarily postponed.
• Arrange for research medications to be sent to subjects by the study sponsor if the research pharmacy is unavailable.
• Institutional policies on clinical research may be more restrictive and should supersede the recommendations contained here.
• Laboratory/basic science research may also need to be restricted based on local policies.

Trainees

What we know

• Although residents and fellows have much to learn from the diagnosis and management of COVID-19, there is widespread concern that the risks of exposing trainees to SARS-CoV-2 may outweigh the benefits.
• There is also concern about further reducing the already significant PPE shortages by involving trainees in direct patient care.
• In a Letter to the Community, the Accreditation Council for Graduate Medical Education (ACGME) announced it has suspended some activities during the COVID-19 pandemic, including self-studies, accreditation site visits, Clinical Learning Environment Review (CLER) program site visits, and resident/fellow/faculty surveys
• The ACGME issued new requirements to allow residents/fellows to participate in telemedicine.
• The ACGME requirements for adequate resources and training, adequate supervision, and work hour limitations have not changed.
• The ACGME has clarified the local circumstances in which fellows may function within their core specialty (i.e., act as attending physicians).
• Designated Institutional Officials (DIOs) may self-declare a Pandemic Emergency Status for all programs within the Sponsoring Institution, during which all Common Program Requirements and specialty-specific Program Requirements are suspended other than those outlined above (adequate resources and training, adequate supervision, work hour requirements, and fellows functioning in core specialty).
• See ACGME’s response to the pandemic crisis for more details.

Recommendations

• Ensure adequate resources including PPE appropriate to the clinical setting for all trainees.
• Assign fellows only to participating sites that ensure the safety of patients and fellows.
• Ensure appropriate supervision of trainees working remotely if they are conducting patient care activities (telephone/telemedicine visits).
• Change all educational conferences to virtual conferences.
• Consider assigning fellows and other trainees to indirect patient care activities and/or telemedicine visits.
• Consider remote supervision of trainees by concurrently monitoring patient care through appropriate telecommunication technology.
Consider the potential impact of COVID-19 on new fellow orientation, fellowship recruitment, and interviews and develop contingencies for conducting these activities by virtual means.

Protecting Healthcare Workers and Workforce Utilization

What we know

- The SARS-CoV-2 infection rate of healthcare workers may be up to 20%, as reported in Italy.9
- The CDC has reported over 9200 COVID-19 cases in US healthcare workers, including some with severe outcomes including death.10
  - This is an underestimate because healthcare worker status was only available for 16% of reported cases.
- In addition to protecting our patients, healthcare workers must take action to prevent infection within and outside patient care settings.
- We must endeavor to avoid the loss of healthcare workers to illness or quarantine, but plans must be developed to mitigate the effects of workforce shortages during the pandemic.
- Given the potential for SARS-CoV-2 to spread via aerosol as well as droplet, the use of N95 masks or other respirators are essential when caring for patients with known or suspected COVID-19.81 It is not known whether surgical masks protect the wearer from infection, but data suggest that a surgical mask worn by infected individuals may reduce the risk of transmission (source control).82 It is unknown whether surgical masks reduce the risk of transmission from asymptomatic healthcare workers to patients or other healthcare workers.

Recommendations

- Continue to cancel or severely restrict all in-person meetings (even small meetings) and change to virtual meetings when possible.
- Practice social distancing even in meetings, e.g., keep an empty chair between each person, and have each individual wear a mask.
- Consider staggering work shifts for physicians, providers, nurses, and staff.
- Create a backup schedule for physicians and surgeons in the event of quarantine or illness.
- Consider assigning backup personnel for providers in leadership positions.
- Consider checking temperatures of all providers and staff as they arrive to the office or clinic. There should be a zero-tolerance policy for presenting to work with fever or symptoms of COVID-19.
- All healthcare workers should wear a surgical mask for performance of standard duties in patient care settings, but utilize a higher level of PPE when there are concerns for contact with patients with suspicious symptoms or known COVID-19.
- These recommendations should continue to be followed even as states begin to loosen restrictions.

Telemedicine

What we know

- Telemedicine can mitigate the exposure of patients and healthcare workers to COVID-19 and has potential to change healthcare delivery now and after the COVID-19 pandemic.83–85
- Emergency funding legislation HB 6074 waived many of the long-standing restrictions to the use of telehealth for Medicare recipients, including: rural area requirements for originating sites (i.e., patient location); allowing a patient’s home to be an eligible originating site; allowing
phones with two-way, real-time interactive audio and visual capabilities to be used; and allowing the provider to conduct a telemedicine encounter from their home.\textsuperscript{86}

- The Department of Health and Human Services Office of Civil Rights announced that it would not impose penalties for the good faith provision of telemedicine during the COVID-19 public health emergency, even if remote communication technologies used for such services may not fully comply with the requirements of the Health Insurance Portability and Accountability Act (HIPAA) Rules.

- Medicare will currently reimburse telephone and telemedicine visits for both new and established patients.

- Providers can bill for telemedicine visits at the same rate as in-person visits.

- Audio-only telephone calls that are used as a replacement for care that would otherwise be billed as in-person or telehealth will be paid the equivalent of in-person visits.

- Telemedicine limitations include patient access to the electronic health record patient portal; access to a computer, phone, or tablet with video/audio capabilities; and ability to manage the technology.

- See the Joint Gastroenterology Societies' message about telehealth.

**Recommendations**

- Consider phone visits or telemedicine as appropriate and available to replace in-person visits.

- Consider ways to mitigate disparities in access to care delivered through telemedicine (e.g., rural populations, older adults, racial/ethnic minorities, low socioeconomic status, limited health literacy, limited English proficiency).\textsuperscript{87}

- Conduct patient education and social work, dietitian, and financial consultations by video conference, telemedicine or telephone for liver transplant evaluations.

- Consider telemedicine alternatives in place of outreach clinics.

- Minimize in-person visits for posttransplant patients by maximizing use of telemedicine.

**Reentry and Return to a Pre-Pandemic State**

**What we know**

- The necessary prioritization of the acute care of patients with COVID-19 and implementation of strategies to minimize risk of disease transmission has resulted in a delay of elective procedures, routine care, and clinical research.

- Many hospitals that are seeing a decline in COVID-19 cases are beginning to consider a safe process of reentry.

- It has been suggested that a backlog of routine procedures and clinic visits could result in an increase in hepatic decompensating events and morbidity in patients with liver disease.\textsuperscript{3}

- Patient perspectives and comfort level about in-person clinic visits, hospital-based procedures, laboratory testing, and imaging studies may influence quality of care.

**Recommendations**

- Develop policies and processes for reentry to gradually ramp up clinical operations and clinical research with pathways for minimizing SARS-CoV-2 transmission and for care of patients who develop COVID-19.

- Consult the CDC and CMS for general guidelines pertaining to reentry.
• Identify patient characteristics (e.g., MELD, recent decompensation, etc.) that define who will be reintroduced into the clinical environment and when. Use a staged approach appropriate for local conditions.
• As the COVID-19 prevalence declines in geographic areas, each transplant center should have plans in place for careful reentry into standard brain dead deceased donor liver transplants followed by acceptable, DCD donor transplants <50 years old, and finally, once COVID-19 risks are minimized within the healthcare environment and well-controlled in the community, living donor liver transplants.
• Consult CDC guidelines for a reentry framework based on potential for patient harm and degree of community transmission.
• Consider how to prioritize patients who need to be seen in person, such as those with decompensated cirrhosis with high MELD scores.
• Schedule patients with sufficient time to screen for fever or COVID-19 symptoms and avoid congregating in the waiting area.
• Patients and caregivers (if caregivers are permitted) should wear a mask in the clinic area.
• Remain aware of SARS-CoV-2 prevalence, incidence, and diagnostic testing availability in your community.  
• Consider the risk of a “second wave” of COVID-19 and establish criteria for reentering the mitigation phase if necessary.  
• Continue to develop a telemedicine program to reduce contact between patients and healthcare workers during the reentry phase and consider the role of telemedicine in patient care beyond the COVID-19 pandemic.
AASLD COVID-19 Clinical Oversight and Publications Subcommittee

Oren K. Fix, MD, MSc, FAASLD (Co-chair)
Swedish Medical Center, Seattle, WA

Elizabeth C. Verna, MD, MS (Co-chair)
Columbia University, New York, NY

Kimberly A. Brown, MD, FAASLD
Henry Ford Health System, Detroit, MI

Jaime Chu, MD
Icahn School of Medicine at Mt Sinai, NY, NY

Bilal Hameed, MD
University of California, San Francisco, CA

Laura M. Kulik, MD
Northwestern Medicine, Chicago, IL

Ryan M. Kwok, MD
Uniformed Services University, Bethesda, MD

Brendan M. McGuire, MD
University of Alabama, Birmingham, AL

Daniel S. Pratt, MD, FAASLD
Massachusetts General Hospital, Boston, MA

Jennifer C. Price, MD, PhD
University of California, San Francisco, CA

Nancy S. Reau, MD, FAASLD
Rush University, Chicago, IL

Mark W. Russo, MD, MPH, FAASLD
Carolinas Medical Center, Charlotte, NC

Michael L. Schilsky, MD, FAASLD
Yale University, New Haven, CT

Norah A. Terrault, MD, MPH, FAASLD
Keck Medicine of USC, Los Angeles, CA

Andrew Reynolds (Patient Advocate)

COVID-19 Working Group Members who have contributed to the development of this document

Jorge A. Bezerra, MD, FAASLD
Cincinnati Children’s Hospital, Cincinnati, OH

David C. Mulligan, MD, FAASLD
Yale University, New Haven, CT

Raymond T. Chung, MD, FAASLD
Massachusetts General Hospital, Boston, MA

K. Rajender Reddy, MD, FAASLD
University of Pennsylvania, Philadelphia, PA

Robert J. Fontana, MD, FAASLD
University of Michigan, Ann Arbor, MI
COVID-19 Liver Disease and Transplant Registries

- **SECURE-Cirrhosis** (COVID-19 in patients with cirrhosis and liver transplant recipients, “PHI-free”)
- **University of Washington** (COVID-19 in solid organ transplant recipients, “PHI-free”)
- **COVID-LT Consortium** (COVID-19 in patients with cirrhosis and liver transplant recipients)
- **NASPghan and SPLIT-TTS- COVID -19 Pediatric Registry** (pre- and post-liver and intestine patients, 0-21 years, “PHI-free”)

Helpful Resources

  - CDC recommendations for cleaning and disinfecting rooms or areas visited by individuals with suspected or confirmed COVID-19
- [The Transplantation Society Guidance](https://www.transplantationguidance.org/guidance/coronavirus/) on Coronavirus Disease 2019 (COVID-19) for Transplant Clinicians
- Association of Organ Procurement Organizations [COVID-19 Bulletin](https://www.aop.org/COVID-19-Bulletin-
- [FDA Guidance](https://www.fda.gov/coronavirus) on Conduct of Clinical Trials of Medical Products During COVID-19 Pandemic
- [Medicare Telemedicine](https://www.medicare.gov/telemedicine) Health Care Provider Fact Sheet
- [CMS Flexibilities to Fight COVID-19](https://www.cms.gov/Coronavirus-COVID-19)
- [ACGME’s Response](https://www.acgmecom) to the Coronavirus (COVID-19)
- [CMS Adult Elective Surgery](https://www.cms.gov/ElectiveSurgery) and Procedures Recommendations:
- [Joint GI Society](https://www.jointgisociety.org) Message for Gastroenterologists and Gastroenterology Care Providers
- Joint GI Society Message about [Telehealth](https://www.jointgisociety.org/topics/telehealth)
| Table 1. Diagnostic Methods for SARS-CoV-2 Detection |
|---------------------------------|----------------|----------------|------------------------------------------------|
| **Test (method)**               | **Turn around (hrs)** | **Sensitivity** | **Comments** |
| CBC with differential & platelets | <1             | NA             | Lymphopenia frequently identified at presentation and associated with poor prognosis. Elevated WBC and thrombocytopenia indicate poor prognosis. |
| Comprehensive metabolic panel   | <1             | NA             | Abnormal aminotransferases are common but usually 1-2x ULN. Alkaline phosphatase usually normal. Acute kidney injury indicates poor prognosis. |
| LDH, D-dimer, CRP, INR, CPK, ferritin | <1           | NA             | Elevated inflammatory markers associated with poorer outcomes. |
| Chest CT                        | <1             | 80%-90%        | Bilateral ground glass opacities (lower lobe and peripheral) seen in >90% of hospitalized cases confirmed by RT-PCR. Specificity only 25%. |
| Nasopharyngeal swab (RT-PCR)    | 2-48           | 40%-80%        | Peak shedding 12-14 days after infection; Nasopharyngeal higher yield than oropharyngeal. Requires frozen transport media if >24 hours. False negative common in early in disease. |
| Qualitative nasopharyngeal swab (non-PCR) | <1           | 80%-90%        | Point of care qualitative test using isothermal detection methods. Results in 15 minutes. |
| Sputum (RT-PCR)                 | 2-48           | 60%-80%        | Should be spontaneous expectorant. Do not induce. |
| Bronchoalveolar lavage (RT-PCR) | 2-48           | 95%            | Recommended only for intubated patients with negative nasopharyngeal swab. |
| Plasma serology (IgG, IgM, IgA) | 1-2            | 70%-90%        | Indicative of prior exposure. False negative early in disease. False positive due to lack of SARS-CoV-2 specificity. IgA/IgM positive at 3-6 days after symptom onset. May be useful in healthcare workers, close contacts, and epidemiological studies. |
| Saliva (RT-PCR)                 | NA             | NA             | May be more sensitive and reliable than nasopharyngeal samples from hospitalized patients and asymptomatic healthcare workers. |
| Nasopharyngeal swab (CRISPR)    | 1-2            | NA             | Colorometric dipstick in development. |
| Blood (RT-PCR)                  | 24             | 15%            | May be present in more severe cases. |
| Stool (RT-PCR)                  | 24             | 30%            | May be detectable throughout disease phase. |
| Cell culture                    | >24 (days)     | NA             | For research purposes only. Requires high level safety lab. Used for vaccine and antiviral testing. |

CBC, complete blood count; CPK, creatine phosphokinase; CRISPR, clusters of regularly interspaced short palindromic repeats; CRP, C-reactive protein; CT, computed tomography; INR, international normalized ratio; LDH, lactate dehydrogenase; RT-PCT, real-time polymerase chain reaction; ULN, upper limit of normal.
<table>
<thead>
<tr>
<th>Agent (route/mechanism)</th>
<th>Target population</th>
<th>Safety issues</th>
<th>Approval Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antiviral Agents</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remdesivir (IV/nucleotide analogue)</td>
<td>Moderate-severe</td>
<td>Nausea/vomiting Grade 1-2 ALT elevations Drug vehicle accumulation in acute kidney injury &lt;br&gt;&lt;br&gt;Exclusions: GFR &lt;30-50 mL/min AST or ALT &gt;5x ULN</td>
<td>Available under FDA EUA but remains under study</td>
</tr>
<tr>
<td>Favipiravir (oral/RNA polymerase inhibitor)</td>
<td>Early to mild disease</td>
<td></td>
<td>Investigational Approved for influenza in Asia Tested with interferon-α aerosol x 14 days</td>
</tr>
<tr>
<td>Lopinavir-ritonavir (oral/HIV protease inhibitor)</td>
<td>Moderate-severe</td>
<td>CYP3A4 substrate Severe DDI with CNI 13% early discontinuation due to side effects</td>
<td>FDA-approved for HIV No survival benefit in RCT vs standard of care x 14 days Shorter time to viral clearance when combined with ribavirin and interferon-beta-1b in a phase 2, open-label, randomized trial73</td>
</tr>
<tr>
<td>Nitazoxanide (oral/host proteins)</td>
<td>Moderate-severe</td>
<td>Similar to placebo in influenza trials</td>
<td>FDA-approved for Cryptosporidium/Giardia In vitro activity against coronaviruses</td>
</tr>
<tr>
<td>Hydroxychloroquine (oral/host proteins)</td>
<td>Moderate-severe</td>
<td>QTc prolongation Nausea and vomiting &lt;br&gt;&lt;br&gt;Exclusions: QTc &gt;415 ms Cardiomyopathy G6PD deficiency</td>
<td>FDA-approved for lupus/rheumatoid arthritis/malaria Available as emergency use May work by reducing ACE2 receptor-mediated endocytosis or inhibiting endosomal acidification</td>
</tr>
<tr>
<td>Chloroquine (oral/host proteins)</td>
<td>Moderate-severe</td>
<td>QTc prolongation Nausea and vomiting &lt;br&gt;&lt;br&gt;Exclusions: QTc &gt;415 ms Cardiomyopathy G6PD deficiency</td>
<td>FDA-approved for malaria May work by reducing ACE2 receptor-mediated endocytosis or inhibiting endosomal acidification Reduced progression of disease and symptom duration in China</td>
</tr>
<tr>
<td>Azithromycin (oral/host proteins)</td>
<td>Moderate-severe</td>
<td>CYP3A4 substrate Moderate DDI with CNI Rare cholestatic hepatitis &lt;br&gt;&lt;br&gt;Exclusion: QTc &gt;415 ms</td>
<td>FDA-approved for bacterial infections Should only be combined with hydroxychloroquine in clinical trials due to risk of QT prolongation</td>
</tr>
<tr>
<td>Famotidine (oral or IV/protease inhibitor)</td>
<td>All</td>
<td>None significant</td>
<td>FDA-approved for other indications Retrospective data only, RCTs ongoing89</td>
</tr>
<tr>
<td>Immunomodulatory Agents</td>
<td>Severe (high IL-6 levels)</td>
<td>Grade 1-2 ALT 20%-40% Grade 3+ ALT 1%-2%. Acute liver failure &lt;1% Neutropenia 3% Thrombocytopenia 2% Opportunistic infections</td>
<td>FDA-approved for RA 8 mg/kg dose</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Tocilizumab (IV/monoclonal IL-6 receptor antagonist)</td>
<td>Severe (high IL-6 levels)</td>
<td>Grade 1-2 ALT 15%-25% Neutropenia 5% Thrombocytopenia 1%</td>
<td>FDA-approved in RA Being tested as IV formulation</td>
</tr>
<tr>
<td>Sarilumab (SC/monoclonal antibody)</td>
<td>Severe (high IL-6 levels)</td>
<td>Grade 1-2 ALT Rash 30% Thrombocytopenia 9%</td>
<td>FDA-approved in Castleman’s disease</td>
</tr>
<tr>
<td>Siltuximab (IV/monoclonal antibody)</td>
<td>Severe (high IL-6)</td>
<td>Grade 1-2 ALT</td>
<td>Investigational Open label 400 mL plasma infusion in 5 patients and 200 mL plasma infusion in 10 patients Finding donors with neutralizing IgG activity not well established Reserved for severe/life threatening cases</td>
</tr>
<tr>
<td>Convalescent plasma (IV/neutralizing antibodies)</td>
<td>Severe or life-threatening pneumonia</td>
<td>Potential TRALI/ anaphylaxis ICU monitoring needed Must screen donor for other transmissible pathogens</td>
<td></td>
</tr>
</tbody>
</table>

ACE2, angiotensin converting enzyme 2; ANC, absolute neutrophil count; CNI, calcineurin inhibitor; DDI, drug-drug interaction; EUA, Emergency Use Authorization; G6PD, glucose-6-phosphate dehydrogenase; GFR, glomerular filtration rate; HIV, human immunodeficiency virus; ICU, intensive care unit; IV, intravenous; RA, rheumatoid arthritis; RCT, randomized controlled trial; SC, subcutaneous; TRALI, transfusion-related acute lung injury; ULN, upper limit of normal
Figures

Figure 1. Approach to the Patient with COVID-19 and Elevated Serum Liver Biochemistries

COVID-19 patient with elevated serum liver biochemistries

Consider etiologies other than COVID-19, including hepatitis A, B and C
- Review medications
- Avoid imaging unless it is likely to change management, e.g., clinical suspicion for biliary obstruction or venous thrombosis

Liver tests stable/improving or worsening?

**Stable/improving**
- Continue to monitor closely

**Worsening**
- Evaluate other causes: myositis (especially when AST>ALT), ischemia, cytokine release syndrome, drug-induced liver injury
- Weigh removal of hepatotoxic agents
- Utility of liver biopsy not established
Figure 2. Approach to Liver Transplant Organ Offers

Acceptable organ offer

Assess hospital resources (ICU, ventilator, PPE, blood products) before accepting organ

Screen recipient by phone for COVID-19 symptoms/fever

Negative screen

Call recipient in to hospital
Consider having a backup recipient wait at home

Screen/test recipient*

Negative screen and negative test

Positive screen and/or positive test

Negative screen and negative test

Positive screen

Positive screen and/or positive test

Do not proceed with transplantation

Call backup recipient in to hospital

*Recipient screening: Screen recipient on arrival for COVID-19 symptoms/fever
Test recipient for SARS-CoV-2, if available

**Donor screening: Screen donor history for possible COVID-19 exposure or clinical symptoms, fever, or chest imaging compatible with COVID-19
Test donor for SARS-CoV-2, if available
Figure 3. Approach to the Liver Transplant Recipient with COVID-19

Early post-transplant

≤6 months from transplant

≥6 months from transplant

Reduce or stop antimetabolite
Maintain calcineurin inhibitor

Reduce or stop antimetabolite
Consider reducing level of calcineurin inhibitor

Lab testing with inflammatory markers
Oxygen saturation
Chest imaging

Normal oxygen saturation and
No imaging findings

Normal oxygen saturation and
Abnormal imaging findings

Abnormal oxygen saturation and/or
Chest imaging findings of COVID-19

Monitor symptoms and labs
Discharge per standard protocol
Follow closely as outpatient
Monitor oximetry if possible

Continue to observe inpatient
Follow oxygen saturation and chest imaging

Initiate* or continue local protocol treatment for anti-inflammatory (anti-cytokine) and antiviral therapy
Monitor inflammatory markers, oxygen saturation, chest imaging, QTc**

Check for termination of viral shedding, if possible
Educate caregivers

Consider discharge when oxygen no longer needed

*Therapy ideally initiated early, prior to advanced respiratory decompensation

**If on hydroxychloroquine and/or azithromycin
References


42. US Food and Drug Administration. Qualitative detection of nucleic acid from the SARS-CoV-2 virus in direct nasal, nasopharyngeal or throat swabs and nasal, nasopharyngeal or throat swabs eluted in viral transport media from individuals who are suspected of COVID-19 by their healthcare provider. Published March 27, 2020. https://www.fda.gov/media/136522/download. Accessed May 2020.


