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Contributor Disclosures

All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: Apr 2020. | **This topic last updated:** May 19, 2020.

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the virus that causes coronavirus disease 2019 (COVID-19). Information about COVID-19 is evolving rapidly, and interim guidance by multiple organizations is constantly being updated and expanded. This topic will discuss issues related to COVID-19 during pregnancy and delivery.

VIROLOGY AND EPIDEMIOLOGY

General issues regarding the virology, geographic distribution, route of transmission, period of infectivity, and immunity of SARS-CoV-2 are reviewed separately. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention".)

Vertical transmission is addressed below. (See 'Vertical transmission' below.)

PREVENTION

Pregnant women should follow the same recommendations as nonpregnant persons for avoiding exposure to the virus (eg, social distancing, hand hygiene, disinfecting surfaces, wearing a mask in public). Women with epidemiologic history of contact should be monitored. (See "Coronavirus

disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Personal preventive measures'.)

Pregnant women with children should exercise caution. COVID-19 in children is often mild and may be asymptomatic, although severe cases have been reported. Given the possibility of transmission of SARS-CoV-2 from asymptomatic individuals (or presymptomatic individuals within the incubation period) [1-7], the Centers for Disease Control and Prevention recommend that children not have playdates with children from other households; that they remain ≥6 feet from people from other households when playing outside; and that they wear cloth face coverings in public settings where other social distancing measures are difficult to maintain [8]. (See "Coronavirus disease 2019 (COVID-19): Considerations in children", section on 'Should play dates and playgrounds be avoided?'.)

Pregnant health care workers have additional concerns, and there is no standard occupational guidance for them regarding work restrictions [9,10].

Pregnant workers in occupations other than health care may continue to work until they deliver, but risk mitigation (reassignment at term to roles with reduced risk of exposure or self-quarantine) can be considered to reduce the individual's risk of being infected peripartum, when maternal infection has broader implications (eg, exposure of health care workers, infant exposure) [9]. The patient's comorbidities and individual work situation should guide the clinician's response to requests for medical leave.

CLINICAL MANIFESTATIONS

All pregnant women should be monitored for development of symptoms and signs of COVID-19, particularly if they have had close contact with a confirmed case or persons under investigation. In a systematic review including 356 cases in pregnant women (33 studies), the most frequent symptoms were fever (67 percent), cough (66 percent), dyspnea (7 percent), sore throat (7 percent), fatigue (7 percent), and myalgia (6 percent) [11]. Rhinorrhea/nasal congestion, anorexia, nausea/vomiting, headache, and possibly abnormalities in smell and/or taste have also been reported. Laboratory findings included lymphopenia (14 percent), modest increase in liver enzymes (5 percent), and thrombocytopenia (1 percent) [11]. These clinical manifestations are similar to those in nonpregnant individuals. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention".)

Complications of infection include acute respiratory distress syndrome, arrhythmias, acute cardiac injury, and shock. (See "Coronavirus disease 2019 (COVID-19): Critical care and airway

management issues" and "Coronavirus disease 2019 (COVID-19): Arrhythmias and conduction system disease" and "Coronavirus disease 2019 (COVID-19): Myocardial injury".)

Classification of disease severity — In the United States, the National Institutes of Health have categorized disease severity as [12]:

- **Asymptomatic or presymptomatic infection** – Positive test for SARS-CoV-2 but no symptoms.
- **Mild illness** – Any signs and symptoms (eg, fever, cough, sore throat, malaise, headache, muscle pain) without shortness of breath, dyspnea, or abnormal chest imaging.
- **Moderate illness** – Evidence of lower respiratory disease by clinical assessment or imaging and a saturation of oxygen (SaO_2) >93 percent on room air at sea level.
- **Severe illness** – Respiratory frequency >30 breaths per minute, SaO_2 ≤93 percent on room air at sea level, ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO_2/FiO_2) <300, or lung infiltrates >50 percent.
- **Critical illness** – Respiratory failure, septic shock, and/or multiple organ dysfunction.

Disease severity has also been categorized as (Wu classification) [13]:

- **Mild** – No or mild symptoms (fever, fatigue, cough, and/or less common features of COVID-19).
- **Severe** – Tachypnea (respiratory rate >30 breaths per minute), hypoxia (oxygen saturation ≤93 percent on room air or PaO_2/FiO_2 <300 mmHg), or >50 percent lung involvement on imaging).
- **Critical** (eg, with respiratory failure, shock, or multiorgan dysfunction).

(See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'Defining disease severity'.)

COURSE IN PREGNANCY

Maternal course — Available data from multiple small series generally suggest that pregnancy and childbirth do not increase the risk for acquiring SARS-CoV-2 infection, do not worsen the clinical course of COVID-19 compared with nonpregnant individuals of the same age, and most infected mothers recover without undergoing delivery [13-26]. The population most commonly affected by severe disease is older adults, particularly those with comorbidities, and most pregnant women are younger than middle age; however, they may have comorbid conditions that increase their risk. It is known that some patients with severe COVID-19 have laboratory evidence of an exuberant

inflammatory response (similar to cytokine release syndrome), which has been associated with critical and fatal illnesses. Whether the normal immunologic changes of pregnancy affect the occurrence and course of this response is unknown. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Course and complications'.)

In pregnant women who develop COVID-19 pneumonia, early data show approximately the same rate of intensive care unit (ICU) admissions as in the nonpregnant population but an increased risk of preterm and cesarean delivery. (See 'Pregnancy complications' below.)

- A preliminary report from the United States indicated 4 of 143 pregnant COVID-19 patients (2.8 percent) were admitted to an ICU, but these data were incomplete [27].
- In an initial United States experience from New York City including 43 pregnant patients with confirmed COVID-19, the disease course was mild in 37 (86 percent), severe in 4 (9.3 percent), and critical in 2 (4.7 percent) [14].
- In a larger cohort of 147 pregnant patients in the WHO-China Joint Mission Report and a separate report of 118 pregnant patients in Wuhan, the illness was severe in 8 percent and critical in 1 percent [17]. These percentages are similar to those of nonpregnant, reproductive-age adults [13,28].

Severe sequelae of maternal infection include prolonged ventilatory support and need for extracorporeal membrane oxygenation (ECMO) [29].

Several maternal deaths from cardiopulmonary complications, sometimes with multiorgan failure, have been reported in the medical literature [30-32]. Most of these women were generally healthy prior to the SARS-CoV-2 infection.

It is important to note that in one report from New York City, 10 of 14 patients (71 percent) who were asymptomatic on admission for an obstetric indication and found to be SARS-CoV-2-positive on universal screening went on to develop symptoms during their delivery admission or postpartum [14]. Of the 14 initially asymptomatic patients, 4 remained asymptomatic, 8 developed mild symptoms, and 2 developed severe/critical disease.

While the course of the infection in pregnant persons is similar to that in nonpregnant persons, there are added issues during pregnancy, such as timing of prenatal care visits and screening tests in uninfected women and, in infected women, potential pregnancy complications, timing and management of labor and delivery, and postpartum care (mother-newborn separation, breastfeeding, infant care, postpartum depression risk). These issues are reviewed below.

Pregnancy complications — Although an early review of 51 pregnant patients with well-documented COVID-19 reported that 39 percent delivered before 37 weeks of gestation and 96 percent delivered by cesarean [23], a subsequent larger systematic review including 252 pregnant COVID-19 patients reported that 15 percent delivered before 37 weeks and 70 percent were delivered by cesarean [11]. It is important to emphasize that available data are generally of low quality, reflecting small numbers of cases and a disproportionate number of patients intubated with COVID-19 pneumonia. Fever and hypoxemia from severe pneumonia may increase the risks for preterm labor, prelabor rupture of membranes, and abnormal fetal heart rate patterns, but preterm deliveries also occurred in patients without severe respiratory disease. It appears that many of the initial third-trimester cases were electively delivered by cesarean because of a bias to intervene catalyzed by the belief that management of severe maternal respiratory disease would be improved by delivery; however, this hypothesis is unproven.

The frequency of spontaneous abortion does not appear to be increased, but data on first-trimester infections are limited [11,33]. At least five critically ill women had fetal deaths: four of these women died, and the other was on ECMO [29-31]. Over 95 percent of newborns have been in good condition at birth; neonatal complications have largely been related to preterm birth and to adverse uterine environments resulting from critical maternal disease [11,31,34].

Hyperthermia, which is common in COVID-19, is a theoretical concern as elevation of maternal core temperature from a febrile illness during organogenesis in the first trimester may be associated with an increased risk of congenital anomalies, especially neural tube defects, or miscarriage; however, an increased incidence of these outcomes has not been observed. Use of acetaminophen in pregnancy, including in the first trimester, has been shown overall to be safe and may attenuate the pregnancy risks associated with fever exposure. (See "Open neural tube defects: Risk factors, prenatal screening and diagnosis, and pregnancy management", section on 'Fever/hyperthermia'.)

Vertical transmission — Standards for neonatal evaluation at delivery of an infected mother and criteria for vertical transmission have not been developed. Assessing the immunoglobulin M (IgM) level for the virus in cord blood and sampling the neonatal nasopharynx, amnion-chorion interface, and placental tissue using aseptic technique immediately after delivery have been suggested. Amniotic fluid obtained at cesarean delivery could also be tested.

In women who test positive for SARS-CoV-2 in the nasopharynx, vaginal and amniotic fluid specimens have been negative to date [33,35,36]. Viremia rates in patients with COVID-19 appear to be low (1 percent in one study [37]) and transient, suggesting placental seeding and vertical transmission are unlikely. Few placentas have been studied, and almost all had no evidence of infection. One exception is a case report of a patient with confirmed COVID-19 who had second-trimester miscarriage in which samples taken from a placental cotyledon and submembrane were

positive for SARS-CoV-2; all fetal, amniotic fluid, cord blood, and maternal blood and vaginal samples were negative [38]. Another report described one positive placental swab from the amniotic surface and two positive membrane swabs from between the amnion and chorion after manual separation of the membranes in women with severe or critical COVID-19 illness delivered by cesarean; none of the infants were positive for SARS-CoV-2 [39].

In reviews including up to 51 pregnant women with COVID-19, no cases of intrauterine transmission have been documented [19,23,24]. Subsequently, several possible cases based on newborn laboratory and/or clinical findings have been reported [20,40-43], but SARS-CoV-2 testing on fetal blood, amniotic fluid, and placenta was either negative or not performed. Many of these infants were delivered by cesarean and had positive nasopharyngeal cultures for SARS-CoV-2 on days 1 or 2 of life, an elevated IgM level, and/or pneumonia. Positive IgM results are not definitive evidence of in utero infection (false positives and cross reactivity occur), and, in many of these cases, early infant infection may have been due to postnatal contact with infected parents or caregivers [44].

APPROACH TO DIAGNOSIS

The possibility of COVID-19 should be considered in patients with new-onset fever/chills and/or respiratory tract symptoms (eg, cough, dyspnea). It should also be considered in patients with severe lower respiratory tract illness without any clear cause. Residing in or travel to a location where there is community transmission of SARS-CoV-2 or close contact with a confirmed or suspected case of COVID-19 in the past 14 days should heighten suspicion.

Patients who meet the testing criteria should undergo testing for SARS-CoV-2 RNA by reverse-transcription polymerase chain reaction (RT-PCR) on a nasopharyngeal swab specimen, ideally in addition to testing for other respiratory pathogens (eg, influenza, respiratory syncytial virus). Criteria for testing and diagnostic issues are discussed in detail separately (see "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Diagnosis'). In areas where the infection is active, we believe testing all patients upon presentation to labor and delivery (or the day before if a scheduled admission) with a rapid test for SARS-CoV-2 is reasonable, if testing is available. (See 'Infection control precautions' below.)

This testing should occur in a location designed to reduce the risk of passing the infection to uninfected persons, such as at dedicated "walk-in" or "drive-in" testing locations from which results can be made readily available to the obstetric providers.

A positive RT-PCR generally confirms the diagnosis of COVID-19, although occasional false-positive tests occur [45]. False-negative tests on initial testing appear to be common, especially in the four days preceding symptoms and the first day of symptoms [46], and have been reported in

pregnant women [47]. Sensitivity depends on several factors: the specific RT-PCR assay, the type of specimen obtained (nasopharyngeal specimens have higher sensitivity than oropharyngeal or nasal specimens), the quality of the specimen, and the duration of illness at the time of testing [45]. If the initial nasopharyngeal test is negative but the suspicion for COVID-19 remains and determining the presence of infection is important for management or infection control, the test should be repeated in 24 hours to a few days. Infection control precautions for COVID-19 should continue while repeat evaluation is being performed. Two subsequent negative samples generally rule out the infection [48]. If there is high suspicion of COVID-19 infection and diagnosis is required for management, lower respiratory tract specimens (eg, sputum, bronchoalveolar lavage) can be tested as they have higher sensitivity [49]. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Laboratory findings'.)

A chest radiograph is sufficient for initial evaluation of pulmonary complications in most hospitalized patients with COVID-19. A single chest radiograph carries a very low fetal radiation dose of 0.0005 to 0.01 mGy. Computed tomography (CT) should be performed, if indicated, as the fetal radiation dose for a routine chest CT (table 1) is also low and not associated with an increased risk of fetal anomalies or pregnancy loss. Some authorities have advocated pulmonary ultrasound, possibly at the same time as the obstetric scan, for quick diagnosis of pneumonia in pregnant women, which in certain locations would be the quickest way to ascertain high suspicion of maternal COVID-19 infection [50,51]. A detailed description of performance of lung ultrasound can be found elsewhere [50]. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'Evaluation' and "Diagnostic imaging in pregnant and nursing women".)

PRENATAL CARE

Preventing exposure in the community — Social distancing and hygienic measures are recommended but may be difficult for pregnant women who are homeless, living in a shelter, living in multigenerational dense housing, or living in multiple places in a short time. Social distancing and hygienic measures are reviewed separately. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Personal preventive measures'.)

Patients with potential exposure — Pregnant patients with an epidemiologic history of contact with a person with confirmed, probable, or suspected COVID-19 should self-isolate and be monitored for symptoms. The incubation period is up to 14 days. Diagnostic testing for SARS-CoV-2 infection depends on test availability. (See "Coronavirus disease 2019 (COVID-19): Epidemiology,

virology, clinical features, diagnosis, and prevention", section on 'Managing asymptomatic individuals with potential exposure'.)

Further evaluation and management of patients who become symptomatic depend on illness severity, underlying comorbidities, and clinical status. Those with at least moderate illness are typically hospitalized. These issues and timing of discontinuation of precautions are reviewed separately. (See "Coronavirus disease 2019 (COVID-19): Outpatient management in adults" and "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults" and "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Discontinuation of precautions'.)

Routine prenatal care in uninfected women — The American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine have issued guidance regarding prenatal care during the COVID-19 pandemic (available at acog.org and SMFM.org) [52,53]. It includes general guidance for testing and preventing spread of COVID-19, algorithms, and suggestions for modifying traditional protocols for prenatal visits. These modifications, which should be tailored for low- versus high-risk patients (eg, multiple gestation, hypertension, diabetes), include telehealth, reducing the number of in-person visits, timing of visits, grouping tests (eg, aneuploidy, diabetes, infection screening) to minimize maternal contact with others, restricting visitors during visits and tests, timing of indicated obstetric ultrasound examinations (eg, gestational age, fetal anomaly, fetal growth, placental attachment), and timing and frequency of use of nonstress tests and biophysical profiles.

There are many ways to reduce the time patients, including patients with high-risk pregnancies, are in the office [54]. For example, the clinician can order a 75 gram two-hour oral glucose tolerance test (GTT) instead of a glucose challenge test and 100 gram three-hour GTT (in women with positive results); cell-free DNA screening can be used (at >10 weeks) for Down syndrome screening rather than the combined test (ie, nuchal translucency on ultrasound and serum analytes). Ideally, every woman should have telehealth capabilities and a means for measuring blood pressure at home.

In the author's practice, during the pandemic, most low-risk pregnant women come to the office only for in-person prenatal visits at approximately 12, 20, 28, and 36 weeks of gestation (ie, at gestational ages when ultrasound and/or laboratory tests can also be performed) to minimize person-to-person contacts. Some practices are encouraging that even these visits occur by telehealth, and others include a visit at approximately 32 weeks [48]. When an outpatient office visit occurs, all patients and health care workers wear at least a surgical mask; no partner is allowed, but video communication is encouraged.

The psychological impact of COVID-19 should also be recognized and support offered. In one study, approximately one-third of respondents reported moderate to severe anxiety [55].

Medical management of pregnant women with COVID-19

Home care — Most pregnant patients with known or suspected COVID-19 have mild disease (no shortness of breath) that does not warrant hospital-level care in the absence of obstetric problems (eg, preterm labor). Patient instructions and other aspects of home care are similar to that in nonpregnant persons, except pregnant women in the third trimester should perform fetal kick counts and report decreased fetal movement [48]. Patients experiencing homelessness should be provided resources such as dedicated housing units, where available. (See "Coronavirus disease 2019 (COVID-19): Outpatient management in adults" and "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Infection control in the home setting' and "Decreased fetal movement: Diagnosis, evaluation, and management".)

The US Food and Drug Administration has expanded its approval for use of noninvasive fetal and maternal monitoring devices in the home in patients who require fetal and/or maternal monitoring for conditions unrelated to COVID-19 [56]. This can help reduce patient and health care provider contact and potential exposure to COVID-19 during the pandemic.

Medical and obstetric care of hospitalized patients — Pregnant women with mild disease plus comorbidities or moderate to critical disease are hospitalized. Pregnant hospitalized patients with severe disease, an oxygen requirement plus comorbidities, or critical disease should be cared for by a multispecialty team at a level III or IV hospital with obstetric services and an adult intensive care unit (ICU) [9,48]. COVID-19 status alone is not necessarily a reason to transfer noncritically ill pregnant women with suspected or confirmed COVID-19. (See 'Classification of disease severity' above.)

Guidelines for management of hospitalized patients with COVID-19, including evaluation and care of critically ill patients, are reviewed elsewhere. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults" and "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues".)

Fetal monitoring — A specific management issue in pregnant patients is fetal monitoring in those who are at a viable gestational age. The need for and frequency of fetal testing depend upon gestational age, stability of maternal vital signs, other maternal comorbidities, and discussions with the patient and her family that consider the possibly increased risks of stillbirth and perinatal morbidities in the absence of testing. For hospitalized patients, a Bluetooth-enabled external fetal monitor can transmit the fetal heart rate tracing to the obstetric provider. The monitor can be used continuously in unstable hospitalized patients in whom emergency cesarean delivery would be

performed for a persistent nonreassuring fetal heart rate pattern. An abnormal tracing might also help guide maternal oxygen therapy. In patients with stable oxygen saturation (SaO_2), a nonstress test can be performed once or twice daily, as one option.

Monitoring for preterm labor — Monitoring pregnant patients for signs and symptoms of preterm labor is a routine component of obstetric care and should be a component of maternal monitoring of pregnant patients hospitalized in nonobstetric settings. (See "Preterm labor: Clinical findings, diagnostic evaluation, and initial treatment".)

Maternal oxygenation level — Among critically ill COVID-19 patients, profound acute hypoxemic respiratory failure from acute respiratory distress syndrome (ARDS) is the dominant finding. General supportive care of the critically ill patient with COVID-19 pneumonia is similar to that in patients with ARDS due to other causes. Common complications of COVID-19-related ARDS include acute kidney injury, elevated liver enzymes, and cardiac injury (eg, cardiomyopathy, pericarditis, pericardial effusion, arrhythmia, sudden cardiac death). During pregnancy, maternal peripheral oxygen saturation (SpO_2) should be maintained at ≥95 percent, which is in excess of the oxygen delivery needs of the mother. If SpO_2 falls below 95 percent, an arterial blood gas is obtained to measure the partial pressure of oxygen (PaO_2): Maternal PaO_2 greater than 70 mmHg is desirable to maintain a favorable oxygen diffusion gradient from the maternal to the fetal side of the placenta.

In the ICU, severely ill patients with COVID-19 are often managed in the prone position. Some ICUs have extended this approach to pregnant women, although even a semi-prone position can be a difficult position in which to place a pregnant woman in the last half of pregnancy. (See "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues" and "Critical illness during pregnancy and the peripartum period", section on 'Supportive care' and "Coronavirus disease 2019 (COVID-19): Myocardial injury".)

Use and type of venous thromboembolism prophylaxis — Direct data on thromboembolic risk with COVID-19 are limited but suggest an increased risk. The American Society of Hematology, the Society of Critical Care Medicine, and the International Society of Thrombosis and Haemostasis [57-59] recommend routine pharmacologic venous thromboembolism prophylaxis in patients hospitalized with COVID-19 unless there is a contraindication (eg, bleeding, severe thrombocytopenia).

We initiate prophylaxis in all pregnant/postpartum women with COVID-19 admitted to the hospital for management of an antepartum or postpartum obstetric or medical disorder or because of the severity of COVID-19 alone. For antepartum prophylaxis in women who are not severely or critically ill and who may deliver within a few days, unfractionated heparin 5000 units subcutaneously every

12 hours is a reasonable dose. Dosing in other inpatient clinical scenarios is discussed separately. (See "Coronavirus disease 2019 (COVID-19): Hypercoagulability", section on 'Inpatient VTE prophylaxis' and 'Postpartum care' below.)

Unfractionated heparin is generally preferred in pregnant women who might be proximate to delivery because it is more readily reversed than low molecular weight heparin. Low molecular weight heparin is reasonable in women unlikely to be delivered within several days and those who are postpartum. Dosing is discussed separately. (See "Coronavirus disease 2019 (COVID-19): Hypercoagulability", section on 'Inpatient VTE prophylaxis' and "Coronavirus disease 2019 (COVID-19): Hypercoagulability", section on 'Outpatient thromboprophylaxis' and "Use of anticoagulants during pregnancy and postpartum".)

Safety of antiviral drug therapy — Several agents are being evaluated for treatment of COVID-19. Although some of these agents are clinically available for other indications, their use for COVID-19 remains investigational.

- Remdesivir – At some hospitals, pregnant women with severe COVID-19 are being offered remdesivir in a compassionate-use protocol. Remdesivir is a novel nucleotide analogue that has activity against SARS-CoV-2 in vitro [60] and related coronaviruses (including severe acute respiratory syndrome [SARS] and Middle East respiratory syndrome-related coronavirus [MERS-CoV]) both in vitro and in animal studies [61]. It has been used without reported fetal toxicity in some pregnant women with Ebola and Marburg virus disease [62] and is being used to treat, on a compassionate-use basis, pregnant patients with severe COVID-19. Randomized trials of the drug during the COVID-19 pandemic have excluded pregnant and breastfeeding women. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'COVID-19-specific therapy'.)

- **Other drugs** – Data from early randomized trials generally suggest **no** benefit from administration of hydroxychloroquine or chloroquine. Furthermore, adverse maternal effects include abnormal heart rhythms (QT interval prolongation and ventricular tachycardia), especially in patients taking other drugs associated with QTc prolongation. Therefore, these drugs should not be used for treatment of COVID-19 outside of ongoing randomized trials. Hydroxychloroquine crosses the placenta. Accumulation in fetal ocular tissue has been observed in animal studies, but an increased risk of fetal ocular abnormalities has not been observed in humans, which is reassuring given that the drug has been used by pregnant women for treatment of systemic lupus erythematosus or for prevention of malaria. Available data are limited, however, and a risk to the fetus cannot be ruled out when used at different doses for other indications [63]. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'Hydroxychloroquine/chloroquine' and "Malaria in pregnancy:

Prevention and treatment", section on 'Safety of antimalarials in pregnancy' and "Pregnancy in women with systemic lupus erythematosus", section on 'Medications'.)

Several other drugs are being used in research studies. One such drug is lopinavir-ritonavir, which is primarily used for treatment of HIV infection, including during pregnancy. It crosses the placenta and may increase the risk for preterm delivery, but an increased risk of teratogenic effects has not been observed in humans. Investigational drugs for COVID-19 that are known to be teratogenic include ribavirin and baricitinib. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'COVID-19-specific therapy'.)

Use of standard medications for managing pregnancy complications

- **Antenatal** betamethasone – For the general population, the Centers for Disease Control and Prevention (CDC) recommend avoiding glucocorticoids in COVID-19-positive persons because they have been associated with an increased risk for mortality in patients with influenza and delayed viral clearance in patients with MERS-CoV infection. However, the CDC has not addressed use of antenatal glucocorticoids to reduce neonatal morbidity and mortality from preterm birth in pregnant COVID-19-positive patients.

  Because of the clear benefits of antenatal betamethasone administration between 24+0 and 33+6 weeks of gestation in patients at high risk of preterm birth within seven days, ACOG continues to recommend its use for standard indications to pregnant patients with suspected or confirmed COVID-19 [64]. However, for pregnant patients with suspected or confirmed COVID-19 at 34+0 to 36+6 weeks of gestation and at risk of preterm birth within seven days, the benefits to the neonate are less clear, and ACOG has advised not administering a course of betamethasone to such patients. However, these decisions may need to be individualized, weighing the neonatal benefits with the risks of potential harm to the pregnant patient. (See "Antenatal corticosteroid therapy for reduction of neonatal respiratory morbidity and mortality from preterm delivery", section on 'Gestational age at administration'.)

- **Low-dose** aspirin – For pregnant women without COVID-19, ACOG has stated that low-dose aspirin should continue to be offered as medically indicated (eg, prevention of preeclampsia) [65]. For those with suspected or confirmed COVID-19 for whom low-dose aspirin would be indicated, the decision to continue the drug should be individualized. For example, continuing preeclampsia prophylaxis is likely not worthwhile in severely or critically ill patients or near term. A panel from the National Institutes of Health has stated that persons with COVID-19 who are taking nonsteroidal anti-inflammatory drugs (NSAIDs) for a comorbid condition should continue therapy as previously directed by their health care provider [12].

Concern about possible negative effects of NSAIDs was raised by anecdotal reports of a few young, nonpregnant patients who received NSAIDs (ibuprofen) early in the course of infection and experienced severe disease [66,67]. However, there have been no clinical or population-based data that directly address the risk of NSAIDs. Given the absence of data, the European Medicines Agency and the World Health Organization do not recommend avoiding NSAIDs in COVID-19 patients when clinically indicated [68,69].

- **Tocolysis** – In women with known or suspected COVID-19, our preferred tocolytic is nifedipine. It is a suitable alterative to indomethacin, which is subject to the concerns discussed above, and to beta sympathomimetics, which can further increase the maternal heart rate.

Follow-up of women who recover from COVID-19 — Development of fetal growth restriction is a theoretic concern and has been described with other SARS infections [70,71]. In the absence of robust data, authorities have suggested that pregnant women with confirmed infection should be monitored with serial ultrasound assessments of fetal growth and amniotic fluid volume [72] beginning 14 days after symptom resolution [73]. For those with first- or early second-trimester infection, a detailed fetal morphology scan at 18 to 23 weeks of gestation is also indicated.

Very limited COVID-19-specific data on fetal growth are available [18]. Suboptimal fetal growth due to placental insufficiency is plausible because maternal COVID-19 has been associated with focal avascular villi and thrombi in larger fetal vessels in the chorionic plate and stem villi [74]. These lesions could be caused by COVID-19-related coagulopathy or placental hypoxia during the acute maternal illness, or both.

Timing delivery in infected women — For most women with preterm COVID-19 and nonsevere illness who have no medical/obstetric indications for prompt delivery, delivery is not indicated and ideally will occur sometime after a negative testing result is obtained or isolation status is lifted, thereby minimizing the risk of postnatal transmission to the neonate [75].

In women with severe illness, there are multiple issues to consider, and timing of delivery needs to be individualized [48,76]. Whether the mother's respiratory disease will be improved by delivery and the risk of postnatal transmission in the delivery room when maternal symptoms are acute are both unclear. It should also be noted that maternal antibody production and, in turn, passive newborn immunity may not have had time to develop. On the other hand, increased oxygen consumption and reduced functional residual capacity, which are normal in pregnancy, may facilitate maternal deterioration in patients with pneumonia [77]. Excessive uterine distension from multiple gestation or severe polyhydramnios in the third trimester may further compromise pulmonary function.

For the hospitalized patient with COVID-19 with pneumonia but not intubated, some authorities have advocated consideration of delivery in pregnancies >32 to 34 weeks. The rationale is that

delivery is performed before the pulmonary situation worsens and ongoing maternal hypoxemia places the fetus at risk of compromise. Most authorities do not advocate delivery prior to 32 weeks, even though the maternal situation may worsen in the second week, given the known morbidity and mortality of very preterm infants.

Timing of delivery of the hospitalized pregnant woman intubated and critically ill with COVID-19 is challenging. After 32 to 34 weeks, some have advocated delivery if the patient is stable, but this could exacerbate the maternal condition. Between viability and <32 weeks, continuing maternal support with fetal monitoring is usually suggested for perinatal benefit as long as the maternal situation remains stable or improving. In some situations, maternal extracorporeal membrane oxygenation may be necessary [78].

MANAGEMENT OF LABOR AND DELIVERY

Although many asymptomatic patients are concerned about leaving their home because of the COVID-19 pandemic, the American College of Obstetricians and Gynecologists (ACOG) continues to recommend following existing evidence-based guidance regarding home birth [65]. (See "Planned home birth".)

Infection control precautions

- **Prehospital notification of possible infection** – The Centers for Disease Control and Prevention (CDC) recommend that pregnant patients who have confirmed or suspected COVID-19 notify the obstetric unit before arrival so that the facility can make appropriate infection control preparations [79]. The obstetric unit should ensure that their infection control practices for these patients are consistent with CDC guidelines.

- **Evaluation of all patients presenting to the hospital** – All patients should be screened for signs and symptoms of COVID-19, as well as whether they have had close contact with a confirmed case or persons under investigation, before entering the hospital for admission to the labor and delivery unit [80]. Screening can include checking temperature and asking about fever and/or new cough, shortness of breath, sore throat, muscle aches, rhinorrhea/nasal congestion, and smell and taste abnormalities. The CDC advises prioritizing the testing of pregnant women with suspected COVID-19 at admission or who develop symptoms of COVID-19 during admission [79]. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Measures for all patients, visitors, and personnel'.)

  Asymptomatic patients and presymptomatic patients may present to the labor and delivery unit, which has implications for the health care staff and management of the newborn. For this

reason, in areas where infection in the community is widespread, we believe testing all patients upon presentation to labor and delivery (or the day before if a scheduled admission) with a rapid SARS-CoV-2 test is reasonable, if testing is available. We believe this information is useful to inform infection control precautions both intrapartum and postpartum, including newborn care [14,81,82]. During the New York City pandemic, 215 pregnant women admitted to two New York City hospitals for delivery were screened for COVID-19, and 33 (15 percent) were SARS-CoV-2-positive [21]. Of the 33 women, 4 were symptomatic and 29 were asymptomatic; thus, 13.5 percent of asymptomatic patients admitted for delivery tested positive for SARS-CoV-2. Among the asymptomatic women who tested positive, 3/29 developed a postpartum fever, and at least one of these patients was presumed to have COVID-19. One additional patient who tested negative on admission became symptomatic postpartum, and repeat SARS-CoV-2 testing was positive. However, these findings are likely not generalizable to areas where the prevalence of COVID-19 is low.

The evaluation and diagnosis of women admitted to labor and delivery with suspected COVID-19 are similar to that of other patients admitted to the hospital with suspected disease. The CDC advises prioritizing the testing of pregnant women with suspected COVID-19 at admission or who develop symptoms of COVID-19 during admission [79]. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Diagnosis'.)

- **Use of personal protective equipment (PPE) on labor and delivery** – Health care workers should use appropriate PPE when caring for patients with COVID-19. In addition, all patients and any visitors should be given face coverings upon entry into the health care setting (medical or cloth masks) for universal source control. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Measures for all patients, visitors, and personnel' and "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Patients with suspected or confirmed COVID-19'.)

  During active labor, in particular, there are concerns of viral dissemination when the patient is forcefully exhaling [83]. Forceful exhalation may reduce the effectiveness of a mask for containing respiratory droplets and preventing the spread of the virus.

- **Care of COVID-19-positive inpatients** – Ideally, pregnant COVID-19 inpatients should be cared for in specially equipped (eg, negative-pressure) rooms in antepartum, intrapartum, and postpartum COVID-19-only units, similar to other adult COVID-19 inpatients who are usually placed in dedicated COVID-19-only units, halls, or hospitals. Patients with suspected or confirmed COVID-19 are normally instructed to wear a face mask, including during labor and delivery, which may be difficult during active pushing [83].

Infection control precautions regarding pregnant patients with confirmed or suspected infection are similar to those for other hospitalized patients and are reviewed separately. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Patients with suspected or confirmed COVID-19'.)

- **Support persons on labor and delivery** – Perhaps the most controversial issue regarding infection control for women in labor and delivery units is whether to allow a support person. Most facilities recognize that a support person is important to many laboring women and permit one support person who must remain with the laboring woman (may not leave her room and then return). A doula is considered a type of health care personnel by some facilities and a visitor by others. (See "Continuous labor support by a doula".)

  The support person should be screened for fever and other symptoms before entering the building and in accordance with hospital policies. Those with any symptoms consistent with COVID-19, exposure to a confirmed case within 14 days, or a positive test for COVID-19 within 14 days should not be allowed to attend the labor and birth. If screening is negative, we require that the support person wear a cloth face covering, at a minimum, consistent with CDC guidance [80]. If the support person arrives at the health care facility without a cloth face covering, a face mask should be issued if supplies are available.

  A support person who screens positive should not be permitted in the hospital. In such cases and when additional support persons are desired, they can be a part of the patient's labor and delivery via video. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Measures for all patients, visitors, and personnel'.)

Route of delivery — COVID-19 is not an indication to alter the route of delivery [16,52]. Cesarean delivery is performed for standard obstetric indications.

Even if vertical transmission is confirmed as additional data are reported, this would not be an indication for cesarean delivery since it would increase maternal risk and would be unlikely to improve newborn outcome. Reports of COVID-19 infection in the neonate have generally described mild disease. (See "Coronavirus disease 2019 (COVID-19): Considerations in children".)

Screening patients scheduled for induction or cesarean delivery — Patients should be screened for COVID-19 and can undergo pre-induction/pre-cesarean laboratory testing the day before a planned induction or cesarean delivery. We evaluate symptomatic patients to determine whether it is feasible to reschedule until results of COVID-19 testing are available. This requires balancing the risks of continuing the pregnancy in the setting of a positive or negative test result. In particular, if the result is positive, the patient may become more severely ill over time since symptoms are often more severe in the second week of the illness.

In asymptomatic women, inductions of labor and cesarean deliveries with appropriate medical indications should not be postponed or rescheduled; this includes 39-week inductions or cesarean deliveries after patient counseling. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Course and complications'.)

Analgesia and anesthesia — In patients with known or suspected COVID-19, neuraxial anesthetic is not contraindicated and has several advantages in laboring patients: it provides good analgesia and thus reduces cardiopulmonary stress from pain and anxiety and, in turn, the chance of viral dissemination, and it is available in case an emergency cesarean is required, thus obviating the need for general anesthesia. The Society of Obstetric Anesthesia and Perinatology suggests considering suspending use of nitrous oxide for labor analgesia in these patients because of insufficient data about cleaning, filtering, and potential aerosolization of nitrous oxide systems [84]. They also urge consideration of limiting use of intravenous, patient-controlled analgesia because of the risk of respiratory depression.

General anesthesia (intubation and extubation) is considered an aerosolizing procedure, so special PPE (ie, N-95 masks, etc) should be worn by all involved health care providers during such a cesarean delivery. (See "Coronavirus disease 2019 (COVID-19): Anesthetic concerns, including airway management and infection control".)

Magnesium sulfate — In women with respiratory compromise, the use of magnesium sulfate for maternal seizure prophylaxis and/or neonatal neuroprotection should be decided on a case-by-case basis since the drug may further depress respirations. Consultation with maternal-fetal medicine and pulmonary/critical care specialists is advised.

Labor management — Generally, management of labor is not altered in women giving birth during the COVID-19 pandemic or in women with confirmed or suspected COVID-19 that is asymptomatic or mild [83]. Person-to-person contact and time in the labor unit and hospital should be limited, as safely feasible. For patients who require cervical ripening, outpatient mechanical ripening with a balloon catheter is an option. For inpatient cervical ripening, using two methods (eg, mechanical and misoprostol or mechanical and oxytocin) decreases the time from induction to delivery, compared with using one agent only. (See "Techniques for ripening the unfavorable cervix prior to induction", section on 'Outpatient cervical ripening' and "Techniques for ripening the unfavorable cervix prior to induction", section on 'Balloon catheter combined with prostaglandins'.)

Continuous electronic fetal monitoring is recommended in women with suspected or confirmed COVID-19; an increased frequency of nonreassuring tracings has been reported, but these case series typically had a high proportion of women with pneumonia. Intake and output of fluids should be carefully monitored in these women, and aggressive hydration should be avoided since it can

lead to pulmonary edema and worsen maternal oxygenation that may already be compromised [77]. In nonpregnant patients with severe COVID-19, conservative fluid management is recommended, as long as hypotension and organ hypoperfusion can be avoided. (See "Acute respiratory distress syndrome: Supportive care and oxygenation in adults", section on 'Fluid management'.)

SARS-CoV-2 has not been detected in vaginal secretions or amniotic fluid, so rupture of fetal membranes and internal fetal heart rate monitoring may be performed for usual indications, but data are limited [19]. It should be noted that labor, and particularly pushing, often causes loss of feces, which can contain the virus and spread the infection [37,85].

We believe that use of interventions that can increase risk of infection and have not been proven beneficial, for example the use of the birth ball or peanut ball, should be limited. As intrapartum oxygen has no proven fetal benefit, the practice of oxygen therapy for fetal resuscitation should be abandoned; the nasal cannula and face mask used are in contact with the maternal respiratory tract and secretions, so handling of such equipment increases contamination/exposure between patient and provider. Lastly, we advocate not delaying pushing in the second stage, although others have suggested minimizing the duration of active pushing because deep breathing and maternal expulsive efforts may increase exposure to the patient's respiratory secretions [77]. (See "Intrapartum category I, II, and III fetal heart rate tracings: Management", section on 'In utero resuscitation' and "Nonpharmacologic approaches to management of labor pain", section on 'Birth ball' and "Management of normal labor and delivery", section on 'Pushing position and technique'.)

Delivery procedures — For women with known or suspected infection, ACOG has stated that delayed umbilical cord clamping is highly unlikely to increase the risk of transmitting pathogens from an infected mother to the fetus [52]; however, many institutions have chosen to prohibit this practice in term infants, in whom the benefits are modest, to minimize newborn exposure to any virus in the immediate environment and reduce the chances that the newborn will require phototherapy for jaundice. Many institutions also prohibit skin-to-skin contact in these cases [86], although the World Health Organization has not advised against this [16]. One expert group suggested leaving the vernix caseosa in place for 24 hours after birth since it contains antimicrobial peptides [87], whereas the American Academy of Pediatrics advised bathing newborns as soon as reasonably possible after birth to remove virus potentially present on skin surfaces [88].

Umbilical cord blood banking can be performed if planned; the risk of COVID-19 transmission by blood products has not been documented and is unclear at present [52].

Procedures for testing for vertical transmission are described above. (See 'Vertical transmission' above.)

Intrapartum and postpartum fever — COVID-19 infection should be part of the differential diagnosis of intrapartum and postpartum fever, particularly when accompanied by respiratory symptoms and reduced oxygenation. Such patients should be tested for the virus, along with evaluation for common causes of intrapartum and postpartum infection (eg, chorioamnionitis, endometritis) [14]. (See "Intrapartum fever" and "Postpartum endometritis" and "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Diagnosis'.)

POSTPARTUM CARE

Venous thromboembolism prophylaxis — Venous thromboembolism (VTE) prophylaxis should be considered in postpartum women with COVID-19, with the decision based on individual risk assessment. There is wide variation in practice. For patients who did not receive antepartum pharmacologic prophylaxis because of COVID-19, we would not administer postpartum prophylaxis if they remain asymptomatic or mildly symptomatic and have an uncomplicated delivery, with no standard indications for postpartum VTE prophylaxis. For patients who received antepartum prophylaxis because of COVID-19, some authorities recommend discontinuing prophylaxis upon discharge in the absence of ongoing risk factors for VTE (eg, immobilization, recent surgery), whereas others continue prophylaxis for 7 to 14 days (and up to six weeks) in patients who had moderate/severe/critical disease or in those with mild disease and other VTE risk factors [48,77,89]. These issues are discussed in more detail separately. (See "Coronavirus disease 2019 (COVID-19): Hypercoagulability", section on 'Inpatient VTE prophylaxis' and "Coronavirus disease 2019 (COVID-19): Hypercoagulability", section on 'Outpatient thromboprophylaxis' and "Use of anticoagulants during pregnancy and postpartum".)

Maternal monitoring

- For patients with known or suspected COVID-19 who are asymptomatic, postpartum maternal monitoring is routine.
- For patients with mild illness (see 'Classification of disease severity' above), we check vital signs and monitor intake and output every 4 hours for 24 hours after vaginal delivery and 48 hours after cesarean delivery.
- For patients with moderate illness, we perform continuous pulse oximetry monitoring for the first 24 hours or until improvement in signs and symptoms, whichever takes longer. The type and frequency of follow-up laboratory studies and chest imaging (initial or repeat) are guided by the patient's course. Several institutional protocols are available. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'Institutional protocols'.)

- For patients with severe or critical illness, very close maternal monitoring and care on the labor and delivery unit or intensive care unit are indicated. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults" and "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues".)

Infant evaluation — The infants of mothers with COVID-19 are considered COVID-19 suspects, and they should be tested, isolated from other healthy infants, and cared for according to infection control precautions for patients with confirmed or suspected COVID-19 [79]. Where testing capacity is available, neonates should be tested for SARS-CoV-2 infection as soon as possible and within the first 24 hours of age using available molecular assays [88]. Repeat testing should be performed at approximately 48 hours of age if the infant is still at the birth facility. Both the throat and nasopharynx should be sampled, but one swab may be used to conserve swabs and polymerase chain reaction testing reagents. A separate rectal swab can be obtained if such testing is available at their center. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Patients with suspected or confirmed COVID-19'.)

Mother-baby contact — Temporary separation of mothers with known or suspected COVID-19 from their newborns has been proposed to reduce the risk of mother-baby transmission, but may also have adverse consequences [90]. For example, not rooming-in and avoiding skin-to-skin contact can be stressful for mothers; disrupt breastfeeding; and have negative effects on newborn stress, feeding, and bonding.

The World Health Organization (WHO) has opined that mothers who have suspected, probable, or confirmed COVID-19 virus infection should be enabled to remain together and practice skin-to-skin contact [16]. The Centers for Disease Control and Prevention (CDC) advise determining whether to separate a mother with known or suspected COVID-19 and her infant on a case-by-case basis, using shared decision making between the mother and the clinical team [79]. Factors to consider include:

- The mother's and infant's clinical conditions.
- Whether the mother's infection is suspected (no SARS-CoV-2 test result) or confirmed, and the infant's SARS-CoV-2 testing result (separation is not necessary if the infant has a positive test).
- The mother's desire to breastfeed.
- The facility's ability to accommodate mother-baby separation or colocation.
- The mother's ability to maintain separation when she goes home, if she has not met criteria to discontinue temporary separation.

- Other risks and benefits of temporary separation of a mother with known or suspected COVID-19 and her infant.

If mother-baby separation is implemented, the following should be considered:

- Infant COVID-19 suspects should be isolated from other healthy infants and cared for according to the Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings.
- If another healthy family member is providing infant care (eg, diapering, bathing, feeding), they should use appropriate personal protective equipment (healthy family members should wear a gown, gloves, face mask, and eye protection).

If separation is indicated (mother is on transmission-based precautions) but not implemented, other measures may be utilized to reduce potential mother-to-infant transmission and include:

- Physical barriers (eg, a curtain between the mother and newborn) can be constructed, and the newborn can be kept ≥6 feet away from the mother.
- The mother can wear a face mask and practice hand hygiene when in close contact with her infant, particularly when feeding.
- If another healthy adult is in the room, they can care for the newborn.

After hospital discharge — After hospital discharge [88,91]:

- A mother with symptomatic COVID-19 infection should maintain a distance of at least six feet from the newborn and use a face mask and hand hygiene for newborn care until (1) at least 3 days (72 hours) have passed since recovery (resolution of fever without the use of fever-reducing medications plus improvement in respiratory symptoms [cough, shortness of breath]) and (2) at least 10 days have passed since symptoms first appeared.
- For mothers with laboratory-confirmed COVID-19 who have never been symptomatic, transmission precautions can be discontinued when at least 10 days have passed since the date of their first positive COVID-19 diagnostic test.

These are symptom- and time-based strategies for discontinuing transmission precautions. Test-based strategies also exist and are discussed in detail separately. A disadvantage of test-based strategies is that a positive SARS-CoV-2 reverse-transcription polymerase chain reaction (RT-PCR) result reflects presence of viral RNA but does not necessarily mean that viable virus is present and can be transmitted [45]. Data regarding postinfection risk of transmission and personal immunity are limited [92]. (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features,

diagnosis, and prevention", section on 'Viral shedding and period of infectivity' and "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Risk of transmission' and "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Discontinuation of precautions'.)

Breastfeeding and formula feeding — It is unknown whether the virus can be transmitted through breast milk because available data are limited to very small case series. All samples of breast milk from 26 infected women tested negative for SARS-CoV-2 in one review, and 10 samples were negative in a separate series [11,93]. In another series of 13 infected women, one of the three samples of breast milk that were tested was positive by viral nucleic acid testing [94]. More data are needed to assess any potential risk of viral transmission from ingesting breast milk.

There is general consensus that breastfeeding should be encouraged because of its many maternal and infant benefits. In the setting of maternal COVID-19 infection, the infant may receive passive antibody protection from the virus since breast milk is a source of antibodies and other anti-infective factors. (See "Infant benefits of breastfeeding" and "Maternal and economic benefits of breastfeeding".)

If mother and baby separation has been implemented, ideally, the infant is fed expressed breast milk by another healthy caregiver until the mother has recovered or has been proven uninfected, provided that the other caregiver is healthy and follows hygiene precautions [79]. Expressing breast milk is important to support establishment of the maternal milk supply.

Before pumping, ideally with a dedicated breast pump, the mother should wear a mask and thoroughly clean her hands and breasts with soap and water and clean pump parts, bottles, and artificial nipples [95]. The CDC has issued guidance about cleaning breast pumps and breastfeeding. If possible, the pumping equipment should be thoroughly cleaned by a healthy person.

If feeding by a healthy caregiver is not possible, mothers with confirmed COVID-19 or symptomatic mothers with suspected COVID-19 should take precautions to prevent transmission to the infant during breastfeeding (wear a mask, hand and breast hygiene, disinfect shared surfaces that the symptomatic mother has contacted). However, it should be noted that the value of precautions, such as cleansing the breast prior to breastfeeding/milk expression or disinfecting external surfaces of milk collection devices (eg, bottles, milk bags) for reducing potential transmission of SARS-CoV-2, has not been formally studied [96].

Ideally, women who choose to formula feed should have another healthy caregiver feed the infant. If this is not possible or desired, such women must also take appropriate infection control precautions, as described above, to prevent transmission through close contact when feeding.

Analgesia — Nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly used for treatment of postpartum pain. As discussed above, concern about possible negative effects of NSAIDs in patients with COVID-19 was raised by anecdotal reports of a few young, nonpregnant patients who received NSAIDs (ibuprofen) early in the course of infection and experienced severe disease [66,67]. However, there have been no clinical or population-based data that directly address the risk of NSAIDs. Given the absence of data, the European Medicines Agency and WHO do not recommend avoiding NSAIDs when clinically indicated [68,69]. Given the uncertainty, we suggest using acetaminophen as the preferred analgesic agent, if possible, and if NSAIDs are needed, the lowest effective dose should be used. (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults", section on 'Uncertainty about NSAID use'.)

Permanent and reversible contraception — Permanent contraception (tubal sterilization) does not add significant additional time or risk when performed at an uncomplicated cesarean birth and thus should be performed if planned. Permanent contraception after a vaginal birth is more of an elective procedure, so such decisions should be made on a local level, based upon available resources.

If not performed or if a reversible contraceptive method is desired, an alternative form of contraception should be provided (eg, immediate postpartum long-acting reversible contraception or depot medroxyprogesterone acetate) as long as the patient desires one of these methods. This avoids additional outpatient postpartum visits. (See "Overview of female permanent contraception" and "Postpartum permanent contraception: Procedures" and "Postpartum contraception: Counseling and methods".)

Discharge from hospital — We suggest early discharge postpartum, such as one day after vaginal delivery and a maximum of two days after cesarean delivery, to limit the patient's personal risk in the hospital environment [83].

Candidates for mother-infant separation after discharge and criteria for discontinuation of separation are discussed above. (See 'After hospital discharge' above.)

Postpartum office visit — Modifying or reducing postpartum outpatient care is appropriate to reduce the risk of inadvertent exposure. For example, it may be possible to perform early postpartum assessments, including wound and blood pressure checks, with telehealth. A comprehensive postpartum visit may still be important by 12 weeks, especially in patients with comorbidities and in patients who lose insurance coverage at that time.

All postpartum patients should still be screened for postpartum depression four to eight weeks after delivery. The most widely used instrument is the self-report, 10-item Edinburgh Postnatal Depression Scale (figure 1A-B), which can be completed in less than five minutes [97], but

alternatives are available. As discussed above, the psychological impact of COVID-19, which may include moderate to severe anxiety, should also be recognized and support offered. (See "Postpartum unipolar major depression: Epidemiology, clinical features, assessment, and diagnosis", section on 'Assessment'.)

PREGNANCY REGISTRIES

Registries are being developed to collect data of how COVID-19 affects pregnancy and newborns. For example:

- Pregnancy CoRonavIrus Outcomes RegIsTrY (PRIORITY) is the official United States registry led by the University of California, San Francisco.
- International Registry of Coronavirus Exposure in Pregnancy (IRCEP) is another registry led by an international group of investigators.

SELECTED RESOURCES

In the United States, the American College of Obstetricians and Gynecologists, the Society for Maternal-Fetal Medicine, and the Centers for Disease Control and Prevention have issued guidance regarding prenatal, intrapartum, and postpartum care during the COVID-19 pandemic [52,98]. This includes general guidance for testing and preventing spread of COVID-19 and suggestions for modifying traditional protocols for prenatal visits, obstetric ultrasound examinations, use of nonstress tests and biophysical profiles, planned induction or cesarean delivery, and contact with the infant.

- American College of Obstetricians and Gynecologists COVID-19 information
- Society for Maternal-Fetal Medicine
- World Health Organization
- Centers for Disease Control and Prevention:
  - Pregnancy and Breastfeeding
  - Interim Considerations for Infection Prevention and Control of Coronavirus Disease 2019 (COVID-19) in Inpatient Obstetric Healthcare Settings
- International Society of Infectious Disease in Obstetrics and Gynecology Recommendations Concerning COVID-19 and Pregnancy [48].

- A dedicated website (www.pregnancycovid19.com) with several helpful pregnancy-specific links and information, including information for patients.

PREGNANCY REGISTRY

Pregnancy Co**R**onav**I**rus **O**utcomes **R**eg**I**s**T**r**Y** (PRIORITY) is a nationwide United States study of pregnant or recently pregnant women who are either under investigation or who have been confirmed to have COVID-19 infection. Providers and patients can send information via priority.ucsf.edu.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Coronavirus disease 2019 (COVID-19) – International and government guidelines for general care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Guidelines for specialty care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Resources for patients".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Coronavirus disease 2019 (COVID-19) and pregnancy (The Basics)" and "Patient education: Coronavirus disease 2019 (COVID-19) overview (The Basics)")

SUMMARY AND RECOMMENDATIONS

- Pregnant women should follow the same recommendations as nonpregnant persons for avoiding exposure to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19). (See 'Prevention' above.)

- Clinical manifestations of COVID-19 in pregnant women are similar to those in nonpregnant individuals. A positive test for SARS-CoV-2 generally confirms the diagnosis of COVID-19, although false-positive and false-negative tests are possible. (See 'Clinical manifestations' above and "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Clinical features' and "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention", section on 'Diagnosis'.)

- Pregnancy does not appear to increase susceptibility to infection or worsen the clinical course, and most infected mothers recover without undergoing delivery. However, severe disease necessitating maternal intensive care unit admission and need for extracorporeal membrane oxygenation can occur, and maternal deaths have been reported. (See 'Maternal course' above.)

- Infected women, especially those who develop pneumonia, appear to have an increased frequency of preterm birth and cesarean delivery. These complications are likely related to severe maternal illness as intrauterine infection does not appear to occur, but this is still under investigation. A few possible early newborn infections and one possible placental infection have been reported. (See 'Pregnancy complications' above and 'Vertical transmission' above.)

- The American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine (SMFM) have issued guidance regarding prenatal care during the COVID-19 pandemic (available at acog.org and SMFM.org), including general guidance for testing and preventing spread of COVID-19, suggestions for modifying traditional protocols for prenatal and postnatal visits and hospital discharge, and algorithms for assessment and management. These modifications are tailored for low- versus high-risk pregnancies. (See 'Prenatal care' above and 'Discharge from hospital' above and 'Postpartum office visit' above.)

- For the general population, the Centers for Disease Control and Prevention recommend avoiding glucocorticoids in COVID-19-positive persons because of the potential for adverse effects on the course of the disease. Because of the clear benefits of antenatal betamethasone administration between 24+0 and 33+6 weeks of gestation in patients at risk of preterm birth within seven days, ACOG continues to recommend its use for standard indications to pregnant

patients with suspected or confirmed COVID-19. (See 'Use of standard medications for managing pregnancy complications' above.)

- For most women with preterm COVID-19 and nonsevere illness who have no medical/obstetric indications for prompt delivery, delivery is not indicated and ideally will occur sometime after a negative testing result is obtained or isolation status is lifted, thereby minimizing the risk of postnatal transmission to the neonate. Severely ill patients at least 32 to 34 weeks of gestation with COVID-19 pneumonia may benefit from early delivery. (See 'Timing delivery in infected women' above.)

- In areas where the infection is active, we believe testing all patients upon presentation to labor and delivery (or the day before if a scheduled admission) is reasonable, if testing is available. In a city with a high infection prevalence, a high proportion of asymptomatic patients (13.5 percent in one study) admitted for delivery tested positive, which has clinical implications for triage, staff, and newborn care. (See 'Infection control precautions' above.)

- Generally, management of labor is not altered in women giving birth during the COVID-19 pandemic or in women with confirmed or suspected COVID-19. SARS-CoV-2 has not been detected in vaginal secretions or amniotic fluid, so rupture of fetal membranes and internal fetal heart rate monitoring may be performed for usual indications, but data are limited. COVID-19 is not an indication to alter the route of delivery. The partner/support person should be screened in accordance with hospital policies and those with any symptoms consistent with COVID-19, exposure to a confirmed case within 14 days, or a positive test for COVID-19 within 14 days should not be allowed to attend the labor and birth. (See 'Management of labor and delivery' above.)

- In patients with known or suspected COVID-19, neuraxial anesthetic is not contraindicated and has several advantages in laboring patients. The Society of Obstetric Anesthesia and Perinatology suggests suspending use of nitrous oxide for labor analgesia in these patients because of insufficient data about potential aerosolization of nitrous oxide systems. (See 'Analgesia and anesthesia' above.)

- At delivery of patients with known or suspected COVID-19, some institutions have chosen to avoid delayed cord clamping in term infants, in whom the benefits are modest, to minimize newborn exposure to any virus in the immediate environment and reduce the chances that the newborn will require phototherapy for jaundice. (See 'Delivery procedures' above.)

- Nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly used for treatment of postpartum pain; however, there are anecdotal reports of possible negative effects of NSAIDs in patients with COVID-19. Given the uncertainty, we use acetaminophen as the preferred analgesic

agent, if possible, and if NSAIDs are needed, the lowest effective dose should be used. (See 'Analgesia and anesthesia' above.)

- Infants born to mothers with known COVID-19 are COVID-19 suspects and should be tested, isolated from other healthy infants, and cared for according to infection control precautions for patients with confirmed or suspected COVID-19. (See 'Infant evaluation' above.)

- Whether to separate a mother with known or suspected COVID-19 and her infant is determined on a case-by-case basis. If the infant tests positive, separation is unnecessary. If separation is indicated (mother is on transmission-based precautions) but not implemented, other measures may be utilized to reduce potential mother-to-infant transmission, including physical barriers and ≥6 feet separation, personal protective equipment and hand hygiene, and utilization of other healthy adults for infant care (feeding, diapering, bathing). (See 'Mother-baby contact' above.)

- The virus has only been found in one sample of breast milk, but data are limited. Droplet transmission to the newborn could occur through close contact during feeding. In mothers with confirmed COVID-19 or symptomatic mothers with suspected COVID-19, to minimize direct contact, ideally, the infant is fed expressed breast milk by another caregiver until the mother has recovered or been proven uninfected, provided that the other caregiver is healthy and follows hygiene precautions. In such cases, the mother should wear a mask and thoroughly clean her hands and breasts before pumping; the pump parts, bottles, and artificial nipples should be cleaned as well. If she breastfeeds the infant directly, similar personal hygienic precautions should be taken. (See 'Breastfeeding and formula feeding' above.)

- Several agents are being evaluated for treatment of COVID-19. Remdesivir is the most promising and has been used without reported fetal toxicity in some severely ill pregnant women. (See 'Safety of antiviral drug therapy' above.)

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Topic 127535 Version 39.0