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COVID-19 Infection, Prevention, and Control Considerations in the Obstetric Environment

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Abstract: Pregnancy increases the risk of severe illness due to coronavirus disease 2019 (COVID-19). Thus, prevention of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission in all obstetrical health care settings requires consistent implementation of multiple evidence-based practices and consideration of local epidemiology, local regulations for COVID-19, and guidance from the Centers for Disease Control and Prevention and Professional Societies. COVID-safe practices should be implemented for patients, visitors/support persons, and health care personnel and include screening, appropriate personal protective equipment, and transmission precautions. Vaccination of all health care personnel, pregnant people, and their support persons remains the best strategy to prevent COVID-19.
Key words: screening, personal protective equipment, quarantine, isolation, SARS-CoV-2

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Introduction

Prevention of coronavirus disease 2019 (COVID-19) in pregnant people is crucial as pregnancy increases the risk of severe illness; pregnant people with COVID-19 are more likely to require intensive care unit admission and mechanical ventilation and die when compared with symptomatic nonpregnant people.[1,2] This chapter

TABLE 1. Glossary of Frequently Used Terms Relevant to SARS-CoV-2 and COVID-19

Term	Definition
Aerosol-generating procedure	Procedures that can generate aerosols that can remain suspended in the air for long periods, travel > 6 feet, and can penetrate or circumnavigate surgical masks Examples include: intubation, noninvasive positive pressure ventilation (BiPAP, CPAP), cardiopulmonary resuscitation, bronchoscopy, and sputum induction No consensus on which procedures are aerosol generating as insufficient data exists to create definitive and comprehensive list
Asymptomatic	No signs or symptoms of SARS-CoV-2 infection, but can transmit virus to others
Antigen test	Diagnostic test that uses an immunoassay to detect fragments of SARS-CoV-2 proteins found on or within the virus
Cocooning	Strategy whereby close contacts are vaccinated to protect individuals too young to be vaccinated or individuals who will not mount a protective immune response following vaccination, eg, immunocompromised person
COVID-recovered	People are generally considered COVID-recovered if > 10 d and <90 have passed since their COVID-19 illness since they are at minimal risk of being reinfected
Exposure	A person is considered exposed to SARS-CoV-2 if they are within 6 feet of an infectious individual for a cumulative time period of ≥ 15 min during 24-h period without the use of appropriate PPE A person is considered exposed if they were present in the same enclosed space while the infected individual underwent an aerosol-generating procedure for any duration of time and were not wearing an N95 respirator
Fully vaccinated	≥ 2 wk after second dose of 2-dose series such as Pfizer or Moderna vaccines ≥ 2 wk after single-dose vaccine such as Johnson & Johnson (Jansen) vaccine
Incubation period	Time period between exposure to an infection and the arance of the first symptoms; for SARS-CoV-2, incubation period is 2-14 d, mean ~5 d
Isolation period	To avoid transmitting the virus to others, the duration of time a person infected with SARS-CoV-2 should remain isolated at home separated from others and wearing a mask (if tolerated) or be on transmission precautions in the hospital For most people with symptomatic SARS-CoV-2 infection, isolation at home or in the hospital can be discontinued 10 d after symptom onset and after resolution of fever for 24 h with antipyretics For people with asymptomatic SARS-CoV-2 infection, isolation at home or in the hospital can be discontinued 10 d after the first positive test
Polymerase chain reaction (PCR) or nucleic acid amplification test (NAAT)	Diagnostic test that detects SARS-CoV-2 RNA that encodes the spike protein and/or nucleocapsid

TABLE 1. (Continued)

Term	Definition
Presymptomatic	No signs or symptoms of SARS-CoV-2 infection, but will develop them later. Can transmit virus while presymptomatic
Quarantine period	Duration of time an *unvaccinated* individual who has been in close contact with someone with COVID-19 should stay at home separated from people they live with (if possible) and observe themselves for symptoms For most unvaccinated people, the quarantine period is 10-14 d
Person under investigation (PUI)	Person with clinical and epidemiologic risk factors for COVID-19 infection, including symptoms of COVID-19 and exposure to COVID-19, and present a risk for COVID-19 transmission while their SARS-CoV-2 test is pending. PUIs should be placed on appropriate COVID-19 precautions until infection is ruled out

BiPAP indicates bilevel positive airway pressure; COVID-19, coronavirus disease 2019; CPAP, continuous positive airway pressure; PPE, personal protective equipment; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

describes evidence-based infection prevention and control (IP&C) strategies applicable to health care settings where pregnant people and their neonates receive care including ambulatory settings and inpatient units such as labor & delivery (L&D) units, newborn nurseries, and neonatal intensive care unit (NICUs). Table 1 presents a glossary of common terms and concepts used throughout the chapter. As the COVID-19 pandemic has evolved rapidly, health care personnel (HCP) caring for pregnant people and their neonates should stay informed about the local epidemiology of COVID-19 and guidance from the Centers for Disease Control and Prevention (CDC), local health departments, and professional societies.

Screening Patients for COVID-19 Symptoms, Exposures, and Travel

Early in the pandemic, we learned the importance of screening patients for COVID-19 symptoms in all health care settings. Symptoms of COVID-19 include fever, cough, shortness of breath, sore throat, myalgias, diarrhea, nasal congestion, headache, chills/rigors, new-onset loss of smell, or altered sense of taste. Differentiating symptoms of pregnancy and labor from COVID-19 symptoms is difficult; symptoms of COVID-19, including fever, fatigue, malaise, and shortness of breath, can be experienced by pregnant people during labor and delivery.[3] In addition, pregnant people infected with SARS-CoV-2 may be asymptomatic, making identification of COVID-19 infections through symptom screening alone inherently insensitive.[1,2] Screening should be done regardless of the patient's vaccination status since fully vaccinated individuals are susceptible to breakthrough infections, as noted with the Delta variant.[4,5]

When presenting to health care settings, patients should also be screened for a diagnosis of COVID-19 in the past 10 days and recent exposure to a person newly diagnosed with COVID-19. Throughout the first 18 months of the COVID-19 pandemic, the risks associated with travel to specific locations changed in accordance with changing epidemiology. Thus, health care settings should

review and update their guidance for travel screening as instructed by local health departments and the CDC.

Screening Staff

All HCP, including volunteers and vendors (when permitted into health care facilities), should self-monitor daily for the development of new symptoms consistent with COVID-19 and stay home and not report to work. Some health care facilities have utilized a mandatory temperature check when entering the facility and/or daily symptom screening, most commonly using a mobile device application, to document HCP attestation of the absence of symptoms, exposures, and high-risk travel and to document testing results, when applicable. While self-administered screening and attestation have limitations as they rely on accurate reporting by HCP, accessibility to a mobile device, and increased staffing at facility entrances, these strategies have been widely implemented and have identified symptomatic HCP.[6,7] As such, they add to the armamentarium of strategies to minimize COVID-19 transmission in health care facilities.

Health care facilities should develop policies and procedures to advise HCP who screen positive about testing for SARS-CoV-2 and when it is safe to return to work. Facilities should be transparent about their paid leave policies for work absence due to new-onset symptoms, COVID-19 infection, and quarantine after exposure to avoid disincentives for staying home.

Screening Visitors and Support Persons

All visitors/support persons (including doulas) should be screened for COVID-19 symptoms, COVID-19 exposures, known SARS-CoV-2 positivity in the last 10 days, and potentially for vaccination status. Some health care facilities are mandating proof of vaccination or a negative SARS-CoV-2 test before visitation. However, there are no published reports yet describing the benefits and challenges of this strategy. Facilities should establish a system for screening 24 hours per day for the obstetrical population and anticipate the resources needed to maintain the infrastructure for screening visitors and support persons. If a visitor/support person screens positive, they should not accompany the pregnant person, and an alternative person should replace them.

Although many facilities restrict visitors during periods of high rates of community transmission of COVID-19, support persons during labor and delivery are essential emotional supports and associated with improved outcomes.[8] While most facilities have allowed at least one support person to accompany, patients admitted to L&D units, limiting visitors has disproportionately affected people of color due to lack of flexibility, issues of patient advocacy, and inadequate communication with non-English speakers.[9,10] The American College of Obstetricians and Gynecologists (ACOG) encourages facilities to develop innovative and collaborative approaches that provide the necessary emotional support during periods of high rates of community transmission (www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics). Despite shorter hospitalizations for both vaginal and cesarean deliveries noted during the pandemic, adverse impacts on postpartum health outcomes have not been described.[11]

Testing for SARS-CoV-2

TESTING PREGNANT PATIENTS

SARS-CoV-2 testing should be performed for all pregnant people who are symptomatic, and depending on local transmission rates of COVID-19, vaccination rates, and health department guidance, may be performed for asymptomatic pregnant people

who are being hospitalized. As symptom screening does not identify all infected individuals, testing all patients being hospitalized ensures appropriate isolation. Testing is generally performed by polymerase chain reaction (PCR) assays or nucleic acid amplification tests (NAAT) rather than antigen-based assays due to the potential for false-negative results by antigen tests in asymptomatic or presymptomatic patients (www.cdc.gov/coronavirus/2019-ncov/lab/resources/antigen-tests-guidelines.html). However, PCR tests and NAATs may be positive for weeks to months after primary infection due to the detection of nonviable viral RNA fragments. In addition, false-negative test results may occur due to inadequate sampling, test characteristics, and viral load at the time of testing.[12] Thus, HCP should be aware of the characteristics of the assays used in their facilities to facilitate interpretation of SARS-CoV-2 testing, including an unexpected negative result, and to provide appropriate patient counseling.

The duration of time before the hospitalization that a test is acceptable may vary by jurisdiction. Depending on resources, testing for elective admissions, for example, planned cesarean section, can be performed as close to the day of hospitalization as possible, for example, within the 3 to 5 days before admission. HCP should be aware of the type(s) of assays approved for preprocedural testing at their facility.

TESTING HCP

Symptomatic HCP, even with mild symptoms and regardless of vaccination status, should undergo testing for SARS-CoV-2 as soon as possible. HCP should be educated that even mild symptoms they attribute to common causes, for example, allergy or asthma, could be manifestations of COVID-19.

TESTING PATIENTS AND HCP AFTER EXPOSURES

Asymptomatic HCP and patients with exposures in either the community or health care settings should be offered testing for SARS-CoV-2 no earlier than 2 days after exposure, and if negative, 5 to 7 days after exposure.[13] Exposed individuals who test negative must complete their recommended quarantine period.

Testing practices will likely evolve further as we increase our understanding of the duration of immunity to SARS-CoV-2 following primary infection versus vaccination, the emergence of variants, and the temporal risk of reinfection. The risk of reinfection is extremely low during the first 3 months after primary SARS-CoV-2 infection and remains low during the first 6 months after infection.[5] Thus, asymptomatic patients with confirmed COVID-19 in the past 3 months likely do not need SARS-CoV-2 PCR testing or isolation; such patients can be assigned a "COVID-recovered" status. Table 2 provides potential scenarios for testing that considers patients who are COVID-19 recovered. A discussion of newborn testing is presented below in the *Considerations for COVID-19 positive mother-newborn dyad* section.

Routes of SARS-CoV-2 Transmission

Transmission of SARS-CoV-2 can occur from symptomatic, presymptomatic, and asymptomatic individuals.[14] Appropriate isolation and implementation of transmission precautions, especially when infected individuals are hospitalized and have prolonged close contact with HCP and proximity to other patients and visitors, are crucial to minimize SARS-CoV-2 transmission. Three routes of SARS-CoV-2 transmission occur: deposition of virus on exposed mucous membranes (droplet transmission), inhalation of virus (aerosol transmission), and touching mucous membranes with soiled hands contaminated with virus (indirect contact transmission) (www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html).

TABLE 2. SARS-CoV-2 Testing Strategies for Hospitalized Patients Based on Previous Testing and Symptoms

When Was the SARS-CoV-2 Test Positive?	Is Person Symptomatic?	Should a SARS-CoV-2 Test Be Performed?
No prior SARS-CoV-2 testing	Yes	Yes
	No	Depends on local epidemiology, testing capacity, and department of health guidance
< 10 d	Yes or no	No, consider COVID-19 positive
≥ 10 d to ≤ 3 mo	No	No, consider "COVID-recovered"
	Yes, new symptoms without alternative explanation	Yes
> 3 mo	Yes	Yes
	No	Depends on local epidemiology, testing capacity, and department of health guidance

COVID-19 indicates coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

TRANSMISSION OF SARS-CoV-2 THROUGH RESPIRATORY DROPLETS

SARS-CoV-2 is primarily spread through respiratory droplets (www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html). Respiratory droplets are generally defined as particles > 5 μm that carry potentially infectious viral particles, produced by coughing, sneezing, singing, and normal speech, and can travel 3 to 6 feet from an infected individual and quickly settle from the air. Transmission can occur if respiratory droplets are deposited onto mucous membranes of the mouth, nose, or eyes. Thus, the risk of infection by respiratory droplets can be reduced by further distance from the infectious source, by source containment of respiratory secretions, and by protecting mucous membranes.

AIRBORNE TRANSMISSION OF SARS-CoV-2

SARS-CoV-2 can be transmitted by aerosolized droplet nuclei which are defined as particles <5 μm which can travel long distances and remain suspended in the air for many hours. An early experimental model demonstrated that SARS-CoV-2 remained viable in aerosols for as long as 3 hours.[15] Transmission can occur if aerosolized droplet nuclei are inhaled. In clinical settings, aerosol-generating procedures include, but are not limited to, open suctioning of airways, bag-mask ventilation, and endotracheal intubation and extubation.[16] However, there is not a definitive list of aerosol-generating procedures, and even coughing, sneezing, and talking have been associated with aerosols and the generation of droplet nuclei.[17] Aerosol transmission, facilitated by suboptimal ventilation, has been highlighted in multiple studies demonstrating transmission in choir rehearsals, poorly ventilated restaurants, and fitness facilities (www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html).

The distinction between respiratory droplets and droplet nuclei can be highly nuanced as there may be considerable overlap in these transmission routes. The paradigm for transmission of respiratory viruses has shifted from the binary nature of these 2 types of infectious particles to a spectrum of particle sizes ranging from <1 to > 100 μm that can be emitted during medical procedures as well as during breathing, talking, and coughing.[18] In addition to small size, the ability for infectious particles to aeroso-

lize and persist in the air for prolonged periods of time and travel long distances is related to ventilation, relative humidity, temperature, ultraviolet radiation, and airflow.[14] Thus the risk of infection by aerosols can be reduced by personal protective equipment (PPE) that prevents inhalation and by improving ventilation (see below).

INDIRECT CONTACT TRANSMISSION

SARS-CoV-2 is less commonly transmitted by indirect contact whereby hands contaminated by respiratory droplets touch mucous membranes. Hand hygiene, including after doffing PPE, is the main strategy to prevent indirect contact transmission. Contaminated surfaces and objects (fomites) play a minimal role in transmission compared with the aforementioned routes, and standard environmental cleaning and disinfection practices are recommended.

PPE

Specific PPE requirements for COVID-19 are guided by our understanding of SARS-CoV-2 transmission. However, given the risk of transmission from asymptomatic and presymptomatic patients as well as the risk of false-negative test results for SARS-CoV-2, recommendations for universal PPE (described below) have also been implemented. Table 3 provides an overview of PPE recommendations at the time of this writing. However, it is highly likely that recommendations will change in response to vaccination rates, the durability of immunity, need for booster doses, community transmission rates, the prevalence and virulence of variants, local health department recommendations, and Occupational Safety and Health Administration (OSHA) mandates.

UNIVERSAL PPE

In health care settings, the universal use of a well-fitting surgical mask and eye protection, that is, goggles or a face shield that covers the front and sides of the face, are recommended for HCP when caring for all patients, particularly during periods of high rates of community transmission of COVID-19.[13] Eyeglasses are not considered sufficient eye protection. Unless there are medical contraindications, patients should wear surgical masks outside of their hospital room, when

TABLE 3. Universal Personal Protective Equipment in Different Health Care Settings When COVID-19 Is Not Suspected or Confirmed

Health Care Setting	Health Care Personnel	Patients	Visitors
Ambulatory/ outpatient procedure areas	Well-fitting surgical mask in all clinical areas, N95 respirator for all aerosol-generating procedures, and eye protection (goggles or face shield) for all patient encounters	Well-fitting surgical mask to be worn for the entirety of visit	Well-fitting surgical mask to be worn for the entirety of visit
Emergency departments			
Inpatient areas		Encourage patients, including those in active labor, to wear a well-fitting surgical mask as tolerated when others are in the room	

others, including HCP, enter their hospital room, and during situations when they are not able to physically distance > 6 feet from others. Similarly, all visitors should wear well-fitting surgical masks and practice physical distancing, where feasible. These practices serve as source control and protect individuals in health care settings who are immunocompromised and cannot mount an immune response to vaccination or those who are too young to be vaccinated. These practices can also substantially reduce the risk of exposures from individuals who are asymptomatic, presymptomatic, or have false-negative test results.[12]

In addition, the universal use of a NIOSH-approved N95 respirator or equivalent is recommended for HCP during *all* aerosol-generating procedures and during procedures that may pose a higher risk for transmission due to their anatomic location as the viral load is higher, for example, dental procedures. An N95 respirator is recommended regardless of patients' SARS-CoV-2 test results. Some facilities have implemented higher level respirators such as powered air-purifying respirators and elastomeric respirators which can be options for HCP who cannot be fit tested for an N95 respirator due to facial structure or facial hair. These devices are not disposable, and cleaning and maintenance protocols are required.

PPE DURING CARE OF PATIENTS WITH COVID-19

Current recommendations for PPE when caring for patients with suspected or confirmed COVID-19 or those who are in their quarantine period following a close exposure to someone with COVID-19 include an N95 respirator or equivalent, eye protection, gown, and gloves (www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html). Some facilities have created a new isolation category, for example, Enhanced Droplet, to communicate the PPE needed for patients. Patients with confirmed or suspected COVID-19 should be placed in a single room with the door closed (if safe to keep the door closed) and with a dedicated bathroom. In settings of limited N95 supply, the same N95 respirator can be used across multiple patient encounters through extended use or reuse when covered by a surgical mask.[19]

Physical Distancing, Engineering Controls, and Indoor Air Quality

An in-depth discussion of strategies to improve physical distancing, establish engineering controls, and enhance indoor air quality are beyond the scope of this chapter. The interested reader is referred to the CDC Web site for further details including technical advice (www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html). Briefly, health care facilities should encourage physical distancing, wherever possible, in waiting rooms and treatment areas. Strategies include scheduling appointments to decrease the number of patients in waiting areas, visual reminders to avoid sitting side-by-side, removing furniture, and limiting group activities. Health care facilities should establish engineering controls to avoid exposures to symptomatic individuals or those with a recent exposure, for example, a triage system whereby such individuals are placed in a single room as quickly as possible. Facilities should work with their engineers to improve ventilation and indoor air quality to reduce the risk of aerosol exposures.

Ambulatory Clinic and Procedure Settings

Patients should be screened *before* their appointments and *upon arrival* for: (1) symptoms consistent with COVID-19, (2)

a diagnosis of COVID-19 within the past 10 days, (2) exposure to COVID-19 within the past 10 to 14 days, and (4) international travel within the past 10 days, if required by local health departments. For patients with a positive screen *before* an appointment, consider, if clinically appropriate, to postpone an in-person appointment until their isolation or quarantine period is completed. Telehealth visits can be used for patients requiring isolation or quarantine. Depending on the jurisdiction, fully vaccinated and COVID-recovered patients may be exempt from quarantine following international travel and/or recent exposure to COVID-19 and thus, not need to postpone appointments. Patients with a positive screen *upon arrival* to the clinic should be immediately placed in an examination room on Contact and Droplet Precautions with the door closed pending further evaluation.

Patient education regarding strategies to prevent SARS-CoV-2 transmission and signs and symptoms of COVID-19 should begin at the time of the initial antepartum visit and continue throughout pregnancy and the postpartum period. Pregnant persons should be instructed to call their providers if they develop respiratory symptoms or have an exposure. They should follow the same recommendations as nonpregnant persons to avoid exposure to SARS-CoV-2 in the community. This includes, but is not limited to, masking, social distancing, avoiding contact with persons who are ill, avoiding crowds, performing frequent hand hygiene, and vaccination. Vaccination has been recognized as the most effective strategy to reduce maternal and fetal complications of COVID-19 infection among pregnant people.[20] Providers should strongly encourage their unvaccinated pregnant and postpartum patients to get vaccinated. COVID-19 vaccines can be administered at the same time as other vaccines (eg, influenza, Tdap).

Pregnant people should identify a primary support person(s) who will stay with them during delivery and postpartum admission. Patients should be aware that during labor and postpartum admission, all visitors will be screened upon arrival to the facility. An alternative support person should be identified in the event the primary support person screens positive for symptoms, a diagnosis of COVID-19, or an exposure. Providers should educate pregnant patients of their facility's visitor restriction policies and ask them to inform their support persons about screening procedures and mask requirements.

Antepartum Units

Pregnant people admitted to antepartum units should be screened as described above and tested for SARS-CoV-2 on admission as per local health department recommendations. PCR test or NAAT are recommended to reduce the risk of false-negative test results from antigen testing in asymptomatic individuals. Daily screening for COVID-19 symptoms should occur as patients on antepartum units may have prolonged hospitalizations and could develop infections if they were admitted during their incubation period or have hospital-acquired COVID-19. All patients who develop new symptoms should be placed on Contact and Droplet Precautions and tested for SARS-CoV-2.

Some institutions have instituted repeat testing at regular intervals for asymptomatic antepartum patients with prolonged hospitalizations due to the potential for urgent delivery. Among patients on an antepartum unit, repeat testing at 5 days did not identify new SARS-CoV-2 infections.[21] In a tertiary care center, serial testing every 5 days found that 1% of patients converted from negative to positive, most of whom had prior infections.[22] However, the benefits and challenges of implementing serial testing of hospitalized patients have not been fully described and should reflect local epidemiology of COVID-19 and testing resources.

HCP should clearly communicate the COVID-19 prevention strategies in place on the antepartum unit. Pregnant people on antepartum units should wear a surgical mask whenever others are in their hospital rooms to avoid exposures. HCP should remind patients to don their masks whenever entering a patients' rooms. Support persons should wear a mask throughout their visit.

L&D Units

L&D facilities vary in space and staffing. Thus, each institution must review these factors to effectively implement IP&C strategies for COVID-19 (www.cdc.gov/coronavirus/2019-ncov/hcp/inpatient-obstetric-healthcare-guidance.html). Screening of all patients and support persons for COVID-19 symptoms, exposure, and recent diagnosis coupled with appropriate isolation is crucial given the close contact between patients and HCP. Issues specific to support persons are discussed above in *Screening Visitors and Support Persons*. Patients who screen positive should be placed on Contact and Droplet Precautions in a single room with a dedicated bathroom. Delayed cord clamping and skin-to-skin contact is encouraged (www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics).[23] Transporting laboring patients to the delivery room, operating room, or intensive care unit should be planned in advance to minimize exposure to others. Due to insufficient information currently available for the safety of inhaled nitrous oxide (NO) in patients with suspected or confirmed COVID-19, L&D units may consider suspending NO use in such patients; patients who are negative for SARS-CoV-2 may be offered NO as anesthesia (www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics).

There is not a consensus about whether or not the second stage of labor and vaginal delivery are aerosol-generating procedures. However, the second stage of labor requires extreme effort which can manifest as forceful exhalation, coughing, panting, and shouting which can generate aerosols.[24] In addition, persons in labor cannot consistently wear a mask, and HCP have close and prolonged proximity with their patients during labor. Thus, an N95 or equivalent, as well as eye protection, could be considered when caring for *all* patients during the second stage of labor and delivery.

Postpartum Units, Newborn Nurseries, and Considerations for COVID-19 Positive Mother-Infant Dyad

Patients on postpartum units should be screened daily for symptoms of COVID-19 and provided surgical masks to wear whenever others are present, including their newborns. Unvaccinated patients should be strongly encouraged to get the COVID-19 vaccine to protect themselves, their infants, other household members, and their community.[20]

Before our understanding of the risks of in utero, perinatal, or postpartum transmission of SARS-CoV-2, the guidance on separating COVID-19 positive persons from their newborns and direct breastfeeding varied among the American Academy of Pediatrics (AAP), the CDC, ACOG, and World Health Organization (WHO).[25] There was a great deal of concern in the obstetrical and pediatric communities as separation can adversely impact maternal-infant bonding, perinatal mental health, and breastfeeding. In July 2020, AAP no longer recommended separation and endorsed direct breastfeeding as early studies showed little to no evidence of poor neonatal outcomes resulting from perinatal exposure to SARS-CoV-2, very low rates of SARS-CoV-2 detection among newborns, and no difference in the likelihood of testing

positive if the newborn was separated or not (www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/faqs-management-of-infants-born-to-covid-19-mothers/).[26,27] The overall risk of neonatal infection is ~2% within the first 24 to 96 hours after birth, but increases to ~4% if the maternal onset of COVID-19 is close to the time of delivery (www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/faqs-management-of-infants-born-to-covid-19-mothers/).

ROOMING-IN PRACTICES FOR COVID-19 POSITIVE MOTHER-INFANT DYAD

Healthy, full-term newborns born to people with confirmed COVID-19 infection within 10 days of delivery should be cared for in their mothers' rooms, that is, "rooming-in"; placed on Contact and Droplet Precautions in an isolette, if feasible based on infant' size; and remain > 6 feet from their mothers unless feeding or being changed. Such newborns are considered persons under investigation (PUIs). In addition, newborns of people with suspected COVID-19 infection due to symptoms or unknown COVID-19 status at delivery, for example, test results pending, should be considered PUIs and room-in with their mothers with the same precautions as above.

COVID-19 positive patients should be instructed to wear a well-fitting surgical mask throughout their hospitalization when others, including their newborns, are in the room and to perform hand hygiene before handling their infants. The risks and benefits of breastfeeding should be discussed, but current evidence does not suggest that SARS-CoV-2 is transmitted by breastfeeding.[23] Those who wish to breastfeed should perform breast and hand hygiene before feedings.

If a mother is unable to care for a PUI newborn, for example, the mother has a clinical deterioration, facilities should place them in the newborn nursery in an isolette on Contact and Droplet Precautions physically separated from non-PUI newborns. If > 1 PUI newborn is in the newborn nursery at the same time, their isolettes should be placed > 6 feet apart.

NEWBORN TESTING AND MONITORING

Testing all newborns of patients who were COVID-19 positive within 10 days of delivery should be performed at ~24 hours of life (unless a newborn's parent refuses). Testing of newborns should be performed on nasopharyngeal, oropharyngeal, or anterior nares specimens using PCR or NAAT, regardless of maternal symptoms or severity of illness. The AAP recommends a second test at ~48 hours of life, but this might not be feasible due to short postpartum hospitalizations; discharges should not be delayed to perform repeat testing.

The families of newborns who test negative for SARS-CoV-2 should be educated about the COVID-19 positive person's mask use until their isolation period has been completed, hand hygiene, and pediatric ambulatory appointments during the first week of life.[25] Newborns should be monitored for symptoms as postnatal transmission of SARS-CoV-2 may occur. If symptoms develop, they should be retested for SARS-CoV-2.

Asymptomatic newborns who test positive for SARS-CoV-2 can be discharged home with frequent monitoring by phone, telemedicine, or in-person. Families should be educated about masks and hand hygiene before and after contact with the newborn to avoid possible transmission from the newborn to others. The AAP recommends repeat testing at 48 to 72 hours until a newborn has 2 consecutive negative results to establish they have cleared their mucosal sites, particularly if the infant requires admission to the NICU (www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/faqs-management-o

f-infants-born-to-covid-19-mothers/). However, this approach may yield false-positive test results for active infection as PCR assays can be positive for prolonged periods due to nonviable viral fragments.

NICU

HCP in the NICU should wear well-fitting surgical masks when around others and eye protection during all patient encounters. PUI newborns and those with confirmed COVID-19 are placed in isolettes on Contact and Droplet Precautions in a single room (when available). If aerosol-generating procedures are performed, such infants should be placed in a negative pressure room (if available), and HCP should wear N95 respirators. PUI newborns requiring AGPs should not be cohorted with other PUI infants if at all possible.

Most NICUs have limited the number of visitors per infant to allow for adequate screening, and social distancing as the open bay or pod structure of many NICUs can make social distancing challenging. Parents/guardians should be instructed to designate a limited number of visitors as well as potential "back-up" visitors should one of the designees be unable to visit. Facilities should allow visitors to change to accommodate fatigue or other priorities that may arise for designated visitors.

All visitors should don a well-fitting mask upon entry to the facility and screened as described above; screening should continue at the bedside during visits. Visitors who develop symptoms consistent with COVID-19 during their visit to the NICU should leave immediately. When visiting NICU infants who are either PUIs or have confirmed COVID-19, visitors should wear a surgical mask, eye protection, gown, and gloves. They should perform hand hygiene before and after donning their PPE. Gowns, gloves, and eye protection should be donned before entering the infant's room/bed space and doffed before leaving the infant's room/bed space. Surgical masks should be removed at the end of the visit, and a new mask donned to exit the facility.

People with confirmed COVID-19 require isolation for a minimum of 10 days from the day of symptom onset or the day of a positive test if asymptomatic (www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html). During the isolation period, such individuals cannot enter the NICU. At the end of their isolation period, such individuals can visit their infant(s) if they have had a marked improvement of symptoms, including being afebrile without the use of antipyretics for at least 24 hours. A negative SARS-CoV-2 test before visiting is not required due to the potential for prolonged positivity without viable virus, as described above. The isolation period should be extended for 20 days for immunocompromised people or for those who experienced severe COVID-19 infection requiring respiratory support. During their isolation period, if desired, infected individuals can express breast milk. They should be instructed to perform hand and breast hygiene before pumping and to clean the pump and its components in between sessions.

MANAGING EXPOSURES AND CONTACT TRACING

Exposures to infectious individuals with COVID-19 can occur in health care settings or in the community. Different jurisdictions may have different parameters to define exposures and to delineate the need to perform contact tracing and recommend quarantine. Characteristics that define the risk of exposure include the proximity of a potentially exposed person to someone with COVID-19 infection, the duration of the exposure, the type of PPE used by the exposed person and by the infected person, and the

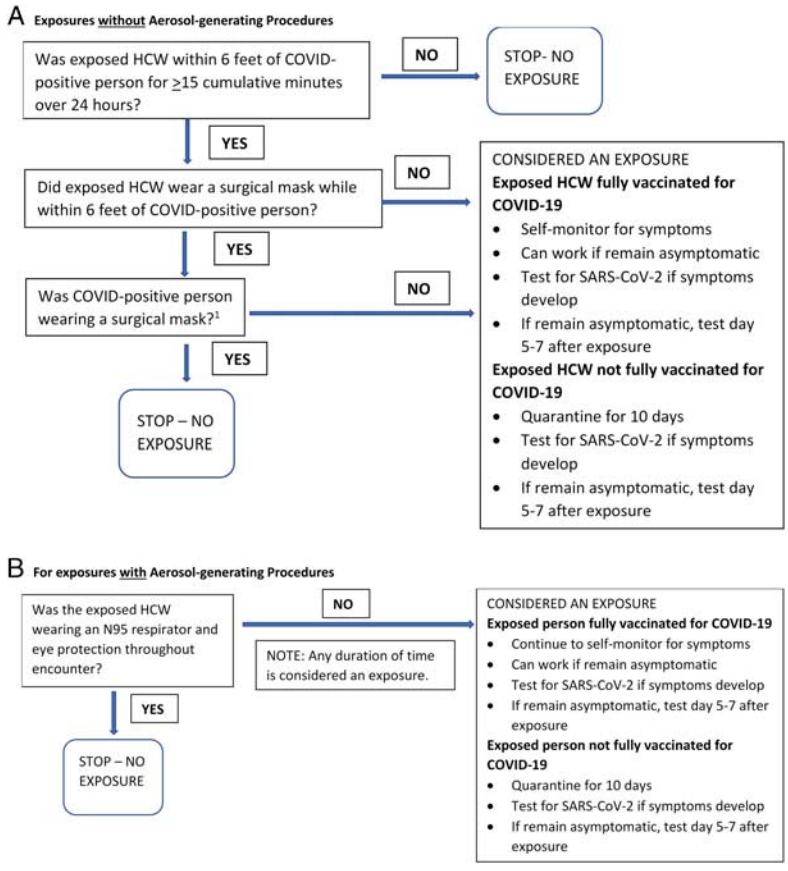

FIGURE 1. Evaluations of exposures to COVID-19 in scenarios with and without aerosol-generating procedures. A, Exposures *without* aerosol-generating procedures. B, Exposures *with* aerosol-generating procedures. [1]Not considered an exposure if HCW wearing a surgical mask and eye protection and infectious person not wearing a mask. COVID-19 indicates coronavirus disease 2019; HCW, health care worker; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2. full color online

immunization status of the exposed person as described in Figure 1.

When exposure is confirmed, contact tracing is used to identify exposed individuals including family members, staff, and other patients. Quarantine of unvaccinated exposed individuals and testing of both unvaccinated and vaccinated exposed individuals is generally recommended.[28] In most health care settings, the department of IP&C coordinates the identification of exposed HCP, patients, and visitors. The department of employee health generally authorizes quarantine and return to work parameters. The interested reader is referred to detailed guidance for contact tracing developed by the CDC.[28]

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