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# Management of COVID-19 Infection During Pregnancy, Labor, and Puerperium

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## INTRODUCTION

There is no specific treatment for COVID-19 infection in the general population till the present time. Treatment of such infection is more challenging during pregnancy as successful drugs that can be used in nonpregnant women may have a hazardous effect on the growing fetus. Most clinical trials for a particular therapy do not include pregnant women for safety reasons. This theory of “protection by exclusion”—although providing maternal and fetal safety—deprives the pregnant women from using a potentially effective drug at early stages of its use. Also, exclusion of pregnant women infected with COVID-19 from interventions with possible benefits makes the assessment of drug safety for the mother, the fetus, and the neonates, and their efficacy during pregnancy is not possible. For these reasons, the current largest clinical trial assessing the different treatment modalities for COVID-19 infection named randomized evaluation of COVID-19 therapy “RECOVERY” is recruiting pregnant women.

## PREVENTION OF INFECTION

As there is no definitive treatment for COVID-19 infection and pregnant women are more vulnerable to viral infections than the general population, prevention of catching the infection is the most important step to avoid its hazardous effects.

The Centers for Disease Control and Prevention (CDC) recommended preventive measures that everyone should follow:

1. Pregnant women should know the main ways of spread of infection through direct contact and through respiratory droplets and the less common ways as contact with contaminated surfaces and airborne transmission in poorly ventilated areas. They must realize that asymptomatic infected personnel could also spread the infection as the symptomatic ones.
2. Avoid contact with those who are infected or exposed to infections even if they were within women household.
3. When interacting with others,
  - a. wear a mask;
  - b. ask your contacts to wear a mask;
  - c. avoid close contact such as shaking hands, hugs, and kissing; and
  - d. try to keep 6 feet or more from others, if possible.

4. Wash your hands for 20 s or more with water and soap. Use a hand sensitizer with 60% alcohol if water and soap are not reachable.
5. Avoid unnecessary activities and poorly ventilated areas.
6. Ask for at least 30 days’ supply of your needed medications to avoid unnecessary visits to the pharmacy.

Pregnant women must contact their healthcare provider immediately in case of having any medical concerns including doubts in catching the infection, feeling depressed, or having any query about your health.

There is no need to skip your medical appointments. These visits are important to provide medical and psychological support especially in hard times. Discuss the safest place for your delivery. Be aware of the safety measures to protect you and your kid during and after delivery and precautions you have to follow during delivery and those who will be in contact with you during your stay at hospital.

Worried women should ask their healthcare provider about safety measures they follow to separate healthy from suspected or confirmed cases. They can make a telemedicine visits through phone or video calls if the healthcare providers have no concerns. These behaviors can be modified according to the situation of the community and risk level.

Pregnant women are instructed to receive their vaccines as scheduled and not to delay it during the epidemic. The recommended vaccines related to COVID-19 infection are the influenza and whooping cough vaccines. Both diseases can produce similar symptoms as COVID-19 and that is confusing for proper management of either infections.

Currently, there are no specific vaccines for COVID-19 infection neither for pregnant women nor for the general population.

The CDC suggested some criteria for effective mask. It must have at least two layers of washable breathable fabric that cover the mouth and nose completely and fit the sides of the face with no gaps. The proper way to wear the mask is to wash the hands before putting it, to place it over the nose and mouth, to fit it below the chin, to fit it against face sides, and then to ensure easy breathing through it. Take off the mask through untying of the strings behind the head, handle it through the ear loops only, fold the outer edges

together, and then wash it. The woman should take care not to touch her face during mask removal and be instructed to wash her hands immediately after removal of the mask. Masks with exhalation valve or vent are not recommended.

If the mask will not be washed immediately, it must be stored in a sealed elastic bag if wet and in a paper bag if dry.

Women are advised, if they have to take off the mask to eat or drink, to keep it in a clean safe place as a paper bag and, after finishing, to put the mask with the same side facing out. They are also instructed to wash or sanitize their hands after removal and putting back the mask.

Only cloth masks can be washed and reused, whereas disposable masks should not be reused. Cloth masks can be washed using the washing machine with the regular laundry using the settings appropriate for the fabric label or the tap water and soap by hands. The mask must be dried completely before use in a hot dryer or air.

Hand sanitizer must be rubbed over all parts of the hands and fingers till it dries. It must be kept away from the eyes and of course not to be swallowed as suggested by some politicians.

Gloves are to be used during cleaning and disinfecting homes and when caring for a diseased person, and hands must be washed after taking off the gloves. Gloves are not needed when using outdoor machines such as ATM as it is not protective, which may help spreading of the germs. Handwashing with water and soap or sanitizers provides the needed protection in these cases (Center for Disease Control and Prevention, 2020d).

There are more than 120 developing vaccines. Human trials are involved in 10 of them (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines>). Vaccines included RNA-based types such as BNT162b1/2 and mRNA-1273, DNA types, inactivated types such as BBIBP-CorV, and adenovirus-vectored ones such as ChAdOx1 nCoV-19 and nonreplicating adenovirus type-5/26 (Yuan et al., 2020).

To fasten vaccine production, the World Health Organization (WHO) follows the ACT Accelerator. Classically, development of vaccines passes through consecutive steps that may take many years. During the current pandemic, the WHO allowed to proceed in the various steps of development in parallel with precautions to maintain safety standards. Once the safety and efficacy of a vaccine is proven, COVAX (guided by the WHO, GAVI, and CEPI) will help its production and distribution all over the world giving priority to high-risk personnel.

The main aim of the developing vaccine is to produce antibodies against the S protein in amounts that can stop viral replication inside the vaccinated person. That can be achieved through assembling the S protein of the virus or its subunits with the adjuvants directly leading to production of neutralizing antibodies and T cell-mediated immune response (Ren et al., 2020; Folegatti et al., 2020; Li et al., 2020) or through using nucleoside-modified RNA (modRNA) as BNT162b1 (Mulligan et al., 2020; Sahin et al., 2020) that encodes the virus receptor-binding domain and BNT162b2 (Walsh et al., 2020) encoding the complete S protein with two proline mutations aiming to keep the prefusion conformation. Targeting the S protein is also tried through DNA-based vaccine (Smith et al., 2020) and attenuated virus with NS1-deleted RBD domain (Kaur and Gupta, 2020).

Pfizer company and its partner BioNTech evaluated the efficacy of their vaccine on 43,000 participants and reported 95% and 94% efficacy in general and elder people (>65 years old), respectively. They reported 162 versus 8 symptomatic cases with confirmed infection and 9 versus 1 severe case in the control versus study group, respectively. Only 3.7% of the vaccinated personnel reported fatigue with no serious side effects. Similar efficacy and safety were reported by Moderna in evaluation of their developing vaccine conducted on 30,000 participants. The press release described a consistently high safety and efficacy within all the studied subgroups. Both vaccines used a novel technique using messenger RNA that codes for the virus surface protein. The main challenge facing these two vaccines is their durability. Degradation of the RNA and lipid particles occurs in warm temperature, so these vaccines require a cold chain to transport them from manufacturing plants to distribution areas.

Both mRNA vaccines need to improve their statistical certainty that can be achieved when recruiting 150 to 165 cases of infected participants.

Comparing these two vaccines, Moderna vaccine has a larger dose of mRNA (100 vs. 30 µg), which can lead to serious side effects. Moderna vaccine can be stored at -20°C compared with -70°C needed to store Pfizer/BioNTech vaccine (Cohen, (n.d.)a).

A Russian vaccine "Sputnik V" uses two different shots using nonharmful adenoviruses as gene delivery "vectors" that hold the gene for SARS-CoV-2 surface protein. The first shot used adenovirus 26 (Ad26), called spike, while the second used adenovirus 5 (Ad5). Testing was done 21 days after the first dose as they attend to receive the second dose. However, the trial covered only 20 confirmed cases, which is too few to prove its efficacy (Cohen, (n.d.)b).

### Available Safety Information Related to the Use of COVID-19 Vaccines in Pregnancy

Despite American College of Obstetricians and Gynecologists' (ACOG's) persistent advocacy for the inclusion of pregnant individuals in COVID-19 vaccine trials, none of the COVID-19 vaccines approved under EUA have been tested in pregnant individuals. However, studies in pregnant women are planned.

A combined developmental and perinatal/postnatal reproductive toxicity (DART) study of Moderna's mRNA-1273 in rats was submitted to the FDA on December 4, 2020. FDA review of this study concluded that mRNA1273 given prior to mating and during gestation periods at dose of 100 µg did not have any adverse effects on female reproduction, fetal/embryonal development, or postnatal development except for skeletal variations, which are common and typically resolve postnatally without intervention. These DART studies provide the first safety data to help inform the use of the vaccine in pregnancy until there are more data in this population ([American Colleague of Obstetrics and Gynecology, 2021](#)).

The ACOG recommends that COVID-19 vaccines should not be withheld from pregnant individuals who meet criteria for vaccination based on Advisory Committee on Immunization Practices (ACIP)—recommended priority groups. While safety data on the use of COVID-19 vaccines in pregnancy are not currently available, there are also no data to indicate that the vaccines should be contraindicated, and no safety signals were generated from DART studies for the Pfizer-BioNtech and Moderna COVID-19 vaccines. Therefore, in the interest of allowing pregnant individuals who would otherwise be considered a priority population for vaccines approved for use under EUA to make their own decisions regarding their health, the ACOG recommends that pregnant individuals should be free to make their own decision in conjunction with their clinical care team.

Discussions between the patient and their healthcare provider may assist with decisions regarding the use of vaccines approved under EUA for the prevention of COVID-19 by pregnant patients. Important considerations include the level of the pandemic activity in the local community, the potential efficacy of the vaccine, and the potential risk and severity of maternal disease, including fetal and neonatal risks of both the disease and the vaccine. Considerations also included the woman current health status and risk of exposure (at work or at home and the possibility for exposing high-risk household members) ([American Colleague of Obstetrics and Gynecology, 2021](#)).

*Vaccination considerations* ([American Colleague of Obstetrics and Gynecology, 2021](#)):

- Pregnant women who experience fever following vaccination should be counseled to take acetaminophen. Acetaminophen has been proven to be safe for use in pregnancy and does not appear to impact antibody response to COVID-19 vaccines.
- There is currently no preference for the use of one COVID-19 vaccine over another except for 16–17 year olds who are only eligible for the Pfizer-BioNtech vaccine.
- Individuals should complete their two-dose series with the same vaccine product.
- COVID-19 vaccines should not be administered within 14 days of receipt of another vaccine. For pregnant individuals, vaccines including Tdap and influenza should be deferred for 14 days after the administration of COVID-19 vaccines.
- Anti-D immunoglobulin (i.e., Rhogam) should not be withheld from an individual who is planning or has recently received a COVID-19 vaccine as it will not interfere with the immune response to the vaccine.

Pregnant patients who decline vaccination should be supported in their decision.

### Lactating Individuals

The ACOG recommends COVID-19 vaccines be offered to lactating individuals similar to nonlactating individuals when they meet criteria for receipt of the vaccine based on prioritization groups outlined by the ACIP. While lactating individuals were not included in most clinical trials, COVID-19 vaccines should not be withheld from lactating individuals who otherwise meet criteria for vaccination. Theoretical concerns regarding the safety of vaccinating lactating individuals do not outweigh the potential benefits of receiving the vaccine. There is no need to avoid initiation or discontinue breastfeeding in patients who receive a COVID-19 vaccine ([Academy of Breastfeeding Medicine, 2021](#)).

### INDIVIDUALS CONTEMPLATING PREGNANCY

Vaccination is strongly encouraged for nonpregnant individuals within the ACIP prioritization group(s). Furthermore, the ACOG recommends vaccination of individuals who are actively trying to become pregnant or are contemplating pregnancy and meet the criteria for vaccination based on ACIP prioritization recommendations. Additionally, it is not necessary to delay pregnancy after completing both doses of the COVID-19 vaccine.

Given the mechanism of action and the safety profile of the vaccine in nonpregnant individuals, COVID-19 mRNA vaccines are not thought to cause an increased risk of infertility.

If an individual becomes pregnant after the first dose of the COVID-19 vaccine series, the second dose should be administered as indicated. If an individual receives a COVID-19 vaccine and becomes pregnant within 30 days of receipt of the vaccine, participation in CDC's V-SAFE program should be encouraged.

Importantly, routine pregnancy testing is not recommended prior to receiving any EUA-approved COVID-19 vaccine ([American College of Obstetrics and Gynecology, 2021](#)).

The ACIP has made the following recommendations for prioritization of COVID-19 vaccine allocation:

Phase 1a: Healthcare workers and long-term care facility residents ([McClung et al., 2020](#)). Phase 1b: Persons aged  $\geq 75$  years and frontline essential workers ([Dooling, 2020](#)). Phase 1c: Persons aged 65–75 years, persons aged 16–64 years with high-risk medical conditions (including pregnancy), and other essential workers ([Dooling, 2020](#)).

\*High-risk medical conditions outlined by the CDC include the following:

- Pregnancy
- Cancer
- Chronic kidney disease
- COPD (chronic obstructive pulmonary disease)
- Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies
- Immunocompromised state (weakened immune system) from solid organ transplant
- Obesity (body mass index [BMI] of  $30 \text{ kg/m}^2$  or higher but  $< 40 \text{ kg/m}^2$ )
- Severe Obesity (BMI  $\geq 40 \text{ kg/m}^2$ )
- Sickle cell disease
- Smoking (current or history)
- Type 2 diabetes mellitus

([ACIP, 2020](#); [Center for Disease Control and Prevention, 2020e](#))

## TREATMENT PLAN

All treatments suggested for COVID-19 are suggestive with no evidence. Analysis of treatment received for pregnant women infected with SARS-CoV-2 revealed marked diversity among different institutions. A global interim guidance from International Federation of Gynaecology and Obstetrics (FIGO) and allied partners suggested the use of symptomatic treatment in suspected cases as antipyretics for fever along with general treatment for

maintenance of fluid and electrolyte balance with proper maternal and fetal monitoring. Mild confirmed cases should be managed as the suspected cases with proper monitoring for superimposed bacterial infections. Antiviral treatment may be considered after proper evaluation of its risks and benefits. In severe and critical cases, immediate aggressive treatment should be started to reduce maternal and perinatal morbidities and mortalities ([Rasmussen et al., 2020](#)). ICU admission in a negative pressure isolation room with proper monitoring of vital signs, fluid and electrolyte balance, and antibacterial and antiviral treatment along with oxygen therapy through noninvasive or invasive ventilation to keep a minimum of 95% O<sub>2</sub> saturation should be done ([Poon et al., 2020](#); [Bhatia et al., 2016](#)). A multidisciplinary team (MDT) including expert obstetricians, anesthesiologist, neonatologist, respiratory internist, and others should be available ([Rasmussen et al., 2020](#)).

The ACOG and the Society of Maternal–Fetal Medicine suggested an Outpatient Assessment and Management for Pregnant Women with Suspected or Confirmed Novel Coronavirus (COVID-19) as follows:

1. Assessment of patients regarding both symptoms and exposure. Symptoms include fever of  $38^\circ\text{C}$  or more, chills, repeated shaking with chills, cough, shortness of breath, sore throat, nasal congestion or rhinorrhea, fatigue, muscle or body aches, headache, new change or loss of taste or smell, nausea or vomiting, and diarrhea. Exposure to known COVID-positive individual especially if unprotected is reported.
2. In the absence of symptoms and exposure history, follow routine prenatal care.
3. In the presence of symptoms and exposure history, test for SARS-CoV-2 infection according to facility and/or local guidance, community spread, and availability of testing.
4. Conduct illness severity assessment by asking about difficulty breathing or shortness of breath, difficulty completing a sentence without gasping for air, or needing to stop to catch breath frequently when walking across the room, cough more than 1 teaspoon of blood, new pain or pressure in the chest other than pain with coughing, inability to keep liquids down, signs of dehydration such as dizziness when standing, delayed response than usual, or confusion during talking.
5. If severity assessment revealed no positive findings, assess clinical and social risks as comorbidities (hypertension, diabetes, asthma, HIV, chronic heart disease, chronic liver disease, chronic lung disease, chronic kidney disease, blood dyscrasia,

and people on immunosuppressive medications), Obstetric issues (e.g., preterm labor) and inability to care for self or arrange follow-up if necessary.

6. If no comorbidities, normal obstetric issues, and able to care for women with herself and arrange for follow-up, consider as low risk. So:
  - a. Refer patient for symptomatic care at home including hydration and rest.
  - b. Monitor for development of any symptoms above and restart algorithm if new symptoms present.
  - c. Routine obstetric precautions.
7. Women with positive illness severity assessment are considered as elevated risk. So, recommend her to immediately seek care in an emergency department or equivalent unit that treats pregnant women. When possible, send the patient to a setting where she can be isolated. Notifying the facility that you are referring a person under investigation is recommended to minimize the chance of spreading infection to other patients and/or healthcare workers at the facility Adhere to local infection control practices including personal protective equipment (PPE).
8. Women with positive clinical and social risks are considered as moderate risk. So, see the patient as soon as possible in an ambulatory setting with resources to determine severity of illness. When possible, send the patient to a setting where she can be isolated. Clinical assessment for respiratory compromise includes physical examination and tests such as pulse oximetry, chest X-ray, or ABG as clinically indicated. Pregnant women (with abdominal shielding) should not be excluded from chest computed tomography (CT) if clinically recommended.
9. Moderate-risk patients with no respiratory compromise or complications and able to follow up with care are managed as low risk as in number 5.
10. Admit the moderate-risk patients with respiratory compromise or complications for further evaluation and treatment. Review hospital or health system guidance on infection control measures to minimize the patient and provider exposure.

The Royal College of Obstetricians and Gynecologists recommended the following points of caring of pregnant women with suspected or confirmed COVID-19 infection:

- Any pregnant woman with suspected COVID-19 infection should be managed as confirmed case till confirmation or exclusion of diagnosis occurs.
- Obstetricians should be oriented with and follow the local protocols for dealing with possible COVID-19 cases. Stabilization of the general condition is the first line of treatment taking into consideration that young healthy women can resist deterioration in respiratory functions with maintenance of adequate oxygen saturation for a certain time and that can be followed by sudden decompensation.
- Obstetrician should consider both the absolute values and the degree of changes in the needed observations and investigations as the absolute oxygen saturation and its changes.
- Warning signs for decompensations include oxygen requirement increase above 40%, respiratory rate higher than 30 breaths/min on oxygen therapy, decreased urine output, or occurrence of drowsiness even with normal oxygen saturation.
- Oxygen saturation should be kept above 94% all the times.
- Intravenous fluid management needs monitoring fluid balancer charts especially in nonmild cases and to maintain neutral fluid balance during labor 250–500 mL of bolus fluids and check for volume overload before administration of further fluids.
- Antibiotics can be started early at first presentation of the disease to control any coexisting or secondary bacterial infections.
- An MDT includes expert obstetrician, anesthesiologist, neonatologist, intensivist familiar with obstetric care, midwife in charge, and neonatal nurse in charge working together with an infection control team.
- All pregnant women should be assessed for risk of thromboembolism and receive prophylactic dose of anticoagulants or therapeutic dose if there is high suspicion of venous thromboembolism (VTE).
- Women with thrombocytopenia (in some cases of severe COVID-19 infection) should stop any thromboprophylaxis and antiplatelet drugs as aspirin and consider using mechanical aids (e.g., intermittent calf compressors) and referred to an expert hematologist 96.
- The need for emergency termination of pregnancy by cesarean delivery (CD) or induction of labor to support maternal resuscitation or to save deteriorating fetal condition is individualized, and the decision needs discussion with all members of the MDT.
- Maternal stabilization before any intervention must be achieved.
- Fetal indications for termination of pregnancy follow the same guidelines of routine obstetrics if the maternal condition is stable ([World Health Organization, 2020b](#); [Royal College of Obstetrics and Gynecology, 2020](#)).

The WHO advised management of COVID-19 cases according to severity.

Mild cases are advised to have self-isolation at home or at health or community facility. The decision is individualized according to the local COVID-19 care pathway, the presenting manifestations, the need for supportive care, the degree of risk for development of severe form, and the available conditions at home. Symptomatic treatments such as antipyretics for fever, analgesics for pain (nonsteroidal antiinflammatory can be used), proper nutrition, and hydration are recommended (World Health Organization, 2020c).

No need for widespread use of antibiotics in mild cases. Widespread use of antibiotics increases bacterial resistance with subsequent increase in morbidity and mortality during and after the pandemic (Llor and Bjerum, 2014; Goossens et al., 2005).

Precautions taken during home isolation include the following:

1. Mild cases should be warned about manifestations of complications and advised to seek immediate medical advice if they encounter any of them.
2. Cases with high risk should be monitored very closely.

Counsel patients with mild COVID-19 about signs and symptoms of complications that should prompt urgent care.

### Remark

Patients with risk factors for severe illness should be monitored closely, given the possible risk of deterioration. If they develop any worsening symptoms (such as light headedness, difficulty breathing, chest pain, dehydration, and so on), they should seek urgent care through the established COVID-19 care pathway. Caregivers of children with mild COVID-19 should monitor for signs and symptoms of clinical deterioration requiring urgent reevaluation. These include difficulty breathing/fast or shallow breathing (for infants: grunting, inability to breastfeed), blue lips or face, chest pain or pressure, new confusion, inability to awaken/not interacting when awake, and inability to drink or keep down any liquids. Consider alternative delivery platforms such as home-based, phone, telemedicine, or community outreach teams to assist with monitoring (Greenhalgh et al., 2020).

Moderate cases with pneumonia should be isolated according to local care pathway at either home, community, or health facility and depending on the clinical presentation, presence of risk factors for development of severe disease, the need for supportive care, and the conditions at home. They should receive the same

treatment as mild cases. Antibiotics are given only when bacterial infection is suspected (only 8% of hospitalized cases with COVID-19 have concomitant bacterial or fungal infections) (Rawson et al., 2020). Antibiotics not broad-spectrum ones can be used in elderly cases and children under 5 years old (World Health Organization, 2019).

Home-isolated cases should be monitored for symptoms and signs of severe disease, and they are instructed to seek urgent care through the established care pathway. They should have continuous follow-up through phone calls, telemedicine, or community outreach teams. Pulse oximeters follow-up at home is not recommended. Hospitalized moderate cases are monitored for vital signs, oxygen saturation, and early warning scores as NEWS2 and PEWS (Duncan et al., 2006).

Severe cases should be cared in areas of health facilities equipped with oxygen delivery systems with disposable oxygen delivery interfaces (such as nasal cannula, masks with reservoir bags and venturi mask, and oxygen saturation monitoring through pulse oximeters). Any patient with emergency manifestations (such as respiratory manifestations including dyspnea, apnea, or severe respiratory distress; vascular manifestations including central cyanosis or shock; neurological manifestations including coma and/or convulsions) or with oxygen saturation below 90% should receive oxygen therapy immediately till reaching 94% or more during resuscitation and 92%–95% or more in pregnant women after stabilization. That can be achieved through adjustment of oxygen flow rates using the appropriate delivery devices (nasal cannula, venturi mask, and face mask with reservoir bag are used to deliver rates up to 5, 6–10, and 10–15 L/min, respectively) (World Health Organization, 2016, 2018).

Positioning as high supported sittings may facilitate breathing, decrease energy expenditure, and optimize oxygenation. Prone position in awake individuals with spontaneous breathing is under investigation to prove its effect in improving oxygenation and ventilation/perfusion ratio. However, that could be difficult to be applied in pregnant women especially those in late trimester (Thomas et al., 2020).

Severe cases with excess respiratory secretions, retained secretions, and/or inadequate cough should have their airway cleared. That can be achieved through gravity-assisted drainage and active breathing cycles with avoidance of devices as inspiratory positive pressure breathing and mechanical insufflation–exsufflation as much as possible (Thomas et al., 2020).

Cases with severe COVID-19 infection should be closely monitored for vital signs, oxygen saturation,



development of complications such as major organ failure (including respiratory, liver, kidney, and heart failures), and venous and arterial thromboembolism.

Cautions should be taken on administration of intravenous fluids, as hypovolemia impairs tissue perfusion and overload may worsen oxygenation (Schultz et al., 2017).

Critical cases with acute respiratory distress syndrome (ARDS) are classified to those with mild, moderate, and severe ARDS (Rhodes et al., 2017; Rimensberger et al., 2015).

Mild ARDS cases can be treated with noninvasive oxygenation methods including high-flow nasal oxygen (HFNO), continuous positive airway pressure (CPAP), or bilevel positive airway pressure (BiPAP). That cannot be applied on cases with respiratory failure, major organ failure, disturbed conscious level, or hemodynamic instability. Cases on noninvasive ventilation should be closely monitored with availabilities of immediate intubations if the patient deteriorated or not improved within 1 h of its administration. Airborne precautions should be fulfilled during use of these methods till evaluation of its safety for its potential for aerosolization. The use of HFNO may decrease the need for intubation when compared with the standard oxygen therapy (Rochweg et al., 2017) and is considered safe in cases with nonworsening hypercapnia (Luo et al., 2015; Lee et al., 2018; Rochweg et al., 2017).

The use of noninvasive ventilation (NIV) in hypoxic respiratory failure (except in pandemic viral illness—studied in SARS and influenza (Rochweg et al., 2017)) is not recommended as it carries the risk of delayed intubation, large tidal volumes, and injurious transpulmonary pressures (Arabi et al., 2014).

Cases with severe ARDS should be intubated and receive invasive mechanical ventilation as respiratory failure in ARDS is caused by intrapulmonary ventilation–perfusion mismatch or shunt (Rhodes et al., 2017).

Pregnant women with ARDS may desaturate rapidly during intubation so preoxygenation with 100% FiO<sub>2</sub> through a face mask with reservoir bag for 5 min is recommended before intubation. A rapid-sequence intubation by an expert provider using airborne precautions is recommended after proper airway assessment (Cheung et al., 2020; Peng et al. 2020; Detsky et al., 2019).

Mechanical ventilation with tidal volumes of 4–8 mL/kg and inspiratory plateau pressure less than 30 cm H<sub>2</sub>O are recommended (Rhodes et al., 2017). In nonpregnant cases, prone position is recommended for 12–16 h daily (Guérin et al., 2013; Messerole et al., 2002). The evidence of prone position is little

but can be considered in early pregnancy, while lateral decubital position is advised in late trimester.

Titration of positive end-expiratory pressure (PEEP) is individualized by weighting its benefits of improving alveolar recruitment and decreasing atelectrauma against its risks of lung injury and high pulmonary vascular resistance, and the patient should be monitored during titration for its effects. Tables are used for guiding PEEP titration based on the FiO<sub>2</sub> needed to maintain SpO<sub>2</sub> (NIH NHLBI ARDS Clinical Network, 2008).

The use of continuous infusion of neuromuscular blockers should not be routine in cases with moderate and severe ARDS (Papazian et al., 2010).

Disconnection from the ventilator is risky as it causes loss of PEEP and atelectasis with increased risk of infection of the care providers so it is better avoided, and if needed, the use of in-line catheters with clamping of the tube is recommended along with avoidance of manual hyperinflation (Thomas et al., 2020).

Cases with refractory hypoxemia can be transferred to extracorporeal membrane oxygenation if available.

Critically ill patients should receive treatment to prevent complications as thromboembolism. Both arterial and venous thromboembolic complications are reported in severe cases of COVID-19 (Siddamreddy et al., 2020; Violi et al., 2020; Wichmann et al., 2020). Anticoagulant drugs such as low-molecular-weight heparin are used according to local and international standards (NICE Guideline, 2018). Mechanical prophylaxis such as intermittent pneumatic compression device is used if anticoagulant drugs are contraindicated.

### Prevention of Other Complications Is Summarized by the WHO in Table 4.1

The RCOG suggested certain criteria for hospital admission for pregnant women with COVID-19 (López et al., 2020). These criteria include the following:

- Persistent fever >38°C despite using paracetamol
- Chest X-ray demonstrating pneumonia
- Pregnant women with other comorbidities such as chronic hypertension, obstructive pulmonary disease, pregestational diabetes, immunosuppression, organ transplant recipients, HIV infection with <350 CD4+ cells, or patients who receive corticosteroids equivalent to >20 mg of prednisone for >2 weeks, use of immunosuppressive drugs, neutropenia, and so on must be carefully evaluated by an infectious disease specialist
- CURB severity scale with a total score >0 (each item gives a score of one point)
  - C: Acute confusion
  - U: Urea >19 mg/dL

TABLE 4.1

Prevention of Other Complications are Summarized by the World Health Organization.

Anticipated Outcome	Interventions
Reduce days of invasive mechanical ventilation	<ul style="list-style-type: none"> <li>• Use weaning protocols that include daily assessment for readiness to breathe spontaneously</li> <li>• Minimize continuous or intermittent sedation, targeting specific titration endpoints (light sedation unless contraindicated) or with daily interruption of continuous sedative infusions</li> <li>• Early mobilization</li> <li>• Implementation of the above as a bundle of care (may also reduce delirium), such as the awakening and breathing coordination, delirium assessment/management, and Early mobility</li> </ul>
Reduce incidence of ventilator-associated pneumonia	<ul style="list-style-type: none"> <li>• Oral intubation is preferable to nasal intubation in adolescents and adults</li> <li>• Keep patient in semirecumbent position (head of bed elevation 30–45 degrees)</li> <li>• Use a closed suctioning system; periodically drain and discard condensate in tubing</li> <li>• Use a new ventilator circuit for each patient; once patient is ventilated, change circuit if it is soiled or damaged, but not routinely</li> <li>• Change heat moisture exchanger when it malfunctions, when soiled, or every 5–7 days</li> </ul>
Reduce incidence of catheter-related bloodstream infection	<ul style="list-style-type: none"> <li>• Use a checklist with completion verified by a real-time observer as a reminder of each step needed for sterile insertion and as a daily reminder to remove catheter if no longer needed</li> </ul>
Reduce incidence of pressure ulcers	<ul style="list-style-type: none"> <li>• Turn patient every 2 h</li> </ul>
Reduce incidence of stress ulcers and gastrointestinal bleeding	<ul style="list-style-type: none"> <li>• Give early enteral nutrition (within 24–48 h of admission)</li> <li>• Administer histamine-2 receptor blockers or proton-pump inhibitors in patients with risk factors for GI bleeding. Risk factors for GI bleeding include mechanical ventilation for <math>\geq 48</math> h, coagulopathy, renal replacement therapy, liver disease, multiple comorbidities, and higher organ failure score</li> </ul>
Reduce the development of antimicrobial resistance Reduce the development of adverse drug effects Promote appropriate antimicrobial prescribing and use during the COVID-19 pandemic	<ul style="list-style-type: none"> <li>• Utilize deescalation protocols as soon as the patient is clinically stable and there is no evidence of bacterial infection</li> <li>• Expose the patient to empiric antimicrobial therapy for the shortest time possible, to prevent nephrotoxicity, cardiac, and other side-effects from unnecessary antimicrobial use</li> <li>• Do not prescribe antibiotics to suspected or confirmed COVID-19 patients with low suspicion of a bacterial infection, to avoid more short-term side effects of antibiotics in patients and negative long-term consequences of increased antimicrobial resistance</li> </ul>

Clinical management of Covid-19 based on WHO recommendations. <https://www.who.int/publications/i/item/clinical-management-of-covid-19>.

- R (respiratory rate):  $\geq 30$  bpm
- B (blood pressure): SBP (systolic)  $\leq 90$  mm Hg or DBP (diastolic)  $\leq 60$  mm Hg
- Intensive care unit admission criteria  
The admission criteria suggested for intensive care unit (López et al., 2020) (adapted from the American Thoracic Society and Infectious Diseases Society of America) include the presence of one major criterion or three minor criteria of the following:
- Major criteria
  - The need for invasive mechanical ventilation
  - Shock with the need for vasopressors
- Minor criteria
  - Respiratory rate  $\geq 30$  bpm
  - PaO<sub>2</sub> (partial pressure of oxygen)/FiO<sub>2</sub> (fraction of inspired oxygen) ratio  $< 250$
  - Multilobar infiltrates
  - Confusion/disorientation
  - Uremia (blood urea nitrogen  $> 20$  mg/dL)
  - Leukopenia  $< 4000$  cells/mm<sup>3</sup>
  - Thrombocytopenia  $< 100,000$  platelets/mm<sup>3</sup>
  - Hypothermia/central temperature  $< 36^\circ\text{C}$
  - Hypotension in need of aggressive fluid resuscitation

A suggested delivery room processing is summarized in Fig. 4.1.

A Summary of Guidelines suggested by different organizations for Intrapartum Care of Pregnant Patients During the COVID-19 Pandemic is shown in Table 4.2.

**BEFORE HOSPITAL ADMISSION**

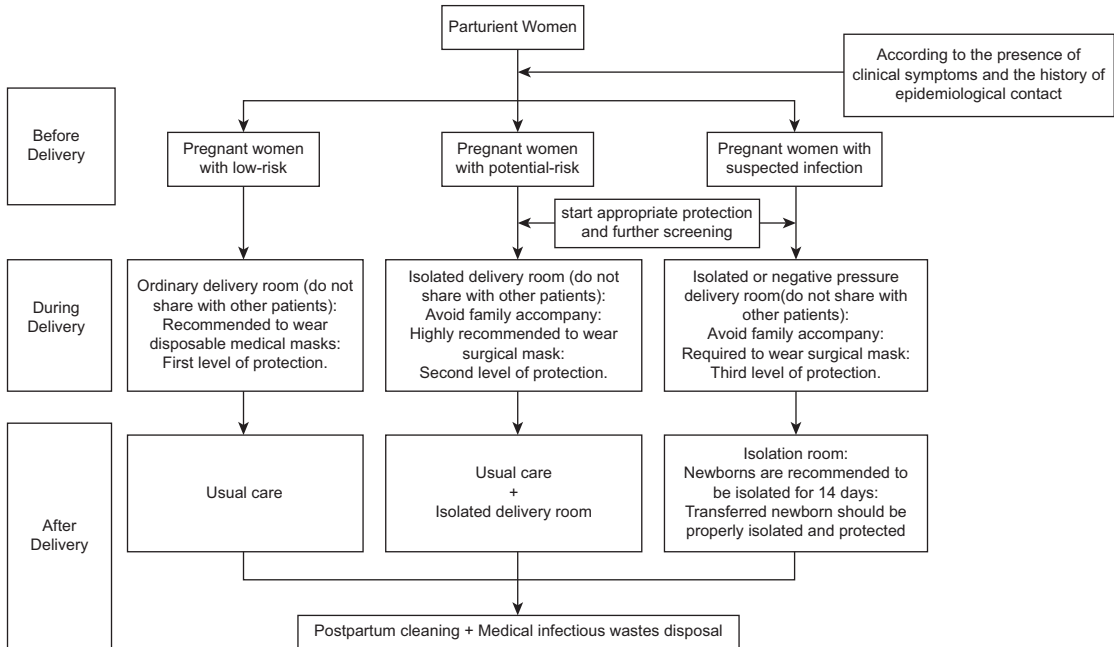
Full explanation of the process of delivery and care all through labor and postpartum time should be discussed with the parturient woman. She needs to realize that symptomatic pregnant women with COVID-19 are at increased risk of more severe illness compared with nonpregnant peers (Panagiotakopoulos et al., 2020). The CDC now includes pregnant women in its “increased risk” category for COVID-19 illness. Although the absolute risk for severe COVID-19 is low, there is an increased risk of ICU admission, need for mechanical ventilation, and death reported in pregnant women with symptomatic COVID-19 infection, when compared with symptomatic nonpregnant women (Zambrano et al., 2020). Pregnant patients with comorbidities such as obesity and gestational diabetes may be at an even higher risk of severe illness consistent with the general population with similar comorbidities (Panagiotakopoulos et al., 2020; Knight

et al., 2020; Zambrano et al., 2020). Similar to the general population, Black and Hispanic individuals who are pregnant appear to have disproportionate SARS CoV-2 infection and death rates (Zambrano et al., 2020). While data indicate an increased risk of severe illness and maternal death, data also indicate that the majority of pregnant individuals diagnosed with COVID-19 experience relatively mild symptoms; however, symptoms lasting up to 8 weeks have been reported (Yee et al., 2020).

**TIMING OF DELIVERY**

Timing of delivery, in most cases, should not be affected by maternal COVID-19 infection. For women with suspected or confirmed COVID-19 early in pregnancy who recover, no alteration to the usual timing of delivery is indicated. For women with suspected or confirmed COVID-19 in the third trimester who recover, it is reasonable to attempt to postpone delivery (if no other medical indications arise) until a negative testing result is obtained or quarantine status is lifted in an attempt to avoid transmission to the neonate. In general, COVID-19 infection itself is not an indication for delivery.

Inductions of labor delivery and CD should continue to be performed as indicated. Decisions on



**FIG. 4.1** The processing flow of delivery during the COVID-19 outbreak based on the risk level of pregnancy infection. A suggested delivery room processing (Qi et al., 2020).

**TABLE 4.2**

**Summary of Guidelines for Intrapartum Care of Pregnant Patients During the COVID-19 Pandemic.**

<b>Title</b>	<b>Professional Society</b>	<b>ISUOG</b>	<b>CNGOF</b>	<b>ACOG</b>	<b>SMFM</b>	<b>RCOG</b>	<b>WHO</b>	<b>CDC</b>	<b>CatSalut</b>	<b>ISS/SIEOG</b>
Intrapartum care	Predelivery Preparation	Social distancing	Social distancing	Notification of the teams of obstetric, pediatric, and anesthesia	Social distancing and stop working 2 weeks before expected delivery time. Screen mother and partner 24 h before admission through phone call.	Social distancing Minimum staffing. Screen mother and partner at maternity unit. Self-isolation of symptomatic partners within 7 days before admission and prevented from hospital entry. Suspected and confirmed COVID19 mothers better stay at home during latent phase of labor; and admitted when in active labor to dry isolated room with running simulations for elective/ emergency procedures.	In suspected and confirmed COVID19 cases, health workers should take all appropriate precautions including hand hygiene and protective clothing such as gloves, gown, and medical mask.	<b>N/A</b>	Screening of symptomatic women at maternity unit. Minimum staffing. Only one partner allowed.	Screen symptomatic women at maternity unit. Asymptomatic: Managed routinely. Stable symptomatic: Admitted to hospital. Unstable symptomatic: referred to hospitals with ICU.
	Delivery time	Routine obstetric indications. In critically ill cases, early delivery is considered.	Routine obstetric indications if patient recovered from infection in early pregnancy. In critically ill cases, early delivery is considered.	Routine obstetric indications if patient recovered from infection in early pregnancy. Postpone delivery if not contraindicated and if patient recovered from infection in late pregnancy till testing negative or quarantine lifted to minimize neonatal transmission.	Routine obstetric indications. Induction of labor is not contraindicated except in limited beds. Delivery should be considered in terms of COVID-19 patients as symptoms peak after 7–14 days after its onset.	Routine obstetric indications.	<b>N/A</b>	<b>N/A</b>	Use PPE in all cases. Continue fetal electronic monitoring.	Routine obstetric indications.

*Continued*

TABLE 4.2

## Summary of Guidelines for Intrapartum Care of Pregnant Patients During the COVID-19 Pandemic.—cont'd

Title	Professional Society	ISUOG	CNGOF	ACOG	SMFM	RCOG	WHO	CDC	CatSalut	ISS/SIEOG
Delivered location		Designated negative-pressure isolation room.	Designated isolation room for suspected or confirmed cases of COVID-19.	N/A	Designated delivery and operating rooms.	Designated isolation room for suspected or confirmed cases.	N/A	N/A	Designated isolation room for suspected or confirmed cases of COVID-19. Designated negative-pressure isolation room for CS.	Designated isolated room for suspected or confirmed cases.
Mode of delivery		As per routine obstetric indications. COVID-19 is <i>not</i> an indication for CS. Expedite CS delivery if fetal distress or maternal deterioration occurs. Avoid water birth.	As per routine obstetric indications. COVID-19 is <i>not</i> an indication for CS. Expedite CS delivery if fetal distress or maternal deterioration occurs.	As per routine obstetric indications. No specific recommendations for CS. Operative vaginal delivery is not indicated for suspected or confirmed cases alone but can be used as routinely indicated.	As per routine obstetric indications. COVID-19 is <i>not</i> an indication for CS.	As per routine obstetric indications except in demanding maternal respiratory condition. Avoid water birth.	As clinically indicated.	N/A	As per routine obstetric indications. COVID-19 is <i>not</i> an indication for CS.	As per routine obstetric indications. COVID-19 is <i>not</i> an indication for CS.
Support person		Limit visitors, no clear number specified.	<b>No visitors</b>	One asymptomatic support person allowed.	One consistent support person allowed. No attendance below 16–18 years of age.	One consistent asymptomatic support person allowed with restriction to the patient's bedside.	N/A	N/A	One of the relatives is encouraged during all the labor and delivery.	Single accompanying asymptomatic person.
Obstetric analgesia and anesthesia		Both regional and general anesthesia are considered.	Both regional and general anesthesia are considered.	N/A	Avoid nitrous oxide	NO evidence against regional or GA. Epidural analgesia is recommended in suspected or confirmed cases to minimize the need for GA in urgent need for delivery.	N/A	N/A	Epidural analgesia is recommended to women with suspected or confirmed COVID-19 to minimize the need for GA if urgent delivery is needed.	Both regional and general anesthesia are considered.
Second stage of Labor		Consider shortening with operative delivery to	N/A	N/A	Do not delay pushing. Considered aerosolizing. N95 should be	Consider shortening with operative vaginal delivery in symptomatic	N/A	N/A	N/A	N/A

	minimize aerosolization and maternal respiratory effort				worn by HCW and patients.	women who become exhausted or hypoxic.				
Third stage of labor		<b>N/A</b>	<b>N/A</b>		Management to reduce blood loss (national blood shortage)	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	Active management in all cases.	Per routine.
Oxygen supplementation	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>		Consider aerosolizing. HCW must wear appropriate PPE. Do not use O <sub>2</sub> for intrauterine resuscitation.	Measurements (in addition to routine maternal–fetal observations) for women with suspected/confirmed COVID-19. Aim to keep O <sub>2</sub> sat >94%.	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
Umbilical cord Clamping	Avoid delayed cord clamping in confirmed and suspected cases	<b>N/A</b>	No recommendations against delayed clamping of umbilical cord.		Avoid delayed cord clamping	Delayed cord clamping is still recommended in the absence of contraindications.	<b>N/A</b>	<b>N/A</b>	Delayed cord clamping is still recommended in the absence of contraindications.	General rule.
PPE use		<b>N/A</b>	<b>N/A</b>		Asymptomatic or negative patients. Patient and provider wear surgical mask. Aerosolizing procedures—N95 for patient and N95, gown, gloves, and face shield for provider.	Level of PPE should be based on the risk of requiring GA. Aerosolizing procedures—use FFP3 mask.	<b>N/A</b>	Same as general population.	<b>N/A</b>	Symptomatic with stable or unstable condition: mothers, medical staff, and accompanying person must wear all protection devices. Masks should be FFP2/FFP3 type.
Elective cesarean delivery/induction of labor (IOL)		<b>N/A</b>	<b>N/A</b>		No Ccontraindication to IOL unless there is limited beds.	For suspected/confirmed cases, consider delay of elective CD or IOL if safely feasible.	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

CD, cesarean delivery; CS, cesarean section; GA, general anesthesia; (Narang et al., 2020).

how to schedule these procedures in the time of the COVID-19 pandemic are best made at the local facility and systems level, with input from obstetric care professionals and based on healthcare personnel availability, geography, access to readily available local resources, and coordination with other centers ([American College of Obstetricians and Gynecologists, 2020](#)).

- Patients undergoing planned induction or CD can have screening and laboratory testing 24–72 h before the planned procedure in an attempt to have results available before admission.
- Symptomatic women should be evaluated to determine whether it is obstetrically feasible to reschedule induction or CD until results of COVID-19 testing are available. This is an individualized decision and requires assessing patient-specific risks of continuing the pregnancy in the setting of an unknown, positive, or negative test result. In particular, if the test result is positive, patients may benefit from delivery since they may become more severely ill over time (symptoms are often more severe in the second week of the illness).
- In asymptomatic patients with a positive SARS-CoV-2 test result, induction of labor delivery or CD performed for appropriate medical/obstetric indications (including week 39 induction of labor) should not be postponed or rescheduled. For those who require cervical ripening, outpatient mechanical ripening with a balloon catheter is an option. For inpatient cervical ripening, using two methods (e.g., mechanical and misoprostol or mechanical and oxytocin) may decrease the time from induction to delivery, compared with using one agent only ([UpToDate, Vincenzo Berghella, 2020](#)).

## ROUTE OF DELIVERY

- In asymptomatic or nonsevere COVID-19 infection, the planned route of delivery in these patients should not be altered ([American College of Obstetricians and Gynecologists, 2020](#)). CD does not appear to reduce the already low risk for neonatal infection ([Walker et al., 2020](#)). Even if vertical transmission at delivery is confirmed as additional data are reported, this would not be an indication for CD 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 ([UpToDate, Vincenzo Berghella, 2020](#)).
- In patients with severe or critical COVID-19, CD is performed for standard obstetric indications including concerns of acute decompensation of

intubated and critically ill mothers. Induction can be performed safely in intubated patients ([Slayton-Milam et al., 2020](#); [Liu et al., 2019](#)), and in one study of 37 CDs and 41 vaginal deliveries in COVID-19 patients, cesarean birth was associated with an increased risk for clinical deterioration (8/37 [22%] vs. 2/41 [5%]), which remained after adjustment for confounders (adjusted odds ratio 13, 95% CI: 1.5–122.0) ([Martínez-Perez et al., 2020](#)). Confounders included maternal age >35 years, body mass index >30 kg/m, maternal comorbidities, need for oxygen supplementation at admission, abnormal chest radiograph at admission, nulliparity, smoking, and preterm delivery. The issue of possible harm from CD should not preclude indicated CD, but it requires further evaluation as the small number of events and bias in case selection for route of delivery could account for the findings ([UpToDate, Vincenzo Berghella, 2020](#)).

- Long induction is better avoided in intubated patients and those laboring in an operating room or intensive care unit, because of the specialized equipment and personnel in these sites. CD is often performed in such patients.
- Regardless of the type or site of delivery (e.g., labor and delivery unit, main operating room, intensive care unit), a multidisciplinary care team should be present (e.g., intensivists, maternal–fetal medicine, neonatology, nursing support from obstetrics, pediatrics, and medical disciplines) to care for the severely/critically ill mother and the potentially heavily sedated newborn.

On admission, primary screening of all women (with first-level protective equipment applied) through checking of temperature, the fetal heart rate, and evaluation of symptoms that may suggest COVID-19 infection, such as fever, respiratory symptoms (cough, dyspnea), gastrointestinal symptoms (vomiting, diarrhea), and other symptoms (loss of taste and smell) before allowing women to sit in the maternity waiting area. Ask about COVID-19 exposure through contact with a suspected or confirmed case or traveling to epidemic area within the past 2 weeks. Any positive history of the aforementioned indicates “potential risk” status ([Qi et al., 2020](#)).

Pregnant women with potential risk and/or suspected infection should go through further screening (with second-level protective equipment applied) for other respiratory pathogens (such as influenza and parainfluenza virus, *Mycoplasma pneumoniae*, and *Chlamydia pneumoniae*), routine blood tests, and markers of inflammation such as C-reactive protein. Testing for

the new coronavirus nucleic acid should be performed. In the presence of any chest manifestations necessitating doing chest CT, it should be done after obtaining an informed written consent. Obstetric management should not be delayed waiting for COVID-19 testing or the results of the performed tests (Qi et al., 2020).

### Delivery Room Management

- Pregnant women suspected to be COVID-19 positive should be immediately transferred to an isolated delivery room (avoiding contact with other patients) or negative pressure delivery room and be required to wear surgical mask (National Health Commission of the People's Republic of China, 2020).
- Family members accompanying the parturient women must not be permitted in suspected or confirmed cases.
- Management of delivery should be carried through specific experienced senior medical specialists supplied with third-level protective equipment to avoid cross-infection.
- Low-risk pregnant women without any history of epidemiological exposure or clinical symptoms are transferred to a separate delivery room for delivery and should wear disposable medical masks. Family members with no history of epidemiological contact and clinical symptoms within the past 2 weeks are allowed to attend the childbirth after wearing disposable medical masks (National Health Commission of the People's Republic of China, 2020).
- Person-to-person contact and time in the labor unit and hospital should be limited, as is safely feasible (UpToDate.Vincenzo Berghella, 2020).
- Continuous electronic fetal monitoring in labor is recommended for all women with suspected or confirmed COVID-19 infection as fetal compromise is relatively common in these women (Royal College of Obstetrics and Gynecology, 2020).
- Unnecessary obstetric interventions should be avoided, and cautions should be taken in procedures as episiotomy and instrumental delivery.
- Currently, we do not recommend water deliveries for pregnant women with suspected infection.
- Epidural analgesia and spinal anesthesia are not contraindicated. On the contrary, epidural analgesia should be recommended to pregnant women with suspected or confirmed COVID-19 infection before or in early labor to reduce cardiopulmonary stress from pain and anxiety and, in turn, the chance of viral dissemination (UpToDate.Vincenzo Berghella, 2020) and minimize the need for general anesthesia (GA) in emergency situations (Royal College of Obstetrics and Gynecology, 2020).
- Delayed cord clamping is still appropriate in the setting of appropriate clinician PPE. Although some experts have recommended against delayed cord clamping, the evidence is based on opinion; a single report later confirmed COVID-19 transmission most likely occurred from the obstetric care clinician to the neonate. Current evidence-based guidelines for delayed cord clamping should continue to be followed until emerging evidence suggests a change in practice.
- Operative vaginal delivery is not indicated for suspected or confirmed COVID-19 alone. Practitioners should follow usual clinical indications for operative vaginal delivery, in the setting of appropriate PPE.
- Labor units may consider suspending use of nitrous oxide for those with suspected or confirmed COVID-19, as there are insufficient data regarding the physiologic safety of its inhalation.
- Oxygen should continue to be considered if maternal hypoxia is noted. Based on limited data, high-flow oxygen use is not considered an aerosol-generating procedure (CDC). Still, there is insufficient evidence about the cleaning and filtering when using oxygen, so it is better to suspend routine use of intrapartum oxygen for indications where benefits of use are not well established (e.g., category II and III fetal heart rate tracings).
- In nonintubated patients with respiratory compromise due to COVID-19, magnesium sulfate for maternal seizure prophylaxis and/or neonatal neuroprotection should be monitored very carefully since high magnesium levels (10–13 mEq/L [12–16 mg/dL or 5.0–6.5 mmol/L]) can cause respiratory paralysis. Consultation with maternal–fetal medicine and pulmonary/critical care specialists is advised (American College of Obstetricians and Gynecologists, 2020).
- The third stage of labor is managed as in non-COVID-19 women, and women who developed postpartum hemorrhage are managed according to standard protocols. However, some clinicians avoid tranexamic acid in COVID-19 patients because its antifibrinolytic properties may increase the risk for thrombosis in those with a hypercoagulable state, such as those with severe or critical disease, and alternative strategies for control of bleeding are available (Ogawa and Asakura, 2020). Some authors suggest avoiding methylergometrine because it has been associated with rare cases of respiratory failure



and severe vasoconstriction in severely ill patients (Donders et al., 2020).

- In patients who develop intrapartum fever, differential diagnosis should include COVID-19 infection especially in the presence of suspected symptoms or hypooxygenation. These women should be tested (or retested) for the virus, along with evaluation for other common causes of intrapartum fever (e.g., chorioamnionitis, epidural fever) (Breslin et al., 2020).
- SARS-CoV-2 has rarely 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 (Schwartz, 2020). It should be noted that labor, and particularly pushing, often causes loss of stools, which can contain the virus and spread the infection (Zhang et al., 2020; Wang et al., 2020).

### Management During Cesarean Delivery

- Suspected or confirmed COVID-19 infection is not an indication for CD, unless the patient's respiratory condition requires urgent termination of pregnancy. Otherwise, CD should be done for routine indications.
- MDT consultation regarding premature delivery in suspected or confirmed cases. The team should include expert obstetricians, anesthesiologists, neonatologists, intensivists familiar with obstetric care, and infectious disease physicians.
- CD should be performed in a negative pressure isolation operating room (third-level protective equipment should be applied). The choice of anesthetic mode is determined by the anesthesiologist, based on the patient's respiratory function.
- For pregnant women with potential infection (potential risk), CD can be done in isolated operating room with second-level protective equipment if properly protected. That could be also applied to low-risk infection women with the use of first-level protective equipment (Qi et al., 2020).

### ANESTHESIA IN EMERGENCY CESAREANS FOR PREGNANT WOMEN WITH CORONAVIRUS DISEASE 2019

- A systematic strategy and adequate preparation are mandatory in COVID-19 cases who need to have emergency CD (30-min decision-to-incision interval) to minimize cross-contaminations. The possibilities of suspected/confirmed COVID-19 patients requiring imminent operative deliveries have to be

communicated to the operating room team so that they could be conducted in negative-pressure operating rooms (Ti et al., 2020).

- Desaturation COVID-19 parturient (oxygen saturation  $\leq 93\%$ ) should receive GA in case of emergency CD. GA is done with rapid sequence induction and tracheal intubation with a cuffed tube. The airway team should wear full PPE and powered air-purifying respirator (PAPR). The use of invasive monitoring (as intraarterial blood pressure and central venous pressure) should be done with cautions in presence of COVID-19 complications as renal failure and disseminated intravascular coagulation (Ashokka et al., 2020).
- The use of regional anesthesia (epidural or spinal) is recommended over GA in COVID-19 parturient when the oxygen saturation is adequate ( $\geq 94\%$ ) as it minimizes aerosolization and cross-infection during airway management (Royal Colleague of Obstetrics and Gynecology, 2020).
- If the parturient has epidural catheter, administration of a top-up with potent local anesthetics (as 10–15 mL of 1.5% lignocaine, alkalized with 8.4% sodium bicarbonate) can achieve a rapid onset of 3.5 min surgical anesthetic plane. Rapid sequence spinal anesthesia (Kinsella et al., 2010) is described for emergency CD, wherein patients are placed in a left lateral position with supplemental oxygen, and a single-shot subarachnoid blockade is administered by the most experienced prescrubbed anesthesiologist. The time required for surgical readiness is comparable with that for GA with better neonatal outcomes (Lim et al., 2018).
- The same precautions used with intubation should be done with extubation after GA (Wax and Christian, 2020). Patients tend to be more agitated during emergence from anesthesia and extubation, which could result in increased likelihood of viral dissemination from coughing as compared with the intubation process (Chan et al., 2018). All operating room personnel should wear full PPE until patients are safely extubated and transferred out of the operating room (Wax and Christian, 2020).
- The disposition for patients with COVID-19 after unplanned CD should be decided at the earliest instance. Early transfer to the postanesthesia care unit (PACU) may result in spreading of infection to other postoperative patients. Suspected and confirmed COVID-19 cases may be allowed to recover within the operating rooms where CD was done, if possible. Then the patients can be transferred directly to isolation wards after recovery (Ashokka et al., 2020).

## Postpartum Care (UpToDate.Vincenzo Berghella, 2020)

1. Infection control measures:
  - a. Mothers with suspected or confirmed SARS-CoV-2 infection should be isolated from other healthy mothers and cared for according to standard infection control guidelines.
  - b. After the mother was transferred to the ward, routine cleaning should be undertaken. The surfaces of the equipment (including the obstetric table, ultrasound machine, and neonatal warm bed) in the isolation delivery room and the negative-pressure delivery room need to be wiped and disinfected immediately, preferably with 1000 mg/L chlorine-containing disinfectant; 75% ethanol can be used for the noncorrosion resistance instruments (Royal Colleague of Obstetrics and Gynecology, 2020). Spraying is not a recommended method of disinfecting the equipment, as this can affect the components. Dedicated cleaning tools are required to avoid cross-contamination. The inspection room should be disinfected with ultraviolet light for at least 60 min each time, once or twice a day, with at least 30 min ventilation after irradiation. The ultrasound probe should be protected with a dark cloth during the irradiation. The room should be vacated when ultraviolet lamps are used (Qi et al., 2020).
  - c. Medical waste disposal: Protective supplies used by medical personnel and all patient waste should be regarded as infectious medical waste, which requires double-layer sealing, clear labeling, and airtight transport (National Health Commission of the People's Republic of China, 2020). If testing of the placenta and/or amniotic fluid is required, strict sampling and sealing should be carried out to avoid contamination of the surface of the container and the spread of infection. The surface of the container should be disinfected before sample inspection to further avoid infection of any personnel (Qi et al., 2020).
2. Maternal monitoring:
  - a. For asymptomatic patients with known or suspected COVID-19, postpartum maternal monitoring is routine (including postpartum vital signs, uterine contractions, maternal mental health, and other conditions of the mother should be monitored, and attention paid to the prevention of postpartum hemorrhage and thrombosis).
  - b. For mild COVID-19 patients, monitoring vital signs and fluid balance (intake and output) every 4 h for 24 h after vaginal delivery and 48 h after CD is advised.
  - c. For moderate COVID-19 patients, continuous pulse oximetry monitoring for the first 24 h or until clinical improvement occurs, whichever takes longer. Follow-up laboratory investigations and chest imaging are individualized according to the course of the disease.
  - d. 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.
3. Venous thromboembolism prophylaxis
  - a. Prophylactic-dose anticoagulation is recommended for pregnant/postpartum patients hospitalized for severe COVID-19, if not contraindicated.
  - b. Anticoagulation is better discontinued when the patient is discharged to home.
  - c. Patients with COVID-19 who do not warrant hospitalization for the infection or who are asymptomatic or mildly symptomatic and hospitalized for reasons other than COVID-19 (e.g., labor and delivery) do not require anticoagulation, unless they have other thrombotic risk factors, such as prior VTE or, in some cases, CD.
  - d. Either low-molecular-weight heparin or unfractionated heparin is acceptable, and both are compatible with breastfeeding.
4. **Postpartum analgesia:** Pain management is routine. Acetaminophen is the preferred analgesic agent; however, nonsteroidal antiinflammatory drugs can be used when clinically indicated.
5. Postpartum fever
  - a. The differential diagnosis of postpartum fever in patients with COVID-19 includes the infection itself as well as postpartum endometritis, surgical site infection, breast inflammation or infection, influenza, pyelonephritis, other viral or bacterial respiratory infections, and, rarely, pseudomembranous colitis due to *Clostridioides difficile*. The combination of composite symptoms, physical examination, and laboratory tests can usually distinguish among these disorders.
  - b. Acetaminophen is the preferred antipyretic agent.
6. **Postpartum patients with new onset of symptoms of COVID-19**—In newly symptomatic patients who previously tested negative for SARS-CoV-2, retesting is appropriate as part of the evaluation of fever or other potential manifestations of COVID-19.

## Newborn Evaluation

- The infants of mothers with suspected or confirmed COVID-19 are considered persons under investigation, and they should be tested for SARS-CoV-2 RNA by reverse-transcription polymerase chain reaction (RT-PCR) ([Center for Disease Control and Prevention, 2020b](#)).
- The [American Academy of Pediatrics \(AAP\)](#) suggests for diagnosis of newborn infection to test at approximately 24 h of age and, if negative, again at approximately 48 h of age since some infants have had a negative test at 24 h only to have a positive test at a later time. If a healthy, asymptomatic newborn will be discharged prior to 48 h of age, a single test at 24–48 h of age can be performed and to obtain either a single swab of the nasopharynx, a single swab of the throat followed by the nasopharynx, or two separate swabs from each of these sites, and submit for a single test. Some centers have transitioned to swabs of the anterior nares. The specifics of testing depend on the requirements of local testing platforms ([American Academy of Pediatrics, 2020b](#)).
- Approximately 2%–3% of infants born to women who test positive for SARS-CoV-2 near the time of delivery have tested positive in the first 24–96 h after birth ([Kotlyar et al., 2020](#); [Woodworth et al., 2020](#)).

## MotherNewborn Contact in the Hospital

- Separation of the newborn from the suspected or confirmed COVID-19-infected mother is not recommended after birth. The newborn's risk for acquiring SARS-CoV-2 from its mother is low, and data suggest no difference in risk of neonatal SARS-CoV-2 infection whether the neonate is cared for in a separate room or remains in the mother's room ([Center for Disease Control and Prevention, 2020b](#)). However, mothers should wear a mask and practice hand hygiene during contact with their infants, and at other times, reasonable physical distancing between the mother and neonate or placing the neonate in an incubator is desirable, when feasible ([UpToDate.Vincenzo Berghella, 2020](#)).
- Factors to consider include the following:
  - Rooming-in helps establish breastfeeding, facilitates bonding and parental education, and promotes family-centered care.
  - Separation may be necessary for mothers who are too ill to care for their infants or who need higher levels of care.
  - Separation may be necessary for neonates who may be at higher risk for severe illness (e.g.,

preterm infants, infants with underlying medical conditions, infants needing higher levels of care).

- Separation to reduce the risk of mother-to-newborn transmission is not useful if the neonate tests positive for SARS-CoV-2, and probably not useful if the mother and newborn will not be able to maintain separation after discharge until they meet criteria for discontinuation of quarantine.
- If separation is implemented, CDC suggest that newborn COVID-19 suspects/confirmed cases should be isolated from other healthy newborns.
- If another healthy family member is providing newborn care (e.g., diapering, bathing, feeding), he or she should use appropriate PPE and procedures (e.g., mask, hand hygiene).

## Criteria for Discontinuing Mothernewborn Infection Precautions

- **Symptomatic mothers**—Previously symptomatic mothers with suspected or confirmed COVID-19 are not considered a potential risk of virus transmission to their neonates if they have met the criteria for discontinuing isolation and precautions ([American Academy of Pediatrics, 2020b](#)):
  - At least 10 days have passed since symptoms onset (20 days if have severe or critical illness or are severely immunocompromised).
  - At least 24 h have passed since their last fever without the use of antipyretics.
  - Symptoms have improved.

However, some obstetric services are recommending that 20 days pass since symptoms first appeared for all pregnant women for time-based clearance, given that the viral shedding data from the CDC did not include pregnant women, and there is some concern that they may shed longer ([UpToDate.Vincenzo Berghella, 2020](#)).
- **Asymptomatic mothers**—For asymptomatic mothers identified through routine SARS-CoV-2 screening upon hospital admission, at least 10 days should have passed since the positive test before discontinuing mother–newborn infection precautions. These are symptom- and time-based strategies for discontinuing transmission precautions. Test-based strategies also exist but are not recommended for most patients because a positive SARS-CoV-2 RT-PCR result can persist for weeks and reflects presence of viral RNA but does not necessarily mean that viable virus is present and can be transmitted ([Sethuraman et al., 2020](#)). Data regarding postinfection risk of

transmission and personal immunity are limited (Kirkcaldy et al., 2020).

### Breastfeeding and Formula Feeding

- The risk of SARS-CoV-2 transmission from ingestion of breast milk is unclear. Although several small series reported that all samples of breast milk from mothers with COVID-19 tested negative (Elshafeey et al., 2020; Liu et al., 2020), other investigators subsequently reported identifying samples of breast milk positive for SARS-CoV-2 by RT-PCR (Kirtsman et al., 2020; Wu et al., 2020; Groß et al., 2020; Chambers et al., 2020). In a WHO study, breast milk samples from 43 mothers were negative for SARS-CoV-2 by RT-PCR and samples from three mothers tested positive, but specific testing for viable and infective virus was not performed (World Health Organization, 2020a). Samples that are SARS-CoV-2 RT-PCR positive do not necessarily contain viable and transmissible virus (Chambers et al., 2020).
- 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 antiinfective factors (UpToDate.Vincenzo Berghella, 2020).

### Breastfeeding

- The AAP supports breastfeeding in mothers with COVID-19, but mothers should perform hand hygiene before and wear a mask during breastfeeding (American Academy of Pediatrics, 2020b). This approach considers the clear mother–infant benefits of breastfeeding, the low likelihood of passing maternal infection to the newborn when infection precautions are taken, and the nonsevere course of newborn infection when it does occur. This policy was based, in part, on a study from New York City that tested and followed 82 infants of 116 mothers who tested positive for SARS-CoV-2: no infant was positive for SARS-CoV-2 postnatally, although most roomed in with their mothers and were breastfed (Salvatore et al., 2020). The infants were kept in a closed isolette while rooming-in, and the mothers wore surgical masks while handling their infants and followed frequent hand- and breast-washing protocols.

### Feeding Pumped Breast Milk

- 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 (Center for Disease Control and Prevention, 2020c). Expressing breast milk is important to support establishment of the maternal milk supply.

- Before pumping, ideally with a dedicated breast pump, mothers should wear a mask and thoroughly clean their hands and breasts with soap and water and clean pump parts, bottles, and artificial nipples (American Academy of Pediatrics, 2020a). 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 (e.g., bottles, milk bags) for reducing potential transmission of SARS-CoV-2, has not been formally studied (Center for Disease Control and Prevention, 2020a).
- **Pasteurized donor human milk**—Holder pasteurization is commonly used in human milk banks and appears to eliminate replication-competent SARS-CoV-2 virus (Unger et al., 2020).
- **Formula feeding**—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 before, to prevent transmission through close contact when feeding (UpToDate.Vincenzo Berghella, 2020).

### 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 on available resources. If not performed or if a reversible contraceptive method is desired, an alternative form of contraception should be provided (e.g., 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 ([UpToDate.Vincenzo Berghella, 2020](#)).

### Discharge from Hospital

**Patients without COVID-19**—In stable patients, we suggest early discharge postpartum (24 and 48 h after vaginal delivery and two CDs, respectively) to limit their personal risk of acquiring infection in the hospital environment ([Boelig et al., 2020](#)). However, this should be considered in the context of the clinical scenario since early discharge may place additional burdens on families to access recommended newborn care and pediatric offices to provide this care ([American Academy of Pediatrics, 2020b](#)).

### Patients with Known or Suspected COVID-19

The decision to discharge a patient with COVID-19 is generally the same as that for other conditions and depends on the need for hospital-level care and monitoring. Patients are counseled about the warning symptoms that should prompt reevaluation by telehealth visit and in-person visit, including emergency department evaluations. These include new onset of dyspnea, worsening dyspnea, dizziness, and mental status changes, such as confusion. Patients are also counseled about what to expect after recovery. Early discharge will require discussion with the facility's pediatric care team and should be linked to home telehealth visits for the mother and infant ([UpToDate.Vincenzo Berghella, 2020](#)).

**Postpartum office visit** ([UpToDate.Vincenzo Berghella, 2020](#)):

- Postpartum outpatient care is better minimized during the pandemic and is appropriate to decrease the risk of exposure to infection. Early postpartum assessments for wound and blood pressure can be achieved through telemedicine facilities.
- A comprehensive postpartum visit is important after 12 weeks, especially for those having comorbidities and in patients who lose insurance coverage at that time.
- Postpartum depression screening should be done 4–8 weeks after delivery for all patients. The most widely used instrument is the self-reported, 10-item Edinburgh Postnatal Depression Scale, which can be completed in less than 5 minutes.
- The psychological impact of COVID-19, which may include moderate to severe anxiety, should also be recognized and support offered.
- Offer modified postpartum counseling regarding
  - any potential changes to the length of hospital stay and postpartum care;

- how to best communicate with their postpartum care team, especially in the case of an emergency;
- when and how to contact their postpartum care clinician;
- any special considerations for infant feeding;
- checking with their pediatric clinician or family physician regarding newborn visits because pediatric clinicians or family physicians also may be altering their procedures and routine appointments;
- postpartum contraception; ideally, all methods of contraception should be discussed in context of how provision of contraception may change within the limitations of decreased postpartum in-person visits;
- any potential changes to their postpartum care team and support system; most patients will likely have had changes to expected care support resources at home (e.g., family who can no longer travel, childcare providers who are no longer available). To the extent possible, patients should be connected to community support resources.
- It should be noted that it may be necessary to provide these services or enhanced resources by phone or electronically where possible. If telehealth visits are anticipated, patients should be provided with any necessary equipment (e.g., blood pressure cuffs) if available and as appropriate.

### Precautions of the Contact Personnel

When caring for patients with confirmed or suspected COVID-19, healthcare workers should use contact and droplet precautions (i.e., gown, gloves, surgical mask, face shield, or goggles). During the patient's second stage of labor, and during episodes of deep respiratory efforts, healthcare workers should also use airborne precautions (i.e., N95 mask or PAPR, where available), in addition to contact and droplet precautions ([American College of Obstetricians and Gynecologists, 2020](#)).

### Prevention of Transmission of Infection

Prevention of spread of infection is mandatory. Caution when dealing with aerosol-generating procedures (AGPs) and applications of PPE is particularly important.

### Aerosol-Generating Procedures

Aerosols generated by medical procedures are one route for the transmission of the SARS-CoV-2. AGPs should be used only if necessary and for the shortest possible duration for suspected and confirmed COVID-19 patients. AGPs should be carried out in a single-room

closed door and preferably completed in a negative-pressure side room with the presence of the least needed healthcare staff wearing their full PPE ([Physiopedia-Contributors, 2020](#)).

Potentially infectious AGPs ([Moses and Consultant Respiratory Physiotherapist, 2020](#)) include the following:

- Intubation, extubation, and related procedures
- Tracheotomy/tracheostomy procedures
- Manual ventilation
- Open suctioning
- Bronchoscopy
- NIV, e.g., BiPAP and CPAP ventilation
- Surgery and postmortem procedures in which high-speed devices are used
- High-frequency oscillating ventilation
- HFNO
- Induction of sputum (*typically involves administration of nebulized saline to moisten and loosen respiratory secretions*) (*this may be accompanied by chest physiotherapy such as percussion and vibration to induce forceful coughing*). *This may be required if lower respiratory tract samples are needed*

Certain other procedures/equipment may generate an aerosol from material other than patient secretions but are not considered to represent a significant infectious risk. These include the following:

- Administration of pressurized humidified oxygen
- Administration of medication via nebulization. *During nebulization, the aerosol derives from a nonpatient source (the fluid in the nebulizer chamber) and does not carry patient-derived viral particles. If a particle in the aerosol coalesces (combines) with a contaminated mucous membrane, it will cease to be airborne and therefore will not be part of an aerosol. Staff should use appropriate hand hygiene when helping patients to remove nebulizers and oxygen masks.*

### Decontamination

Reusable (communal) noninvasive equipment must be decontaminated in the following circumstances:

- between each patient and after patient use;
- after blood and body fluid contamination; and
- at regular intervals as part of equipment cleaning.

An increased frequency of decontamination should be considered for reusable noninvasive care equipment when used in isolation/cohort areas ([Moses and Consultant Respiratory Physiotherapist, 2020](#)).

### Equipment ([Physiopedia-Contributors, 2020](#))

- Reusable equipment should be avoided if possible; if used, it should be decontaminated according to the

manufacturer's instructions before removal from the room. If it is not possible to leave equipment inside a room, then follow IPC Guidelines on Decontamination. This usually involves cleaning with neutral detergent and then a chlorine-based disinfectant, in the form of a solution at a minimum strength of 1000 ppm available chlorine (e.g., "Haz-Tab" or other brands).

- If possible, use dedicated equipment in the isolation room. Avoid storing any extraneous equipment in the patient's room.
- Dispose of single-use equipment as per clinical waste policy inside a room.
- Point-of-care tests, including blood gas analysis, should be avoided unless a local risk assessment has been completed and shows it can be undertaken safely.
- Ventilators and mechanical devices (e.g., cough-assist machines) should be protected with a high-efficiency viral–bacterial filter such as BS EN 13328-1.
- When using mechanical airway clearance, filters should be placed at the machine end and the mask end before any expiratory or exhalation ports. Filters should be changed when visibly soiled or dependent on the filter used either after each use or every 24 h. Complete circuit changes should be undertaken every 72 h.
- Closed-system suction should be used if patients are intubated or have tracheostomies.
- Disconnecting a patient from mechanical ventilation should be avoided at all costs, but if required, the ventilator should be placed on standby.
- Manual hyperinflation (bagging) should be avoided if possible and attempt ventilator recruitment maneuvers where possible and required.
- Water humidification should be avoided, and a heat and moisture exchanger should be used in ventilator circuits.
- Disposable crockery and cutlery may be used in the patient's room as far as possible to minimize the numbers of items which need to be decontaminated.
- Any additional items such as stethoscopes, pulse oximeters, or ultrasound probes that are taken into a room will also need to be disinfected, regardless of whether there has been direct contact with the patient or not. This is due to the risk of environmental contamination of the equipment within the isolation room.

### Patients' Rooms ([Physiopedia-Contributors, 2020](#))

- If AGPs are undertaken in the patient's own room, the room should be decontaminated 20 min after the end of the procedure.

- If a different room is used for a procedure, it should be left for 20 min and then cleaned and disinfected before being put back into use.
- Clearance of any aerosols is dependent on the ventilation of the room. In hospitals, rooms commonly have 12 to 15 air changes per hour, and so after about 20 min, there would be less than 1% of the starting level (assuming cessation of aerosol generation).
- If it is known locally that the design or construction of a room may not be typical for a clinical space, or that there are fewer air changes per hour, then the local infection prevention and control team would advise on how long to leave a room before decontamination.

### PRECAUTIONS FOR HEALTHCARE PERSONNEL: PERSONAL PROTECTIVE EQUIPMENT

COVID-19 infection is highly contagious, and this must be taken into consideration when planning intrapartum care. PPE recommended by the CDC is listed in the following, and the CDC provides strategies for how to optimize the supply of PPE.

#### General Considerations

- To protect patients and coworkers, all healthcare personnel should always wear a facemask while they are in a healthcare facility, regardless if patients are wearing a face covering or facemask ([Center for Disease Control and Prevention, 2020d](#)). Recent data suggest that universal masking, appropriate use of N95 respirators, and close evaluation of extended use or reuse of N95 respirators in the healthcare setting can play a crucial role in decreasing healthcare-related COVID-19 infection ([Chu et al., 2020](#); [Degesys et al., 2020](#); [Seideman et al., 2020](#)).
- In areas with moderate to substantial community transmission, healthcare personnel should also wear eye protection in addition to their facemask (CDC).
- In areas where universal testing is not employed and adequate PPE is available, universal PPE, including respirators (e.g., N95 respirators), is recommended until the patient's status is known.
- Importantly, all medical staff should be trained in and adhere to proper donning and doffing of PPE.
- Although there is understandable emphasis on facial protection, data from the SARS outbreak suggest that the comprehensive array of recommended PPE (listed below) used alongside hand hygiene and environmental cleaning leads to the optimal decreased risk of transmission of respiratory viruses, and this is likely true for COVID-19.
- During a possible N95 shortage, extended use or limited reuse of N95 masks may be implemented or necessary. If extended use or limited reuse is being implemented, policies regarding extended use or limited reuse should be in accordance with CDC/NIOSH recommendations, considering the actual masks being used. These policies should also be developed in coordination with local occupational health and infection control departments.
- Although limited data have noted subtle physiologic changes (with no known clinical impact) associated with extended wear of N95 masks ([Bae et al., 2020](#)), the reduction of infectious risk outweighs any theoretical physiologic concern.

### Caring for Individuals with Potential or Confirmed COVID-19

All medical staff caring for potential or confirmed COVID-19 patients should use PPE listed in the following, including respirators (e.g., N95 respirators).

The CDC recommended the following PPE:

- Respirator or facemask (cloth face coverings are *not* PPE and should not be worn for the care of patients with known or suspected COVID-19 or in other situations where a respirator or facemask is warranted):
  - Put on a respirator or facemask (if a respirator is not available) before entry into the patient's room or care area.
  - N95 respirators or respirators that offer a higher level of protection should be used instead of a facemask when performing or present for an AGP. Disposable respirators and facemasks should be removed and discarded after exiting the patient's room or care area and closing the door. Perform hand hygiene after discarding the respirator or facemask.
  - If reusable respirators (e.g., PAPRs) are used, they must be cleaned and disinfected according to manufacturer's reprocessing instructions before reuse.
  - When the supply chain is restored, facilities with a respiratory protection program should return to use of respirators for patients with known or suspected COVID-19.
- Eye protection:
  - Put on eye protection (i.e., goggles or a disposable face shield that covers the front and sides of the face) upon entry to the patient's room or care area. Personal eyeglasses and contact lenses are *not* considered adequate eye protection.

- Remove eye protection before leaving the patient's room or care area.
- Reusable eye protection (e.g., goggles) must be cleaned and disinfected according to manufacturer's reprocessing instructions before reuse.
- Disposable eye protection should be discarded after use.
- Gloves:
  - Put on clean, nonsterile gloves upon entry into the patient's room or care area.
  - Change gloves if they become torn or heavily contaminated.
  - Remove and discard gloves when leaving the patient's room or care area, and immediately perform hand hygiene.
- Gown:
  - Put on a clean isolation gown upon entry into the patient's room or area. Change the gown if it becomes soiled. Remove and discard the gown in a dedicated container for waste or linen before leaving the patient's room or care area. Disposable gowns should be discarded after use. Cloth gowns should be laundered after each use.
  - If there are shortages of gowns, they should be prioritized for the following:
    - AGPs
    - Care activities where splashes and sprays are anticipated
    - High-contact patient care activities that provide opportunities for transfer of pathogens to the hands and clothing of the healthcare practitioner. Examples include the following:
      - Dressing
      - Bathing/showering
      - Transferring
      - Providing hygiene
      - Changing linens
      - Changing briefs or assisting with toileting
      - Device care or use
      - Wound care

During N95 respirator shortages, facilities might need to prioritize N95 respirator use for AGP\* or surgical procedures that involve anatomic regions where viral loads might be higher (e.g., nose and throat, oropharynx, respiratory tract). Even during a shortage, it is important that medical staff use appropriate forms of PPE, including surgical masks. During shortages, facilities are encouraged to take steps that facilitate the protection of medical staff and enable personnel to protect themselves. Finally, although individual physicians, after careful consideration, may opt to provide care without adequate PPE, physicians are not ethically

obligated to provide care to high-risk patients without protections in place. ACOG continues to advocate for congressional and regulatory action to increase access to PPE for obstetrician–gynecologists, particularly in labor and delivery units.

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