

Simulations of Deliveries of SARS-CoV-2 Positive Pregnant Women and Their Newborn Babies: Plan to Implement a Complex and Ever-Changing Protocol

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Abstract

Management of severe acute respiratory Syndrome corona virus-2 (SARS-CoV-2) infected pregnant women at time of delivery presents a unique challenge. The variability in the timing and the method of delivery, ranging from normal vaginal delivery to an emergent cesarean section, adds complexity to the role of the health care providers in the medical care of the patient and in the interactions, they have with other providers. These variations are further influenced by the availability of isolation rooms in the facility and adequacy of personal protective equipment. The protocols already set in place can be further challenged when the facility reaches its capacity to manage the patients.

To fulfill the goal of providing adequate management to the SARS-CoV-2 infected pregnant women and their infants, avoid variation from suggested guidelines, and decrease risk of exposure of the health care workers, the health care provider team needs to review the variations regularly. While familiarity can be achieved by reviewing the guidelines, clinical case simulations provide a more hands-on approach.

Using case-based simulations and current guidance from the Center for Disease Control, American Academy of Pediatrics, and recent reviews, we discuss a management guideline developed at our institution to facilitate provision of care to SARS-CoV-2 infected pregnant women during delivery and to their infants, while protecting health care providers from exposure, and in keeping with the local facility logistics.

Keywords

- ▶ SARS-CoV-2
- ▶ COVID-19
- ▶ pregnant
- ▶ delivery
- ▶ newborn
- ▶ discharge

Key Points

- Simulation of delivery of SARS-CoV-2 positive pregnant women can minimize the risk of exposure to health care professionals.
- Four common scenarios of delivery as described can be adapted for the evolving guidelines for the management of SARS-CoV-2 positive pregnant women.
- Integrating simulations of management of SARS-CoV-2 positive pregnant women is feasible in daily clinical routine.

A large number of health care providers have been exposed to and infected by severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) and some have succumbed to corona virus-induced disease 2019 (COVID-19).¹ Pregnant women

infected with SARS-CoV-2 present a unique challenge to health care providers at the time of delivery because of the limited time frame within which medical decisions need to be made. These decisions pertain to variation in acuity of labor, delivery

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methods, and outcomes (i.e., spanning from normal vaginal delivery to emergent cesarean section). This complexity is compounded by the presence or absence of COVID-19-associated symptoms in the pregnant women as well as by the availability of health care workers, isolation rooms, and personal protective equipment (PPE).² Although there are guidelines for specific scenarios, workflow may need to be adapted based on hospitalization of increasing numbers of SARS-CoV-2 positive patients, which may impact the capacity of the health care facility. Recognizing the need for quick adaptability, we discuss simulations developed at our institution based on current guidance from Centers of Disease Control (CDC) and American Academy of Pediatrics (AAP).³⁻⁵

Our facility performs universal screening on all mothers admitted in labor using reverse transcription polymerase chain reaction (RT-PCR) (Cepheid GeneXpert, Sunnyvale, CA). We then dichotomize all SARS-CoV-2 positive pregnant women admitted in labor based on the presence of symptoms. As more institutions implement universal SARS-CoV-2 screening for all pregnant women in labor,⁶ managing simulations based on this grouping will become more important, and will need to be adapted according to the logistics of the local institution. In [Table 1](#), we present simulations of four major scenarios based on method and urgency of delivery among SARS-CoV-2 positive pregnant women. We then dichotomize the approach further based on the clinical assessment of the newborn. We also highlight the importance of shared decision making regarding the infant's care following its clinical assessment. For instance, further newborn care, including logistics about the infant's stay in the hospital or discharge home, will vary based on maternal testing and symptoms. Support available for the mother in the hospital and at home,⁵ along with the desire to feed expressed breast milk or breast feed are among the considerations we present in [Table 2](#). Our experience highlights the importance of routine drills to practice these different scenarios, building upon a recently published review on resuscitation and postresuscitation care of the infants born to SARS-CoV-2 positive pregnant women that outlines recommended and alternative management methods.⁷ The goal of simulating the different scenarios, such as those summarized in [Tables 1](#) and [2](#), is to seamlessly facilitate interdisciplinary communications and also reinforce delivery of appropriate care. We discuss one such case simulation below.

Case Simulation and Debriefing

A mother of unknown gestational age presents in advanced labor to the emergency room (ER) with unknown SARS-CoV-2 status. While the obstetrician (OB1) and neonatologist (N1) (who waits outside the room with PPE ready) are called to the ER to evaluate the patient, a SARS-CoV-2 RT-PCR is sent. Since the patient is stable, she is transferred with a face mask to the obstetrics floor. She is admitted as a person under investigation in one of the negative pressure room pending the results of the RT-PCR. Per the evaluation by OB1, the patient is estimated to have full term pregnancy with growth

retardation in the fetus with breech presentation. N1 discusses the possible scenarios based on type of delivery and test results with the mother over the phone.^{3-5,7} Obstetrics, anesthesia, and the neonatal team (N1 and a neonatal nurse [NN1]) along with the hospital-designated safety officer (who observes all the providers as they don and doff in a prescribed manner,⁸ and follow infection control protocols) huddle to plan for vaginal delivery and possible cesarean section if there is failure to progress or if there is fetal distress. Decision is made to proceed with epidural administration and a trial for a vaginal delivery. The baby delivers vaginally. As per the third column of [Table 1](#), NN1 receives the baby and places it in a heated isolette outside the negative pressure room and doffs with the help of safety officer. N1 covers the isolette with a plastic sheet and takes the baby to the isolation room in the neonatal intensive care unit (NICU), which is in the same corridor. We recognize that the physical structure of the hospital allows us to do this in less than 30 seconds. In facilities where the NICU is at a distance, the baby may need to be moved to another negative pressure labor room. Alternatively, N1 may enter the labor room after delivery with the radiant warmer placed at least 6 feet away from the mother, and additionally separated by a physical barrier, such as a plastic curtain.⁷ Following transfer to the NICU, the infant is taken to the isolation room, where N1 and a neonatal nurse (NN2) will evaluate the baby. After stabilization and anthropometric measurements, the baby is given a bath. In the interim, the results from the mother's testing reveal that she is positive for SARS-CoV-2. She is updated on the results, and since there is no significant other with her, she is presented with two alternative methods of providing care of the infant. She decides to have the infant in the room, feeds the infant mother's own milk, and follows directions to keep the baby 6 feet away, with appropriate use of mask and hand and breast hygiene. The infant is tested in 24 hours by a SARS-CoV-2 RT-PCR which came out negative. As per the mother's request, the dyad is discharged at approximately 36 hours after all routine newborn screenings are completed. The mother is instructed about the needed precautions,⁵ as she lives alone and has no support at home. In addition, a detailed report is sent to the pediatrician by a fax or directly updating them with a phone call. Having running this simulation, we then discuss issues that may have arisen and the many variations in presentation or decision-making which may have occurred as further drills. The drills typically occur after the morning and evening sign outs (as teams work in 12 or 24 hours shifts). Each drill takes approximately 15 to 20 minutes, at which time each participant is given a small card which lists the exact task that the person has to perform in the varied case scenarios. These simulations reinforce management as well as introduce and clarify each participant's role, thereby decreasing the likelihood of miscommunication, which is an important cause of poor clinical outcomes and breach in infection control protocols. The improved communication during these simulations also decreases the health care providers' anxiety regarding exposure as they become aware of and comfortable with their roles and variations in the role that may occur

Table 1 Four basic scenarios for drills and management of the newborns after delivery^{3-5,7}

C-section	C-section	C-section	Vaginal	Vaginal
Emergent or < 34 wk GA	Elective and stable infant	Emergent or < 34 wk GA	Unstable by history or < 34 wk GA	Stable infant
Huddle between NICU, anesthesia, and OB team	Huddle between NICU, anesthesia, and OB team	Huddle between NICU, anesthesia, and OB team	Huddle between NICU, anesthesia, and OB team	Huddle between NICU, anesthesia, and OB team
Deliver in negative pressure or HEPA cleared operating room (OR)	Deliver in negative pressure or HEPA cleared operating room (OR)	Deliver in negative pressure or HEPA cleared operating room (OR)	Deliver in negative pressure or HEPA cleared labor room	Deliver in negative pressure or HEPA cleared labor room
Neonatal nurse #1 in the OR hands the baby to the	Neonatal nurse #1 in the OR hands the baby to the	Neonatal nurse #1 in the OR hands the baby to the	Neonatal nurse #1 in the LDR hands the baby to the	Donned NICU team (MD and NN1) ready outside the room for possible consult/resuscitation
Neonatologist with incubator outside OR	Neonatologist with incubator outside OR	Neonatologist with incubator outside OR	Neonatologist with incubator outside the labor room	Well-baby Pediatrician notified
Transport the incubator ^a to NICU isolation room or predetermined negative pressure postpartum room ^b	Transport the incubator ^a to NICU isolation room or predetermined negative pressure postpartum room ^b	Transport the incubator ^a to NICU isolation room or predetermined negative pressure postpartum room ^b	Transport the incubator ^a to NICU isolation room or predetermined negative pressure postpartum room ^b	Stays in labor room with mother ^e
Donned neonatal nurse #2 waiting in NICU isolation room or predetermined negative pressure postpartum room to help in evaluation and resuscitation of the baby as needed, while neonatal nurse #1 after doffing the gown and outer gloves in the OR and donning another set joins the ongoing resuscitation	Evaluation/resuscitation by neonatologist in the NICU isolation room or predetermined negative pressure postpartum room. Donned neonatal nurse #2 waits outside the room for assistance if resuscitation required	Evaluation/resuscitation by neonatologist in the NICU isolation room or predetermined negative pressure postpartum room. Donned neonatal nurse #2 waits outside the room for assistance if resuscitation required	Neonatal nurse #2 waiting in NICU isolation room or predetermined negative pressure postpartum room to help in evaluation and resuscitation of the baby as needed, while neonatal nurse #1 after doffing the gown and outer gloves in the OR and donning another set joins the ongoing resuscitation	
Evaluate/resuscitate infant	Evaluate/resuscitate infant	Evaluate/resuscitate infant	Evaluate/resuscitate infant	
Stable	Sick or < 34 wk GA	Sick or < 34 wk GA	Stable	Sick or < 34 wk GA
Discuss with parents and brings the baby to the mother's postpartum room ^c	Treat in isolation or negative pressure room in the NICU, ^d Transfer to NICU after stabilization, if in negative pressure postpartum room	Treat in isolation or negative pressure room in the NICU, ^d Transfer to NICU after stabilization, if in negative pressure postpartum room	Discuss with parents and brings the baby to the mother's postpartum room ^c	Treat in isolation or negative pressure room in the NICU, ^d Transfer to NICU after stabilization, if in negative pressure postpartum room
SARS-CoV-2 RT-PCR testing at 24 h of life and repeat at 48h if the baby is still in the hospital				

Abbreviations: GA, gestational age; HEPA, high-efficiency particulate air; NICU, neonatal intensive care unit; OB, obstetrician; OR, operating room; PPE, personal protective equipment; RT-PCR, reverse transcription polymerase chain reaction.

^aIsolates that have the hoods raised are preferred and, when being transported, should be covered by a plastic sheet or infant can be transported in a bassinette covered with croup tent with viral filter placed on the outlet.

^bThis transport away from the operating room decreases the exposure of the neonatal team to the droplet and aerosolization associated with intubation of the mother and delivery process. The postpartum room where the baby is transported to has already been contaminated by the mother in labor and she is transferred to this room postoperatively reducing the number of rooms exposed to pregnant women SARS-CoV-2 positive infection.

^cSee ▶ **Table 2**.

^dWhere there are no isolation rooms, for infants not requiring respiratory support could be placed in an isolate under droplet precautions.

^eDiscussion with parents: if mother is symptomatic ideal situation would be that the baby is separated from all COVID-19 positive mothers and be fed by healthy caregiver using bottle or expressed breast milk until mother has:

- Resolution of fever without the use of fever-reducing medications, and
- Improvement in respiratory symptoms (e.g., cough, shortness of breath), and
- Two nasopharyngeal swabs for SARS-CoV-2 testing that are negative × 2 and were performed at least 24-h apart.

But mother may opt to keep the baby with her in the postpartum room (strong recommendation for not doing it when she is SARS-CoV-2 positive and symptomatic). If the baby stays in room with the mother, the following should be done:

- Baby should be minimum of 6 feet apart, and
- There should be a physical barrier between the mother and the baby, and
- Expressed breast milk preferred and needs to be fed by healthy caregiver, or
- If mother wants to breast feeds despite counseling, she must perform hand hygiene, wear PPE, and clean breast before breast feeding.

Table 2 Plan for discharge of the baby based on shared decision between the health care providers and the parents⁵

Scenario	Ideal (test-based strategy)	Alternative (symptom or time-based strategy)
Mother positive BUT asymptomatic. Infant is negative	The newborn would be discharged to a healthy caregiver Mother has negative results of an FDA Emergency Use Authorized COVID-19 molecular assay for detection of SARS-CoV-2 RNA from at least two consecutive respiratory specimens collected ≥ 24 h apart (total of two negative specimens)	The newborn would be discharged to a mother on contact and droplet precautions until mother has: - at least 10 days have passed since the date of their first positive COVID-19 diagnostic test assuming they have not subsequently developed symptoms since their positive test
Mother is positive AND symptomatic. Infant is negative	The newborn could be transferred to a healthy caregiver preferably below 60 years of age Mother has negative results of an FDA Emergency Use Authorized COVID-19 molecular assay for detection of SARS-CoV-2 RNA from at least two consecutive respiratory specimens collected ≥ 24 h apart (total of two negative specimens)	The newborn would be discharged to a mother precautions until mother has: 1. mother has at least 3 d (72 h) have passed since recovery defined as resolution of fever without the use of fever-reducing medications, and improvement in respiratory symptoms (e.g., cough, shortness of breath), and 2. at least 10 d have passed since symptoms first appeared
Mother is positive BUT asymptomatic. Infant is positive BUT asymptomatic	Infants should not be cared for by uninfected persons The newborn would be discharged to a mother who remains on contact and droplet precautions until mother has: - has negative results of FDA Emergency Use Authorized COVID-19 molecular assay for detection of SARS-CoV-2 RNA from at least two consecutive respiratory specimens collected ≥ 24 h apart (total of two negative specimens) Infants determined to be positive by testing (or whose status cannot be determined due to lack of testing), but with no symptoms of COVID-19, may be discharged home on a case-by-case basis with appropriate precautions and plans for planned and frequent outpatient follow-up contacts (either by phone, telemedicine, or in office) through 14 d after birth	Infants should not be cared for by uninfected persons. The newborn would be discharged to a mother: - precautions if the mother has at least 10 d have passed since the date of their first positive COVID-19 diagnostic test assuming they have not subsequently developed symptoms since their positive test Infants determined to be positive by testing (or whose status cannot be determined due to lack of testing), but with no symptoms of COVID-19, may be discharged home on a case-by-case basis with appropriate precautions and plans for planned and frequent outpatient follow-up contacts (either by phone, telemedicine, or in office) through 14 d after birth
Mother is positive WITH or WITHOUT symptoms. Infant is positive AND symptomatic	Infant remains hospitalized until at least 3 d (72 h) have passed since improvement of respiratory symptoms <i>AND</i> until there are two consecutive negative tests for SARS-CoV-2 of combined throat/nasopharynx specimens done at 48- to 72-h intervals, first done at 24 h of life Symptomatic mothers with COVID-19 should not visit infants requiring neonatal intensive care until they <i>meet symptom based or test based requirements</i> Symptom based: 1. Resolution of fever without the use of antipyretics for at least 72 h and improvement (but not full resolution) in respiratory symptoms <i>AND</i> 2. At least 10 d have passed since symptoms first appeared <i>OR</i> Test based: 1. Negative results of FDA Emergency Use Authorized COVID-19 molecular assay for detection of SARS-CoV-2 RNA from at least two consecutive respiratory specimens collected ≥ 24 h apart (total of two negative specimens)	

Abbreviations: FDA, Food and Drug Administration; RNA, ribonucleic acid; RT-PCR, reverse transcription polymerase chain reaction.

Note: All infants born to SARS-CoV-2 positive women are discharged after detailed report to the pediatrician to prevent the mother coming for the appointment and exposing the clinic staff. Advice is given to the caregiver or the mother to take the baby to the clinic by a healthy member of the family and subsequent daily follow-up done by phone, telemedicine, or in office. Repeat SARS-CoV-2 RT-PCR may be performed at 48 hours if baby discharged before 48 hours from the hospital.

as the clinical scenarios evolve. We have also observed that instituting these simulations has decreased the instances of conflicting information that parents receive from different caregivers, which has directly improved patient satisfaction, even among the most anxious patients. The effectiveness of our approach in managing variability in clinical presentation and thereby management plans until the time of delivery, highlights the advantages of creating a similar document suited to the local institutions. In addition to the guidelines, routine simulation by the multidisciplinary health care team consisting of obstetricians, anesthesiologists, neonatologists, nurses, and the operating room technicians will improve medical outcomes while reducing inadvertent exposure of the health care providers to SARS-CoV-2 positive mothers.⁹ Our simulations add to a recent publication limited to the second stage of labor, where the authors demonstrated that development of a multidisciplinary management plan decreases the exposure of health care personnel to SARS-CoV-2.¹⁰ We would also like to highlight that, in light of the evolving knowledge on this new virus, the scenarios should be constantly updated to incorporate new guidance from the CDC, AAP, and other subspecialty societies. For instance, there has been an increase in deliveries of SARS-CoV-2 positive pregnant women outside the hospital and emergent delivery may also occur in the ER or in the medical intensive care unit, where a pregnant woman with COVID-19 may be hospitalized. These approaches also need the support of clinical leadership, such as division directors, so that everyone is encouraged to participate and there are no missing links that could lead to poor patient care and/or increased risk of exposure of the health care providers.

It is evident that this health care crisis will not completely disappear in the near future. Continuing such simulations, even when the incidence of SARS-CoV-2 positivity among pregnant women is lower, will help keep health care providers in a state of readiness for appropriate management of these deliveries, ensuring that the health care providers

remain protected from unnecessary exposure and infection while continuing to provide the best outcomes.

Conflict of Interest

None declared.

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