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Simulation Patient Design (July, 2021)
Case of a Pregnant Patient with Severe COVID-19 Respiratory Failure

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Introduction

Emergence of a novel coronavirus, termed SARS-CoV-2, and the associated potentially life-threatening respiratory disease, COVID-19, has rapidly spread across the globe creating a massive public health problem, characterized as a pandemic by the World Health Organization.[1]

Pregnant women are particularly vulnerable to respiratory pathogens, such as SARS-CoV-2 and severe pneumonia due to physiological and immunological changes. Altered T lymphocyte immunity, increased oxygen consumption, decreased functional residual capacity and decreased chest compliance, all contribute to higher maternal and fetal morbidity and mortality.[2,3,4] Most studies reported to date investigated the general population, with sparse information about pregnant women and associated perinatal and neonatal complications. Major reported complications among pregnant women include severe pneumonia (0-14%), preterm labor (47%) and increased need for cesarean delivery (CD), particularly among symptomatic women.[5]

In a multinational retrospective cohort study involving 887 singleton pregnancies with laboratory-confirmed SARS-CoV-2 infection from 76 centers in 25 countries, the risk of composite adverse maternal outcomes was higher in high-risk pregnancies (odds ratio, 1.52; 95% confidence interval, 1.03-2.24; p=0.035) than in low-risk pregnancies.[6] In addition, women carrying high-risk pregnancies were at higher risk of hospital admission, severe respiratory symptoms, admission to the intensive care unit (ICU), and invasive mechanical ventilation.[6] The World Association of Perinatal Medicine (WAPM) study reported 388 women with singleton pregnancies positive for COVID-19 at RT-PCR nasal and pharyngeal swab, in 73 centers in 22 countries.[7] The study examined the strength of association between maternal and pregnancy characteristics and the risk of adverse perinatal outcomes in pregnancies with laboratory confirmed COVID-19. Early gestational age at the time of infection, maternal ventilatory support and low birthweight were the main determinants of adverse perinatal outcomes in neonates born following maternal COVID-19.[7] Conversely, the risk of vertical transmission seems negligible.[8]

Anesthesiologists, obstetricians and other healthcare workers (HCWs) on Labor and delivery (L&D) may encounter respiratory failure in pregnant patients from many etiologies. The ongoing COVID-19 pandemic highlights the need for diagnostic and management strategies for infectious pregnant women to maintain their safety along with their fetus, and for HCWs. HCWs may be required to make rapid critical decisions such as when to perform intubation and delivery, even in unfamiliar environments such as the ICU, and to perform bedside CDs. The decision-making process is replete with unknown consequences, yet delays in management can impact outcomes and survival. Management challenges in the ICU are compounded by multiple disciplines working together with different aims, for example to stabilize the mother and deliver the fetus, all while wearing personal protective equipment (PPE) that can increase communication difficulties.

The importance of a multidisciplinary team managing COVID-19 respiratory failure in pregnant patients is clear given multiple complex decisions that are necessary, however consensus is lacking regarding crucial treatment decisions, such as when to intubate or when to deliver the fetus.

Educational Rationale: To teach team skills in managing severe respiratory failure of a pregnant patient due to a highly transmissible infectious etiology in an ICU setting
Target Audiences: Nursing, OB, Anesthesiology, ICU, Pediatric/Neonatology ICU
Learning Objectives: As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies. Upon completion of this simulation (including the debrief) learners will be able to:

- *Medical knowledge:* Recognize signs and symptoms of respiratory failure in pregnant women with respiratory failure
- *Patient care:* Demonstrate competency in intubation, manage maternal hemodynamics and perform a bedside CD (if indicated, and dependent on individual hospital policy and logistics etc.) in a patient with a highly transmissible respiratory infection in the ICU
- *Practice-based learning and improvement:* Practice emergent donning/doffing of PPE, and adhere to protocols to minimize transmission of disease to other patients and HCWs
- *Interpersonal and communication skills:* Manage a multidisciplinary emergency in an unfamiliar environment impeded by communication barriers due to PPE
- *Professionalism:* Address the patient's anxiety with short and empathic explanations during a well-managed emergency situation
- *Systems-based practice:* Develop and use institution-specific guidelines to manage a pregnant patient with COVID-19

Questions to ask after the scenario:

1. Who was the case manager/team leader during the case?
2. When were critical decision-making points during the case?
3. Were all team members involved in the decision-making process?
4. Was each team member's role clearly identified?
5. Was all necessary equipment available?
6. Was a 'time out' performed at the start of the surgery (is a 'time out' necessary)?
7. What criteria are used to intubate a pregnant patient with respiratory distress?
8. Which factors are important when deciding to perform an emergency CD in the ICU?
9. What are advantages and disadvantages of performing a bedside CD in the ICU?
10. How would a maternal cardio-respiratory arrest impact management, including a perimortem CD?

Assessment Instruments:

1. Learner Knowledge Assessment form (Appendix 1)
2. Simulation Activity Evaluation form (Appendix 2)

Equipment Needed and Set-up:

Intravascular:	Arterial line set, 17G peripheral IV access, 2L Lactated Ringer's solution, 2 IV sets, 2 syringe pumps
Airway:	High-flow nasal cannula (HFNC), non-rebreather face mask, size 4 face mask, Ambu bag with PEEP valve (7.5/10 cm H_2O), oral airways (2 sizes), ETT 7.0, 6.5, 6.0, nasogastric tube, ventilator (not an anesthesia machine ventilator)
Monitors:	Vital signs monitors including invasive blood pressure, capnography
Fetal equipment:	Fetal monitoring, infant's incubator, scalpel/complete emergency CD kit, surgical drapes, chlorhexidine, gown and sterile gloves
PPE:	According to local hospital policy for airborne infection (such as COVID-19)

Drugs: Propofol, etomidate, ketamine, fentanyl, midazolam, morphine, succinylcholine, rocuronium, oxytocin, methylergonovine, misoprostol, adrenaline, phenylephrine, norepinephrine, tranexamic acid (TXA), ephedrine, albuterol inhaler, prophylactic antibiotics (as per hospital policy)

In-situ set-up

Pregnant manikin: Dressed with hospital gown on an ICU bed, head of bed at 45-degree angle, peripheral IV-line sited, invasive and non-invasive blood pressure/ECG/pulse oximetry/CTG
Room: Closed room with a designated donning/doffing zone for PPE outside the room
Simulation Scenario Set-up: Preferred start team will be all personnel except an ICU nurse out of the patient room.

The case:

Catherine is a 38-year-old woman, G3P2 at 35 weeks gestation. She has a history of two vaginal deliveries, asthma, Type 2 DM treated with daily insulin injections, and she is morbidly obese. She has no known drug allergies.

She was admitted to the ICU 2 days ago with severe COVID-19 pneumonia (PCR positive for SARS-CoV-2 6 days ago) and is requiring support with high flow nasal cannula (HFNC) on 40 L/min with FIO_2 1.0.

Height: 170 cm (5'6")
Weight: 102 Kg (225 lbs)
BMI 35.3

Simulation Pre-brief

- Read the scenario and instruct team members on their role during the simulation-anesthesiologist, intensivist and ICU nurse, neonatologist and neonatal nurse, OB Attending, OB resident, Midwife, OR nurse
- The learners take their place

Scenario Details*

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in ICU Complains of shortness of breath	Patient awake + responsive, anxious Fast shallow breathing, with a cough HR 95 bpm BP 100/75 mm Hg SpO_2 85% (HFNC) Resp 32/min Temp 38.9^oC	1. ICU nurse performs initial patient evaluation + examination ☐ Call intensivist, OB + extra nurse ☐ Check HFNC function + parameters: 40 L/min FiO_2 1.0 ☐ Send ABG ☐ Obtain approval to administer paracetamol 1 g IV			
Non-reassuring fetal heart trace Respiratory failure progresses	^ABG results: pH 7.24 PaO_2 47 mm Hg (6.3 kPa) $PaCO_2$ 21 mm Hg (2.8 kPa) Bicarb 9 mEq/L Lactate 3.5 Deteriorating level of consciousness	1. Intensivist to intubate patient ☐ ICU nurse prepares intubation cart ☐ Call anesthesiology team 2. OB team ☐ Ask for CTG + recognize sinusoidal pattern ☐ Plan to proceed with emergency CD ☐ Inform anesthesiology team/OR nurses/NICU			
All teams are in the ICU (Anesthesiology, OB, NICU, OR nurse, ICU nurse)	Patient is placed with left uterine displacement, patient anxious gasping for air coughs heavily HR 130 bpm BP 106/67 mm Hg SpO_2 83% (HFNC) Resp 35/min Temp 39^oC During intubation: HR 140 bpm BP 90/60 mm Hg SpO_2 67% Resp 0/min Temp 39^oC Post intubation: HR 140 bpm	1. Intensivist/anesthesiology team intubates the patient ☐ Check IV line ☐ Administer 1 L IV crystalloid ☐ Induce anesthesia with cardiovascular-stable induction agents ☐ Rapid sequence induction ☐ Use video laryngoscope ☐ Confirm correct ETT placement ☐ Administer intravenous maintenance anesthesia ☐ Administer intravenous antibiotics for surgical prophylaxis (depending on current regimen) 2. OB prepares for CD^+ ☐ Place urinary catheter ☐ Scrub the patient ☐ Deliver fetus + placenta			

	BP 80/45 mm Hg SpO_2 86% (PPV) Temp 39^oC				
Fetus requires resuscitation Hemodynamically/respiratory unstable patient	HR 148 bpm BP 78/35 mm Hg SpO_2 80% (PPV) Temp 39^oC	1. Anesthesiologist ☐ Administer phenylephrine/ norepinephrine infusion ☐ Administer uterotonic drugs ☐ Administer 1 L IV crystalloid ☐ Send ABG 2. OB ☐ Close incision 3. Neonatology ☐ Resuscitate neonate ☐ Transfer neonate to NICU			
Further deterioration	HR 150 bpm BP 75/30mm Hg SpO_2 79% (PPV) Temp 39^oC	1. Anesthesiologist ☐ Increase phenylephrine/ norepinephrine infusion ☐ Perform TTE ☐ Communicate with surgeon regarding bleeding status ☐ Confirm/adjust ventilator settings ☐ Request + administer nitric oxide ☐ Call ECMO team 2. OB ☐ Scan abdomen for bleeding ☐ Assess uterine tone			
Patient improves with nitric oxide + vasopressor	HR 120 bpm BP 95/45 mm Hg SpO_2 91% FIO_2 1.0 (intubated) Temp 37.8^oC Repeat ^ABG results: pH 7.28 PaO_2 62 mm Hg (8.3 kPa) $PaCO_2$ 45 mm Hg (6.0 kPa) Bicarb 24 mEq/L Lactate 2.5	1. OB + anesthesia teams discuss differential diagnoses and bleeding risk 2. Anesthesiologist ☐ Discuss with ECMO team ☐ Continue vasopressors ☐ Actively warm ☐ Send complete blood count 3. Update family 4. Team debrief (include any system issues)			

***Macro scenario deterioration summary**

With our experience many SARS-CoV-2 patients have a 'common pathway' when respiratory function deteriorates. It usually begins with pyrexia which leads to a hypermetabolic state and increase in the work of breathing due to poor lung function, and they need invasive ventilation and possibly other interventions to improve V/Q mismatch. If respiratory collapse occurs late (e.g. >10 days) in the disease course it is common to see septic shock with secondary infection.

^Arterial blood gas analysis

The ABGs in the scenario reflect a mixed picture that the authors have seen with severe respiratory disease in pregnant patients with COVID-19.

ABG 1 - Reflects a patient who had been in compensated respiratory alkalosis for several days and then had new metabolic acidosis. She was unable to compensate for the metabolic acidosis as she had maximized her ability in previous days - reflecting the severity of her condition.

ABG 2 - The patient now has combined respiratory and metabolic acidosis. The authors have noticed that many patients with severe COVID-19 demonstrate this pattern immediately after invasive ventilation.

[+]Bedside cesarean delivery in the ICU

Dependent on individual hospital policy and logistics etc., except when perimortem.

Appendix 1

Learner Knowledge Assessment
Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: _____ Date: _____

OB Nursing Anes Neonatologist

Each item has two components. The 'Before the simulation' column (left side) examines your perspective at the beginning of the simulation. The "End of Simulation" column (right side) is to evaluate your perspective at the completion of the simulation.

1. How would you rate your knowledge of severe COVID-19 pregnancy complications?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none						Knowledgeable	Little/none						Knowledgeable

2. How would you rate your knowledge of differential diagnoses of cardiovascular collapse in a pregnant patient with severe COVID-19?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none						Knowledgeable	Little/none						Knowledgeable

3. How would you rate your knowledge of signs and symptoms of respiratory and cardiovascular collapse in a pregnant patient with severe COVID-19?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none						Knowledgeable	Little/none						Knowledgeable

4. How would you rate your knowledge of delivery planning for a pregnant patient with severe COVID-19?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none						Knowledgeable	Little/none						Knowledgeable

5. How would you rate your overall confidence to manage a pregnant patient with severe COVID-19 and respiratory and cardiovascular collapse?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none						Knowledgeable	Little/none						Knowledgeable

Appendix 2

Simulation Activity Evaluation

DATE OF SIMULATION: _____

OCCUPATION: Consultant PG Yr 1 2 3 4 STUDENT NURSE MIDWIFE OTHER

SPECIALTY:_____ YEARS IN PRACTICE: _____

Please rate the following aspects of this training program using the scale listed below:

1 = Poor 2 = Suboptimal 3 = Adequate 4 = Good 5 = Excellent

Use "N/A" if you did not experience or otherwise cannot rate an item

INTRODUCTORY MATERIALS						
Orientation to the simulator	1	2	3	4	5	N/A
PHYSICAL SPACE						
Realism of the simulator space	1	2	3	4	5	N/A
EQUIPMENT						
Satisfaction with the mannequin	1	2	3	4	5	N/A
SCENARIOS						
Realism of the scenarios	1	2	3	4	5	N/A
Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
Overall quality of the debriefings	1	2	3	4	5	N/A
DID YOU FIND THIS USEFUL?						
To improve your clinical practice?	1	2	3	4	5	N/A
To improve your teamwork skills?	1	2	3	4	5	N/A
To improve your VERBAL communication?	1	2	3	4	5	N/A
To improve your NONVERBAL communication?	1	2	3	4	5	N/A
FACULTY						
Quality of instructors	1	2	3	4	5	N/A
Simulation as a teaching method	1	2	3	4	5	N/A

COMMENTS/SUGGESTIONS:

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