

# Prone Positioning for Pregnant Women With Hypoxemia Due to Coronavirus Disease 2019 (COVID-19)

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The coronavirus disease 2019 (COVID-19) pandemic has prompted expanded use of prone positioning for refractory hypoxemia. Clinical trials have demonstrated beneficial effects of early prone positioning for acute respiratory distress syndrome (ARDS), including decreased mortality. However, pregnant women were excluded from these trials. To address the need for low-cost, low-harm interventions in the face of a widespread viral syndrome wherein hypoxemia predominates, we developed an algorithm for prone positioning of both intubated and nonintubated pregnant women. This algorithm may be appropriate for a wide spectrum of hypoxemia severity among pregnant women. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus is responsible for the clinical manifestations of COVID-19. This syndrome can manifest as severe pneumonia complicated by hypoxemia and ARDS. Given the current global COVID-19 pandemic, with a large number of ARDS cases, there is renewed interest in the use of prone positioning to improve oxygenation in moderate or severe hypoxemia. Among the populations who can benefit from prone positioning are pregnant women experiencing severe respiratory

distress, as long as the physiologic changes and risks of pregnancy are taken into account.

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Ventilator management for pregnant patients differs from that for nonpregnant patients in that we aim for pregnancy-specific relative hypocapnia (decreased PaCO<sub>2</sub>) where possible while maintaining lung-protective tidal volumes and plateau pressures (the pressure applied to the small airways and alveoli during mechanical ventilation, which, if excessive, can lead to ventilator-associated lung injury). When severe lung pathology prevents both, permissive hypercapnia (elevated PaCO<sub>2</sub>) may be tolerated in favor of maintaining lung-protective ventilation strategies, including low tidal volume ventilation (4–8 mL/kg predicted body weight) and positive end-expiratory pressure (PEEP) to reduce end-expiratory atelectasis while preventing hyperinflation by limiting the plateau pressure. Permissive hypercapnia is not contraindicated in pregnancy. Mild hypercapnia (PaCO<sub>2</sub> 50–60 mm Hg) is generally acceptable, but PaCO<sub>2</sub> levels greater than 60 mm Hg have been associated with decreased uterine blood flow and increased fetal intracranial pressure in animal models.<sup>1</sup> The weight gain and pressure of the gravid uterus in advanced pregnancy may limit achieving a plateau pressure less than 30 cm H<sub>2</sub>O. Esophageal pressure monitoring is an option to help distinguish lung pressure from chest wall pressure by estimating transpulmonary pressure, the distending pressure of the lungs. High-PEEP strategies often employed for acute respiratory distress syndrome (ARDS) have known physiologic effects of decreased preload and cardiac output. Given the risk of aortocaval

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Video Available Online

**Video 1** Prone positioning in awake pregnant patient. Created by Mary Catherine Tolcher, MD, MSc, and Jennifer R. McKinney, MD, MPH. Used with permission.

compression by a gravid uterus combined with fetoplacental needs for cardiac output, high-PEEP strategies beyond 10 mm Hg should be pursued cautiously and require ongoing monitoring of maternal and fetal status. The use of sedation and paralytics to improve oxygenation is not contraindicated during pregnancy; however, doses may need to be increased owing to the increased volume of distribution.

In the presence of ARDS of any etiology, prone positioning has proven beneficial effects on oxygenation and mortality.<sup>2</sup> Recent global anecdotal reports have also found prone positioning to be particularly helpful for patients with coronavirus 2019 (COVID-19) with moderate or severe respiratory disease. Although data are limited, case reports and expert experience suggest that pregnant women may be safely prone and that prone positioning may, in fact, be particularly useful in these patients owing to its ability to relieve both diaphragmatic compression from abdominal contents and aortocaval compression from the gravid uterus if performed correctly.<sup>3</sup> Indeed, a recent case of a pregnant woman at 31 weeks



Video Available Online

**Video 2** Prone positioning in intubated pregnant patient. Created by Mary Catherine Tolcher, MD, MSc, and Jennifer R. McKinney, MD, MPH. Used with permission.

of gestation with COVID-19 and severe ARDS included the successful use of prone positioning.<sup>4</sup>

Prone positioning during pregnancy requires special considerations. Routine indications and contraindications apply, with additional caution for patients within 2 days postoperative from cesarean delivery owing to concerns for incisional complications and pain in the immediate postoperative period. Additionally, prone positioning for patients at 34 weeks of gestation or more may be more technically difficult owing to the large gravid uterus at advanced gestational ages, and the risks and benefits of delivery before prone positioning should be strongly considered. Furthermore, special attention must be paid to padding above and below the gravid uterus to offload the uterus and avoid aortocaval compression, particularly in late



Scan this image to view Video 1 on your smartphone.



Scan this image to view Video 2 on your smartphone.



pregnancy (ie, beyond 24–28 weeks of gestation). Although padding specific to the gravid uterus is commercially available, prone positioning can also be safely achieved using the pillows and blankets easily found in the inpatient setting. Fetal monitoring during prone position sessions may be technically challenging, but continuous external fetal monitoring is recommended beyond 24 weeks of gestation.<sup>5</sup>

The authors developed a clinical guideline and algorithm including indications, contraindications, and a step-by-step guide on how to prone position both awake and intubated pregnant patients (Appendix 1, available online at <http://links.lww.com/AOG/B944>). To develop this algorithm, we extracted and combined information from separate institutional protocols developed for prone positioning of nonpregnant patients in the medical intensive care unit and from one developed specifically for pregnant patients anticipated to be admitted to a dedicated obstetric intensive care unit. This algorithm is the amalgamation of the clinical expertise and proning experiences of medical and obstetrics intensivists, which was further honed using early experience gained from prone positioning of pregnant women with hypoxemia related to COVID-19. Following an algorithm such as that described in Appendix 1 and illustrated in Appendices 2 and 3 (available online at <http://links.lww.com/AOG/B944>) allows optimal placement of padding and safe maneuverability for pregnant women. The prone positioning technique for awake pregnant women is demonstrated in Video 1 and for intubated pregnant women in Video 2. Simulation training that includes both obstetric and critical care staff is essential for optimizing outcomes by familiarizing staff with this uncommon procedure in pregnancy. Multidisciplinary collaboration and care planning discussions between the obstetrics, intensive care, anesthesiology, and neonatology teams should be carried out at the time of admission of a pregnant patient to the intensive care unit and should be ongoing during the course of care to capitalize on varying areas of expertise and to optimize patient outcomes.

Prone positioning may not be successful in all cases. Oxygen saturation or arterial blood gas level should be closely monitored to assess responsiveness.<sup>5</sup> If the patient is unable to tolerate the position, right or

left lateral positions may be attempted. In addition, shorter prone position sessions may be considered for patients with mild or moderate ARDS (eg, 2 hours in awake pregnant women). Prone positioning for intubated patients with severe ARDS is typically performed for at least 16 hours per day.<sup>2</sup> Potential complications of prone positioning include facial edema and skin breakdown; pressure ulcers; dislodgement of the endotracheal tube, lines, or drains; and worsening oxygenation or hemodynamic instability.

Management of severe respiratory disease in pregnant women during the current pandemic is complex. If prone positioning is performed correctly, taking into account the pregnant anatomy and physiology, pregnancy should not be a contraindication to this potentially beneficial therapy. Delivery should be considered as a component of the management of refractory hypoxemic respiratory failure or worsening critical illness in pregnant women, especially if they are at 32 weeks of gestation or more. However, as in all cases of critical illness during pregnancy, including moderate or severe ARDS in the setting of COVID-19, maternal care and delivery decisions are best individualized after multidisciplinary discussion with the critical care, obstetrics or maternal–fetal medicine, and anesthesiology teams.

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