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Critical Illness in Pregnancy

Part I: An Approach to a Pregnant Patient in the ICU and Common Obstetric Disorders

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Managing critically ill obstetric patients in the ICU is a challenge because of their altered physiology, different normal ranges for laboratory and clinical parameters in pregnancy, and potentially harmful effects of drugs and interventions on the fetus. About 200 to 700 women per 100,000 deliveries require ICU admission. A systematic five-step approach is recommended to enhance maternal and fetal outcomes: (1) differentiate between medical and obstetric disorders with similar manifestations, (2) identify and treat organ dysfunction, (3) assess maternal and fetal risk from continuing pregnancy and decide if delivery/termination of pregnancy will improve outcome, (4) choose an appropriate mode of delivery if necessary, and (5) optimize organ functions for safe delivery. A multidisciplinary team including the intensivist, obstetrician, maternal-fetal medicine specialist, anesthesiologist, neonatologist, nursing specialist, and transfusion medicine expert is key to optimize outcomes. Severe preeclampsia and its complications, HELLP (hemolysis, elevated liver enzymes, and low platelets) syndrome, and amniotic fluid embolism, which cause significant organ failure, are reviewed. Obstetric conditions that were not so common in the past are increasingly seen in the ICU. Thrombotic thrombocytopenic purpura of pregnancy is being diagnosed more frequently. Massive hemorrhage from adherent placenta is increasing because of the large number of pregnant women with scars from previous cesarean section. With more complex fetal surgical interventions being performed for congenital disorders, maternal complications are increasing. Ovarian hyperstimulation syndrome is also becoming common because of treatment of infertility with assisted reproduction techniques. Part II will deal with common medical disorders and their management in critically ill pregnant women. CHEST 2015; 148(4):1093-1104

ABBREVIATIONS: AFE = amniotic fluid embolism; DIC = disseminated intravascular coagulation; HELLP = hemolysis, elevated liver enzymes, and low platelets; HUS = hemolytic uremic syndrome; LDH = lactate dehydrogenase; MMR = maternal mortality rate; OHSS = ovarian hyperstimulation syndrome; TTP = thrombotic thrombocytopenic purpura

Obstetric patients form a small but important population that may need intensive care. ICU physicians need to be familiar with the unique differences in management when treating two patients simultaneously (mother and fetus). Medical disorders

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present differently during pregnancy. Normal ranges for vital signs and laboratory tests may differ. Potentially harmful fetal effects of x-rays can limit diagnostic options. Moreover, physiologic targets like arterial pressure, Pao_2, and $Paco_2$ may have to be modified to ensure fetal well-being.

Obstetric patients include women admitted during pregnancy or the first 42 days (6 weeks) after termination of pregnancy.[1-3] Although ICU admission rates are comparable in developed and developing countries (200-700 women per 100,000 deliveries),[3-8] maternal mortality differs greatly. In 1990, the maternal mortality ratio (MMR) (MMR = maternal deaths per 100,000 deliveries) was 26 in developed nations and 430 in the developing nations.[9] Over the last 24 years, with improvements in public health systems, better access to health care, and possibly improved intensive care, MMR has declined to 16 (38% decrease) in developed countries and 230 (46% decrease) in developing countries in 2013,[9] but it is still short of the Millennium Development Goal of the World Health Organization, which targeted a 75% reduction in MMR between 1990 and 2015.[9] In this two-part series on critical illness in pregnancy, we review important concepts that are essential for a critical care physician to optimally manage an obstetric patient in the ICU.

Physiology of Pregnancy

Maternal cardiovascular changes start in the first trimester, peak at the end of the second trimester, and then plateau until delivery. Cardiac output increases by 30% to 50% from 8 to 28 weeks' gestation and can worsen underlying cardiac conditions such as mitral stenosis.[10] After the first trimester, supine positioning may decrease cardiac output and cause symptomatic hypotension due to decreased venous return from aortocaval compression. Therefore, pregnant patients in a supine position (on an operating room table or ICU bed) should be tilted 15° to 20° degrees to either side by using a pelvic tilt wedge, to displace the uterus laterally.[11]

Plasma volume increases dramatically and is 50% higher by term. Red cell mass increases less, resulting in "physiologic anemia."[10,12,13] One putative benefit of this is that decreased blood viscosity prevents excessive thromboembolic events by compensating for the hypercoagulable state resulting from an increase in coagulation factors.[13] Another potential benefit is the ability to tolerate 500- to 1,000-mL blood loss during delivery without significant consequence. Patients with preeclampsia have significant intravascular hypovolemia and are more susceptible to the hemodynamic effects of obstetric hemorrhage. In addition, hemoconcentration in preeclampsia increases the risk of placental and other thromboembolic events. Arterial BP initially decreases, reaching its nadir at 28 weeks, gradually increasing to normal at term.[10,13]

Progesterone-mediated increase in tidal volume results in increased minute volume, decreased $Paco_2$, and respiratory alkalosis. Elevation of the diaphragm by the gravid uterus and hormonally induced changes in the shape of the chest wall reduce functional residual capacity, residual volume, and expiratory reserve volume.[13] Glomerular filtration rate increases by 50%, resulting in a low serum creatinine (< 0.8 mg/dL). Renal insufficiency in pregnancy is defined by a serum creatinine of > 1 mg/dL, and renally excreted drugs should be dosed accordingly.[10,13] Delayed gastric emptying and a relaxed esophageal sphincter increase the risk of aspiration during endotracheal intubation, seizures, and altered mental status. Adaptive alteration of the helper T cell immune response in pregnancy to T helper 2 type occurs to facilitate "immune tolerance" of the fetus; this could, however, increase risk of some infections in pregnancy.[14]

During labor, cardiac output increases by 15% to 20% because of autotransfusion of 300 to 500 mL during each uterine contraction; blood volume increases by 500 mL after delivery of the placenta.[10] Neuraxial anesthesia with resultant sympathetic blockade may partially attenuate these changes. Cardiac output is also affected by anxiety, pain, maternal (supine) position, and Valsalva maneuver.[10,13] The leukocyte count may increase to 15,000/μL and, rarely, as high as 25,000/μL. Gastric emptying is further delayed during labor.[10] Diaphragmatic fatigue may sometimes occur following straining during prolonged labor.

Causes of Critical Illness in Pregnancy

Obstetric patients require ICU admission for organ dysfunction caused by obstetric or medical disorders or both (Table 1).[1,2,15] In obstetric literature, these disorders are classified as direct causes of maternal morbidity or mortality if they result from obstetric complications (obstetric hemorrhage, hypertensive disorders of pregnancy, amniotic fluid embolism, fatty liver of pregnancy, and surgical or anesthetic complications of cesarean section). Indirect causes include medical disorders not directly attributable to the pregnant state.[9] Obstetric disorders are responsible for 50% to 75% of ICU admissions, with preeclampsia-eclampsia, obstetric hemorrhage, and pelvic sepsis accounting for 80% of obstetric ICU admissions across all geographic regions