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Critical Care in Pregnancy

This Practice Bulletin was developed by the ACOG Committee on Practice Bulletins—Obstetrics with the assistance of Lauren A. Plante, MD, MPH. The information is designed to aid practitioners in making decisions about appropriate obstetric and gynecologic care. These guidelines should not be construed as dictating an exclusive course of treatment or procedure. Variations in practice may be warranted based on the needs of the individual patient, resources, and limitations unique to the institution or type of practice.

Critical care in pregnancy is a field that remains unevenly researched. Although there is a body of evidence to guide many recommendations in critical care, limited research specifically addresses obstetric critical care. The purpose of this document is to review the available evidence, propose strategies for care, and highlight the need for additional research. Much of the review will, of necessity, focus on general principles of critical care, extrapolating where possible to obstetric critical care.

Background

Recent case series suggest that between 0.1% and 0.8% of obstetric patients are admitted to a traditional intensive care unit (ICU) (1–9). Among this population, the risk of death ranges from 2% to 11%. Although survival is better than that in an unselected population, mortality is substantially higher than the maternal mortality ratio in the developed world. In addition, approximately 1–2% of pregnant women receive critical care outside of a traditional ICU, but within a specialized obstetric care unit (10, 11). Therefore, overall estimates suggest that 1–3% of pregnant women require critical care services in the United States each year, approximately 40,000–120,000 women (based on 4 million births per year) (12).

Techniques for Critical Care

Competence in a number of core procedural skills is necessary for any physician practicing in critical care. Except in very large maternity centers, there is little opportunity to develop or maintain these skills, although alternative means may be available. Some techniques can be performed under supervision in other settings (eg, airway techniques under anesthesiologists' supervision in the operating room), others can be rehearsed through electronic resources or online (electrocardiogram interpretation), and still others lend themselves to task training through medical simulation.

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Organization of Critical Care

In an open ICU, any physician can write orders or perform procedures; management or consultation by a qualified intensive care physician is not mandatory. In a closed ICU, only the critical care attending physician or house staff can write orders and manage patient care. The hybrid or transitional model allows all physicians to write orders but requires an on-site critical care physician to provide consultation, conduct rounds, or co-manage all patient care. Additional terminology classifies ICU physician staffing as high-intensity (closed ICU or mandatory intensivist consultation) or low-intensity (optional intensivist) (13). High-intensity ICU physician staffing is associated with lower ICU mortality, lower hospital mortality, and decreased length of stay in both the ICU and the hospital, compared with low intensity ICU physician staffing (13). Although there are limited data specifically addressing the critical care obstetric patient, it seems reasonable that these findings would apply to this population as well (14, 15).

Critical care requires a multidisciplinary approach to achieve the best outcomes (16). The usual ICU team includes physicians, nurses, pharmacists, and respiratory therapists. In critical care obstetrics, the team also should include obstetricians or maternal–fetal medicine subspecialists, obstetric nurses, and neonatologists.

The obstetrician transferring a patient to an ICU must be familiar with the types of units available at the institution, such as a general medical–surgical ICU or a specialty unit for cardiothoracic or neurologic or neurosurgical care as well as the role of the obstetrician within each unit (17).

There are three levels of adult critical care described by the American College of Critical Care Medicine, with Level I delivering the highest level of care. Alternatives to traditional ICU care include intermediate-care or high-dependency units such as post-ICU step-down units, telemetry units for cardiac patients, and units for patients requiring long-term ventilator use (10, 11, 18).

Admission to Intensive Care

Because ICU beds are a scarce resource, ICU admission should be reserved for those patients who are likely to benefit. Most obstetric patients will be admitted under the objective parameters triage model. In this model, specific criteria trigger ICU admission, regardless of diagnosis. These triggers were achieved by consensus, in response to the review by the Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations), and are acknowledged to be largely arbitrary. They include specific abnormalities in vital signs, laboratory values, and imaging and physical findings. Admission criteria for nonpregnant patients are

listed in the box “Objective Parameters Model for Admission of Nonpregnant Patients to an Intensive Care Unit.” A description of changes to normal laboratory values during pregnancy is provided in the box “Key Laboratory Values That are Different in Pregnancy.”

Considerations in Transfer

The care of any pregnant woman requiring ICU services should be managed in a facility with obstetric adult ICU and neonatal ICU capability. Standard guidelines for perinatal transfer have been published by the American College of Obstetricians and Gynecologists and the American Academy of Pediatrics and follow federal Emergency Medical Treatment and Labor Act guidelines (19). These guidelines generally recommend antenatal rather than neonatal transfer and describe the responsibilities of the referring and receiving hospitals. In the event that maternal transport is unsafe or impossible, alternative arrangements for neonatal transport may be necessary. In patients where imminent delivery is expected, transfer should be held until after delivery.

The minimal monitoring required for a critically ill patient during transport includes continuous pulse oximetry and electrocardiography as well as regular assessment of vital signs (19, 20). All critically ill patients must have secure venous access before transport. Patients who already have arterial or central lines or other invasive monitoring devices in place should have those monitored as well. Women who are mechanically ventilated must have the endotracheal tube position confirmed and secured before transport and must be assessed for adequacy of oxygenation and ventilation.

There are no data to guide obstetric monitoring during transport of the critically ill obstetric patient. Fetal and tocodynamic monitoring during transport is likely feasible but of unproven utility (21). In some circumstances, identifying fetal compromise in transit may allow for advance preparation for intervention, including delivery, by the receiving institution. Simple measures, such as left uterine displacement and supplemental oxygen, should be applied routinely during transport.

Clinical Considerations and Recommendations

► *What are the findings in a pregnant or postpartum woman that might prompt ICU admission?*

Patients should be transferred to an ICU if they need circulatory or pulmonary support. An obstetric service should adopt site-specific guidelines for transfer based

Objective Parameters Model for Admission of Nonpregnant Patients to an Intensive Care Unit

Vital Signs

- Heart rate of less than 40 beats per minute or greater than 150 beats per minute
- Blood pressure of less than 80 mm Hg systolic (or 20 mm Hg below the patient's usual blood pressure)
- Mean arterial pressure of less than 60 mm Hg
- Blood pressure of greater than 120 mm Hg diastolic
- Respiratory rate of greater than 35 per minute

Laboratory Values

- Serum sodium level of less than 110 mEq/L or greater than 170 mEq/L
- Serum potassium level of less than 2 or greater than 7 mEq/L
- Pao₂ of less than 50 mm Hg
- pH level of less than 7.1 or greater than 7.7
- Serum calcium level of greater than 15 mg/dL
- Serum glucose level of greater than 800 mg/dL
- Toxic drug level in a hemodynamically or neurologically compromised patient

Imaging

- Cerebrovascular hemorrhage, contusion, or subarachnoid hemorrhage with altered mental status or focal neurologic findings
- Ruptured viscus or esophageal varices with hemodynamic instability
- Dissecting aortic aneurysm

Electrocardiography

- Myocardial infarction with complex arrhythmia, hemodynamic instability, or congestive heart failure
- Sustained ventricular tachycardia or ventricular fibrillation
- Complete heart block with hemodynamic instability

Physical Findings

- Airway obstruction
- Anuria
- Burns of greater than 10% of body surface area
- Cardiac tamponade
- Coma
- Continuous seizures
- Cyanosis
- Unequal pupils (unconscious patient)

Guidelines for intensive care unit admission, discharge, and triage. Task Force of the American College of Critical Care Medicine, Society of Critical Care. *Crit Care Med* 1999;27:633-8.

Key Laboratory Values That are Different in Pregnancy

Hemodynamic Variables

- Increased cardiac output
- Decreased systemic vascular resistance
- Decreased blood pressure
- Increased heart rate
- Decreased pulmonary vascular resistance

Respiratory Variables

- Decreased functional residual capacity
- Increased minute ventilation

Laboratory Variables

- Increased PAO₂ and Pao₂
- Decreased Paco₂
- Decreased serum bicarbonate (HCO₃)
- Decreased hemoglobin and hematocrit levels
- Increased white blood cell count
- Decreased protein S levels
- Decreased coagulation factors XI and XIII levels
- Increased coagulation factors I, VII, VIII, IX, and X levels
- Increased fibrinogen levels
- Increased D-dimer levels
- Increased erythrocyte sedimentation rate
- Decreased serum creatinine levels
- Decreased blood urea nitrogen level (BUN)
- Decreased uric acid level
- Increased alkaline phosphatase level
- Increased aldosterone level
- Increased serum cortisol, free cortisol, cortisol-binding globulin, and adrenocorticotrophic hormone level
- Increased insulin level
- Decreased fasting blood glucose level
- Increased triglyceride level
- Increased cholesterol, low-density lipoprotein, and high-density lipoprotein levels

Data from Gabbe SG, Niebyl JR, Simpson JL, Galan H, Goetzl L, Jauniaux ER, et al, editors. *Obstetrics: normal and problem pregnancies*. 5th ed. Philadelphia (PA): Churchill Livingstone Elsevier; 2007.

on the level of care required. These guidelines also should define and distinguish between levels of care that can be provided on the labor floor or, if applicable, the obstetric intermediate care unit.

Hemorrhage and hypertension are the most common causes of ICU admission in obstetric patients (1–7, 9, 22–36). Most of these patients typically require relatively simple interventions, monitoring, and supportive care.

Approximately 20–30% of obstetric ICU patients have nonobstetric causes for an ICU admission, such as sepsis (1, 5, 7, 11). Early goal-directed therapy for sepsis should not be delayed until the admission to the ICU but should begin as soon as septic shock is diagnosed (37–39). The patient should be stabilized, intravenous access maintained, urine output and fluid volume managed, and antibiotics started for treatment of sepsis. Broad-spectrum antibiotic therapy should be started within 1 hour of the diagnosis of severe sepsis or septic shock (37). Cultures, including blood cultures, should be obtained, but should not delay initiating antibiotics. Fetal resuscitation in utero through maternal oxygen therapy and circulatory support is preferable to cesarean delivery for nonreassuring fetal heart rate patterns in most cases.

Approximately 75% of obstetric ICU patients admitted to the ICU are postpartum (5, 6, 25). This may be due to specific postpartum causes, such as postpartum hemorrhage, or to ascertainment bias; obstetricians may be less willing to transfer or intensivists less willing to accept a patient whose fetus must still be considered in care planning. The process of transport itself is risky for a critically ill patient, who requires ongoing monitoring and maintenance while in transport. In a viable pregnancy, fetal monitoring during transport between obstetric units and the ICU may be prudent, especially if the patient is in labor (20).

Admission to the ICU is dependent on levels of care available on a local level. Patients needing the following procedures should be treated in a critical care unit:

1. Respiratory support, including airway maintenance and endotracheal intubation
2. Treatment of pneumothorax
3. Cardiovascular support, including treatment with pressors
4. Pulmonary artery catheterization (insertion, maintenance, and interpretation)
5. Abnormal electrocardiographic findings requiring intervention, including cardioversion or defibrillation interpretation

► ***What is the obstetrician–gynecologist’s role in the transfer of a patient to a critical care unit?***

When obstetric patients are transferred to the ICU, the obstetrician’s role will depend on the ICU model (open or closed) and the patient’s status (antepartum or postpartum). Regardless of the primary caregiver, patient care decisions must be made collaboratively between the intensivist, obstetrician, and neonatologist, and should involve the patient, her family, or both.

Obstetric input in the care of the postpartum ICU patient may include evaluation of vaginal or intraabdominal bleeding, evaluation of obstetric sources of infection, duration of specific therapies, such as magnesium for eclampsia prophylaxis, and feasibility of breast-feeding, especially compatibility of various medications with breast-feeding. There may be issues related to surgical interventions, including reexploration of the abdomen, or reclosure of abdominal or vaginal incisions. Under some circumstances, the obstetrician and the neonatologist also will need to advocate for bringing together the critically ill mother and her baby.

Multidisciplinary care is essential for the critically ill obstetric patient. When a pregnant patient is transferred to the ICU, members of the care team should assess the anticipated course of her condition or disease, including possible complications, and set parameters for delivery, if appropriate. The plan should be clear to the medical team and to the patient’s family, and to the patient herself if she is able to understand. Because the risk–benefit calculation for a given intervention may change as pregnancy progresses, it is important to reevaluate the care plan on a regular basis.

The plan for delivery should be made long before delivery is imminent, and it must include decisions about preferred location for delivery, preferred mode of delivery (vaginal versus cesarean), need for analgesia or anesthesia, and access to pediatricians. It also must include an alternative plan or set of plans in the event that the original plan cannot be followed.

If postpartum ICU admission is necessary, the patient and her family may have questions regarding the obstetric events that precipitated transfer even when obstetric care has been optimal. Anger, dissatisfaction, or legal action often follow a perceived bad outcome; in the case of a postpartum complication or condition requiring critical care, the obstetrician may bear the brunt of these questions. Although a full discussion about disclosure and review of adverse events is beyond the scope of this document, resources are available to assist the obstetrician through this stressful time (40).

► ***How should care be organized when a laboring patient needs critical care?***

If a laboring patient requires critical care services, it is important to determine the optimal setting for her care.

If the fetus is pre-viable or the duration of ICU services is anticipated to be lengthy, the labor floor is unlikely to be the best option. However during active labor, the labor unit may be the best choice if adequate maternal support can be provided. Advantages of vaginal delivery in the ICU include the availability of critical care interventions and staff. Disadvantages include lack of space to conduct a vaginal delivery and to accommodate pediatric personnel and equipment, and unfamiliarity of critical care personnel with obstetric interventions and management. Factors that will affect this decision include the degree of patient instability, interventions required, staffing and expertise available, anticipated duration of ICU stay, and probability of delivery.

Delivery in the ICU is associated with an increased likelihood of operative vaginal delivery. In part, this is because patients with translaryngeal intubation cannot close the glottis to push; therefore, an assisted second stage of labor may be required. In addition, ICU patients often have underlying cardiac or neurologic processes where an assisted second stage of labor is recommended. Adequate analgesia is required, although assessment of pain may be complicated by altered mental status or intubation. Regional analgesia is preferred but may not be possible because of coagulopathy, hemodynamic instability, or difficulties with patient positioning. Parenteral narcotics can be used instead of regional analgesia but are less effective in preventing pain; suboptimally treated pain may result in hemodynamic derangements that must be anticipated and treated.

Cesarean delivery in the ICU is complex and has significant disadvantages compared with procedures performed in a traditional operating room. These disadvantages include inadequate space for anesthetic, surgical, and neonatal resuscitation equipment and attendant personnel unfamiliar with the operation. In addition, ICUs have the highest rates of health care associated infections in a hospital, so the risk of nosocomial infection with drug-resistant organisms is increased (41, 42). Cesarean delivery in the ICU should be restricted to cases in which transport to the operating room or delivery room cannot be achieved safely or expeditiously, or to a perimortem procedure.

► ***Are there special fetal considerations in the care of a pregnant woman in a critical care setting (eg, assessment of gestational age, fetal monitoring, or complications related to medications)?***

Establishment of gestational age is crucial to determine whether the fetus is of gestational age sufficient to ensure a good chance of survival after birth. When pos-

sible, prenatal care records should be obtained to establish the most accurate dating criteria. In the event that gestational age remains uncertain, prompt ultrasound evaluation should establish the best possible estimate with documentation of the potential range of uncertainty.

Use of obstetric medications may pose particular challenges in the critically ill patient; known side effects must be carefully monitored and risk–benefit ratios should be assessed in each individual situation. Examples of common drug-related side effects include tachycardia and decreased blood pressure with beta-agonists, effects on platelet function and renal perfusion with indomethacin, and negative inotropic effects on cardiac function with magnesium. If preterm delivery may be necessary, a course of antenatal corticosteroids should be given to promote fetal lung maturity in fetuses between 24 weeks of gestation and 34 weeks of gestation, and are not contraindicated in an ICU setting even in the setting of sepsis.

Pregnancy often modifies drug effects or serum levels. Drugs that cross the placenta may have fetal effects; for example, sedative or parasympatholytic drugs can affect the fetal heart rate tracing. However, necessary medications should not be withheld from a pregnant woman because of fetal concerns. Additionally, necessary imaging studies should not be withheld out of potential concern for fetal status, although attempts should be made to limit fetal radiation exposure during diagnostic testing.

Fetal surveillance often is used when a pregnant patient is admitted to the ICU. Because fetal heart rate monitoring reflects uteroplacental perfusion and maternal acid–base status, changes in baseline variability or the new onset of decelerations may serve as an early warning system for derangements in maternal end-organ status. Changes in fetal monitoring should prompt reassessment of maternal mean arterial pressure, hypoxia, acidemia, or compression of the inferior vena cava by the gravid uterus. Correction of these factors may result in improvement of the tracing and every attempt should be made at intrauterine fetal resuscitation.

► ***Is intraoperative fetal monitoring needed for a pregnant patient?***

Although there are no data to allow for a specific recommendation regarding fetal monitoring for nonobstetric surgery, it is important for physicians to obtain obstetric consultation before performing nonobstetric surgery. Obstetricians are uniquely qualified to discuss aspects of maternal physiology and anatomy that may affect intraoperative maternal–fetal well-being. The decision to use fetal monitoring should be individualized and, if used, may be based on gestational age, type of surgery, and

facilities available. Ultimately, each case warrants a team approach (anesthesia, obstetrics, and surgery) for optimal maternal and fetal safety.

▶ ***When is perimortem caesarean delivery appropriate?***

Although there are no clear guidelines regarding perimortem cesarean delivery, fetal survival is unlikely if more than 15–20 minutes have passed since the loss of maternal vital signs. There are insufficient data on which to base conclusions regarding the appropriateness of cesarean delivery when efforts at resuscitation have failed. Based on isolated case reports, cesarean delivery should be considered for both maternal and fetal benefit approximately 4 minutes after a woman has experienced cardiopulmonary arrest in the third trimester (43, 44).

Summary of Recommendations and Conclusions

The following conclusions are based on good and consistent scientific evidence (Level A):

- ▶ Pregnancy changes normal laboratory values and physiologic parameters.
- ▶ Approximately 75% of obstetric ICU patients are admitted to the unit postpartum.
- ▶ Hemorrhage and hypertension are the most common causes of admission from obstetric services to intensive care.

The following recommendations are based on limited or inconsistent scientific evidence (Level B):

- ▶ Cesarean delivery in the ICU should be restricted to cases in which transport to the operating room or delivery room cannot be achieved safely or expeditiously, or to a perimortem procedure.
- ▶ Treatment of sepsis should not await admission to an ICU but should begin as soon as septic shock is diagnosed.

The following recommendations and conclusions are based primarily on consensus and expert opinion (Level C):

- ▶ High-intensity ICU physician staffing is associated with lower ICU mortality rates, lower hospital mortality rates, and decreased length of stay in both the

ICU and a hospital, compared with models in which intensivist consultation is optional.

- ▶ Decisions about care for a pregnant patient in the ICU should be made collaboratively with the intensivist, obstetrician, specialty nurses, and neonatologist.
- ▶ The care of any pregnant woman requiring ICU services should be managed in a facility with obstetric adult ICU and neonatal ICU capability.
- ▶ Necessary medications should not be withheld from a pregnant woman because of fetal concerns.
- ▶ Necessary imaging studies should not be withheld out of potential concern for fetal status, although attempts should be made to limit fetal radiation exposure during diagnostic testing.

Proposed Performance Measure

Percentage of pregnant or postpartum patients in the ICU who have documented involvement of an obstetrician-gynecologist

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The MEDLINE database, the Cochrane Library, and ACOG’s own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985 and January 2008. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

- I Evidence obtained from at least one properly designed randomized controlled trial.
- II-1 Evidence obtained from well-designed controlled trials without randomization.
- II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
- II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
- III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.

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