

# Case Study

## Obstetrical Trauma With Maternal Death and Fetal Survival

**Matthew Mowry, MSN, RN, CEN**

Trauma during pregnancy is the leading cause of non-obstetric-related maternal and fetal death. This article summarizes obstetric physiology and outlines the assessment and treatment of traumatic injuries of the pregnant patient. A case is presented in which a pregnant woman with blunt abdominal trauma was managed efficiently in a trauma center within a hospital that does not have in-house obstetric services. **Key words:** fetal survival, maternal death, pregnancy, trauma

**T**RAUMA DURING pregnancy is the number one cause of maternal death in the absence of other obstetric (OB) causes. It is also the number one cause of fetal demise. It is reported that up to 7% of all pregnancies are complicated by trauma.<sup>1</sup> Maternal mortality rates are noted to be as high as 11%. With trauma, fetal mortality rates can range as high as 65%, especially when associated with maternal death. The best chance for fetal survival is to ensure the survival of the mother.

The most common cause of fetal death is due to placental abruption, direct traumatic injury, hypoxia, maternal shock, disseminated intravascular coagulation, and unexplained fetal loss. Uterine rupture is rare and is a result of a direct impact to the abdomen. The risk for maternal and/or fetal injury is 10% to 15% during the first trimester, up to 40% in the second trimester, and up to 54% during the third trimester.<sup>2</sup> The most common mecha-

nism is motor vehicle crashes, followed by gunshot wounds, stabbing, and assault.

### PHYSIOLOGY

With relatively minor trauma, injury can pose a serious threat to the mother and her developing fetus. The clinical assessment is complicated by the many physiologic changes that occur during pregnancy. An increase in progesterone can lead to smooth muscle relaxation and decrease blood pressure by up to 15 mm Hg. Increased estrogen levels can increase heart rates up to 15 beats per minute while also increasing cardiac output by 30% to 50%.<sup>3</sup> Maternal blood volume also increases by 30% to 50%. This hyperdynamic and hypervolemic state makes the assessment for shock challenging because the mother may not show signs of distress until she hemorrhages 1500 to 2000 mL. After 2500 mL of blood loss, the mother's condition can rapidly deteriorate.<sup>3</sup> Once shock develops, the chances of saving the fetus are 20%.

During pregnancy, the mother's oxygen requirement is increased by 20%. Oxygenation of the fetus is constant as long as the mother's PaO<sub>2</sub> remains at 60 mm Hg. In the event of hypoxia, the fetus will shunt oxygen to the brain and heart, exposing the other organs to hypoxic injury.

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**Author Affiliation:** Shock Trauma Center, Allegheny General Hospital, Pittsburgh, Pennsylvania.

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**Correspondence:** Matthew Mowry, MSN, RN, CEN, Shock Trauma Center, Allegheny General Hospital, 320 East North Ave, Pittsburgh, PA 15212 (mmowry@wpahs.org).

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## **PREHOSPITAL CARE**

One of the most important aspects of OB trauma begins at the scene. The concepts are similar to other trauma patients including rapid transport to a designated trauma center. Although the presence of a pregnant abdomen may be intimidating or distracting to some, focus must be maintained on saving the pregnant mother.

As noted earlier, it may be difficult to assess shock due to the physiologic changes. Careful attention to the ABCs should be taken, including supplying supplemental oxygen and obtaining intravenous access with fluid resuscitation. If the patient is being extricated and transported on a long backboard, it is important to keep the board tilted at a 15 degree angle with the right hip elevated. This will avoid compression of the vena cava by the gravid uterus. If this technique is not employed, hypotension can ensure, resulting in a 30% decrease in cardiac output. This lack of perfusion can impact vital organ and even lead to death.

## **HOSPITAL CARE**

While evaluating and treating the pregnant trauma patient, the principles of Advanced Trauma Life Support are applied as they would be to a nonpregnant trauma patient. Similar to prehospital care, the Primary Survey should employ techniques to avoid aortocaval compression by keeping the mother in a left lateral decubitus position. Supplemental oxygen and fluid resuscitation should also be provided. During the Secondary Survey, a detailed medical and OB history should be obtained about the mother. This would include last menstruation, due date, and any complications during pregnancy. Assessing the fundal height can be used to determine the fetal age. This can be used to determine early delivery and fetal viability. Typically, trauma centers use 20 to 24 weeks as viable gestational age.

As soon as possible, a cardiotocographic monitor should be utilized. When applied to

the abdomen, this ultrasound transducer is used to record fetal heartbeat and uterine contraction. Direct trauma to the uterus and maternal hemorrhage can cause uterine contractions and preterm labor. The presence of vaginal bleeding can be indicative of placental abruption, uterine rupture, or other traumatic injuries to the pelvis or vagina. While the FAST (Focused Assessment with Sonography for Trauma) is being performed as part of the routine trauma examination, the fetus can be evaluated with this ultrasound technique, aiding in the assessment of fetal heart rate, position, gestational age, and potential for placental abruption. In the event the mother goes into cardiac arrest, the decision to perform an emergency cesarean section needs to be taken within 4 minutes, with delivery in 5 minutes.<sup>3</sup>

## **ACCESS TO OB CARE**

Access to OB services has been on the decline since the late 1990s. For instance, 68% of the OB units in Philadelphia County have closed since 1997.<sup>4</sup> The reasons for closing these units are multifactorial. Primarily, an aging population, decrease in birthing rates, and higher costs due to an increase in cesarean sections. Areas with uninsured and high Medicaid rates often have insufficient reimbursement to sustain these programs. Rural areas have been hit particularly hard, requiring pregnant women to travel further and limiting access to prenatal care.

Allegheny General Hospital (AGH) in Pittsburgh, Pennsylvania, has followed this national trend. Because of a decline in childbirths and as a cost-saving initiative, OB services were consolidated into West Penn Hospital, its sister facility in the West Penn Allegheny Health System. Allegheny General Hospital is a level I trauma center and therefore a plan was developed to meet the Pennsylvania Trauma System Foundation's standard for obstetrics, which states that the service must be on-call and promptly available.

## **TRAUMA CENTER PROTOCOLS WITHOUT OB SERVICES**

Pregnant patients who are transported to AGH below 20 weeks' gestation are managed as a standard, nonpregnant patient, as the fetus is deemed nonviable. However, if 20 weeks' gestation or higher, emergency medical services (EMS) is advised that AGH does not currently have inpatient OB services and that it may want to transport the patient to a facility that provides that level of care unless immediate stabilization is required. If time is available, the trauma attending physician is notified and decision can be made to accept or divert this patient. If the pregnant patient does arrive, the goal is to evaluate, treat, and stabilize until a determination is made whether the patient needs to be transferred to an appropriate facility.

In the event a pregnant trauma patient more than 20 weeks' gestation arrives, AGH's Emergency Dispatch center follows a checklist that activates the Trauma, OB, and Neonatal Transport teams. A standard trauma alert is sent notifying the team of all the pertinent information, including gestational age of the fetus. There is also a second OB Trauma page sent to a predetermined group of OB physicians at West Penn Hospital and AGH's OB clinic. At this point, Security is notified to begin transport of the OB physician to AGH. A locally contracted ambulance service is also contacted to arrange transport of West Penn's Neonatal Transport team. Finally, the operating room is contacted to be prepared for a potential emergency cesarean section. The process was tested numerous times prior to implementation, with an average OB response time of 20 to 30 minutes, depending on the time of day and traffic conditions. In the years since implementation, on average, 2 to 3 pregnant trauma patients would arrive at AGH, often with low acuity.

### **CASE SCENARIO**

Since the inception of the off-site OB program, the program had been tested with sev-

eral low-acuity pregnant trauma patients. Several drills had also been conducted to determine the efficacy and safety of having a trauma center with remote OB services. These capabilities were put to the full test early one fall evening.

A 37-week pregnant woman in her early 30s had been shopping at a local department store. She was a gravida 2, para 1 with her baby born healthy a few years earlier. However, this woman had a history of drug abuse and was being maintained on a standard dose of methadone. The woman was single and had a boyfriend who was involved with the care of her child. While waiting for a ride outside, she had sat on the curb of the department store's parking lot. At that moment, an elderly driver in his late 80s pulled into the parking lot in a minivan. The driver's family reported he had Alzheimer disease. Crash investigators presumed the driver mixed up the brake and the gas pedals, pinning the pregnant woman for more than 30 seconds against a brick wall.

EMS was dispatched and responded to the scene in less than 5 minutes. Once on scene, paramedics found the patient lying supine with her head in a bystander's lap. The patient was unresponsive, with weak central pulses and a heart rate of 120 beats per minute. No obvious injuries or bleeding was noted. High-flow oxygen via a nonrebreather was applied, and transportation was expedited by placing the patient on a long backboard. Respirations were becoming increasingly labored, and pupils were fixed with an upward gaze to the left. An oral airway was attempted but her jaws were clenched. Total scene time was under 10 minutes. As the ambulance was preparing to leave, a bystander called out to EMS that the patient was 8 months pregnant.

The level I trauma center was less than a mile from the scene. EMS had called the hospital's Emergency Dispatch to report a critical pregnant trauma patient with suspected crush injuries to the abdomen. EMS placed a left tibial intraosseous (IO) line. During the 3-minute transport, her heart rate decreased

into the 50s. While pulling into the trauma center's driveway, cardiopulmonary resuscitation (CPR) was started and continued into the trauma bay.

Meanwhile at the trauma center, the Emergency Dispatch team was working diligently to mobilize all of the components for the Trauma/OB teams to manage this complex situation. Upon first hearing EMS report, the emergency department (ED) staff separated into 2 teams, one to assist the trauma staff in resuscitating the traumatically injured mother and the second team to anticipate emergency cesarean delivery and neonatal resuscitation. Armed with the advanced notice, the Trauma team was also able to secure additional trauma surgeon support and the in-house pediatrician. The Emergency Dispatch Center had also called and activated the Neonatal Transport team, with a separate dedicated security staff to transport the neonatologist. Since this case occurred during regular business hours, the obstetrician was contacted by Emergency Dispatch at the OB clinic situated 1 block from the hospital. The operating room was also alerted and on standby. With all components in place, the teams waited in anticipation for the arrival of this severely injured pregnant woman.

The patient presented to the trauma bay with ongoing CPR by EMS. The Trauma team immediately began its Primary Survey with the focus on saving the mother. The Emergency Medicine (EM) staff successfully performed rapid sequence intubation using video-assisted laryngoscopy. The endotracheal tube placement was confirmed with an end-tidal CO<sub>2</sub> colorimetric change. The surgeons made numerous attempts and ultimately secured a left subclavian and femoral venous introducer. The Massive Transfusion Protocol that was initiated but was held because of the inability to definitively confirm line placement, as there was no blood return. Advanced Cardiac Life Support continued, with ongoing CPR as well as multiple doses of epinephrine and 1 dose of sodium bicarbonate through the IO line. The surgeons also placed bilateral chest tubes without any

change in her condition. An ultrasound probe was placed over the heart and showed no cardiac activity. With ongoing CPR, 2 trauma surgeons proceeded with an emergency cesarean section 10 minutes into the ongoing cardiac arrest and resuscitation. At this point, it was deemed unlikely that the mother would survive and efforts were focused on saving the unborn fetus.

The surgeons noted the patient had a previous C-section scar and used that as the landmark for their incision. The uterus was then identified and eviscerated, all of this occurring with ongoing CPR. The uterus was then opened and the baby was then removed. Two umbilical clamps were placed and umbilical cord was cut. The baby was then handed over to the Neonatal Resuscitation team. The mother's abdomen was then further explored to identify any source of controllable hemorrhage. There were several liters of blood in the abdomen and no pulse on the aorta. The mother was pronounced dead 1 minute after the baby was delivered. At this point, Emergency Dispatch was notified that the baby was already delivered, canceling the obstetrician and noting the Neonatal Transport team was already *en route*.

The initial Neonatal Resuscitation team comprised EM physicians and nurses. The baby had an Apgar score of 0, extremely cyanotic with no pulse or respiration. Cardiopulmonary resuscitation was started after placing the baby in the ED's neonatal radiant warmer. The nose and mouth were suctioned with a bulb syringe and then a 2.5 endotracheal tube was placed on the first attempt. Placement was confirmed with end-tidal CO<sub>2</sub> colorimetric change. Oral gastric tube insertion and umbilical line catheterization were accomplished by the EM staff. After ventilating the baby with a bag-valve mask for approximately 1 minute, the baby developed a heart rate of 125. After pulses were confirmed, the neonatologist arrived and care was handed over to him and the pediatrician. Chest radiograph confirmed placement of all tubes and lines. At 5 minutes, Apgar score improved to 3 but still critically low.

The Neonatal team had plans to transport the patient back to the Health System's dedicated OB facility that includes a level III neonatal intensive care unit, the highest level available. However, that hospital is not a trauma center. The baby had no visible signs of trauma but continued to remain in critical condition. The attending trauma surgeon, who has ultimate responsibility for the mother and the baby, requested transport instead to the locally specialized Children's Hospital that is also a level I trauma center. Since trauma could not be excluded because of the mother's direct and severe blow to the abdomen, a trauma evaluation was necessitated and beyond the capabilities of both hospitals.

The baby was transported without further issue and admitted to the Children's Hospital intensive care unit. The patient was therapeutically cooled and remained sedated and intubated for several days. A magnetic resonance image revealed a small subdural hemorrhage, moderate anoxic encephalopathy, and pulmonary hemorrhage. The patient was soon extubated and able to be bottle-fed. He developed seizure activity but was able to be controlled with medication. Because of the mother's history of drug abuse, care was also complicated because of neonatal abstinence syndrome. The patient had an Injury Severity Score of 19. A score of 16 or higher is considered major trauma. After 3 weeks, the patient was discharged home in the care of his grandmother. At that point, there was no immediate concern for development delays. At a 6-month follow-up visit, the patient continued to develop as expected, meeting target goals for the baby's age.

The Medical Examiner presented the case to the Trauma Services at its Multidisciplinary Morbidity and Mortality Rounds. It was noted that the mother had a therapeutic dose of methadone on her toxicology report. She was noted to have very extensive liver and spleen lacerations that were not compatible with life. She also had bilateral pulmonary contusions and a total of 10 rib fractures; 5 on each hemithorax. The patient had an Injury Severity Score of 42.

A multidisciplinary postevent meeting was held to discuss areas of performance improvement. The OB team conveyed the need to determine requirement for cesarean section earlier on if the mother is in cardiac arrest. In this case, the decision was made at 10 minutes and ideally should be made at 4 minutes. Trauma and OB/Neonatal teams also discussed need for improved communication. As expected, the noise level was elevated and clearly identifying oneself and provider role is the key in such a complex and tense situation. It was also noted that the emergency transport for the physicians did not have the ability to use lights and sirens. The health system's newly hired security firm did not possess this ability and has led to further investigation into faster transport.

Overall, it was noted that all the teams and specialties involved did a tremendous job saving the baby's life. Unfortunately, the mother succumbed to her lethal, nonsurvivable injuries. Although it is rare to survive these types of injuries and procedures, it can be done with training, preplanning, and coordinated care.

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