

**“Infant Survival After Cesarean Section for Trauma”  
(1996), by John A. Morris, Jr., Todd J. Rosenbower,  
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In the May 1996 edition of *The Annals of Surgery*, John A. Morris and his collaborators published “Infant Survival After Cesarean Section for Trauma,” in which they evaluate the use of emergency cesarean sections for the treatment of pregnant trauma patients. During a cesarean section, a physician removes a fetus from a pregnant woman through an incision in her abdomen and uterus. When a pregnant woman experiences trauma, physicians can perform an emergency cesarean section to remove the fetus and administer medical treatments that would not be possible while the woman is pregnant. In their article, Morris and his colleagues examine the fetal outcomes following emergency cesarean sections to determine when the procedure should be used in a trauma setting. The authors support the use of emergency cesarean sections in trauma patients when those patients demonstrate high degrees of maternal and fetal distress. Morris and his team’s article is one of the first to focus on how trauma affects third trimester pregnancies and to develop an algorithm to help physicians treat those patients.

Pregnant women who experience trauma, such as a penetrating wound or multiple sudden injuries, are taken to trauma centers where they can be given the most complete care. Pregnancy complicates trauma treatment. In addition to the normal dangers of trauma, trauma during pregnancy can lead to miscarriage, preterm labor, or placental abruption. Preterm labor is when a woman goes into labor before her fetus has come to full term, thirty-seven to forty-two weeks’ gestation. A placental abruption occurs when the placenta, the structure that nourishes the fetus in the womb, peels away from the inner wall of the uterus, causing a lack of oxygen to the fetus and large amounts of bleeding in the pregnant woman. Emergency cesarean sections can be used to save both the pregnant woman and fetus in the case of placental abruption, cardiac arrest, and many other complications of trauma. In rare cases, a physician performs a perimortem cesarean section. A perimortem cesarean section is one that occurs just after the time of maternal cardiac arrest, before or after the woman is pronounced dead. The purpose of that procedure is to save the life of the fetus and to enable physicians to begin to resuscitate the woman.

The authors of “Infant Survival After Cesarean Section for Trauma” investigated the use of emergency cesarean sections for those complications. Morris is a trauma physician who studied trauma patients and intensive care units in hospitals. Morris and his co-authors worked in the departments of surgery at multiple level-one trauma centers throughout the US. The article, “Infant Survival After Cesarean Section for Trauma,” provides physicians working in emergency medicine guidelines on the indications for emergency cesarean sections. The team reviewed every case of trauma during pregnancy at nine level-one trauma centers in different US cities. Through their evaluation, they identified common patterns during treatment that lead to increased patient survival.

Morris and his co-authors organize “Infant Survival” into five sections. They begin by introducing the rarity and difficulties of trauma in pregnancy. Further, they describe the necessity for a study to evaluate the costs and benefits of emergency cesarean sections in third trimester trauma cases.

In the second section, "Methods," the authors explain case selection and define terms such as maternal and fetal distress. The third section, "Results," is broken into categories of "maternal outcome" and "fetal outcome." In the last section, titled "Discussion," the authors analyze the implications of their findings, which they split into three sections labeled "The Salvageable Infant," "Clinical Implications," and "Perimortem Cesarean Section."

In the "Methods" section, Morris and his team state that they collected data from nine level-one trauma centers in the United States from January 1986 to December 1994. The researchers explain that they employed a retrospective study where they evaluated past cases, because it would be unethical to test different emergency cesarean section procedures on trauma patients. The authors include nine centers in their evaluation to increase the diversity of the cases.

In continuation of their methods section, the researchers further detail how they selected cases for research. The authors retrospectively identified all the pregnant trauma admissions who underwent emergency cesarean sections at the nine hospitals. After identifying thirty-two cases, Morris and his team collected clinical and demographic data on each of those patients and their fetuses. The researchers write that they were interested in the way the patients were injured, the severity of their injuries, and the timing between injury, arrival to the trauma center, and cesarean section. They also recorded the pregnant woman's and fetus's age, the presence of a fetal heartbeat, and the level of fetal or maternal distress. Finally, they evaluated the patient's recorded Glasgow Coma Scale, the patient's diagnostic test results, and their overall outcome such as long term injury or death. The Glasgow Coma Scale is a common scale used to assess the severity of head injury a patient has undergone and in the study, it was an indicator of the severity of the patient's injuries. The researchers identify all of those variables as important to evaluation and development of emergency cesarean delivery guidelines.

Before presenting the results of their study, the team defines recurrent terms. They define fetal distress as a slow fetal heart rate or bradycardia, slowing of the fetal heart rate or decelerations, and lack of fetal heartbeat or fetal heart tones. The common definition of fetal viability is the ability of a fetus to live outside of the womb. The authors determine their own definition of infant viability in the case of emergency cesarean sections. They describe that viability as the presence of both a fetal heartbeat and a gestational age greater than or equal to twenty-six weeks.

After defining their terms, Morris and his co-authors present the results of their study regarding survival outcomes of emergency cesarean sections. The authors state that forty-five percent of the fetuses and seventy-two percent of the pregnant women survived the emergency cesarean sections. The researchers present tables outlining what type of trauma each pregnant woman sustained, their severity of injury score, as well as other variables to show the impact of each on survival.

The authors first examine the cases of maternal death at length. They determine that the maternal deaths could be attributed to either severe injuries, which would likely result in death despite emergency cesarean delivery, or extended observation of the pregnant woman after she was stabilized and before initiation of the procedure. In the results section, the authors highlight that three perimortem cesarean operations were performed on women in their study, as such procedures are rare. A perimortem cesarean section is one that occurs around the time of death. According to the authors, the three women who underwent a perimortem cesarean section experienced high severity injuries and were in cardiac arrest when the cesarean section began. Although all three women died, one infant lived as result of the procedure.

The authors then discuss the fetal outcomes. Of the infants delivered, thirteen did not have a heart beat present before the cesarean section began and did not survive. The authors explain that they did not count the death of those infants as a result of the emergency cesarean sections performed because they considered the fetuses non-viable before the operation began due to a lack of heartbeat. Of the fetuses who were considered viable, seventy-five percent survived the emergency cesarean section.

In the largest section, "Discussion," Morris and his team discuss the risks of trauma specific to pregnancy and treatment of both the fetus and pregnant woman. Morris and his team define a subgroup of infants they call salvageable infants. They describe that subgroup as infants who are greater than or equal to twenty-six weeks' gestation with the presence of fetal heart sounds. They

emphasize that the survival of those infants is independent of maternal distress or injury, meaning those infants will most likely survive despite the severity of the pregnant woman's condition. The authors note that previous literature defined viability at twenty-eight weeks, yet eighty percent of the infants born between twenty-six and twenty-eight weeks during their study survived. Therefore, they recommend that trauma surgeons should attempt to save infants who qualify under their new definition of the salvageable infant.

As the discussion continues, Morris and his team assert that treatment of the fetus should be ignored if it does not qualify as salvageable. Instead, the physician should focus on the survival of the pregnant woman alone. They recommend the use of a Doppler machine in the initial evaluation of pregnant trauma patients. A Doppler machine uses ultrasound waves to estimate blood flow through vessels or the heart, therefore it can be used to assess blood flow through the fetal heart and to detect fetal heart tones. It is critical in determining further course of treatment. The authors argue that if no fetal heart tones are found or the infant is estimated less than twenty-six weeks' gestation, maternal resuscitation should be attempted. Finally, if a heartbeat is present and gestational age is estimated greater than twenty-six weeks, Morris and his team advise physicians to monitor the fetus in the process of maternal treatment and recommend immediate emergency cesarean section at signs of fetal distress.

In the discussion section, the authors also recommend fetal monitoring for a minimum of four hours following trauma in patients where the pregnant woman and fetus survive without need for immediate cesarean delivery. That cardiac monitoring assists physicians in evaluating the potential for placental abruption and other incidences of fetal distress. In the hospitals involved in the study, the research team implemented a twenty-four-hour protocol for fetal heart sound monitoring and recommend that as the new standard of care in their article.

In the final section of discussion, Morris and his team insist that perimortem cesarean sections should not be delayed for ultrasound evaluation of the fetus. Instead, they should be performed no matter the expected outcome for the fetus as it could potentially save the life of the pregnant woman. They continue to describe a procedure for a perimortem cesarean section, which occurs while simultaneously continuing efforts for maternal resuscitation.

Morris and his team's article has been cited in over a hundred follow up studies regarding pregnancy and trauma. The authors justified the use of emergency cesarean sections, which are a standard of care being used throughout emergency departments in the US, and provided a method for improved survival rates. Subsequent research has confirmed Morris and his colleagues guidelines on emergency cesarean sections. As of 2017, cardiac monitoring has been made mandatory in the nine hospitals involved in the study, for at least twenty-four hours following trauma. Researchers continue to increase survival rates of pregnant women and their fetuses in trauma cases.

## Sources

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