

## “Perimortem Cesarean Delivery” (1986), by Vern Katz, Deborah Dotters, and William Droegemueller

In 1986, Vern L. Katz, Deborah J. Dotters, and William Droegemueller published “Perimortem Cesarean Delivery,” an article in which they developed the Four Minute Rule for perimortem cesarean sections. The Four Minute Rule states that if a pregnant woman’s heart stops beating, physicians should begin an operation to deliver the fetus within four minutes and aim to have the fetus delivered within five minutes of cardiac arrest. Although cardiac arrest during pregnancy is uncommon, it can happen when pregnant women experience trauma, blood clots, infection, or have preexisting heart conditions. In the article, the authors emphasize how the Four Minute Rule increased maternal and fetal survival rates and decreased cases of severe fetal brain damage. The article “Perimortem Cesarean Delivery” was the first article to present the Four Minute Rule, which has influenced international guidelines and become the standard for maternal resuscitation and fetal survival in emergency medicine, operating rooms, and many other aspects of medical practice.

In October 1986 the medical journal *Obstetrics and Gynecology* published “Perimortem Cesarean Delivery.” The article’s authors, Katz, Dotters, and Droegemueller, worked as physicians in the Department of Obstetrics-Gynecology at North Carolina Memorial Hospital in Chapel Hill, North Carolina. Katz studied many aspects of women’s medicine, including the effects of stress and exercise on pregnancy. Dotters researched toxic shock syndrome as well as surgical treatments of large ovarian cysts. Droegemueller researched battered-child syndrome and diverse topics in the field of obstetrics and gynecology. Together, the authors have published further research on complications during pregnancy.

In “Perimortem Cesarean Delivery,” the authors recommend a new standard of practice regarding postmortem cesarean sections. A cesarean section is an operation in which a fetus is surgically removed from a pregnant woman through an incision in her abdomen and uterus. Cesarean operations have been used for many years and until the nineteenth century were primarily used to save the child by removing it from a woman who had already died before or during childbirth. A postmortem cesarean operation is completed after the death of the pregnant woman. In the article “Perimortem Cesarean Delivery” the authors introduce the term perimortem cesarean section, meaning a cesarean section that occurs just after the time of maternal cardiac arrest, either before or after the woman is officially declared to be dead.

The authors begin the article with an introduction to the history of postmortem cesarean delivery, followed by a discussion of the changing causes of maternal death over the last hundred years. After evaluating those causes, the authors introduce a short segment titled “Current Perspectives.” In that segment, the authors explain two necessary decisions to make regarding a cesarean operation for a pregnant woman in cardiac arrest during her third trimester: whether or not to perform the operation and when to operate. The authors ultimately argue that the operations should always be done and that they should be done as quickly as possible. They briefly introduce the Four Minute Rule. In the fourth section, the authors elaborate on their reasons for the rule and detail important aspects of maternal and fetal physiology including diversion of maternal blood flow to the fetus and blockage of vital maternal vessels by a uterus containing a fetus. In the final section, the authors evaluate the potential medical and legal risks of performing the perimortem operation as the woman is unconscious and unable to give consent to the operation. They insist that there is no legal standing to prosecute the physician, even if the woman and infant do not survive.

In the first section of the article, Katz and his team discuss the history of postmortem cesarean sections, which date back to eighteenth century BC. The authors state that, in the past, postmortem

cesarean sections were performed to save an infant's life after a pregnant woman died. Political leaders even created laws and made those procedures mandatory in an effort to save the fetus, which could later become a productive member of society. Katz and his colleagues then move on to discuss how the high infant mortality rates in previous centuries led to a view that cesarean operations were not worth the risks. According to the researchers, that perception caused a decrease in physician use of postmortem operations. The authors then state that many maternal deaths in the past resulted from dehydration and sepsis or infection. Those conditions often led to the death of a fetus before the death of the mother, making most postmortem cesarean deliveries unsuccessful, as the fetus did not survive.

In the second section, the authors evaluate the changing causes of maternal death over the last hundred years and claim that there are fewer antepartum, or before delivery, deaths and intrapartum, or during delivery, deaths due to a more than twenty-five percent decrease in maternal infection rates. The authors assert that the majority of maternal deaths in the twenty-first century are related to acute afflictions, or medical conditions that develop quickly. Those acute conditions include traumatic injuries, complications from anesthesia, embolisms or blood clots, and strokes. Katz and his colleagues reviewed 269 cases of perimortem cesarean delivery and include a table showing the causes of maternal death for the 188 infants who survived.

After discussing mortality rate data, the authors move into a short discussion of how physicians should evaluate possible perimortem cesarean deliveries. They claim that there are two important decisions to be made regarding the procedure. First, physicians must decide whether or not it is necessary to perform the operation, and second, physicians must decide when to operate. Due to the promising rate of infant survival shown in their data, Katz and his colleagues assert that physicians should always consider cesarean delivery in women who suffer cardiac arrest in their third trimester of pregnancy because it is likely that the infant will survive and the operation will give the woman a better chance for survival as well. In the matter of timing, Katz and his colleagues argue that physicians should initiate the cesarean section within four minutes of cardiac arrest and they should complete the delivery within five minutes of cardiac arrest. The authors establish those two guiding principles as their Four Minute Rule.

Following that definition, Katz and his team elaborate on their development of the Four Minute Rule, including a discussion of a pregnant woman's physiology. They explain that pregnant women are more susceptible to irreversible brain damage from lack of oxygen than non-pregnant women, due to diversion of her blood flow to the fetus. The authors derive the five-minute limit for delivery of the fetus from evidence that shows that pregnant women suffer the onset of irreversible brain damage when they are deprived of oxygen for four to six minutes. The authors further describe how cardiopulmonary resuscitation (CPR) is less successful in third trimester pregnant women. They explain that the fetus in the uterus partially blocks the blood flow from a large vein, the vena cava, which makes it more difficult to pump enough blood through the woman's body to sustain her brain function. Therefore, the authors suggest that performing a perimortem cesarean section is likely the most important step in resuscitating a pregnant woman in cardiac arrest because it relieves that pressure on the vena cava. Katz and his associates note the possibility for an assistant to maneuver the uterus in an attempt to decrease the pressure on the vena cava, but state that if the woman's pulse does not resume after multiple compressions, physicians should begin the operation.

Next, the authors review the physiology of the infant and the importance of timing in the infant's resuscitation as well. They present a table in which they review case studies of infant survival after perimortem cesarean operations. In the table, 70 percent of infants who survived a perimortem cesarean operation were delivered within five minutes of maternal cardiac arrest. Those delivered after five minutes often had severe damage to their nervous systems. The authors compare infant survival after maternal cardiac arrest with a study of resuscitated infants that went into cardiac arrest during birth. For the infants who experienced cardiac arrest, resuscitation was most successful within five minutes of cardiac arrest and the best long term outcomes were for infants who were resuscitated within that same five-minute timeframe. The authors explain that infants can tolerate lack of oxygen for approximately four minutes by directing blood to their most vital organs. However, the authors also cite experiments that demonstrated that infants can have good long term outcomes even if they were without oxygen for greater than four minutes. Therefore, the authors

justify initiating a cesarean operation up to 25 minutes after maternal cardiac arrest, stating that is the longest recorded time an infant survived without oxygen.

In the final section of the paper, Katz and his colleagues acknowledge the risks associated with a perimortem cesarean delivery. They briefly note the medical risks of infant nervous system damage during the operation and the risk of harm to a woman who was wrongfully diagnosed with cardiac arrest. The authors move into a legal context and state that there are no legal risks for a physician that performs a perimortem cesarean operation, no matter the outcome, as no physician has ever been found liable for injuries to the infant or the pregnant woman in those cases. They also point out that some areas of the US have specific laws that protect physicians who perform perimortem cesarean operations. The authors evaluate the chance that a physician would be charged with mutilating a corpse, but explain that the operation does not apply as a wrongful dissection because there is no criminal intent. Katz and his fellow authors also assess the need for a patient or their power of attorney to consent for an operation. Consent is a demonstration of understanding and permission that patients give to physicians before they perform an operation. Usually, without the patient's consent, a physician cannot operate. The authors argue that emergency consent is implied in the cases of maternal cardiac arrest and family member consent is irrelevant because they have no legal right to deny consent to an operation that may save an infant's life.

After publishing "Perimortem Cesarean Delivery," Katz and his colleagues continued to publish articles that further developed the Four Minute Rule and emphasized its applicability. In 2005, Katz, physician Keith Balderston, and physician Melissa DeFreest presented new case studies that supported the efficacy of the Four Minute Rule in their paper "Perimortem Cesarean Delivery: Were our Assumptions Correct?" In 2015, physicians Carl Rose, Arij Faksh, Kyle Traynor, Daniel Cabrera, Katherine Arendt, and Brian Brost published the paper "Challenging the 4- to 5-Minute Rule: From Perimortem Cesarean to Resuscitative Hysterotomy," in which they advocated for the use of the term resuscitative hysterotomy, rather than perimortem cesarean, in order to place greater importance on the life and resuscitation of the pregnant woman. As of 2017, the Four Minute Rule, despite small changes, continues to be standard in emergency departments and operating rooms across the US. The Four Minute Rule became part of international guidelines, such as the European Resuscitation Council guidelines, and is being used by multiple medical fields including emergency, trauma, and critical care medicine. When used, those guidelines lead to an increased likelihood of maternal and fetal survival without brain damage.

## Sources

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