Introduction: Perimortem cesarean section is a rare, time-critical, and potentially life-saving procedure for both the fetus and mother. This makes perimortem cesarean section an ideal and recommended subject for simulation learning and practice.

Methods: Various attempts have been made to produce models to simulate emergency cesarean sections. We designed a cost-effective and easy to assemble model that can be used with any high fidelity simulator. The model was used as part of a simulation education module that is part of resident educational conferences. After the simulation day, residents were asked to fill out an anonymous online survey using a 5-point Likert scale.

Results: Thirty-four emergency medicine residents took part in a perimortem cesarean section case. Nine (26%) completed the online survey. Eight respondents agreed or strongly agreed [4.33 (0.71)] that the model helped to familiarize them with a perimortem cesarean section. Eight residents also agreed or strongly agreed [4 (0.87)] that they were better prepared to perform this procedure, and 9 residents felt that knowledge from this session would help with their emergency department rotations [4.11 (0.33)]. Six residents agreed or strongly agreed that this model was a good replication of human anatomy [3.78 (0.97)]. All respondents agreed or strongly agreed [4.56 (0.53)] that this session enhanced learning more than traditional lectures and reading alone.

Conclusion: We present here an inexpensive, easy to make, and portable model, which can be used to simulate an emergency cesarean section.

Key Words: Perimortem cesarean section, Simulation model

Perimortem cesarean section is a rare, time-critical, and potentially life-saving procedure for both the fetus and mother. Postmortem sections have been referenced in distant history, notably in Shakespeare’s play Macbeth. This practice fell out of favor through the years but was resurrected in the mid 1980s. It still remains a very rare procedure with Katz et al finding only 38 case reports identified in the literature during a review in 2005.

In a 1986 review of causes of maternal death, Katz et al identified a shift from chronic infectious disease to more acute cardiopulmonary collapse. This suggests that an otherwise healthy mother likely nourished a healthy fetus up until the time of arrest. Because mothers are healthier, the fetus has some, though limited, reserve buying time for delivery and resuscitation of the infant. Today, case reports suggest fetal survival and neurologic outcome are related to time between maternal death and delivery. Further investigation supports the generally accepted goal for initiation of perimortem cesarean section is 4 minutes with delivery within 5 minutes for optimal outcome.

Outcomes tend to be poorer with time, infant survival and good neurologic outcome has been reported with sectioning up to 30 minutes after maternal death.

In the event of maternal cardiac arrest, cardiopulmonary resuscitation should be initiated. Any fundal height at or above the level of the umbilicus is potentially a salvageable fetus. A fetus of this size also has the potential to impede maternal venous return, so the patient should be placed in the left lateral position, and case reports suggest perimortem cesarean section can be beneficial for maternal resuscitation by relieving inspiratory vital capacity compression. If this is the case, perimortem cesarean section should be considered with ongoing maternal cardiopulmonary resuscitation using the procedure as described by Stallard et al. American Heart Association, American College of Obstetricians and Gynecologists, and East group guidelines recommend perimortem cesarean sectioning, ideally within 4 minutes of maternal arrest, as part of both fetal and maternal resuscitation.

In light of the evidence, experts and organizations have emphasized the importance of preparation and multidisciplinary collaboration. Although rare, a strategy for management of circulatory arrest in pregnancy should be established in all labor and emergency units, including the availability of an emergency cesarean section kit.

The rare incidence of maternal arrest, the need for time-critical performance of the procedure, the requirement for ongoing maternal resuscitative efforts during the procedure, and the need for interdisciplinary collaboration for continued resuscitative efforts directed at not one but two patients after the procedure makes perimortem cesarean section an ideal
and recommended subject for simulation learning and practice.\textsuperscript{6,15,16} Given that simulation had been found in previous studies to improve team training and enhance didactic teaching, this model is an ideal teaching tool for this topic.\textsuperscript{17}

**METHODS**

**Cesarean Section Model**

Various attempts have been made to produce models to simulate emergency caesarian sections. We designed a cost-effective and easy to assemble model that can be used with any high fidelity simulator.

To construct the model, we assembled the following items: foam mattress pad ($10 each), 1 bushel-sized laundry basket ($2.75), 2 shower curtains (1 flesh-colored and 1 clear) ($5.00), 1 child’s 15-in play ball ($3.00), punching balloons, and zip ties. All of the previous items were purchased for a total of $70. These materials yielded 7 models.

Mattress pad foam was cut into 20 × 22-in pieces. Two pieces of the laundry basket sides 12-in high × 6-in wide were cut and then stapled to the rough side of the mattress pad foam. These pieces were spaced equally apart on the foam. The laundry basket pieces provide support to the model. The flesh-colored shower curtain was then placed on the smooth side of the mattress pad foam and curled around the edges where it was stapled along the border. Keeping the shower curtain material as tight as possible is important to model integrity. The shower curtain material served as the skin. Clear shower curtain material was now applied to the rough side of the model by stapling it to the laundry basket pieces. This served as the peritoneal layer.

The external portion of the model was now completed (Fig. 1). This model can be combined with a Noelle simulator. If using a different simulator model, a rope can be attached to the border of the external abdomen, which can be tied around the mannequin.

To assemble the internal portion of the model, we started by filling the punching balloon with water. We tied off the top and put it aside. The 15-in play ball was cut with an opening large enough to accommodate the fetus. This served as the uterus. We used a Gaumard birthing fetus in our model. For ease of insertion, we folded the fetus and wrapped the umbilical cord around the model. Be careful when inserting the fetus because the ball can easily tear. Applying baby powder inside the ball helps with facilitating insertion of fetus (Fig. 2). Next, we inserted the punching balloon inside the ball on the anterior aspect of the uterine model. This added realism to the delivery by providing simulated amniotic fluid. The ball was closed with a zip tie.

Now the uterus was loaded into the empty Noelle abdomen or can be placed on the abdomen of any mannequin. Tape can be applied to any open edges of abdomen (Fig. 3).

The model was then used as part of a simulation education module that is part of resident educational conferences. The residents were presented with a young female patient who was 38 weeks pregnant and was involved in a motor vehicle collision. Just before arrival, emergency medical services reported a loss of vital signs. During this 30-minute scenario, the residents were expected to perform a perimortem cesarean section and resuscitate the neonate. The mother expires in this scenario. Debriefing followed the scenario, which included indications for a perimortem cesarean section and how to perform the procedure.
FIGURE 4. Trainee feedback.

After the simulation day, residents were asked to fill out an anonymous, online survey (www.surveymonkey.com) using a 5-point Likert scale (5=strongly agree). Likert scale results are reported as mean (SD). The Washington University institutional review board approved the study.

RESULTS

Thirty-four emergency medicine residents of a 4-year training program took part in perimortem cesarean section case. Nine (26%) completed the online survey (Fig. 4). Eight respondents agreed or strongly agreed [4.33 (0.71)] that the model helped to familiarize them with perimortem cesarean section. Eight residents also agreed or strongly agreed [4 (0.87)] that they were better prepared to perform this procedure, and 9 residents felt that knowledge from this session would help with their emergency department rotations [4.11 (0.33)].

Only 6 residents agreed or strongly agreed that this model was a good replication of human anatomy [3.78 (0.97)]. All respondents agreed or strongly agreed [4.56 (0.55)] that this session enhanced learning more than traditional lectures and reading alone.

DISCUSSION

We have described how to build an inexpensive, portable, and well-accepted model from those who responded to the survey that can be used by emergency medicine residents and other practitioners to gain experience in the skills required to perform a perimortem cesarean section. All respondents agreed that this style of teaching enhanced the learning when compared with lectures alone. The majority of residents responding also found that this model helped to better prepare them for this rarely needed but high-risk skill.

CONCLUSION

We present here an inexpensive, easy to make, and portable model, which can be used to simulate an emergency perimortem cesarean section. Limitation included the small response rate for the survey leading to the possibility of response bias. Duplication of the study with mandatory survey response could be considered for more reliable data. Further research would need to be conducted to establish if this model would lead to improved patient outcomes, but given the rare occurrence of perimortem cesarean section, data will be scarce (see Video, Supplemental Digital Content 1, http://links.lww.com/SHI/A72; construction of cesarean section model and use in practice).

REFERENCES