3. Bremer C, Cassata L. Trauma in pregnancy. Nurs Clin North Am 1986; 21:705–716.
4. Buchsbaum H. Traumatic injury during pregnancy. In: Barber HRK Graber EA, ed. Surgical Disease. Philadelphia: WB Saunders; 1974:184–202.
5. Chang SS, Chang MC, Morris JA Jr. Trauma in pregnancy–the maternal-fetal relationship. J Tenn Med Assoc 1994; 87:291–292.
6. Esposito TJ, Gens DR, Smith LG, et al. Trauma during pregnancy. A review of 79 cases. Arch Surg 1991; 126:1073–1078.
7. Franger AL, Buchsbaum HJ, Peaceman AM. Abdominal gunshot wounds in pregnancy. Am J Obstet Gynecol 1989; 160:1124–1128.
8. Johnson JD, Oakley LE. Managing minor trauma during pregnancy. J Obstet Gynecol Neonatal Nurs 1991; 20:379–384.
9. Kissinger D, Rozycki GS, Morris JA Jr., et al. Trauma in pregnancy: predicting pregnancy outcome. Arch Surg 1991; 31:1079–1086.
10. Lavery JP, Staten-McCormick M. Management of moderate to severe trauma in pregnancy. Obstet Gynecol Clin North Am 1995; 22:69–90.
11. Lee RB, Wudel JH, Morris JA Jr. Trauma in pregnancy. J Tenn Med Assoc 1990; 2:74–76.
12. Mighty H. Trauma in pregnancy. Crit Care Clin 1994; 10:623–634.
13. Neufeld JD, Moore EE, Marx JA, Rosen P. Trauma in pregnancy. Emerg Med Clin North Am 1987; 5:623–640.
14. Oakley LE, Johnson JD. Traumatic injury during pregnancy. Crit Care Nurse 1991; 11:64–73.
15. Pearlman MD, Tintinalli JE, Lorenz RP. Blunt trauma during pregnancy. N Engl J Med 1990; 323:1609–1613.
16. Rothenberger D, Quattlebaum FW, Perry JF Jr., et al. Blunt maternal trauma: a review of 103 cases. J Trauma 1978; 18:173–179.
17. Smith LG. Assessment and initial management of the pregnant trauma patient. J Trauma Nurs 1994; 1:8–18.
18. Timberlake GA, McSwain NE Jr. Trauma in pregnancy. A 10-year perspective. Am Surg 1989; 55:151–153.
19. Mossman KL, Hill LT. Radiation risks in pregnancy. Obstet Gynecol 1982; 60:237–242.
20. Awwad JT, Azar GB, Aouad AT, et al. Postmortem cesarean section following maternal blast injury: case report. J Trauma 1994; 36:260–261.
21. Iliya FA, Hajj SN, Buchsbaum HJ. Gunshot wounds of the pregnant uterus: report of two cases. J Trauma 1980; 20:90–92.
22. Carlson E. Emergency c-section. Ann Emerg Med 1983; 12:410–411.
23. Ritter J. Postmortem cesarean section. JAMA 1961; 175:715–716.
24. Buchsbaum HJ, Cruicshank DP. Postmortem cesarean section. In: Buchsbaum HL, ed. Trauma in Pregnancy. Philadelphia: WB Saunders; 1979:236–249.
25. DePace NL, Betesh JS, Kotler MN. 'Postmortem' cesarean section with recovery of both mother and offspring. JAMA 1982; 248:971–973.
26. Arthur R. Postmortem cesarean section. Am J Obstet Gynecol 1978; 132:175–179.
27. Williams JK, McClain L, Rosemurgy AS, Colorado NM. Evaluation of blunt abdominal trauma in the third trimester of pregnancy: maternal and fetal considerations. Obstet Gynecol 1990; 75:33–37.
28. Baker SP, O'Neill B, Haddon W Jr., et al. The injury severity score–a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974; 14:187–196.
29. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974; 2(872):81–84.
30. Rutledge R, Fakhry SM, Rutherford EJ, et al. Comparison of APACHE II, Trauma Score, and Injury Severity Score as predictors of outcome in critically injured trauma patients. Am J Surg 1993; 166:244–247.
31. Peckham CH, King RA. A study of intercurrent conditions observed during pregnancy. Am J Obstet Gynecol 1963; 87:609–624.
32. Scorpio RJ, Esposito TJ, Smith LG, Gens DR. Blunt trauma during pregnancy: factors affecting fetal outcome. J Trauma 1992; 32: 213–216.
33. Sherman HF, Scott LM, Rosemurgy AS. Changes affecting the initial evaluation and care of the pregnant trauma victim. J Emerg Med 1990; 8:575–582.
34. Agran PF, Dunkle DE, Winn DG, Kent D. Fetal death in motor vehicle accidents. Ann Emerg Med 1987; 16:1355–1358.
35. Pearlman MD, Tintinalli JE, Lorenz RP. A prospective controlled study of outcome after trauma during pregnancy. Am J Obstet Gynecol 1990; 162:1502–1507.
36. Goodwin TM, Breen MT. Pregnancy outcome and fetomaternal hemorrhage after noncatastrophic trauma. Am J Obstet Gynecol 1990; 162:665–671.
37. Drost TF, Rosemurgy AS, Sherman HF, et al. Major trauma in pregnant women: maternal/fetal outcome. J Trauma 1990; 30: 574–578.
38. Farmer DL, Adzick NS, Crombleholme WR, et al. Fetal trauma: relation to maternal injury. J Pediatr Surg 1990; 25:711–714.
39. Hoff WS, D'Amelio LF, Tinkoff GH, et al. Maternal predictors of fetal demise in trauma during pregnancy. Surg Gynecol Obstet 1991; 172:175–180.
40. Neufeld JD. Trauma in pregnancy, what if. . . ? Emerg Med Clin North Am 1993; 11:207–224.
41. Rothenberger DA, Horrigan TP, Sturm JT. Neonatal death following in utero traumatic splenic rupture. J Pediatr Surg 1981; 16: 754–755.
42. Eddy V, Morris JA Jr, Rozycki G. Trauma and pregnancy. In: Ivatury R, Cayten C, eds. The Textbook of Penetrating Trauma. Baltimore: Williams & Wilkins; 1995: 695–701.
43. Perinatal care at the threshold of viability. Committee Opinion 1995; 163:1–4.
44. American College of Surgeons. Advanced Trauma Life Support Course Book. Chicago: ACS; 1990.
45. Hack M, Taylor HG, Klein N, et al. School-age outcomes in children with birth weights under 750 g [see comments]. N Engl J Med 1994; 331:753–759.
46. Allen MC, Donohue PK, Dusman AE. The limit of viability—neonatal outcome of infants born at 22 to 25 weeks' gestation. N Engl J Med 1993; 329:1597–1601.
47. Colucciello S. The challenge of trauma in pregnancy: guidelines for targeted assessment, fetal monitoring, and definitive management. Emerg Med Rep 1995; 16:171–181.
48. Crosby WM, Castiloe JP. Safety of lap-belt restraint for pregnant victims of automobile collisions. N Engl J Med 1971; 284:632–636.

## Discussion

DR. J. ALEX HALLER, JR. (Baltimore, Maryland): Mr. President, Mr. Secretary, Ladies, and Gentlemen. I appreciate the opportunity of having reviewed Dr. Morris's manuscript, not just for myself but, as he knows, he had two reviewers because my wife Emily, who is an obstetrician and in a high-risk pregnancy group, also greatly enjoyed the paper and has a few comments to be passed along to you, John, through me.

One of her questions is the fact that there is no mention in your data or in the documentation of what the role of an obstetrician was in the decision and the management of these patients. And although you say in passing that it is important to get obstetric consultation, I would like to ask you, for her, exactly what that means and how frequently there was an obstetrician present in that evaluation?

This is not provincial on her part, but simply emphasizes the importance of your point that you need to have fetal monitoring, and that is not just fetal heart rate, but the curves associated with contraction of the uterus, the deceleration and acceleration present in those fetal movements, and that is very difficult just to learn overnight as a resident working in a trauma center.

But obstetricians should be available and they should participate, as she points out, particularly in that area.

I have a couple of questions, and I want to direct those questions by having three slides shown. You mentioned in your manuscript but did not get a chance to emphasize that on the basis of your data you would like to see some changes in the recommendations of the Advanced Trauma Life Support (ATLS) course in the section on trauma to pregnant patients.

These are three of those slides, and I want to just show them because I thought it might be helpful to you in making the point and also gives me the chance to ask a question and hope for an answer.

Continuous fetal monitoring needs to be defined because that is not present in every emergency room and is not just fetal heart tones, as pointed out by my consultant. It is important to have an obstetrician present, particularly if you have any time to make those decisions.

And the second slide speaks to the changed physiology in the patient in the third trimester that we all know about but needs to be emphasized. And I wonder if some of these changes, particularly in blood volume, the changes in peripheral vascular resistance might not be reflected, John, in the fact that the Injury Severity Scores (ISSs) do not correlate. It may well be—and I would like to ask you and your group—if the ISSs are appropriate for a patient who has a 50% increase in blood volume? Perhaps these need to be looked at from that standpoint and might be a partial explanation for why those patients with high ISSs and their fetuses did just as well and often better.

And, finally, I wanted to emphasize that because you would like to see this determination of fetal viability moved up into the primary care and primary evaluation section of the ABCs isn't it also important to move up in your consultation list an obstetrician when a patient comes in who is greater than 25 weeks pregnant? You already know you have an obstetrical problem, don't you need a consultant at that point?

Thank you very much.

DR. EDWIN IDE SMITH (Dallas, Texas): President Thompson, Secretary Copeland, Members, and Guests.

I would like to address penetrating wounds of the pregnant uterus—an example of which is shown on this slide, a case that was reported by Dr. Kendall McNabney and myself a number of years ago. There are two areas of interest. First are the legal and ethical problems which may arise. This newborn baby suffered an intrauterine penetrating wound of the abdomen when the mother was stabbed by the father. The mother refused to bring charges against the father. Subsequently the father was prosecuted by the authorities on behalf of the infant. However, when the parents came into court hand-in-hand, charges were dropped.

There would be serious ethical and legal problems if the mother would refuse operation with a child whose heart sounds were failing. I would ask the authors if, in their experience, there were any notes of problems of this sort.

The second area is what were the causes of the deaths of the infants? Were they largely placental or were they largely injury to the infant? With the current sttus of perinatology and the frequent invasion of the uterus for either diagnostic or therpeutic purposes, there might be some additional diagnostic information that might be valuable in a semi-emergent condition. I wonder if the authors might speculate as to what help modern perinatology and intrauterine surgery might afford.

This little newborn had only a contusion of the small intestine and an abrasion of the liver. It is probable that an intestine without air is much less vulnerable to penetrating injury.

A distinguishing member of this Association now departed, Mark Ravitch, wrote in 1981 regarding fetal surgery that "Men have climbed Mt. Everest because it is there. One must have a better reason for invading the pregnant womb." The comment is very reminiscent of Dr. Ravitch. Today, however, I would suggest that there might be a reason to consider trauma such a special reason to invade the pregnant womb.

Thank you. I appreciate the opportunity to comment.

DR. GRACE ROZYCKI (Atlanta, Georgia): President Thompson, Secretary Copeland, Members, and Guests, it is indeed an honor to be asked to discuss this paper from nine premier trauma centers in our country.

This study attempts to define the role of a critical issue, the indication of a perimortem cesarean section in the traumatized patient. I commend the authors for their fine work, not only because trauma surgeons need to know the answer, but also because our colleagues in obstetrics, neonatology, pediatrics, emergency medicine, and nursing also need some guidelines as well.

Additionally, this was not an easy task because complete data on the injured pregnant patient is not always available in trauma registries.

I have two questions for the authors. Relative to the unique physiology of the pregnant patient—*i.e.*, the physiologic hypervolemia and its concomitant hyperdynamic state—we know that Injury Severity Score does not relate well to, as you mentioned, the outcome or the maternal physiology. Would revised trauma score and possibly admission base deficit be better to examine, and would this have eliminated the delays in diagnosis of fetal distress?

Also, did you stratify the mothers' injuries? In other words, relate a specific injury—*e.g.*, a blow to the abdomen—to fetal outcome? I think this is not only important for those with a direct blow or traumatized pelvis, but also for those with severe closed-head injury who have a continuous prolonged catecholamine release causing uteroplacental vasoconstriction and fetal distress long before it is known in the mother.

I enjoyed reading this paper very much and express my appreciation to the Association for the privilege of the floor.

DR. RICHARD J. FIELD, JR. (Centerville, Mississippi): Dr. Thompson, Dr. Copeland, Members, and Guests, I appreciate the opportunity of the floor. I have no questions because I agree with Dr. Morris and his group in what they have done. I particularly thank him for bringing this subject to our attention. There is very little written in the literature regarding third trimester cesarean section in the traumatized individual. My problem was the same as Dr. Morris's because this trauma in the third trimester of pregnancy is a rather infrequent happening, and when it does occur, it may find us unprepared as to a proper plan of action. We have had two cases in our institution in the last 20 years, and both times we did do surgery with success. I am a representative of surgery in rural Mississippi, and in very few places do we have obstetrician gynecologists in this environment. Thus, in our hospital, the two general surgeons, my son and I, do the cesarean sections for the general practitioners and nurse midwives who do the obstetrics for us out there.

Our obstetricians do use the fetal monitor and find it, although not completely accurate, a good indicator of the status of the fetus. When there is a problem, they contact us, and as a team we make the decision to accomplish a cesarean section. In the two cases mentioned, it was obvious that there was fetal distress, leading us to a rather rapid cesarean section in each case. A cesarean section is a relatively easy and quickly accomplished procedure that can be done generally in less than 30 minutes. Thus, the trauma is minimal to the patients and can be accomplished in the severely traumatized individual as necessary. We feel it is important to be aggressive in this type case and are encouraged by Dr. Morris's fetal survival and his belief, as is ours, that the cesarean section does not increase the mortality or morbidity either to the fetus or to the mother.

Thank you very much for the floor, and thank you for presenting this interesting and important paper.

DR. LEWIS M. FLINT, JR. (New Orleans, Louisiana): Thank you, Mr. President. For those of you who wondered about the ownership issue of Tulane, I will be happy to discuss it with you. It has not been terrible so far.

I would just like to congratulate John and his colleagues on this work and ask a couple of questions because, while we heard a lot about outcome, that is, alive or dead, we did not hear much about outcome in these young patients who have a long time to live.

For example, because we know that many injured patients are intoxicated with alcohol or other drugs, were there complications of maternal drug or alcohol use in any of your surviving infants?

You promised to tell us how much it cost to take care of the surviving infants, but that data was not in the presentation, and I would just like to know how many had to spend a significant period of time in the neonatal intensive care unit, how many of them had to be ventilated, and how long was the average hospital stay for the surviving infants.

I think this is an important contribution, and I congratulate you for the hard work that you and all the other individuals did to put it together.

DR. BASIL A. PRUITT, JR. (San Antonio, Texas): Dr. Thompson, Dr. Copeland, Members, and Guests. I rise to compliment the authors and the many institutions that contributed to this paper. We have examined fetal survival in a cohort of pregnant burn patients and confirmed that gestational age is the most important determinant of fetal outcome.

I have a feeling that we have seen the results of just the first 24 hours during the resuscitation period, Dr. Morris, and I wonder what happens in those patients that go to the intensive care unit following initial recovery. In our pregnant burn patients we found that hypoxemia, hypotension, electrolyte abnormalities, and sepsis are powerful deteminants of pregnancy outcome and of maternal survival as well, and I wonder if you looked at that.

Lastly, in those patients who do have a complicated course and develop premature labor, have you found any role for tocolytic agents in maintaining the intra-uterine persistence of the pregnancy?

Thank you.

DR. TODD J. ROSENBOWER (Closing Discussion): I would like to thank all the discussants for their comments and questions and thank the Association for allowing me to close this presentation.

First, Dr. Haller, obstetricians were in all of these cases. At our institution when a pregnant patient comes in, an obstetrician is involved immediately in the emergency department. They usually perform the ultrasound for us and initiate the fetal monitoring.

Continuous fetal monitoring involves an external monitor, a cardiotopographic monitor, somebody competent at reading the monitoring, usually an obstetric nurse.

As for the Injury Severity Score score appropriate for this group, given their changed physiology, this is an anatomic measure, we realize, not a physiologic measure, so I really cannot comment much on that.

For Dr. Smith, regarding problems with permission for cesarean sections in women who have suffered penetrating trauma, we only had three women who suffered penetrating trauma, and in those three women, we had no problem with permission for the cesarean section.

Also, for the causes of the infant deaths, although we did not receive any postmortem data on these patients—most of them did not have an autopsy—we believe that most of the deaths were related to placental injuries.

And, finally, for Dr. Smith: The role of modern perinatology in intrauterine surgery and penetrating trauma, well, I really do not have any data on that, so I cannot give you a very good answer.

With respect to Dr. Rozycki's questions, would Revised Trauma Score and admission base access aid in fetal survival? Admission base access, I think, would and has been documented in the previous literature. The Revised Trauma Score, we did not do in real time.

With regards to categorizing the injuries to the fetus, because this was a retrospective multi-institutional group, we did not do that.

With regard to Dr. Flint: The complications of maternal drug use in surviving infants, I can tell you what our long-term survival of the infants is. Of the 15 surviving infants, we have long-term follow-up on 7 of them. Four of those infants are alive and well, no long-term problems. Three of those infants do have some long-term problems. One has chronic lung disease. Another has retinopathy prematurity and a unilateral hearing loss. And the fourth has developmental delay cerebral palsy, hypothyroidism, and retinopathy prematurity.

Questions from Dr. Pruitt: Because of the retrospective nature of the study, we were unable to categorize all patients that went to the intensive care unit. But at our institution, patients were monitored in the intensive care unit. Some had gone as long as 2 days before needing the emergency cesarean section.

And, finally, the patients in preterm labor and tocolytics, again, the retrospective nature of the study did not allow us to study this, although, I can tell you in the literature that Dr. Pearlman reported that 90% of the patients who suffered premature labor as a complication of trauma in pregnancy did not require tocolytics.

Again, I would like to thank the Association for allowing me to close this presentation.