Hemoperitoneum Score Helps Determine Need for Therapeutic Laparotomy

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Purpose: **Sonography provides a fast, portable, and noninvasive method for patient assessment. However, the benefit of providing real-time ultrasound (US) imaging and fluid quantification shortly after patient arrival has not been explored. The objective of this study was to prospectively validate a US hemoperitoneum scoring system developed at our institution and determine whether sonography can predict a therapeutic operation.**

Methods: **For 12 months, prospective data on all patients undergoing a trauma sonogram were recorded. All sonograms positive for free fluid were given a hemoperitoneum score. The US score was compared with initial systolic blood pressure and base deficit to assess the ability of sonography to predict a therapeutic laparotomy.**

Results: **Forty of 46 patients (87%) with a US score ≥ 3 required a therapeutic laparotomy. Forty-six of 54 patients with a US score < 3 (85%) did not need operative intervention. The sensitivity of sonography was 83% compared with 28% and 49% for systolic blood pressure and base deficit, respectively, in determining the need for therapeutic operation.**

Conclusion: **We conclude that the majority of patients with a score ≥ 3 will need surgery. The US hemoperitoneum scoring system was a better predictor of a therapeutic laparotomy than initial blood pressure and/or base deficit.**

Key Words: **Ultrasound, Prospective, Trauma, Hemoperitoneum, Laparotomy, Score.**

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For the blunt trauma victim, swift identification of intra-abdominal bleeding with prompt and appropriate laparotomy is critical for reducing unnecessary morbidity and mortality. Yet even for the seasoned clinician, determination of the need for operative intervention can present a challenge. The information immediately available to the surgeon after a patient's arrival includes physical examination of the abdomen, the initial systolic blood pressure (SBP), and base deficit (BD), all of which are unreliable. For the unstable or marginally stable patient, diagnostic peritoneal lavage (DPL) has been the favored modality for the assessment of intra-abdominal hemorrhage.[1–3] DPL, however is invasive and overly sensitive, resulting in unnecessary laparotomies.[4–8] Although it is regarded as a rapid technique, unless the lavage fluid is grossly positive, DPL can delay laparotomy while awaiting laboratory determination of red blood cell counts.

Popular in Europe and Asia for over two decades, trauma sonography is emerging as the preferred screening test for blunt abdominal trauma in North America. Prospective studies from the United States report sensitivities ranging from 81% to 98% for the detection of intra-abdominal injury.[9–12] Abdominal sonography provides a noninvasive, rapid, portable, and low-cost method of patient evaluation. Sonography permits demonstration of the amount and extent of intraperitoneal hemorrhage. The benefit of providing real-time imaging with fluid quantification immediately after patient arrival has yet to be explored. Estimates of fluid volume thus far have been limited to descriptive terms such as "trace," "moderate," and "large." To provide a more meaningful estimate of fluid volume, we previously reviewed our positive trauma sonograms and developed a scoring system for hemoperitoneum.[13] A retrospective analysis was performed on 400 positive abdominal ultrasound (US) studies collected from our trauma database. A hemoperitoneum score was calculated for each positive ultrasound and recorded along with the initial systolic blood pressure and base deficit. The results of this study were analyzed by using various predetermined values for the hemoperitoneum score correlated with patient outcome. A receiver operator characteristic curve identified an ultrasound score of ≥ 3, SBP of ≤ 90 mm Hg, and BD of ≥ 6 as the most accurate predictors of a therapeutic operation. The objective of this current study was to prospectively validate our hemoperitoneum scoring system as a predictor of the need for a therapeutic laparotomy.

PATIENTS AND METHODS

All blunt abdominal trauma patients triaged to the Ryder Trauma Center at the University of Miami/Jackson Memorial Hospital underwent screening abdominal sonography if not cleared by physical examination. To validate the scoring system, we prospectively evaluated all patients with a positive trauma ultrasound during 12 consecutive months ending

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in January 1999. Patients were evaluated using an Acuson 128/XP ultrasound system (Acuson, Mountain View, CA). Studies were performed using a 3.5-MHz sector transducer or, occasionally, a 2-MHz sector transducer for large patients. A registered sonography technologist, supervised by a faculty radiologist or senior radiology resident, performed the sonography. All examinations were performed at arrival in the resuscitation room with the overhead lights turned off (spotlights used as needed for ongoing resuscitation). Our routine screening sonogram consists of longitudinal and transverse images of the right upper quadrant, including the right subphrenic space and subhepatic space; the left upper quadrant, including the left subphrenic space and perisplenic area; and pelvis. These five peritoneal regions represent the sites for potential fluid accumulation and are used to determine the hemoperitoneum score. To optimize evaluation of the pelvis, the inserted urinary catheter was clamped and, if needed, a sterile saline solution was infused to distend an empty bladder.

To determine a patient's hemoperitoneum score, the region of the peritoneum containing the largest collection of fluid is identified first. Since the patient is supine and gravity-dependent fluid will fill the peritoneal recesses, a measurement of the fluid pocket is obtained from anterior (near the surface of the abdomen) to posterior, at the site of greatest depth. This is not a measurement of the greatest diameter of a fluid collection but rather that of a fluid level in a supine abdomen, and may be measured either on transverse or longitudinal images. The depth is calculated by the US machine and recorded to the nearest tenth of a centimeter. To complete the score, one point is given for each additional area positive for fluid. The depth of the largest collection plus the total additional points given equals the patient's hemoperitoneum score (Fig. 1).

All sonograms positive for free fluid were given a hemoperitoneum score and formed our study population. Although evaluation of the liver, spleen, and pericardium were also assessed (as part of our routine screening examination), the presence of parenchymal injury or hemopericardium was not considered for scoring purposes. Sonograms were excluded if positive for parenchymal injury or hemopericardium without free intraperitoneal fluid. To determine the best predictor of a therapeutic operation, the initial systolic blood pressure and base deficit were also recorded for each patient with a positive ultrasound. The predetermined values for an US score (USS) of ≥ 3, SBP of ≤ 90 mm Hg, and BD of ≥ 6 were analyzed with χ^2 (significance was defined as $p < 0.05$) as potential predictors of the need for operative inter-

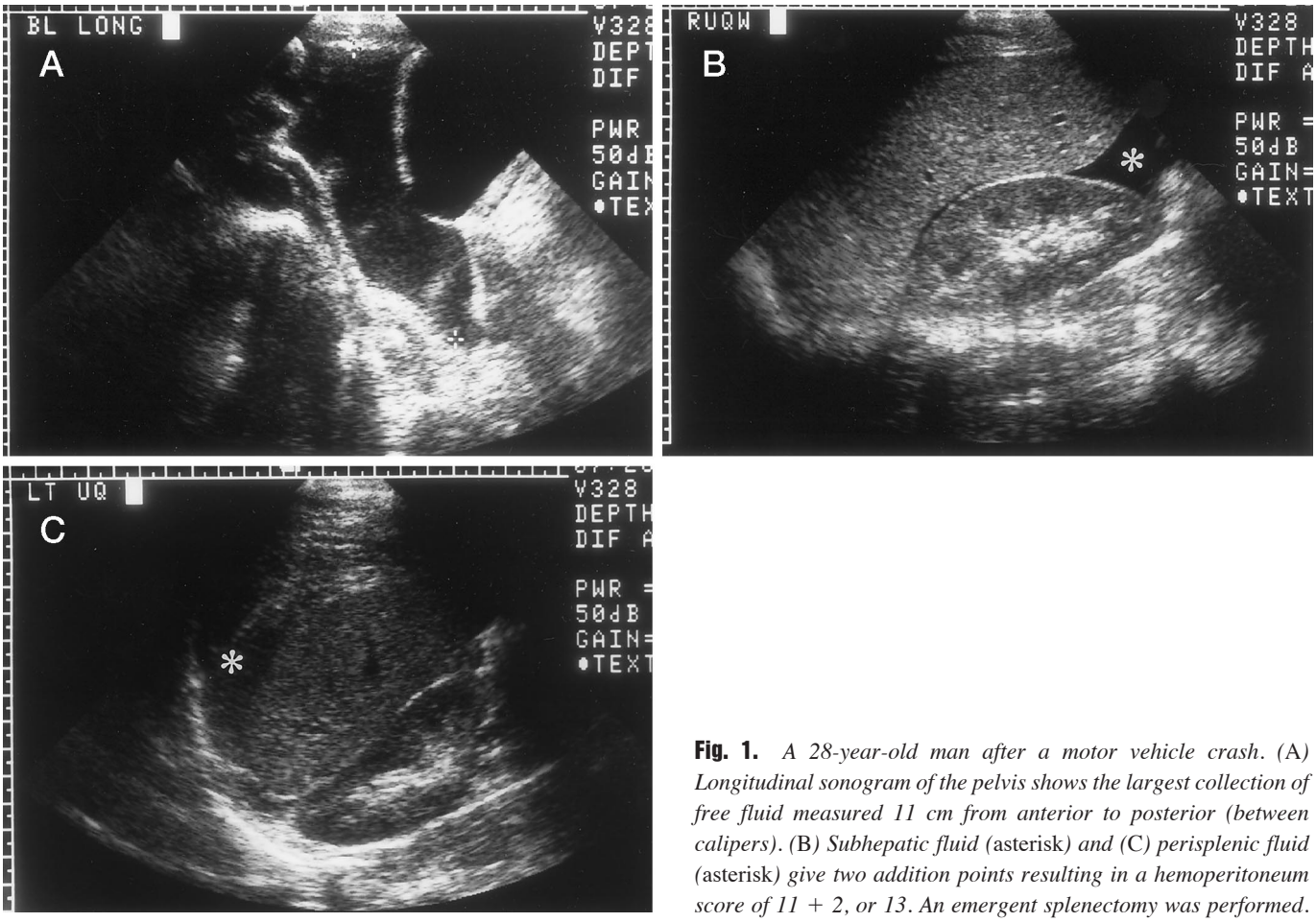

Fig. 1. *A 28-year-old man after a motor vehicle crash. (*A*) Longitudinal sonogram of the pelvis shows the largest collection of free fluid measured 11 cm from anterior to posterior (between calipers). (*B*) Subhepatic fluid (*asterisk*) and (*C*) perisplenic fluid (*asterisk*) give two addition points resulting in a hemoperitoneum score of 11 + 2, or 13. An emergent splenectomy was performed.*

vention. Comparison of the accuracy of the USS, SBP, and BD was performed using analysis of variance (significance defined as $p < 0.05$).

The surgical team made operative decisions with all available information including SBP, BD, USS, physical examination, and computed tomographic (CT) scan. Criteria for determination of a therapeutic laparotomy were created post hoc. All attending trauma surgeons involved agreed to the criteria. The laparotomy was considered therapeutic when findings included one or more of the following: spleen or liver lacerations bleeding at the time of surgery, hollow viscus perforation, diaphragmatic laceration, and bleeding mesenteric injury. A nontherapeutic laparotomy resulted when operation revealed nonbleeding liver or spleen lacerations, hollow viscus contusions, and stable mesenteric hematomas.

RESULTS

There were 1,292 sonograms obtained during the 12-month study period. From this group of patients, 100 sonograms were positive for free intraperitoneal fluid and formed our study population.

Hemoperitoneum Score

Forty-six of the 100 patients had a USS ≥ 3 (Table 1). In this group, 40 of the 46 (87%) required a therapeutic operation, whereas 6 of 46 (13%) did not require operative intervention. Fifty-four patients had a USS < 3. In this group, 46 (85%) patients, including 2 patients undergoing a nontherapeutic operation, did not need operative intervention (Fig. 2). Eight of the 54 patients or 15% of patients with a USS < 3 had a therapeutic operation.

Initial Systolic Blood Pressure

Eighteen of the 100 patients presented with shock with SBP ≤ 90 mm Hg (Table 2). In this group, 13 of 18 (72%) underwent a therapeutic operation. Eighty patients were normotensive at arrival (SBP > 90 mm Hg). Thirty-four of these patients (42%) required operative intervention, whereas 46 (58%) did not. The outcome of patients with a high USS was compared with the initial systolic blood pressure (Table 3). Ten patients presented with shock (SBP ≤ 90 mm Hg) and a USS ≥3. In this group, all 10 (100%) underwent therapeutic operation. Thirty-six patients presented normotensive (SBP > 90 mm Hg) and had a USS of 3 or greater. In this group 32 of the 36 (89%) had deterioration of blood pressure within the next 4 hours and underwent a therapeutic operation. Eight patients presented with shock with a low USS (<3). In this group, there were five operations, of which three were therapeutic. Finally, only 2 of the 46 patients (4%) that presented normotensive with a low ultrasound score required an operative intervention.

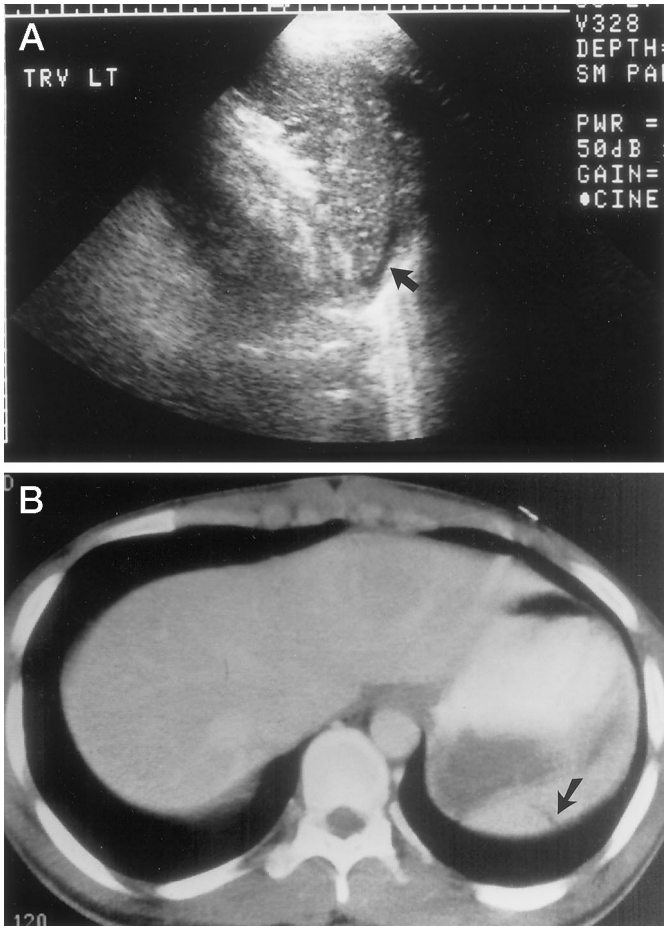

Fig. 2. *A 19-year-old man after an altercation. (*A*) Sonogram positive for fluid in the left upper quadrant only. Transverse image of perisplenic area shows 0.3 cm of fluid (*arrow*). Hemoperitoneum score = 0.3. (*B*) CT scan reveals a small splenic laceration (*arrow*) that was managed nonoperatively.*

Table 1 Ultrasound hemoperitoneum score versus need for laparotomy

	OR n (%)	No OR[a] n (%)
USS ≥ 3	39 (85)	7 (15)
USS < 3	8 (15)	46 (85)[b]
Total	47	53

OR, operation; USS, ultrasound score.
[a] $p << 0.0001$.
[b] Includes two nontherapeutic operations.

Table 2 Initial systolic blood pressure versus need for laparotomy

	OR n (%)	No OR n (%)
SBP ≤ 90 mm Hg	13 (72)	5 (28)
SBP > 90 mm Hg	34 (43)	46 (56)
Total[a]	47	51

OR, operation; SBP, systolic blood pressure.
[a] Initial blood pressure not available on all patients.

TABLE 3 Initial Systolic Blood Pressure and Need for Laparotomy in Patients with a Score of ≥ 3

SBP	OR n (%)	No OR n (%)	Total
≤ 90 mm Hg	10 (100)	0	10
> 90 mm Hg	32 (89)	4(11)	36

SBP, systolic blood pressure; OR, operation.

Base Deficit

Thirty-three patients in the study had a BD ≥ 6 (Table 4). In this group, 22 (67%) underwent a therapeutic operation and 11 (33%) were not operated on. For those with a BD < 6, 23 of 55 (42%) required operative intervention and 32 (58%) were managed nonoperatively.

Sensitivity, specificity, and accuracy for the ultrasound score, the initial systolic blood pressure, and base deficit are listed in Table 5. For predicting a therapeutic operation, a USS ≥ 3 has a sensitivity, specificity, and accuracy of 83%, 87%, and 85%, respectively. By comparison, initial SBP was 28% sensitive, and BD was 49% sensitive. The specificity for SBP and BD were 90% and 74%, respectively, and the accuracy for each was 58%.

DISCUSSION

The speed, safety, and cost-effectiveness of sonography in the rapid assessment of blunt abdominal trauma has been well documented in the literature of both Europe and North America.[9–12,14–18] The advantage of providing real-time imaging of intra-abdominal hemorrhage during the critical phase of patient evaluation, however, has not been reported. A recognized limitation of DPL is the inability to quantify intra-abdominal bleeding. With the increasing recognition that hemoperitoneum does not always necessitate laparotomy, the high rate of nontherapeutic operations associated with DPL may no longer be acceptable. In comparison, abdominal CT scan permits us to visualize the quantity of intra-abdominal hemorrhage and the extent of visceral injury that helps select patients for nonoperative therapy.[19–22] However, difficulties and dangers of transport immediately after a patient's arrival have limited the use of CT scan to stable patients.

In the setting of hypovolemic shock, when time is a critical factor in patient survival, decisions are generally made on the basis of information available within the first few minutes after a patient's arrival. This has traditionally consisted of physical examination, DPL (only if grossly positive), blood pressure, and base deficit. Given this information, a nontherapeutic operation may be expected in as many as 19% to 39% of patients.[23,24] In the patient with multiple injuries, if the major source of hemorrhage is from orthopedic or retroperitoneal trauma, unnecessary laparotomy wastes time and delays control of serious injury. Sonography has the potential to provide the information that has been lacking thus far in assessment of the trauma patient. Our study evaluates a new system of fluid quantification and compares it with the more established criteria of systolic blood pressure and base deficit to determine the best predictor of a therapeutic operation.

In our series, 87% of patients with a high hemoperitoneum score (≥3) required a therapeutic operation. There were 54 patients with a low score (<3), with 10 of these patients undergoing laparotomy. Of the laparotomies performed on patients with a low score, two were nontherapeutic. For our analysis, we considered these two operations as unnecessary and included them in the group managed nonoperatively. As a result, 46 patients (85%) with a score < 3 did not need operative intervention. Blood pressure was significantly less successful at predicting a therapeutic operation. Although not surprising that 72% of hypotensive patients required operative intervention, almost half (42%) of initially stable patients required surgery. Furthermore, of 36 patients that were initially normotensive but had a high ultrasound score, 32 (89%) deteriorated and required operative intervention within 4 hours of admission. Base deficit was also nonspecific when compared with our hemoperitoneum score. For patients with a BD ≥ 6, two thirds (67%) needed surgery and one third (33%) did not. Patients with a low base deficit were also difficult to differentiate. Forty-two percent underwent a therapeutic operation and 58% did not require surgery.

Although one would think combining the criteria may improve results, this was not the case. Since SBP and BD both had poorer sensitivities, combining them only reduced the sensitivity of the USS. As an example, there were two patients with low USS, normal SBP, and low BD undergoing laparotomy; one required a splenectomy and the other was nontherapeutic and no injury was identified, only clear fluid.

Table 4 Base deficit versus need for laparotomy

BD	OR n (%)	No OR n (%)
≥ 6	22 (67)	11 (33)
< 6	23 (42)	32 (58)
Total[a]	45	43

[a] Base deficit not available on all patients.
BD, base deficit; OR, operation.

Table 5 Comparison of the ability to predict the need for a therapeutic operation for an ultrasound hemoperitoneum score, initial systolic blood pressure, and base deficit

	Sensitivity (%)	Specificity (%)	Accuracy (%)
USS ≥ 3	83	87	85
SBP ≤ 90 mm Hg	28	90	58
BD ≥ 6	49	74	58

US, ultrasound score; SBP, initial systolic blood pressure; BD, base deficit.

The decision to take a patient to the operating room was made by the on-call attending trauma surgeon. Our hemoperitoneum score attempts to aid this decision-making process; however, as we encountered in our study, there will be patients that do not follow the expected course. We encountered six patients with a high USS in whom surgery, however, was not performed. Two patients died from lethal brain injury before laparotomy. The remaining four patients (with scores ranging from 3–8) were stable with normal BD. Two patients had CT scan-diagnosed liver lacerations and were followed with serial hematocrits. Two patients had unexplained free intraperitoneal fluid with no injury by CT scan and were observed for 24 hours and discharged without incident. We also encountered 10 patients with low scores that underwent exploratory laparotomy. Two of these patients suffered multiple orthopedic injuries as well as central nervous system trauma and underwent laparotomy for hypotension. Both of these were nontherapeutic. Half of the remaining eight patients also had multiple injuries (orthopedic and neurologic), with a change in vital signs prompting surgery. Two patients underwent splenectomy and two required treatments of liver lacerations. For the remaining four patients in this group, each has a unique quality requiring more detailed description. One patient was a Jehovah's Witness with a drop in hematocrit. Inability to transfuse this patient necessitated laparotomy. A 32-week-pregnant female patient required an emergent cesarean section for placental abruption, and splenectomy was performed at that time. We encountered one patient with a right hemidiaphragm rupture and a liver laceration. Two liters of blood were evacuated from the right chest. Decompression into the thorax likely explains the artificially low USS. The last of these four subjects was a patient with an initial USS of 1.0. Subsequent CT scan revealed active extravasation of contrast from a splenic laceration and increased free intraperitoneal fluid. Ongoing hemorrhage or potential dislodgment of soft clot is always a possibility, emphasizing that emergent follow-up sonography, CT scan, or laparotomy must be available in the presence of a positive sonogram.

Our results indicate that an ultrasound score is better than both initial systolic blood pressure and base deficit at determining which patients will need operative intervention; however, no single result can stand alone when making such decisions. Any amount of free fluid should be carefully assessed along with the complete clinical presentation of the patient. Some patients with a low score, 15% in our study, will need surgery. Most patients with a high score should go directly to the operating room. Our data demonstrated that even the majority of stable patients with a high score would deteriorate and need operative therapy. Use of this scoring system may prevent sending a potentially unstable patient to the CT scanner, where a hypotensive event might occur.

There are two issues pertaining to the use of a scoring system not directly addressed in this study. Our system was developed at an urban Level I trauma facility with extremely short transport times. A hemoperitoneum score ≥ 3 would suggest the need for operative intervention at our institution but may not translate to a rural setting with long transport times. For our scoring system to work in such an environment, a new threshold may have to be identified. Minimal experience with the scoring system may be required to identify a level that best reflects an institution's patient population. Finally, an added benefit to the use of any scoring system is improvement in the transmission of information and the provision of a reproducible number should a follow-up sonogram be required.

In conclusion, the use of ultrasound as a screening test for blunt abdominal trauma not only offers the expeditious identification of hemoperitoneum but also allows for fluid quantification through use of a scoring system. Providing the surgeon with a hemoperitoneum score will help in the decision-making process. The majority of patients (87%) with a high ultrasound score (≥ 3) will require a therapeutic operation. Our hemoperitoneum score was a more accurate predictor of the need for a therapeutic operation than initial systolic blood pressure and base deficit.

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DISCUSSION

Dr. Steven R. Shackford (Burlington, Vermont): Drs. McKenney have provided us with a study to better define the clinical utility of ultrasound in trauma. The authors have applied a measure of objectivity to the positive focused abdominal sonogram for trauma, and in doing so, have increased the clinical relevance and clinical utility of ultrasonography in the management of patients with abdominal injury.

The commitment and dedication of the Department of Radiology to Ryder Trauma Center is exceptional if not surreal. When I last visited there, an ultrasound technologist, radiology resident, and state-of-the-art scanner were committed to the trauma bay 24 hours a day, 7 days a week. At the University of Vermont, we do not have this commitment from radiology, and as such, all the sonograms are performed by surgical residents and attendings.

Let me assure you that the technical skills necessary to acquire and interpret the images and make the measurements described in Dr. McKenney's manuscript are easily acquired by surgeons and are currently being taught in the ultrasound educational program of the American College of Surgeons.

I have several questions for Drs. McKenney. Conventionally, we use a transverse scan for the pelvic view in the FAST exam. Why was the sagittal, rather than the transverse plane, used in the measurement? That is, why depth rather than width, and why not both and treat them all as spheroids and calculate the volume?

How many of the 100 patients with positive ultrasound examinations also had a CT scan that was accessible to the attending surgeon making the judgment about taking the patient to the operating room? In essence, how often was a CT scan used in the judgment algorithm?

The prospective nature of this study should have allowed the attending surgeons to develop some objective criteria for what constituted a therapeutic laparotomy, such as the requirement for technical debridement of nonviable tissue or technical hemostasis. Were such criteria developed prospectively? If so, what were they and were they applied homogeneously and universally?

Finally, Grace Rozycki and I proposed this algorithm shown on the slide for the use of FAST examination after blunt abdominal trauma. Given the results of your study, how would you modify or change it?

I want to thank the Program Committee for allowing me to discuss this manuscript, and the authors for submitting the paper to me many weeks in advance of the meeting.

Dr. Mark Healey (Burlington): I'd just like to make a point and ask a question. It's important when you're applying a diagnostic method, especially methods that are used for screening for a problem, to apply them to the appropriate population.

If you apply diagnostic ultrasound to a patient like you described who was "markedly unstable," you're going to artificially elevate the accuracy of your test. For instance, a patient comes in who has clear indications for surgery, he's hypotensive and has peritonitis. You throw the ultrasound on there and say, "Good, there's another positive ultrasound. We've diagnosed another one."

I would like to know what the score would be if you eliminate those patients who had clinical indications for surgery. I think that would be an important addition to your manuscript before you assess the accuracy of the ultrasound.

Dr. Kimberly K. Nagy (Chicago, Illinois): I have a couple of questions. First, I'm wondering at what point did you actually measure these pockets of fluid? Did you do this with your machine while you were doing the FAST examination? Or did you do this later on your hard copy?

My second question relates to a certain group of patients, that is, those patients with isolated hollow viscus injuries. These patients notoriously have very small amounts of fluid in their abdomens and would have a low ultrasound score. These patients also might not have hypotension or an elevated base deficit. How did these patients fall out in your study?

Dr. William Hoff (Coatesville, Pennsylvania): I was curious as to whether, as part of your ultrasound FAST protocol, you do a serial ultrasound, say, 30 minutes, 20 minutes later, as has been described, particularly in the more stable patients. And if so, did you look at the change in the hemoperitoneum score?

Dr. Ronald I. Gross (Bridgeport, Connecticut): A quick question regarding the technique of using hard copy versus video. When you train your residents for QA and QI, do you use video to assess and compare and would it help the accuracy? In a retrospective analysis of your own data, would it help if you had video to compare with the hard copy that you used and then perhaps compare the results?

Dr. Mark G. McKenney (closing): Dr. Shackford and audience, I would like to thank you for your comments, and now I will attempt to answer them.

The first question was why was the depth measured to determine the score and not the width or both? The answer is that when we originally developed this scoring system, again based on the initial 56, we found that measuring the depth not only was as accurate as measuring both, but was a little faster. So therefore we dropped off measuring the width. We didn't compare measuring the width alone, because occasionally you'll end up with a situation where you have a very wide pocket that's not very deep, and we're trying to avoid falsely elevating the score, but that could be reevaluated.

The second question from Dr. Shackford was how often was CT scan utilized in making the operative decision and how many CTs were there? Seventy patients obtained a CT scan, but this did not influence the decision to operate. The decision to operate was based only on the vital signs of the patient, as was our current algorithm at the time.

The third question was how did we define a therapeutic operation, and unfortunately there was no working definition. At this point, I wish Dr. Shackford had been in our research meetings to help us decide if that might have been a good thing to do on a prospective study; again, we did not do that. There was no defining criteria. The operating surgeon filled out the data collection sheet at the end of the operation, and there was a simple question, "Was this therapeutic or not?"

The last question was how would I alter the algorithm published by Rozycki and Shackford in *Ultrasound for the Surgeon*. At first, I would like to point out that this is an extremely useful algorithm and shows great insight. If I could make one suggestion, it would be that if you have a positive ultrasound and the patient is stable and the ultrasound score is high, I think that patient should probably go back for a laparotomy. Almost 90% will have to go back anyway, and I think waiting allows that group to continue to bleed until they have alteration in their vital signs, so you could probably take them back somewhat early if you did it on the basis of the ultrasound score.

Dr. Healey asked that the ultrasound score must be applied to the appropriate group and wondered whether I falsely elevated the accuracy, or whether the accuracy was falsely elevated, because if a patient came in with markedly low vital signs and a high score, it is very obvious that the patient needs to go to the operating room.

With that, I agree. Surprisingly, however, there were only 10 patients who met that actual criteria, and all 10 did end up with a therapeutic laparotomy. What was, I thought, interesting when the study was completed, was that 36 patients came in initially stable and had a high ultrasound score. And at T plus 5 minutes when a patient arrives, you'll probably have a blood pressure, an ultrasound score, and blood sent off and waiting for the base deficit.

In this group of 36 that had a high score and stable vital signs, 89%, or 32 patients, required therapeutic laparotomy.

Dr. Nagy asked at what point was the ultrasound score measured. The ultrasound score utilized for this study was the initial ultrasound score done right after the patient's arrival. If they had a follow-up ultrasound done, that wasn't part of this database. It is interesting information to see that an ultrasound score goes from 1 to 6, but this was the initial ultrasound score, again to stress the fact that at T plus 5 minutes you probably have the blood pressure and the ultrasound score to help you make decisions.

Dr. Nagy also asked were there hollow viscus injuries that might have a low ultrasound score and still need an operative intervention, which I completely agree with. In this study of 100, however, there was only one isolated viscus injury, and interestingly enough, that was a ruptured stomach after a patient had consumed a 12-pack and gotten in a motor vehicle crash, which led to a high ultrasound score. But that is a concern.

Dr. Hoff asked whether we do serial ultrasounds later and what was the ultrasound data based on? Again, the ultrasound score presented here is the initial ultrasound score. I think a serial examination is very interesting, and it's also interesting to point out the change in the score if this occurs.

Dr. Gross asked if videotaping of the ultrasound and later looking at the ultrasound score might help. I think this would be a great help. It would be very interesting to actually have this and be able to look at the different ways that you can get a score of 3 and to see what occurs. It also would be interesting to be able to have that data for a retrospective review with perhaps a larger series.

I would like to thank Dr. Shackford, the audience, members, and guests for your participation and for these interesting questions. Thank you.