Nonoperative Management of Splenic Injuries

Have We Gone Too Far?

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Hypothesis: Patients with severe blunt injuries to the spleen have a high likelihood of failing nonoperative management of splenic injuries (NOMSI).

Design: Review of medical records, helical computed tomographic imaging data, and trauma registry data.

Setting: Academic level I trauma center at a large county hospital.

Patients: A total of 105 patients with blunt trauma to the spleen, admitted between January 1995 and December 1998, who survived more than 48 hours and had complete records. Of these patients, 53 (56%) were selected for NOMSI. The splenic injury was graded by the Organ Injury Scale of the American Association for the Surgery of Trauma (grades I to V, with grade V being the worst possible injury).

Main Outcome Measures: Failure of NOMSI, defined as the need for operation to the spleen after a period of nonoperative management.

Results: Compared with patients who had successful NOMSI, the 29 patients (52%) in whom NOMSI failed were older and more severely injured. They also required extra-abdominal operations more frequently, underwent transfusion with more units of blood while being managed nonoperatively, and had higher grades of splenic injury. Splenic injury grade III or higher and transfusion of more than 1 U of blood were identified as independent risk factors for failure of NOMSI. The existence of both risk factors predicted failure in 97% of cases. The grading by computed tomography correlated well with the actual injury to the spleen as seen at operation.

Conclusions: In patients with high-grade splenic injuries who require a transfusion of more than 1 U of blood, NOMSI is very likely to fail. Decreasing the threshold for operation or intensifying the monitoring is highly recommended for such patients.

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NONOPERATIVE management of splenic injuries (NOMSI) has replaced splenorrhaphy as the most common method of splenic conservation. NOMSI is currently used in up to 70% of patients with documented blunt trauma to the spleen. With increasing experience, the criteria for NOMSI have expanded, so patients previously excluded from this form of therapy are now included. The only absolute criterion that mandates operation is the presence of hemodynamic instability. Complex splenic injuries, older age, preexisting splenic pathologic condition, blood transfusion requirement, or neurologic injuries are not universally accepted as reasons to avoid NOMSI. As more patients are subjected to NOMSI, appropriate criteria for NOMSI will be better defined.

Failures of NOMSI could lead to complications, and because physicians are increasingly under pressure to discharge patients early, some of these complications may occur after discharge. Identification of patients at high risk for NOMSI failure may lower the threshold for operation or increase the length of in-hospital observation. A combination of radiographic and physiologic parameters could identify such patients.

See Invited Critique at end of article

The objectives of this study are to (1) examine the outcome of splenic injuries treated by NOMSI, (2) identify risk factors that can predict failure of NOMSI among patients with splenic injuries, and (3) compare splenic injury grading by computed tomography (CT) against operative grading.

RESULTS

We found 105 patients who had blunt splenic trauma, survived more than 48 hours, and had complete medical records. In 85% of the population, the injuries were...
PATIENTS AND METHODS

We reviewed the medical records and trauma registry records of all patients who were admitted to the Los Angeles County/University of Southern California Medical Center from January 1995 to December 1998 and had documented blunt trauma to the spleen. Thirty-eight patients who died within 48 hours and 25 patients with incomplete information on their medical records were excluded. During the entire period of the study, our academic level 1 trauma center was staffed by 6 dedicated full-time trauma surgeons. Active attending staff participation is mandatory around-the-clock for all trauma admissions. Detailed protocols are used to manage patients with blunt trauma to the abdomen.

Patients who did not undergo emergent laparotomy because of hemodynamic instability or peritoneal signs but who had mild abdominal tenderness or fluid on abdominal ultrasound or could not be reliably examined clinically were evaluated by abdominal CT scan. Injuries to the spleen identified on CT scan were managed nonoperatively, regardless of the severity of splenic trauma, if the patient (1) could be examined reliably, (2) had a systolic blood pressure higher than 90 mm Hg, (3) had no peritoneal signs, and (4) did not require a transfusion of more than 4 U of blood. Among patients who could not be clinically evaluated because of head injuries, severe intoxication, spinal cord injuries, or pharmacologic sedation, NOMSI or surgical management was selected on a case-by-case basis according to the patient’s physiologic parameters, radiographic findings, and laboratory results. Patients managed by NOMSI were kept in the hospital for 3 to 7 days in the absence of other reasons that mandated longer hospitalization (eg, associated injuries).

Failure of NOMSI was defined as the need for operation due to ongoing bleeding from the spleen in patients initially managed nonoperatively. A decrease in the systolic blood pressure to less than 90 mm Hg despite adequate resuscitation, the need for more than 4 U of blood to maintain a hemoglobin level higher than 100 g/L (10g/dL), the development of peritoneal signs, or evidence of intra-abdominal hypertension (bladder pressure >20 cm H2O) were the criteria used to discontinue NOMSI and take the patient to the operating room. Patients selected for NOMSI were identified retrospectively by 2 methods: (1) a note on the medical record that stated clearly that the patient was selected for nonoperative management or (2) transport to the operating room longer than 3 hours after admission. In our experience, a 3-hour delay usually indicated that the patient had been initially managed nonoperatively. However, more patients may have been initially managed nonoperatively, for example, those in whom early NOMSI failed and an operation was done within 3 hours of arrival.

The severity of injury was measured by the Injury Severity Score (ISS) for the entire body and the Abbreviated Injury Score (AIS) for the different body regions. The injury to the spleen, as shown on CT and/or found at operation, was graded according to the Organ Injury Scale of the American Association for the Surgery of Trauma (Table 1). The operative grading was considered the criterion and was compared with CT grading. Therefore, the accuracy of CT grading was calculated based only on patients who had both a CT and an operation.

Spiral CT data acquisition was obtained by a Picker PQ2000 or 5000 (Picker International, Highland Heights, Ohio). The images were reconstructed with 10-mm collimation at 15-mm increments. Patients received 400 mL of contrast (5% diatrizoate meglumine solution; Bristol-Myers Squibb, Princeton, NJ) orally or through the nasogastric tube 30 to 60 minutes before scanning. In addition, 150 mL of intravenous contrast (60% iohalumate meglumine [Conray] or 60% iohexol [Omnipaque]) was administered 45 seconds before data acquisition at a rate of 2 mL/s via an automated injector (MedRad, Pittsburgh, Pa). The CT scans were interpreted initially by board-certified radiologists with extensive experience in trauma. A different board-certified radiologist (N.Y.) with trauma expertise and familiarity with the current splenic injury grading system reviewed all CT scans retrospectively and assigned grades of injury. This radiologist was blinded to the clinical grading of splenic injury as assessed by the surgeon in the operating room.

The mean values of continuous variables were tested for statistical significance using the t test. The proportions of outcome for categorical variables were tested using the chi² test or the Fisher exact test. A significance level at P<.05 was maintained. The strategy of our statistical analysis was as follows. We compared demographic, physiologic, injury severity, and outcome differences between patients treated by NOMSI and patients treated by immediate operation. We compared the same characteristics between patients in whom NOMSI succeeded and patients in whom NOMSI failed. For some continuous variables, we created dichotomous variables using clinically significant cutoff point or points found during our analysis to produce statistical significance. We compared patients with successful or failed NOMSI for these dichotomous variables to identify potential risk factors for failure of NOMSI. The following dichotomous variables were created: (1) age older than 55 years or 55 years or younger, (2) age older than 30 years or 30 years or younger, (3) ISS of 16 or more or less than 16, (4) ISS of 23 or more or less than 23, (5) abdominal AIS of 3 or more or less than 3, (6) chest AIS of 2 or more or less than 2, (7) head AIS of 2 or more or less than 2, (8) extremity AIS of 2 or more or less than 2, (9) systolic blood pressure higher than 90 mm Hg or 90 mm Hg or lower, (10) Glasgow Coma Scale score greater than 12 or 12 or less, (11) Glasgow Coma Scale score greater than 8 or 8 or less, (12) CT splenic injury grade of III or more or less than III, and (13) blood transfusion during nonoperative management of more than 1 U or 1 U or less. We selected variables that were different at a P<.2 level for logistic regression to identify independent risk factors of failure of NOMSI. Finally, we examined the agreement between operative and CT grading by the k statistic. Kappa values of less than 0.40 reflect poor agreement, values between 0.40 and 0.75 reflect fair to good agreement, and values above 0.75 indicate strong agreement.
associated injuries and physiologic compromise related to her severe liver cirrhosis. Complications developed in 42 patients (40%). The mean ± SD intensive care unit stay for 52 patients who required intensive care and survived was 13 ± 12 days. The mean ± SD hospital stay for the entire population of survivors was 16 ± 15 days.

OPERATIVE VS NONOPERATIVE MANAGEMENT

Forty-nine patients (47%) underwent emergent laparotomy, and 56 (53%) were selected for NOMSI. Patients who required immediate operation were more severely injured and physiologically compromised, had higher grades of splenic injury and more associated intra-abdominal injuries, and required more units of blood to be transfused during the first 24 hours compared with patients treated initially by NOMSI. Consequently, their intensive care unit and hospital stays were longer (Table 2).

SUCCESS OF NONOPERATIVE MANAGEMENT

Among 56 patients, NOMSI was successful in 27 (48%). The remaining 29 patients (52%) in whom NOMSI failed were older, had higher mean ISSs, required extra-abdominal operations more frequently, underwent transfusions with more units of blood while managed nonoperatively, and had higher grades of splenic injury (Table 3). There were no differences in mechanism of injury, sex, and incidence of associated injuries. Although clinically noticeable, the differences in morbidity, mortality, and length of stay were not statistically significant. The comparison of the dichotomous variables between the patients with successful or failed NOMSI is shown in Table 4.

The following variables were entered into stepwise logistic regression analysis: age older than 30 years, ISS of 25 or higher, abdominal AIS of 3 or higher, operations other than laparotomy, transfusion with more than 1 U of blood, and CT splenic injury grade of III or higher. The analysis identified the following 3 variables as independent risk factors for failure of NOMSI: transfusion of more than 1 U of blood, CT splenic injury grade of III or higher, and abdominal AIS of 3 or higher. The latter variable cannot be conveniently used because the estimation of AIS is not always feasible at the early stages after admission, when decisions need to be made. For this reason, we emphasize the 2 remaining independent risk factors. The probabilities of failure of NOMSI based on the existence of either or both of these factors are displayed in Table 5.

Of the 29 patients in whom NOMSI failed, the time between admission and transport to the operating room was less than 24 hours in 18 (62%). In the remaining 11 patients (38%), NOMSI failed after at least 1 day of observation, including 3 patients (10%) who were operated on on the fourth, fifth, and seventh days after admission. The mean ± SD period of observation for those in whom NOMSI failed was 29 ± 3 hours.

COMPARISON BETWEEN CT AND OPERATIVE GRADING OF SPLENIC INJURY

Forty-five patients were graded by both a CT and an operation (Table 6). The weighted κ statistic for correlation of injury grading by CT or operation was 0.777 (95% confidence interval, 0.651-0.903), which indicates strong correlation. In 36 patients (80%), the CT and operative gradings were identical. Of the remaining 9 patients (20%), 8 had a difference of 1 grading point and only 1 had a difference of 2 points (from a CT grade 1 to an operative grade III). In 2 patients (4%), the difference in grades could be considered clinically significant; 1 patient with CT grade I and 1 with CT grade II were found at operation to have grade III injuries. Both were initially managed nonoperatively and taken to the operating room 24 hours after admission following transfusions of 4 and 8 U of blood, respectively. The patient with the 8-U blood transfusion had associated fractures, which required emer-

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Laceration &lt;1 cm parenchymal depth or subcapsular hematoma &lt;10% of surface</td>
</tr>
<tr>
<td>II</td>
<td>Laceration 1 to 3 cm or subcapsular hematoma 10% to 50%</td>
</tr>
<tr>
<td>III</td>
<td>Laceration &gt;3 cm or subcapsular hematoma &gt;50%</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration to segmental or hilar vessels with significant devascularization (&gt;25% of spleen)</td>
</tr>
<tr>
<td>V</td>
<td>Completely shattered spleen or hilar injury with complete devascularization</td>
</tr>
</tbody>
</table>

Table 1. Simplified Version of the Splenic Injury Scale of the American Association for the Surgery of Trauma

Table 2. Comparison of Patients With Blunt Trauma to the Spleen Treated byImmediate Operation With Those Treated by Initial Observation*

<table>
<thead>
<tr>
<th>Variable</th>
<th>NOMSI (n = 56)</th>
<th>Operation (n = 49)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicle crash</td>
<td>45 (80)</td>
<td>45 (92)</td>
<td>.10</td>
</tr>
<tr>
<td>Male</td>
<td>38 (68)</td>
<td>32 (65)</td>
<td>.78</td>
</tr>
<tr>
<td>Age, y</td>
<td>32 ± 17</td>
<td>39 ± 20</td>
<td>.06</td>
</tr>
<tr>
<td>Age &gt;55 y</td>
<td>4 (7)</td>
<td>10 (20)</td>
<td>.58</td>
</tr>
<tr>
<td>ISS</td>
<td>17 ± 11</td>
<td>31 ± 12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>ISS ≥25</td>
<td>14 (25)</td>
<td>35 (71)</td>
<td>.001</td>
</tr>
<tr>
<td>Abdominal AIS ≥3</td>
<td>29 (52)</td>
<td>43 (88)</td>
<td>.005</td>
</tr>
<tr>
<td>SBP &lt;90 mm Hg on arrival</td>
<td>22 (39)</td>
<td>42 (85)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Intubated in emergency department</td>
<td>8 (14)</td>
<td>23 (47)</td>
<td>.001</td>
</tr>
<tr>
<td>GCS score</td>
<td>14 ± 2</td>
<td>12 ± 4</td>
<td>.005</td>
</tr>
<tr>
<td>GCS score ≤12</td>
<td>6 (11)</td>
<td>15 (31)</td>
<td>.01</td>
</tr>
<tr>
<td>Grade of splenic injury</td>
<td>2.7 ± 1.0</td>
<td>3.6 ± 1.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Grade of splenic injury ≥3</td>
<td>32 (57)</td>
<td>41 (84)</td>
<td>.003</td>
</tr>
<tr>
<td>Associated intra-abdominal injury</td>
<td>13 (23)</td>
<td>26 (53)</td>
<td>.002</td>
</tr>
<tr>
<td>Associated extra-abdominal injury</td>
<td>49 (88)</td>
<td>44 (89)</td>
<td>.76</td>
</tr>
<tr>
<td>Operation other than laparotomy</td>
<td>14 (25)</td>
<td>16 (32)</td>
<td>.39</td>
</tr>
<tr>
<td>ICU stay, d</td>
<td>6 ± 11</td>
<td>12 ± 14</td>
<td>.01</td>
</tr>
<tr>
<td>Hospital stay, d</td>
<td>12.5 ± 14</td>
<td>20 ± 16.5</td>
<td>.01</td>
</tr>
<tr>
<td>Mortality</td>
<td>14 (25)</td>
<td>28 (57)</td>
<td>.001</td>
</tr>
<tr>
<td>Mortality</td>
<td>1 (2)</td>
<td>14 (28)</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Values are provided as number (percentage) for categorical variables and as mean ± SD for continuous variables. NOMSI indicates nonoperative management of splenic injuries; ISS, Injury Severity Score; AIS, Abbreviated Injury Score; SBP, systolic blood pressure; GCS, Glasgow Coma Scale; and ICU, intensive care unit.
NOMSI is the prevailing method of splenic preservation after blunt trauma. The incidence of NOMSI increases over the years, as physicians gain more confidence in managing selected splenic injuries without immediate operation. Nonoperative management is not an easy approach. It requires close monitoring, serial clinical examinations, an increased level of vigilance, and familiarity with the course of splenic injuries. The length of hospital stay required for observation is unknown. The combination of the increasing popularity of NOMSI and the pressure to discharge patients early may create the ideal setting for delays in recognition and treatment of the pressure to discharge patients early may create the combination of the increasing popularity of NOMSI and nonoperative management with those in whom nonoperative management failed.

**COMMENT**

The results of this study indicate 2 independent risk factors of failure of NOMSI: a high CT grade of splenic injury (grade III and above) and a transfusion with more than 1 U of blood. The combination of these 2 risk factors predicts failure of NOMSI very accurately (in 97% of the cases). In the absence of these 2 factors, NOMSI is likely to be successful in 97% of the cases (3% failure rate).

Although abdominal AIS was also shown to be an independent risk factor for failure of NOMSI, we eliminated it from our prediction model for the following reasons: (1) the abdominal AIS is an imperfect system to grade the severity of abdominal injury; (2) AIS may not be readily available in many institutions at the time of injury, when the decisions need to be made; (3) a prediction model is likely to be memorized and practiced at the bedside only if it is short and simple; and (4) most important, this prediction model, including only the 2 risk factors, showed very high accuracy, unlikely to be significantly improved by the addition of other risk factors.

There are 3 primary problems with the current prediction model. First, the threshold for transfusion is not consistent among surgeons. We assume that a hemoglobin level of less than 90 g/L (9 g/dL) associated with tachycardia (heart rate >100/min) is an indication for transfusion for most trauma patients. However, multiple other factors may affect this decision.

Second, surgeons who treat such patients should be familiar with the American Association for the Surgery of Trauma grading system of splenic injuries to classify correctly the severity of splenic trauma. In its simplified form (Table 1), one needs to remember only the numbers 1 and 3: lacerations less than 1 cm are grade I injuries, 1 to 3 cm are grade II, and more than 3 cm are grade III; hilar injuries are grade IV, and shattered spleens are grade V. Even if this grading system has limitations, it provides a uniform language to communicate and correlates well with outcome. Subjective and vague classifications, such as “small” or “large” splenic injury, should not be acceptable in the era of modern trauma surgery.
The splenic injury imaging data are acquired by helical CT. We also do not report on isolated CT scan data but combine it with physiologic criteria—in this case, the need for blood transfusion—to increase predictability.

Another difference between this study and the existing literature is the focus on high-grade injuries. Although high success rates of NOMSI have been reported, the number of high-grade injuries included in these studies is limited. For example, Barone et al reported an 83% success rate with NOMSI; only 4 patients with grade III and IV injuries were included, and NOMSI failed in all the patients. Wasvary et al reported a 91% success rate with NOMSI, but among the 6 patients who had grade III and IV injuries, the success rate was only 50%. A large study by Pachter et al showed a remarkably high success rate of NOMSI, approaching 98% in the examined population. However, there were only 5 patients with grade IV and V injuries; the only 2 patients in whom NOMSI failed belonged to this group. Thus, the failure rate of NOMSI in this group was 20-fold higher (from 2% to 40%) compared with the reported failure rate of the entire population. In our study, we included 66 patients who had grade III or higher splenic injuries. Most patients managed by NOMSI had such grades (30 of 56 patients). The failure rate in this subgroup was 73%.

The retrospective design of this study does not allow us to ask if failure of NOMSI among patients who had high-grade splenic injuries and transfusion of more than 1 U of blood was associated with preventable morbidity. The inability to evaluate the medical records of 25 patients, predominantly because of incomplete data on the severity of splenic injury, is of concern. The results of this study were used to design a prospective study, currently ongoing in our institution, that will examine the effect of successful or failed NOMSI on patient outcome. At this point, we urge caution for the liberal use of NOMSI, approaching 98% in the examined population. However, there were only 5 patients with grade IV and V injuries; the only 2 patients in whom NOMSI failed belonged to this group. Thus, the failure rate of NOMSI in this group was 20-fold higher (from 2% to 40%) compared with the reported failure rate of the entire population. In our study, we included 66 patients who had grade III or higher splenic injuries. Most patients managed by NOMSI had such grades (30 of 56 patients). The failure rate in this subgroup was 73%.

This is an additional reason to encourage transfer of such patients to trauma centers staffed with surgeons who are dedicated to or have a special interest in trauma and are likely to be familiar with this grading system.

The third problem relates to the correlation of CT grading with the actual injury to the spleen. When we compared CT grading with operative grading, the correlation proved to be very good. In 80% of the patients, the grade of injury assigned by CT was the same as the grade assigned at operation. The grades differed by more than 1 point in only 1 patient. We believe that, overall, the new-generation helical CT scans provide accurate information that can reliably assist in clinical decisions for the management of splenic injuries.

How does this study correlate with or differ from other studies on the same topic? The existing literature is divided into studies that support the use of CT scan data to predict the outcome of NOMSI and studies that report that CT information is unreliable for this purpose. Many of the conclusions of these studies are limited, because pediatric and adult populations are mixed, outcomes of liver and splenic injuries are reported together, grading systems used differ, and CT scan technology used during that time is outdated by current standards. In this study, we describe only adult patients with splenic injury, graded by the currently used grading system of the American Association for the Surgery of Trauma. The splenic injury imaging data are acquired by helical CT. We also do not report on isolated CT scan data but combine it with physiologic criteria—in this case, the need for blood transfusion—to increase predictability.

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REFERENCES


DISCUSSION

David B. Hoyt, MD. San Diego, Calif: Nothing has changed more in the management of trauma in the last 10 years than the development of nonoperative management of solid organs of the abdomen. This has paralleled the transition from diagnostic peritoneal lavage to ultrasound and CT scanning for objective evaluation of the abdomen. This has allowed for the selection of nonoperative management to follow, and there is no question when done correctly, this is better management and, at least for liver injuries, this is probably accompanied by a lower mortality overall as well.

The authors report their 4-year experience with nonoperative management of splenic injury and point out that they have a much higher failure rate than typically reported. This can be predicted by initial transfusion and initial CT grading, and they leave us with the suggestion that a grade III or above injury requiring greater than 1 U of transfusion should have an operation.

Agree in general that this would be a patient that will continue to bleed, and as the authors point out, this is the source of early operation in other series. I would argue, however, that the authors are being a bit hard on themselves to call it nonoperative failure at 3 hours, which was their defined time point. In evaluating a patient for therapy, there is a dynamic time frame in which assessment includes both CT evaluation and a longitudinal evaluation for the presence of ongoing hemorrhage. We stand by the bedside and watch the patient. Most spleens or livers that can be successfully managed nonoperatively are bleeding very slowly, if at all, when they present. It takes a finite window to evaluate a patient for bleeding before deciding if the significant bleeding is occurring. This decision is often made at 3, 4, 5, or 6 hours following operation, and I would submit that this is not a failure of operating too early but simply an expression of the appropriate response to ongoing bleeding. This leads to the same results, however, and it would require the authors' cases to be reclassified as operative cases rather than nonoperative failure and thereby might make a difference in the true failure rate and make it much lower.

I have several questions for you, George. First, how many had operations in the time window from 3 to 6 hours that were classified as failures? Were they, in fact, hypotensive during this period of time? When or how often was splenorrhaphy done in this group that was operated immediately and those more delayed? Are you using preemptive angiography for any patients, and do you think this has a role? Finally, shouldn't we create a certain standard for observation in operative decision making before we classify some injuries as failure of nonoperative management rather than simply the application of appropriate operative intervention? In the past, we operated for a positive DPL [diagnostic peritoneal lavage], and we often found a nonbleeding organ. Spending an extra 2 to 3 hours deciding about the appropriateness of operation seems thoughtful and needs reassessing before we make a decision about classifying this as a failed nonoperative therapy.

Jerry M. Shuck, MD. Cleveland, Ohio: The presentation was extremely thoughtful. It came at us from a different

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perspective, and it made us think a little harder on what we are really doing. There is a spin-off of these kinds of studies where we do not operate on spleens so much any more, or livers, or stab wounds. Some centers are using history and physicals even to evaluate gunshot wounds and observe these patients. I do not officially represent the Residency Review Committee, although I am vice chairman of it. I would like to tell you that the only operative category that has fallen in the past decade has been operative trauma. It is difficult now for many programs in this country to reach the minimum cases for their residents to be trained in operative trauma. We are now looking to see if we should lower the minimum number.

The upside of that is that we are expecting more careful evaluation of trauma patients utilizing ultrasound, history and physicals—and thinking. We now expect residents to document the observed trauma patients who were not operated upon. The American Board of Surgery wants those data, yet residents do not bother to record these trauma patients. The residents are really managing these patients, although they are not operating on them.

Frederick A. Moore, MD, Houston, Tex: Your experience is much different from other recent published series. You pursued nonoperative management in 56% of your patients, which is a bit higher than other series, but your overall failure rate of 53% is way over what has been reported by others. If you take the adult series that include high-grade splenic injuries published in the past 3 years, the rate of failure is 10% to 15%. This leads me to question, what is your definition of a failure? I suspect that once you start transfusing blood, the patient goes to the operating room. Therefore, it is not surprising that blood transfusion emerges as an independent predictor of failure. You conclude that nonoperative management should be taken with extreme caution. Could you attribute any adverse outcomes to nonoperative management in your series?

Stephen Smith, MD, Wichita, Kan: I have 3 questions. I also wonder about splenectomy with arterial embolization: was this used, and if so, how did it influence your nonoperative management success rates? Second, how do you perform surveillance of the nonoperative patients? Do you recommend serial ultrasound examinations or CT scans, or do you simply follow up the patient clinically and with transfusion requirements, serial hemoglobin, and hematocrits? Have you ever used laparoscopy as an intermediate procedure? Third, in the immediate operative group, you quote a mortality rate of 28%, which seems a bit high for isolated splenic injuries. Was this mortality rate secondary to associated injuries?

H. Gill Cryer, MD, Los Angeles, Calif: I agree that if any patient dies as a result of nonoperative management of splenic trauma then we have gone too far. However, I am not sure that it is as bad as you make it out to be. As you know, in the Los Angeles trauma system, there is a quality assurance indicator for the nonoperative management of splenic injuries. Across the 13 trauma centers, about 50% of the patients, just like in this study, were managed nonoperatively, but unlike this paper, only about 10% or less are failures. We define failure a little differently, with a fallout defined as operation greater than 6 hours, and if so due to a deliberate decision of the physician to not operate initially. Dr Hoyt also asks about the standardization of the classification. Should we use a standardized classification for failure? I think this is an excellent suggestion. It goes back to the trend of evidence-based medicine. We are very supportive of that and would love to see standardized a classification so that we can all compare our results reliably and send clear messages to the surgical community. How many operations were done between 3 and 6 hours, I do not know.

Did we use splenorrhaphy? Splenorrhaphy was used in about 15% of patients in both groups, and there was no statistical significance between the 2 groups. Did we use preoperative angiography? Yes, we did, particularly after Dr Fabian’s papers from Tennessee that showed that a blush shown on the CT scan is a predictor of failure and should require some kind of intervention, most probably interventional angiography and embolization of the splenic artery. We have used it with 3 patients in this series with good results.

Dr Shuck, we have pioneered nonoperative management with good results. The reason why the operative numbers have gone down is a function of the increased rates of nonoperative management and the decreased overall number of penetrating trauma that is seen across the country. Studies like this may help reexamine this issue.

Dr Moore, as I said before, our study is different than others because we were a little bit harder on ourselves and reported higher failure rates by including a strict definition of NOMSI failure. When you read the studies that have been reported so far, you realize that there is no better way of report-
Recognition of the important functions of the spleen in children led to nonoperative methods for the management of spleen injuries more than 2 decades ago. Improvements in computed tomography and, more recently, ultrasound techniques for the detection of intra-abdominal bleeding and organ injury have joined with improved monitoring and critical care to make nonoperative management of most spleen and liver injuries in patients of all ages a clinical reality. Advanced interventional radiology procedures are now available, which offer ways to stop bleeding and deal with postinjury abscesses and fluid collections. That nonoperative therapy of spleen injuries is one of the accepted standards of spleen injury care is an unassailable truth. On the other hand, the article by Velmahos and colleagues serves to remind us that our knowledge is not complete regarding spleen injuries, and that dangerous failures of management can occur. The failure rate and the patterns of failure have been nagging, troublesome questions for clinicians dealing with spleen injuries in adults. Higher injury grade, a large volume of extrasplenic blood seen on computed tomographic scan, comorbid diseases, and the need for transfusion are factors statistically predictive of the failure of nonoperative management, and this has been confirmed by Velmahos and colleagues.

Little is known about the patterns of failure. Most failures are heralded by drops in the hemoglobin level or worsening abdominal physical examination findings. A troublesome few patients, however, fail by becoming acutely hemodynamically unstable. Inevitably, some of this last group will not tolerate bleeding and will die. Are these events predictable and preventable? The current study reports a high failure rate (32%) in patients with severe injuries. Other authors have reported failure rates in the 2% to 18% range, but some of these failures occur late, after hospital discharge. Are any patients placed at risk by nonoperative therapy? The number is certainly small but is not known precisely. The article by Velmahos and colleagues, like most others in the literature, suffers because the “at-risk” sample of patients is too small to allow firm conclusions. Can failures be predicted in individual patients? Sadly, our predictive judgments are not perfect.

What recommendations can be made? I would suggest the following:

• A national (or at least multi-institutional) registry is needed to document the proportion of patients who die or suffer considerable morbidity after the failure of nonoperative management of spleen injuries. The Eastern Association for the Surgery of Trauma, Knoxville, Tenn, is completing a study that will be a good start in this area. Data are needed that would help to predict the failure of nonoperative management in larger, more statistically powerful patient samples than are currently available. Computed tomographic signs that should prompt early angiography other than contrast “blush” should be sought.

• Nonoperative management is the preferred option in children and should be considered in most stable adult patients.

• Splenectomy remains a desirable option in the management of patients for whom surgeon, anesthesia, blood bank, operating room, radiology, and critical care resources are not optimal for successful nonoperative management. Surgeons who choose splenectomy under these circumstances should not be criticized.

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