Nonoperative Treatment of Blunt Injury to Solid Abdominal Organs

A Prospective Study

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Hypothesis: Nonoperative management (NOM) of injuries to the liver, spleen, and kidney is highly successful, as shown in retrospective studies, but needs prospective validation. Patients in whom NOM is likely to fail can be identified by specific criteria.

Design: Prospective observational study.

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

Patients: Two hundred six patients with injuries to the liver (n=99), spleen (n=103), and/or kidney (n=40).

Main Outcome Measures: Failure of NOM.

Results: Fifty-seven patients (28%) underwent immediate operation; among the other 149, NOM failed in 33 (22%). The rate of failure for spleen injury (34%) was higher than for liver (17%) or kidney injury (18%) (P<.01). Failure of NOM was due to delayed bleeding from a solid viscus in 20 of the 33 patients. Intestinal injury was detected in only 1 patient initially selected for NOM. Specifically among patients with liver injury, no failure was due to delayed bleeding from the liver. Patients with failed NOM were more likely to have a positive abdominal ultrasonographic finding (61% vs 22%; P<.01), a grade of splenic injury of at least III on computed tomographic scan (CT) (n=20 [17%] vs n=16 [48%]; P<.01), and an amount of free fluid of greater than 300 mL on CT (36% vs 8%; P<.01) and to receive blood transfusions during NOM (58% vs 16%; P<.01). The groups were not different with regard to associated extrabdominal injuries (including head injuries). Mortality was not different, but morbidity was marginally higher in patients with failed NOM (29% vs 45%; P=.08). We identified the following 4 independent risk factors of failure by means of stepwise logistic regression: nonliver (splenic or renal) injury, positive abdominal ultrasonography findings, amount of free fluid on CT of greater than 300 mL, and need for blood transfusion. According to a statistical model, the presence of all 4 independent risk factors predicted NOM failure in 96% of the patients, and the absence of all predicted success in 98%.

Conclusions: In a prospective study, the rate of NOM failure for solid abdominal organ injuries is higher than the rates reported in retrospective studies. Nonoperative management is less likely to fail in liver injuries than in splenic or kidney injuries. Use of NOM should be exercised with caution if blood transfusion is needed, fluid is identified on the screening ultrasonogram, or a significant quantity of blood is discovered on CT.

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searcher or reviewer is left to speculate about possible NOM failure based on the time that elapsed from admission to operation. Such cutoff time points, beyond which NOM is considered to have failed, are arbitrary and vary widely from study to study. Also, the cause of failure is inadequately discussed. Retrospective reviews may not capture the real reason for NOM failure, which may not be related to delayed bleeding from the solid viscera; that failure can be predicted early by easily obtainable clinical factors; and that a group at high risk for failure can be identified on the basis of these factors.

Prospective reports on the outcomes of NOM are needed. The objectives of this prospective study are to (1) define the rate of NOM failure, (2) explore the causes of NOM failure, and (3) identify independent predictive factors of NOM failure. We hypothesize that NOM in patients with blunt trauma to the liver, spleen, or kidney is highly successful and rarely fails due to delayed bleeding from the solid viscera; that failure can be predicted early with the application of ultrasonography and diagnostic peritoneal aspiration; and that a group at high risk for failure can be identified on the basis of these factors.

**METHODS**

**INCLUSION CRITERIA AND MANAGEMENT POLICIES**

From January 1, 1999, through June 30, 2001, all patients with blunt trauma to the liver, spleen, or kidney who were admitted to the level I trauma center of the Los Angeles County and University of Southern California Medical Center, Los Angeles, were included prospectively. Patients who received a thoracotomy in the emergency department and died immediately were excluded. During the study period, the trauma center was run by 7 full-time trauma surgeons who offered in-house coverage 24 h/d, 7 d/wk. Focused abdominal sonography for trauma (FAST) was offered to all patients with blunt trauma. Of patients with significant blunt abdominal trauma, those who were hemodynamically unstable and had confirmation of intra-abdominal fluid by means of ultrasonography or diagnostic peritoneal aspiration were taken directly to the operating room. Patients who were hemodynamically stable but had diffuse and significant abdominal tenderness were also usually taken directly to the operating room. All other patients with blunt abdominal trauma underwent computed tomographic (CT) scanning of the abdomen and pelvis.

The diagnosis of hepatic, splenic, or renal injury was established in the operating room or the CT suite. If the diagnosis was made in the CT suite, a decision was made and recorded at that time to manage the injury operatively or expectantly. The decision was made on the basis of the patient’s physiological condition, CT findings, and extra-abdominal injuries. Patients whose injuries were managed expectantly were observed closely in a monitored environment. No uniform policy was followed regarding repeat CT, period of in-house observation, or abstinence from certain activities. Grading of the injuries was performed according to the criteria published by the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma. A dedicated trauma radiologist reviewed prospectively all the CT scans, graded the injury, and quantified the amount of free fluid existing in the peritoneal cavity.

**GROUPS AND OUTCOMES**

Three groups were identified. Group OP included patients who underwent immediate operation; group NOM, patients in whom initial management was nonoperative. Within group NOM, we identified those patients who were successfully treated nonoperatively (group NOM-success), and those who, after an initial period of nonoperative management, required an operation (group NOM-failure). The primary outcome of this study was failure of NOM, defined as the need to perform an operation on a patient who underwent initial management expectantly. On many occasions, laparotomy confirmed that an abdominal organ other than the liver, the spleen, or the kidney was the cause of failure (eg, as in the case of a mesenteric laceration or a small-bowel perforation). If the solid viscus (liver, spleen, or kidney) was the cause of NOM failure and delayed operation, then the failure was defined as organ specific (liver specific, spleen specific, or kidney specific). Secondary outcomes were morbidity and mortality.

**DATA COLLECTION AND STATISTICS**

We collected data on demographics, type of blunt trauma (motor vehicular crash, fall, assault, or other), severity of injury (as expressed by the Injury Severity Score), physiological condition on admission, CT findings, operative findings, fluid resuscitation, blood transfusion, and hospital course, including morbidity and mortality. The following comparisons were performed: group OP vs group NOM (and specifically vs group NOM-success vs group NOM-failure), and group NOM-success vs group NOM-failure. Categorical variables were compared by the χ² or Fisher exact test and continuous variables by the Wilcoxon 2-sample test. For multiple comparisons, multiplicity-adjusted P values were derived by the step-down Bonferroni test. Variables that on univariate analysis were different at the level of P < .05 were entered into stepwise logistic regression analysis to identify independent risk factors for failure of NOM. A statistical predictive model of failure and success of NOM was created on the basis of presence or absence of the independent risk factors. A level of P < .05 was used to declare statistical significance.

**RESULTS**

During the study period, 206 consecutive patients (66% male; 77% motor vehicular crashes; mean Injury Severity Score, 18) were included. Of those, 103 (50%) had a splenic injury; 99 (48%), a liver injury; 40 (19%), a renal injury; 22 (11%), 2 organs injured; and 14 (7%), all 3 injured. Associated intra-abdominal injuries existed in 15 patients (7%) and extra-abdominal injuries in 135 (66%). Specifically, head injury was recorded in 22 (11%). Fifteen patients (7%) died, and the average hospital stay among survivors was 15 days.

**OP VS NOM GROUPS**

Fifty-seven patients (28%) underwent immediate operation. Compared with 149 patients who underwent NOM initially, patients in the OP group had a higher mean ± SD Injury Severity Score (21 ± 10 vs 15 ± 9; P = .01) and a higher incidence of head injury (19% vs 7%; P = .01), associated intra-abdominal injuries (14% vs 5%; P = .02), hypotension on admission (47% vs 21%; P < .01), drop in the hematocrit level of greater than 20% within the first hour (46% vs 13%; P < .01), positive FAST results (82% vs 31%; P < .01), and CT-graded injuries of III or higher for the spleen (52% [12 of 23 patients] vs 24%; P = .05). The 2 groups were not significantly different in

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terms of age, extra-abdominal injuries, and injury grading of the liver and kidney. Patients in the OP group had a higher incidence of morbidity (54% vs 33%; P<.01) but not mortality (9% vs 7%; P=.61) and a longer hospital stay (mean±SD, 21±21 vs 11±10 days; P=.01) compared with the NOM group.

NOM-SUCCESS VS NOM-FAILURE GROUPS

Of the 149 patients initially undergoing NOM, NOM failed in 33 (22%). Compared with patients in the NOM-success group, those in the NOM-failure group had a higher incidence of splenic injury, associated intra-abdominal injury, positive FAST results, amount of free fluid on CT, and CT grade of III or higher for the spleen (but not the liver or kidney) and greater amounts of blood transfused and fluid resuscitation in the first 6 hours (Table 1). They also had a marginally higher morbidity but a similar mortality rate. The rate of NOM failure for spleen injury (34%) was higher than that for liver (17%) or kidney injury (18%) (P<.01). For grades III or higher, the rate of NOM failure was 44% for the spleen, 18% for the liver, and 32% for the kidney.

Patients in the NOM-success group were clearly different from those in the OP group; however, those in the NOM-failure group were similar in many fields to the OP group, including the outcomes of morbidity, mortality, and length of hospital stay (Table 2). Hospital stay in NOM-success patients was significantly longer owing predominantly to associated injuries and not the management of the spleen.

INDEPENDENT RISK FACTORS AND PROBABILITY OF NOM FAILURE

Logistic regression identified the following independent risk factors of failure: nonliver injury (ie, splenic or renal injury), a positive FAST finding, the need for blood transfusion, and an estimated amount of free fluid on CT of greater than 300 mL, as seen in the following tabulation:

(866)
The probability of NOM failure was estimated by the following statistical predictive model:

\[
\text{Logarithm Odds of Failure} = -3.8622 + \\
(1.5620 \times \text{Nonliver Injury}) + \\
(1.2138 \times \text{Positive FAST}) + \\
(2.568 \times \text{Need for Blood Transfusion}) + \\
(1.6996 \times \text{Amount of Fluid on CT} > 300 \text{ mL}),
\]

where yes indicates 1 and no indicates 0 (Table 3). According to this model, if all independent risk factors are present, there is a 96% probability that NOM will fail; if all are absent, there is a 2% probability that NOM will fail.

### CAUSES OF FAILURE

Of the 33 patients in the NOM-failure group, 23 had an injury to the spleen, 12 to the liver, 6 to the kidney, 7 to 2 organs, and 1 to all 3 organs. The reasons for NOM failure are outlined in the following tabulation:

<table>
<thead>
<tr>
<th>Cause of Failure</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed bleeding from the spleen</td>
<td>17</td>
</tr>
<tr>
<td>Delayed bleeding from the kidney</td>
<td>3</td>
</tr>
<tr>
<td>Pancreatic injury</td>
<td>2</td>
</tr>
<tr>
<td>Abdominal compartment syndrome</td>
<td>2</td>
</tr>
<tr>
<td>Small-bowel rupture</td>
<td>1</td>
</tr>
<tr>
<td>Diaphragmatic laceration</td>
<td>1</td>
</tr>
<tr>
<td>Nontherapeutic laparotomy</td>
<td>6</td>
</tr>
</tbody>
</table>

Six patients received a nontherapeutic laparotomy. These patients had a combination of increasing abdominal tenderness, decreasing hemoglobin level, or increasing white blood cell count. Intestinal injury was the cause of NOM failure in 1 patient. Small quantities of blood or stable retroperitoneal hematomas were found. Only 20 (61%) of the 33 patients experienced failure due to delayed bleeding from the nonoperatively managed solid organ. In the 72 patients undergoing NOM who had liver injury, no failure was due to delayed bleeding from the liver. Of the 33 patients undergoing NOM who had renal injury, failure in 3 (9%) was due to delayed renal bleeding. Of these, 2 had grade IV injuries, 1 had grade V injuries, and all received a nephrectomy. Of 67 patients with splenic injury, 17 (25%) had delayed splenic bleeding and received a splenectomy; they had splenic injury of grade III or higher.

### ORGAN-SPECIFIC FAILURE RATE

To avoid the confounding effect of multiple solid-organ injuries, we identified the patients who had only 1 solid organ injured. Eighty-one patients had isolated splenic injuries; 72, isolated liver injuries; and 20, isolated renal injuries. As shown in Table 4, the NOM failure rates were 33% for the spleen, 9% for the liver, and 11% for the kidney. Some of these failures were caused by associated abdominal organ injuries or were nontherapeutic laparotomies. When we recorded failures caused by the solid organs, the organ-specific NOM failure rate was 28% for splenic-related failure, 0% for liver-related failure, and 11% for renal-related failure.

Increasing success rates have been reported with NOM of abdominal solid-organ injuries after blunt trauma. Most data are retrospective. The current study establishes the incidence of failure of NOM on the basis of prospective collection of data. It also identifies the causes and independent predictors of failure. As shown, abdominal solid organs behave differently. Delayed bleeding from the liver is rare, and in our series, it was absent. Delayed bleeding from the kidney is possible, although uncommon; approximately 1 of every 10 patients initially undergoing NOM will require surgical intervention for delayed or ongoing renal bleeding. Delayed bleeding from the spleen occurs frequently; if NOM is offered irrespective of grade of injury, almost 1 of every 4 patients initially undergoing NOM may eventually require splenectomy. These estimations are based on patients who have only 1 solid organ injured and exclude the confusing effect of combined solid-organ injuries (eg, combined liver and splenic injury). The rates reflect reliably the potential outcome of NOM for each of these solid organs.

### COMMENT

Predictors of NOM failure have been discussed in other reports and include hypotension on admission, high CT grades of injury, active contrast extravasation on CT, and the need for blood transfusion.\(^5,17,20,25\) The importance of other factors such as advanced age or neurologic injury has been debated. Recent evidence suggests that these factors should not prevent NOM.\(^23\) In the present study, the logistic regression identified 4 independent risk factors for NOM failure. These risk factors

### Table 4. Probability of Failure of NOM on the Basis of Prospective Collection of Data

<table>
<thead>
<tr>
<th>Liver Injury</th>
<th>Blood Transfusion</th>
<th>Positive FAST Result</th>
<th>&gt;300 mL of Fluid on CT</th>
<th>Probability of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0.06</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>0.09</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0.28</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>0.25</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>0.21</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0.10</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0.09</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0.06</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomography; FAST, focused abdominal sonography for trauma; NOM, nonoperative management.
Table 4. Treatment of Patients With Only 1 Solid Organ Injury

<table>
<thead>
<tr>
<th>Solid Organ Injured</th>
<th>Immediate Operation</th>
<th>Initial NOM</th>
<th>Failure of NOM†</th>
<th>Failure of NOM Specific to the Solid Organ†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spleen (n = 81)</td>
<td>27 (33)</td>
<td>54 (67)</td>
<td>18 (33)</td>
<td>15 (28)</td>
</tr>
<tr>
<td>Liver (n = 72)</td>
<td>17 (24)</td>
<td>55 (76)</td>
<td>5 (9)</td>
<td>0</td>
</tr>
<tr>
<td>Kidney (n = 20)</td>
<td>2 (10)</td>
<td>18 (90)</td>
<td>2 (11)</td>
<td>2 (11)</td>
</tr>
</tbody>
</table>

Abbreviation: NOM, nonoperative management.
*Data are expressed as number (percentage) of patients.
†Calculated across patients initially undergoing NOM.

and the predictive model structured around them can obviously help the clinician make decisions. In the presence of a splenic or renal injury with a positive FAST result, an estimated amount of free fluid on CT of greater than 300 mL, and the requirement for blood transfusion, the risk for NOM failure is 96%. If these factors are absent, the risk for NOM failure is only 2%.

The grade of injury was a significant factor affecting the outcome of NOM of the spleen. There was a strongly significant difference in the rates of splenic injuries of grade III and higher between patients undergoing successful and failed NOM. However, the grade of injury was not significantly different between the NOM-success and NOM-failure groups in patients with liver or kidney injuries. A previous report from our group identified a high grade of splenic injury as an independent risk factor of failure.11 Similarly, all NOM failures among patients with renal injuries were for injury grades of III or greater. In contrast, other studies report no association of injury grade and NOM failure.23-25 The failure rate of splenic NOM in this study is higher than reported in other studies with better NOM success rates.3,16 This may be due to the relatively high grades of injury included in our NOM group. Fifty-four percent of our patients with splenic injury undergoing NOM had an injury grade of III or higher, compared with only 34% in the study by Pachter et al.1 Although the overall NOM success rate in this study was 98%, for splenic injury grades of IV and V, it was 40%. In the study by Wasvary et al.16 the percentage of patients with splenic injury grade III or higher is unclear, but the only 3 patients in whom NOM failed owing to delayed splenic bleeding had grade III injuries.

One of the independent risk factors for NOM failure in this study, the volume of 300 mL of free intraperitoneal fluid on CT, seems a small quantity at first glance. In our experience, fluid has to be found in more than 1 site to make up for this volume. Therefore, if fluid is observed in multiple sites (e.g., the pelvis, splenorenal space, and hepatorenal space), it is likely that the patient has more than 300 mL. Also, for results of the FAST examination to be interpreted as positive, at least 200 mL of free intraperitoneal fluid is required.26 Therefore, in the presence of a positive FAST result, the amount of abdominal fluid should approach the above-mentioned volume. One could argue that it may be difficult for clinicians to estimate the amount of fluid on CT. On the contrary, we believe that surgeons are in a unique position to learn how to estimate intra-abdominal fluid accurately by comparing their CT reading against operative findings. In a previous prospective study, we have found that the estimation of intrathoracic fluid on CT by experienced trauma surgeons correlates well with the readings by trauma radiologists and intraoperative findings.27 Intra-abdominal fluid estimation following splenic injury also correlated well with the intraoperative finding of blood.27 The estimation of fluid reported in the present study was done by means of volumetric assessment by an experienced trauma radiologist (R.R.). However, the CTs were also independently read by trauma surgeons. The comparison of the readings of these abdominal CTs between trauma surgeons and radiologists will be a subject of another study.

The causes of failure have not been well described in the literature. Our study shows that failure occurs in approximately one third of patients for reasons other than the solid-organ injury. In fact, 18% of them underwent operation owing to increasing abdominal tenderness or CT findings suspicious for hollow visceral injury, only to have a nontherapeutic laparotomy. Anxiety about the possibility of missing small-bowel injuries in patients undergoing NOM is an issue.28,29 In the examined population, small-bowel injury was rare and represented less than 1% of the NOM group. The only patient with a small-bowel injury had suggestive evidence on CT (bowel wall edema), was followed up closely, and was taken to the operating room 2 hours after CT because of increasing abdominal tenderness. He had an uncomplicated course and was discharged on the sixth postoperative day. Nonoperative management of injuries to the spleen is more likely to fail than NOM of injuries to the liver or kidney.

Despite its prospective design, our study has several limitations. We did not have a specific protocol regarding blood transfusion. We did not use a strict limit of hemoglobin level to transfuse patients, but considered transfusion in the context of the physiological condition of the patient and individualized treatment accordingly. Similarly, criteria for taking the patient to the operating room after a period of NOM were not established. It was up to the attending trauma surgeon to make a decision about discontinuing NOM. In 6 such cases, the laparotomy was nontherapeutic. Although, in retrospect, this decision can be viewed as erroneous, at the time the surgeons reacted correctly to the patient’s deteriorating physical examination or laboratory results. We cannot report on the value of follow-up CT or the period of convalescence required before returning to full activity, because no standard protocols were used. The strength of our study lies in the prospective documentation of the decision to treat a patient nonoperatively or to interrupt NOM and treat surgically. For this reason, the rates of NOM, NOM success, and NOM failure are reliable. Probably, this is the main reason for the higher
incidence of NOM failure reported in our study compared with other retrospective studies.

We recommend NOM in most hemodynamically stable patients without peritoneal signs, regardless of the solid organ injured, age, mental state, or presence of extra-abdominal injury. With splenic and renal injuries, particularly those of grade III or higher, NOM is more likely to fail compared with liver injuries. A positive FAST result or an amount of fluid on CT of greater than 300 mL predicts failure. Similarly, the requirement for blood transfusion during NOM should elevate the level of suspicion for the need of operation. Hollow visceral organ injuries are rare in patients undergoing NOM and should not be a cause for denying NOM. Patients who do not have the identified independent risk factors for failure can be observed more cost-effectively in non-intensive care unit environments and be discharged after a short hospital stay. Patients with some of the risk factors should be monitored closely in the intensive care unit, and patients with all the risk factors are better served by an early operation.

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REFERENCES


DISCUSSION

Richard J. Mullins, MD, Portland, Ore: The authors’ goal was to develop a decision rule. They wanted to determine if they could identify high-risk factors that could be used confidently and promptly to identify patients who needed a laparotomy. They were hoping with that rule to avoid delaying surgery in somebody who was destined to fail nonoperative management.

Dr Velmahos, are there 2 ways to look at the surgeons’ dilemma? Is the issue you are studying operative vs nonoperative management of spleen injury, or is the issue did patients with spleen injury have a therapeutic laparotomy or a nontherapeutic laparotomy? I understood your data to show that only 6 patients had nontherapeutic laparotomies, and thus you considered the vast majority of patients who had either an immediate or delayed laparotomy as having had a therapeutic laparotomy. I would challenge you that perhaps more patients had a laparotomy that did not accomplish much in the way of therapy.

My question, stated in perhaps modern parlance Dr Velmahos: is there a circumstance when a nontherapeutic laparotomy should be considered a medical error? A second question is, do you expect that if I used this model in my hospital I would repeat your 96% accuracy from LA County Hospital? Dr Velmahos, who were the decision makers regarding operative/nonoperative management? Was it the resident, or was it the faculty? Can you tell us how often the resident wanted to do one thing and the faculty reached a different conclusion?

You reported that an experienced trauma radiologist read all of the CTs. Can you tell us the interrater reliability in deciding to categorize a patient as having or not having a 300-mL threshold of abdominal blood? I assume the surgeon read the CT on the spot and made the decision, while the radiologist read the CT the next morning. Did you conclude there was a price that was paid in some of your patients for delayed surgical intervention? Dr Velmahos, would you decide upon nonoperative management in a patient with a brain injury using the guidelines as in a patient without a brain injury?
You have indicated to us that nonoperative management should be exercised with caution if you have 1 of these 4 findings. Do I correctly understand that you are very confident in the absence of those 4 findings that you can manage the patient nonoperatively?

Clayton H. Shatney, MD, San Jose, Calif: I am always curious when somebody says that a patient “required” something, whether it was an operation, or in this study, a transfusion. The question I have for you is, what is your transfusion trigger in a stable patient? You had mentioned “a” transfusion, so are you saying that if you have to give just 1 U in a patient who remains stable and clinically benign, you would operate because you gave that 1 U? Could you please clarify? What about patients who have an extremity fracture? You’d expect them to lose 1 or 2 U? How do you factor all of that in, Dr Velmahos?

The second thing is, if I recall correctly, this study ended in June of 2001 or sometime in 2001, so we are now out another year and a half from the time that you ended it. Correct me if I am wrong. In that interval, there has been a very heightened interest in using embolization in patients with isolated splenic injuries who become a bit unstable, rather than taking them to the operating room. Likewise, there is a recent paper from Japan on the use of embolization in renal trauma, which I personally have had experience with, and it works. In light of this increasing and expanding interest and indication for embolization, would this affect your recommendation if you had a patient tomorrow that you entered into a similar series?

Daniel R. Margulies, MD, Los Angeles, Calif: I have a very specific question about the spleen. You had most of your failures in patients with splenic injuries, and you classified the failures as delayed bleeding. I wondered if you could clarify for us what exact trigger or criteria you used to decide when to operate. For instance, was it 1 U of blood transfusion, 2 U, or a hematocrit threshold, and how did age alter this criteria? What criteria are used matters because it will, by definition, affect which ones are going to become nonoperative failures.

Gill Cryer, MD, Los Angeles: It seemed in your predictive equation that the blood transfusion played a major role. It really depends on your trigger for taking somebody to the operating room as to how important that finding would be. So, for instance, would you have any attendings in your institution that would continue to observe a patient with a splenic injury once they had to start transfusing blood? Conversely, is it the same with the liver? In other words, since you didn’t have any liver injuries bleed, you were either very aggressive about operating on them initially, or your nonoperative protocol is very effective. How do you decide when to take a liver injury to the operating room?

Further along those lines, if you removed the blood transfusion from your predictive equation, would the findings of fluid on ultrasound and the large amount of fluid on CT scans still be just as descriptive?

Michael E. Lekawa, MD, Orange, Calif: Dr Velmahos, that was just an excellent paper, and I actually thought there could be a couple of twists to it. My first question has to do with free fluid on ultrasound. If you have a patient who has free fluid on ultrasound but just a rim of it and they are unstable with multiple injuries, say head injuries and femur fractures, does any free fluid buy them the operating room and therefore take them out of nonoperative management, or do you judge the amount of fluid on your ultrasound?

Secondly, we bring you to the question on interventional radiology. In our institution, our interventionalists are much more comfortable embolizing the liver than they are the spleen. Is that similar in your institution? Is that possibly why the liver patients did so much better than your spleen patients, and possibly the idea of setting a standard here, that these are the patients who failed and had to go on? What that sort of tells us is that the best we can do, then, is whatever standard has been hit now. If we sort of apply these findings to who needs intervention quicker to make it so they don’t fail, as opposed to whom I should just take to the operating room, that might be another way to look at it.

Gail T. Tominaga, MD, Honolulu, Hawaii: I have a few questions. Who decided when someone needed an operation when they were being watched nonoperatively? How was that decision made? Was there a set criterion that all attendings used, or was it left up to surgical judgment?

David Wisner, MD, Sacramento, Calif: I am assuming in your institution that attendings are making these calls because of the way you guys are organized. Was there a difference among the attendings in terms of the rate of successful nonoperative management, since really the decision to operate on a patient we treat sometimes more objectively than it really is. It’s a subjective decision-making process, and so one way to look at your paper is that, rather than defining a decision-making rule, you have really just described how you guys correctly decide when to operate on patients who you have tried to manage nonoperatively.

Samuel E. Wilson, MD, Orange: Rather than “delayed” bleeding, aren’t you really talking about time to recognize continued bleeding?

Dr Velmahos: I think I should have really removed this “truth from a prospective study” from the title [laughter].

Dr Wilson: Well, the amount of discussion is directly relevant to the value of the paper.

Dr Velmahos: Dr Mullins asked if nontherapeutic laparotomies should be considered failures. I answer, yes, they are. The reality is that, whether it’s an error in judgment or due to real progression of physical examination findings, the patient is taken to the operating room. There the patient is subjected to the risk of anesthesia in the middle of the night, on an unprepared stomach, and subjected to the morbidity of a laparotomy, even if nontherapeutic. Therefore, my answer is that it should be considered a failure of nonoperative management.

Who made the decision? Was it the resident or the attending surgeon? In our setting, there is 24/7 in-house coverage by dedicated attending trauma surgeons. Even if it is a county hospital and we are aware about the need to allow autonomy to our residents, the final decision is made by the attending. The resident forms a plan and discusses it with the attending, but the ultimate decision is made by the attending.

Do surgeons read CT as accurately as the radiologists? This is going to be the subject of another study from this data. We believe that experienced surgeons can and should read CT scans accurately on focused areas: not expected to find coccidioidomycosis but expected to identify the appropriate grade of liver and splenic injury and the appropriate amount of blood. We have published 2 studies previously documenting that the surgeon’s focused reading can be reliable and comparable to the radiologist’s.

Does delayed intervention produce adverse consequences? I have doubts. A delay up to a certain amount of hours probably does not. We did have 2 patients who developed abdominal compartment syndrome as the resuscitation was going on. But this was rather due to progression of their disease than delaying the operation. We had not identified any preventable morbidity attributable to delay in operation.

Do patients with head injuries have the same or less likelihood to be managed nonoperatively? In our institution, they have the same likelihood. There is reasonable evidence supporting the safety of managing patients with head injuries nonoperatively. If the CT scan is appropriate, and otherwise the patient seems to be stable, these patients will be managed nonoperatively despite the presence of a head injury in our institution.
Drs Shatney and Wisner asked whether we have established transfusion policies. We don't have any transfusion policies. Following up with another question about a policy on taking patients to the operating room following a period of nonoperative management, we don't have a certain policy either. We are developing a policy based on the results of our study, but at the time we do not. However, this trauma team has existed for the past 10 years, we are the same people who were there back in 1992, and we have worked together extensively under the same principles more or less. I expect that our practices are similar with appropriate variations, nevertheless small variations. We do more or less the same things.

Did we use embolization? Sure, we were very aggressive with angiographic embolization. We are very aggressive with the liver and the kidney and we are still exploring the value of angiographic embolization of the spleen. In the Japanese article that Dr Shatney referred to, the authors were subjecting to angiography all grade III injuries and above. This seems like an overkill. If there are CT scan findings like a blush of if the patient shows signs of slow bleeding, then angiographic embolization of the spleen is a good thing.

Again, Drs Margulies and Cryer asked how did we decide to take patients to the operating room. I gave the answer that we do not have a uniform policy. Dr Lekawa, any fluid on ultrasounds is a risk factor. There is good evidence that ER physicians and surgeons can identify fluid only if it is at least 200 to 400 mL. So any amount of fluid is a risk factor, given the fact that any fluid means more than 200 to 400 mL.

Dr Tominaga, I hope I have addressed your questions already. Dr Wilson, you asked if failure of nonoperative management is due to acute delayed bleed or due to ongoing slight oozing. I wouldn’t have any hard data to give you an answer for that. But my impression is that there is ongoing oozing. In young trauma victims, the vital signs do not change until the slight oozing becomes significant blood loss. That’s when we recognize it and take the patient to the OR.

**ARCHIVES OF INTERNAL MEDICINE**

Overweight and Obesity as Determinants of Cardiovascular Risk: The Framingham Experience

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**Background:** To our knowledge, no single investigation concerning the long-term effects of overweight status on the risk for hypertension, hypercholesterolemia, diabetes mellitus, and cardiovascular sequelae has been reported.

**Methods:** Relations between categories of body mass index (BMI), cardiovascular disease risk factors, and vascular disease end points were examined prospectively in Framingham Heart Study participants aged 35 to 75 years, who were followed up to 44 years. The primary outcome was new cardiovascular disease, which included angina pectoris, myocardial infarction, coronary heart disease, or stroke. Analyses compared overweight (BMI [calculated as weight in kilograms divided by the square of height in meters], 25.0-29.9) and obese persons (BMI ≥ 30) to a referent group of normal-weight persons (BMI, 18.5-24.9).

**Results:** The age-adjusted relative risk (RR) for new hypertension was highly associated with overweight status (men: RR, 1.46; women: RR, 1.75). New hypercholesterolemia and diabetes mellitus were less highly associated with excess adiposity. The age-adjusted RR (confidence interval [CI]) for cardiovascular disease was increased among those who were overweight (men: 1.21 [1.05-1.40]; women: 1.20 [1.03–1.41]) and the obese (men: 1.46 [1.20-1.77]; women: 1.64 [1.37-1.98]). High population attributable risks were related to excess weight (BMI ≥ 25) for the outcomes hypertension (26% men; 28% women), angina pectoris (26% men; 22% women), and coronary heart disease (23% men; 15% women).

**Conclusions:** The overweight category is associated with increased relative and population attributable risk for hypertension and cardiovascular sequelae. Interventions to reduce adiposity and avoid excess weight may have large effects on the development of risk factors and cardiovascular disease at an individual and population level. (2002;162:1867-1872)

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