Western Trauma Association Critical Decisions in Trauma: Nonoperative Management of Adult Blunt Hepatic Trauma

Rosemary A. Kozar, MD, PhD, Frederick A. Moore, MD, Ernest E. Moore, MD, Michael West, MD, Christine S. Cocanour, MD, James Davis, MD, Walter L. Biffl, MD, and Robert C. McIntyre, Jr., MD

Key Words: Blunt hepatic trauma, Nonoperative management, Hemoperitoneum, Computed tomography, Angioembolization, Biliary complications.

(*J Trauma.* 2009;67: 1144–1149)

This is a recommended algorithm of the Western Trauma Association for the management of blunt hepatic injuries. Because there are no published prospective randomized trials, the recommendations are based on available published prospective, observational, and retrospective data and expert opinion of Western Trauma Association members. The algorithm (Fig. 1) and accompanying text represent safe and reasonable treatment strategies that could be followed at most trauma centers. We recognize that there will be variability in decision making and institutional and patient-specific factors that may warrant deviation from the recommended algorithm. We encourage institutions to use this algorithm as a basis to develop institution-specific protocols. The algorithm contains letters, which correspond to the text. Their purpose is to explain the critical factors affecting decisions and to guide the reader through the algorithm.[1,2] References to support each step are inserted as appropriate. Specific areas where published data are lacking are mentioned as potential topics for future studies.

Submitted for publication February 11, 2009.
Accepted for publication July 29, 2009.

From the Department of Surgery (R.A.K.), University of Texas Health Science Center at Houston, Houston, Texas; Department of Surgery (F.A.M.), The Methodist Hospital, Houston, Texas; Department of Surgery (E.E.M., W.L.B.), Denver Health Medical Center, Denver, Colorado; Department of Surgery (M.W.), San Francisco General Hospital, San Francisco, California; Department of Surgery (C.S.C.), University of California Davis, Sacramento, California; Department of Surgery (J.D.), UCSF/Fresno, Fresno, California; and Department of Surgery (R.C.M.), University of Colorado Health Sciences Center, Denver, Colorado.

The Western Trauma Association develops algorithms to provide guidance and recommendations for particular practice areas, but does not establish the standard of care. The WTA develops algorithms based on the evidence available in the literature and the expert opinion of the task force in the recent timeframe of the publication. The WTA considers use of the algorithm to be voluntary. The ultimate determination regarding its application is to be made by the treating physician and health care professionals with full consideration of the individual patient's clinical status as well as available institutional resources and is not intended to take the place of health care providers' judgment in diagnosing and treating particular patients.

Presented at the 39th Annual Meeting of the Western Trauma Association, February 22–28, 2009, Crested Butte, Colorado.

Address for reprints: Rosemary Kozar, MD, PhD, Department of Surgery, University of Texas Health Science Center at Houston, 6431 Fannin, MSB 4.284, Houston, TX 77030; email: Rosemary.A.Kozar@uth.tmc.edu.

DOI: 10.1097/TA.0b013e3181ba361f

OPERATIVE TO NONOPERATIVE MANAGEMENT OF BLUNT HEPATIC TRAUMA

During the past 2 decades, treatment of blunt hepatic injuries has dramatically changed. A shift occurred from operative management emphasizing nonresectional techniques and packing in the 1980s to selective nonoperative management in the 1990s and now to nonoperative management with selective operative management. Decreased mortality associated with nonoperative management can be credited to astute observations made by trauma surgeons in concert with the use of computed tomography (CT) to aid in the diagnosis of hepatic injuries, availability of angioembolization for treatment of bleeding hepatic injuries, and appreciation of the coagulopathy of trauma.[3–6] Table 1 summarizes the success of nonoperative management and its associated low hepatic-related morbidity and mortality.[7–11] Only studies with more than 50 adult patients with blunt hepatic trauma treated by nonoperative management were included. A recent review of the National Trauma Data Base noted that 86.3% of hepatic injuries are now managed without operative intervention,[12] an even higher percentage than previous studies reported.[7,9] Not surprisingly, more complications related to nonoperative management are being diagnosed. The following algorithm focuses on nonoperative management of blunt hepatic trauma.

ANNOTATED TEXT FOR ALGORITHM

A. The initial assessment of patients with suspected blunt abdominal trauma should focus on the patient's abdominal examination, vital signs, and response to resuscitation. General principles of advanced trauma life support should be instituted, and the response to resuscitation closely monitored. Peritonitis remains an indication for exploration after blunt abdominal trauma.

B. Although there is no well-accepted definition of hemodynamic instability, the traditionally accepted value is ≤90 mm Hg. However, recent studies demonstrate that patients are at risk for hemorrhage and death with a blood pressure ≤110 mm Hg and a base deficit of 4.[13,14] To assist in early triage decisions, a hemodynamic instability score has been proposed for patients with blunt splenic trauma.[2] Initial evaluation should also include an assess-

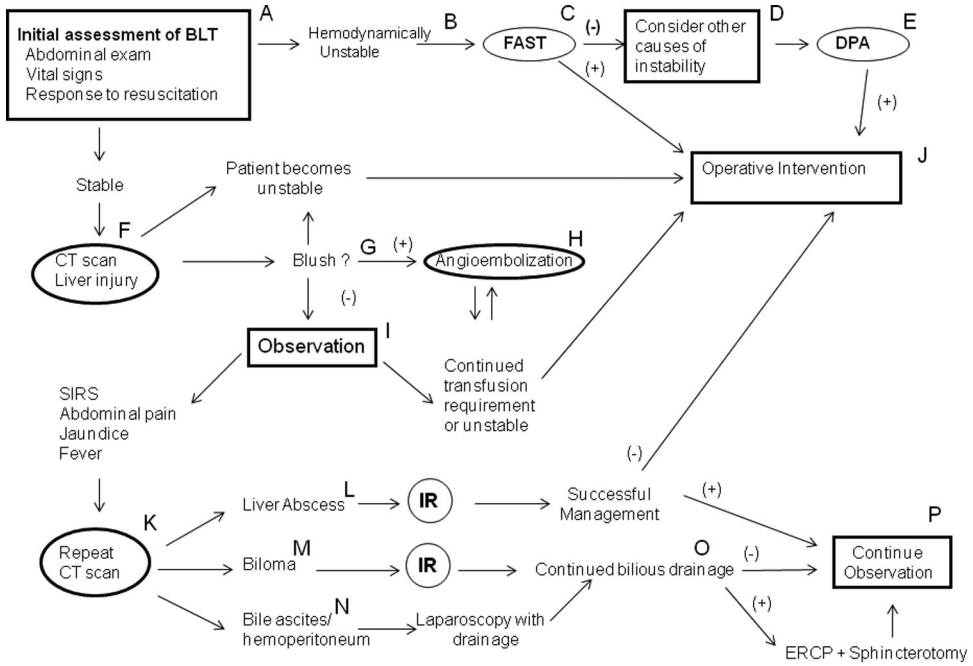

Figure 1. Algorithm for the management of nonoperative blunt hepatic trauma.

TABLE 1. Nonoperative Management and Outcome of Blunt Liver Injuries

Institution, Year	Nonoperative Rx, N (%)	Grade 4–5, N (%)	Early Failure (%)	Liver-Related Morbidity (%)	Liver-Related Mortality (%)
Bowman Gray, 1994	72 (55)	15 (21)	3	1	0
University Tennessee, 1995	112 (82)	43 (38)	11	4	1
New York University, 1996	404 (47)	58 (14)	4	1	0.4
University Tennessee, 2000	560 (85)	127 (23)	8	1	0.4
USC, 2003	55 (71)	16 (29)	15	2	0

ment of admission coagulopathy. The early use of a massive transfusion protocol, rather than the excessive use of crystalloids, is encouraged for patients with ongoing transfusion needs and has been shown to reduce mortality.[15] Recent data also support the early use of plasma to packed red blood cells in a ratio approaching 1:1, although a prospective randomized trial has not yet been performed.[16,17] The association between plasma- and transfusion-related acute lung injury suggests the need for further investigation into this practice.[18]

C. Hemodynamically unstable patients should have a focused abdominal sonogram for trauma (FAST) if not performed as part of their initial evaluation and if available and reliable. Hemoperitoneum diagnosed by a positive FAST examination in a persistently unstable patient should prompt operative intervention. If the initial FAST is negative, a second should be repeated as part of the secondary survey.[19]

D. Patients with persistent hemodynamic instability and a negative FAST pose a diagnostic dilemma and should not be triaged to the CT scanner, rather resuscitation should continue as the differential diagnosis of refractory shock is pursued. Patients with blunt hepatic injuries are at risk for both associated abdominal and extra-abdominal injuries.[8,20] Extra-abdominal sources of exsanguinating hemorrhage include massive hemothorax and severe pelvic fracture, whereas nonhemorrhagic shock from cardiogenic (tension pneumothorax, cardiac tamponade, and myocardial contusion or infarct) or neurogenic (spinal shock) causes may be present either as the sole source or in addition to hemorrhagic sources of instability. Rather than continuing shock resuscitation in the trauma bay, an alternative is to proceed to the operating room for an exploratory laparotomy in patients at risk for imminent cardiac arrest.

E. If hemoperitoneum remains a concern in an unstable patient with a negative FAST, a diagnostic peritoneal aspirate should be considered. A positive diagnostic peritoneal aspirate is aspiration greater than 10 mL of gross blood and warrants operative exploration in an unstable patient.[21]

F. A CT scan of the abdomen is the optimal diagnostic modality to aide in both the diagnosis and management of blunt hepatic trauma in hemodynamically stable patients.[22] Liver injuries are graded per the American As-

sociation for the Surgery of Trauma liver injury scale, which was developed as part of the transition to nonoperative management and remains valid today.[23] A recent report using data from the National Trauma Data Bank demonstrated that increasing injury severity was associated with increasing organ injury scale grades.[12] In addition, organ-specific operative rates increased with increasing grade, although grade alone did not accurately predict the need for operation. When patients with isolated liver injuries were analyzed, 91.5% of grade I and II injuries, 79% of grade III, 72.8% of grade 4, and 62.6% of grade 5 injuries were successfully managed without operative intervention. Therefore, even high-grade injuries have a high likelihood of successful nonoperative management.

G. The finding of a "blush," or pooling of intravenous contrast material within the liver parenchyma, on CT scanning is indicative of active hemorrhage. Earlier studies suggested that these patients should undergo operative intervention, regardless of hemodynamic stability, though the availability of angiographic embolization may have successfully managed the hemorrhage.[9,24,25] More recently, Fang et al.[22,26] reported on the significance of a blush in stable patients with blunt hepatic trauma. Their initial study in 1998 followed up eight hemodynamically stable patients with pooling into the peritoneal cavity.[25] Six of these patients rapidly became unstable and underwent emergent laparotomy, and the other two required delayed operations for liver-related complications. In a later study, they attempted to categorize pooling of contrast material into free extravasation with pooling into the peritoneal cavity, intraparenchymal contrast pooling with associated hemoperitoneum, and intraparenchymal contrast pooling without hemoperitoneum.[26] Although the sample size was very low, all patients (6/6) with free pooling required laparotomy for hemodynamic deterioration, 66% (4/6) of patients with intraparenchymal pooling and hemoperitoneum required operation, while no patient (3/3) with intraparenchymal pooling alone required surgery or angioembolization. Finally, a larger study by this group confirmed that intraperitoneal extravasation was the most specific sign to predict the need for surgery by both univariate and logistic regression analysis.[22] Although data are very limited, it seems logical to suggest that hemodynamically stable patients with free intraperitoneal extravasation undergo immediate angiography if readily available, performed in a monitored setting, and at an institution where blood products and an operative team are immediately available. More controversial is the group of stable patients with intraparenchymal contrast pooling. It is not clear from available data whether immediate angiographic embolization is required. Close observation alone with planned angiographic embolization for signs of ongoing bleeding, such as a drop in hematocrit or need for transfusion, is also an option in appropriate facilities.[26–28] Neither the true incidence of pseudoaneurysm or arteriovenous fistula nor their natural history (regression or rupture) are well defined. With the current use of multichannel detector CT scanners, pooling of contrast is an increasingly common finding. A well-performed clinical trial to address the optimal management of hemodynamically stable patients with contrast pooling on CT scanning is needed.

H. Neither the presence nor the absence of active bleeding on CT scanning absolutely predicts the need for angiography. Vasospasm at the time of CT and delayed clot lysis can both contribute to an initial lack of contrast extravasation, whereas active bleeding may be due to hemorrhage from portal or hepatic vein lesions. Bleeding seen during the arterial phase of the scan, however, confirms bleeding from an arterial source. Angioembolization is an important adjunct to management of patients managed both operatively and nonoperatively with high-grade liver injuries. Early angioembolization can decrease the need for transfusions and liver-related operations.[29,30] Conflicting data exist as to whether it can improve outcome in patients requiring operative intervention.[20,31,32] Unless angiography is immediately available, most would consider preoperative angiography only for stable patients with pooling seen on CT scanning. There are several reports, however, suggesting that angiography be used as an extension of resuscitation in patients with ongoing resuscitative needs.[33,34] This practice cannot be advocated except in selected centers.

I. Carillo et al.[35] proposed criteria for nonoperative management of hepatic trauma to include: hemodynamically stable (not defined) patients with liver injuries diagnosed on CT scan, hepatic-related transfusion limited to 4 units of blood, and absence of other abdominal injuries that required exploration. The hepatic-related transfusion limit has not been verified. The morbidity of ongoing transfusions in an otherwise hemodynamically stable patient versus the morbidity of hepatic surgery remains to be well defined. Transfusion requirement in the first 24 hours postinjury has been shown to predict the development of liver-related complications.[36]

J. Operative intervention is still required for the patients sustaining blunt hepatic trauma, primarily related to hemodynamic instability on presentation. Christmas et al.[37] confirmed higher liver-related morbidity and mortality for the patients undergoing operative intervention. When surgery is indicated, management should focus on cessation of bleeding, applying the principles of damage control surgery and hemostatic resuscitation.[38] Different from operative intervention for blunt splenic injuries, bleeding from blunt hepatic injuries may actually be exacerbated by operation. In fact, Richardson et al.[3] suggested that the primary reason for the decrease in hepatic-related mortality over the past several decades is the shift to nonoperative management. A detailed description of operative management is beyond the scope of this text but will be a future topic for critical decisions.

K. Not surprisingly, because more aggressive nonoperative management is being pursued, more liver-related complications are being diagnosed. Although routine follow-up

CT scans are not necessary, persistent systemic inflammatory response syndrome, abdominal pain, jaundice, or an unexplained drop in hemoglobin should prompt an evaluation by CT scanning.[39] Complications are primarily related to the grade of liver injury and the need for transfusion.[36] Reported complication rates range from 0% to 7% when all grades are considered, but can be as high as 14% when only high-grade injuries are considered. Paramount to the successful management of hepatic complications is a multimodality treatment strategy to include endoscopic retrograde cholangiographic embolization (ERCP) and stenting, transhepatic angioembolization, and image guided percutaneous drainage techniques. Despite these advances, operative intervention still plays a role. When patients not requiring laparotomy within the first 24 hours after injury were examined, complications that required delayed operative intervention included bleeding, abdominal compartment syndrome, and failure of percutaneous drainage techniques.[36] Delayed hemorrhage is the most frequent, although still rare, postinjury complication.[9,36,38] "Late" bleeds from blunt hepatic injuries generally occur within the first 72 hours postinjury.[36] Management principles discussed earlier should be applied and may include angioembolization or operative stabilization.

L. A hepatic or perihepatic abscess appears on CT scan as a focal collection with gas bubbles or a fluid collection with an air fluid level. The incidence is low and can usually be managed by percutaneous catheter drainage, though operative drainage may still be needed for failures.

M. Biliary complications include biloma, biliary fistula, bile leak, and bile peritonitis. Approximately, one-third of liver-related complications are biliary in nature with an overall incidence of approximately 3%, although higher rates have been reported.[28,36,40] Typically, biliary complications present in a delayed fashion in patients with grade 4 injuries.[36] A biloma results when bile leaks into the hepatic parenchyma, increasing pressure leads to necrosis, and eventual formation of a biloma.[41] Management consists of percutaneous catheter drainage. It is not known whether all asymptomatic bilomas require treatment.

N. Bile peritonitis, defined as peritoneal and systemic signs of inflammation, typically presents several days after injury. Patients develop systemic inflammatory response syndrome in response to devitalized liver tissue rather than sepsis.[42] Although laparotomy remains an option, drainage can be safely and effectively performed by laparoscopy.[28,43–45] Although these signs may prompt consideration of a missed bowel injury, the incidence is very low even in patients with high grade injuries.[36]

O. Although most peripheral biliary leaks will seal without treatment, continued high output biliary drainage may warrant adjunctive ERCP to aid in healing. Ponsky and coworkers[46] suggest stenting rather than spincterotomy for more effective resolution of biliary leaks. Neither the optimal duration of leak before ERCP nor the duration of leak before operative consideration has been studied.

P. Continued observation is necessary, as multiple and recurrent late complications occur.[28] The Pittsburgh group recently reported the safety of hepatic resection in the management of complex liver injuries.[47] Although patients in this series underwent primary operative therapy and the majority were not major resections, their excellent results suggest that delayed resection for necrotic or devitalized hepatic tissue or major intraparenchymal bile leaks may be an option in select cases at institutions with the appropriate hepatic expertise.

REFERENCES

1. McIntyre RC Jr, Moore FA, Davis JW, Cocanour CS, West MA, Moore EE Jr. Western Trauma Association critical decisions in trauma: foreword. *J Trauma.* 2008;65:1005–1006.
2. Moore FA, Davis JW, Moore EE Jr, Cocanour CS, West MA, McIntyre RC Jr. Western Trauma Association (WTA) critical decisions in trauma: management of blunt splenic trauma. *J Trauma.* 2008;65:1007–1011.
3. Richardson JD, Franklin GA, Lukan JK, et al. Evolution in the management of hepatic trauma: a 25 year perspective. *Ann Surg.* 2000;232:324–330.
4. Kashuk JL, Moore EE, Millikan JS, Moore JB. Major abdominal vascular trauma—a unified approach. *J Trauma.* 1982;22:672–679.
5. Brohi K, Singh J, Heron M, Coats T. Acute traumatic coagulopathy. *J Trauma.* 2003;54:1127–1130.
6. MacLeod JB, Lynn M, McKenney MG, Cohn SM, Murtha M. Early coagulopathy predicts mortality in trauma. *J Trauma.* 2003;55:39–44.
7. Meredith JW, Young JS, Bowling J, Roboussin D. Nonoperative management of blunt hepatic trauma: the exception or the rule? *J Trauma.* 1994;36:529–534; discussion 534–535.
8. Croce MA, Fabian TC, Menke PG, et al. Nonoperative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. The results of a prospective trial. *Ann Surg.* 1995;221:744–753; discussion 753–755.
9. Pachter HL, Knudson MM, Esrig B, et al. Status of nonoperative management of blunt hepatic injuries in 1995: a multicenter experience with 404 patients. *J Trauma.* 1996;40:31–38.
10. Malhotra AK, Fabian TC, Croce MA, et al. Blunt hepatic injury: a paradigm shift from operative to nonoperative management in the 1990's. *Ann Surg.* 2000;231:804–813.
11. Velmahos GC, Toutouzas K, Radin R, et al. High success with nonoperative management of blunt hepatic trauma: the liver is a sturdy organ. *Arch Surg.* 2003;138:475–480; discussion 480–481.
12. Tinkoff G, Esposito T, Reed J, et al. American Association for the Surgery of Trauma Organ Injury Scale I: spleen, liver, and kidney, validation based on the National Trauma Data Bank. *J Am Coll Surg.* 2008;207:646–655.
13. Eastridge BJ, Scalino J, McManus JG, et al. Hypotension begins at 110 mm Hg: redefining "hypotension" with data. *J Trauma.* 2007;63:291–297; discussion 297–299.
14. Davis JW, Parks SN, Kaups KL, Gladen HE, O'Donnell-Nicol S. Admission base deficit predicts transfusion requirements and risk of complications. *J Trauma.* 1996;41:769–774.
15. Cotton BA, Gunter OL, Isbell J, et al. Damage control hematology: the impact of a trauma exsanguination protocol on survival and blood product utilization. *J Trauma.* 2008;64:1177–1182; discussion 1182–1183.
16. Holcomb JB, Wade CE, Michalek JE, et al. Increased plasma and platelet to red blood cell ratios improves outcome in 466 massively transfused civilian trauma patients. *Ann Surg.* 2008;248:447–458.
17. Gonzalez EA, Moore FA, Holcomb JB, et al. Fresh frozen plasma should be given earlier to patients requiring massive transfusion. *J Trauma.* 2007;62:112–119.
18. Gajic O, Rana R, Winters JL, et al. Transfusion-related acute lung injury in the critically ill: prospective nested case-control study. *Am J Respir Crit Care Med.* 2007;176:886–891.
19. Blackbourne LH, Soffer D, McKenney M, et al. Seconary ultrasound examination increases the sensitivity of the FAST exam in blunt trauma. *J Trauma.* 2004;57:934–938.

20. Duane TM, Como JJ, Bochicchio GV, Scalea TM. Reevaluating the management and outcomes of severe blunt liver injury. *J Trauma.* 2004;57:494–500.
21. Davis JW, Moore FA, McIntyre RC Jr, Cocanour CS, Moore EE, West MA. Western Trauma Association critical decisions in trauma: management of pelvic fracture with hemodynamic instability. *J Trauma.* 2008; 65:1012–1015.
22. Fang JF, Wong YC, Lin BC, Hsu YP, Chen MF. The CT risk factors for the need of operative treatment in initially stable patients after blunt hepatic trauma. *J Trauma.* 2006;61:547–553; discussion 553–554.
23. Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: spleen and liver (1994 revision). *J Trauma.* 1995;38:323–324.
24. Pachter HL, Hofstetter SR. The current status of nonoperative management of adult blunt hepatic injuries. *Am J Surg.* 1995;169: 442–454.
25. Fang JF, Chen RJ, Wong YC, et al. Pooling of contrast material on computed tomography mandates aggressive management of blunt hepatic injury. *Am J Surg.* 1998;176:315–319.
26. Fang JF, Chen RJ, Wong YC, et al. Classification and treatment of pooling of contrast material on computed tomographic scan of blunt hepatic trauma. *J Trauma.* 2000;49:1083–1088.
27. Hagiwara A, Murata A, Matsuda T, Matsuda H, Shimazaki S. The efficacy and limitations of transarterial embolization for severe hepatic injury. *J Trauma.* 2002;52:1091–1096.
28. Kozar RA, Moore JB, Niles SE, et al. Complications of nonoperative management of high-grade blunt hepatic injuries. *J Trauma.* 2005;59: 1066–1071.
29. Wahl WL, Ahrns KS, Brandt MM, Franklin GA, Taheri PA. The need for early angiographic embolization in blunt liver injuries. *J Trauma.* 2002;52:1097–1101.
30. Mohr AM, Lavery RF, Barone A, et al. Angioembolization for liver injuries: low mortality, high morbidity. *J Trauma.* 2003;55:1077–1082.
31. Asensio JA, Demetriades D, Chalwan S, et al. Approach to the management of complex hepatic injuries. *J Trauma.* 2000;48:66–69.
32. Asensio JA, Roldán G, Petrone P, et al. Operative management and outcomes in 103 AAST-OIS grades IV and V complex hepatic injuries: trauma surgeons still need to operate, but angioembolization helps. *J Trauma.* 2003;54:647–654.
33. Ciraulo D, Luk S, Palter M, et al. Selective hepatic arterial embolization of grade IV and V blunt hepatic injuries: an extension of resuscitation in the nonoperative management of traumatic hepatic injuries. *J Trauma.* 1998;45:353–359.
34. Hagiwara A, Murata A, Matsuda T, Matsuda H, Shimazaki S. The usefulness of transcatheter arterial embolization for patients with blunt polytrauma showing transient response to fluid resuscitation. *J Trauma.* 2004;57:271–276; discussion 276–277.
35. Carillo E, Spain D, Wohltmann D, et al. Interventional techniques are useful adjuncts in nonoperative management of hepatic injuries. *J Trauma.* 1999;46:619–622; discussion 622–624.
36. Kozar RA, Moore FA, Cothren CC, et al. Risk factors for hepatic morbidity following nonoperative management. *Arch Surg.* 2006;141: 451–458; discussion 458–459.
37. Christmas AB, Wilson AK, Manning B, et al. Selective management of blunt hepatic injuries including nonoperative management is a safe and effective strategy. *Surgery.* 2005;138:606–610; discussion 610–611.
38. Lee SK, Carrillo EH. Advances and changes in the management of liver injuries. *Amer Surg.* 2007;73:201–206.
39. Cuft RF, Cogbill TH, Lambert PJ. Nonoperative management of blunt liver trauma: the value of follow up abdominal computed tomographic scans. *Amer Surg.* 2000;66:332–336.
40. Howdieshell TR, Purvis J, Bates WB, Teeslink CR. Biloma and biliary fistula following hepatorraphy for liver trauma: incidence, natural history, and management. *Am Surg.* 1995;61:165–168.
41. Sugimoto K, Asari Y, Sakaguchi T, Owada T, Maekawa K. Endoscopic retrograde cholangiography in the nonsurgical management of blunt liver injury. *J Trauma.* 1993;35:192–199.
42. Cogbill TH, Moore EE, Jurkovich GJ, Feliciano DV, Morris JA, Mucha P. Severe hepatic trauma: a multi-center experience with 1,335 injuries. *J Trauma.* 1988;28:1433–1438.
43. Carillo EH, Reed DN, Gordon L, Spain DA, Richardson JD. Delayed laparoscopy facilitates the management of biliary peritonitis in patients with complex liver injuries. *Surg Endosc.* 2001;15:319–322.
44. Franklin GA, Richardson JD, Brown AL, et al. Prevention of bile peritonitis by laparoscopic evacuation and lavage after nonoperative treatment of liver injuries. *Am Surg.* 2007;73:611–616; discussion 616–617.
45. Letoublin C, Chen Y, Arvieux C, et al. Delayed celiotomy or laparoscopy as part of the nonoperative management of blunt hepatic trauma. *World J Surg.* 2008;32:1189–1193.
46. Marks JM, Ponsky JL, Shillingstad RB, Singh J. Biliary stenting is more effective than sphincterotomy in the resolution of biliary leaks. *Surg Endosc.* 1998;12:327–330.
47. Polanco P, Leon S, Pineda J, et al. Hepatic resection in the management of complex injury to the liver. *J Trauma*. 2008;65:1264–1269; discussion 1269–1270.

EDITORIAL COMMENT

Extensive experience in the nonoperative management of blunt hepatic injuries has accrued over the past two decades resulting in management paradigms based on trial and error. Published, prospective randomized trials, as the authors have rightly pointed out, are lacking, and for the most part, treatment plans were, and are currently, based on basically what has worked in a sustained fashion with universally reproducible results. The authors provide us with an algorithmic approach, based on sound data and expert opinions as to how to manage patients sustaining blunt hepatic injuries.

In general, algorithms provide a quick but not simple set of avenues, turns, and detours, which can guide surgeons in attaining their final destination—a medical GPS, if you will. What separates this particular algorithm from those we frequently encounter is a thorough detailed analysis and rationale for each step. Moreover, the authors stress that the guidelines set forth in this article are not written in stone and that they merely serve as a template on which physicians can add, modify, or deviate from, based on individualized care when the need arises.

Several key points stressed by the author are of paramount importance:

1. Hemodynamic instability in the patients with isolated hepatic injuries should prompt operative intervention.
2. The scanner is not the appropriate venue to triage hemodynamically unstable patients.
3. The use of DPA is an invaluable tool in patients unstable with a negative FAST.
4. Isolated high grade injuries (IV–V), which meet inclusion criteria, can successfully be managed nonoperatively.

The significance of contrast pooling noted on computed tomography scan in the stable patient remains unanswered and merits comment. In the past, the fear of unpredictability prompted surgeons to angioembolize these lesions. Perhaps, this was "overkill" and unnecessary. However, cumulated data powered to significance will be required to answer this question. At present, it would be reasonable to defer angioembolization unless signs of bleeding become apparent. With free extravasation into the peritoneal cavity, a situation fraught with peril, particularly in the unstable patient, perhaps

the better part of valor would be an expeditious operation rather than attempts at angioembolization.

The Western Trauma Association Algorithmic approach to nonoperative management of adult blunt hepatic injuries should be mandatory reading, and it should be glued to every resident handbook. The guide lines presented are evidence based and meticulously thought out. At the same time, however, they leave room for interpretation and individualization. It is important to recognize that even in a world of algorithmic GPS systems, when hanging over a precipice, it is always good to have a reverse gear.

H. Leon Pachter, MD, FACS
The George David Stewart Professor and Chair
Department of Surgery
NYU School of Medicine
New York City, New York