Observation for Nonoperative Management of Blunt Liver Injuries: How Long Is Long Enough?

Nancy A. Parks, MD, James W. Davis, MD, Dana Forman, DO, and Deborah Lemaster, RN, MSN

Background: Nonoperative management (NOM) of blunt liver injury is the standard of care in hemodynamically stable patients. However, there are no data regarding the optimum length of inpatient observation. The purpose of this study is to review NOM guidelines for patient safety and optimal length of stay (LOS).

Methods: A retrospective review of the trauma registry at a Level I trauma center was performed to identify all patients admitted with blunt liver injuries. Guidelines for length of observation were developed, such that patients were discharged with normal physical examination and stable hemoglobin, regardless of grade of injury. Data collected include injury severity score, grade of liver injury, LOS, success rate of NOM, time to failure of NOM, and reason for failure of NOM.

Results: From August 2002 to March 2009, 591 patients were admitted for NOM of blunt liver injuries. Of these, 35 patients (6%) failed NOM; 19 failed secondary to hemorrhage, mostly from associated injuries. Average LOS for patients with isolated liver injuries was 2.2 days. Only one patient failed NOM as an outpatient. There were no adverse outcomes from these NOM guidelines.

Conclusions: The length of observation should be based solely on clinical criteria. Patients with liver injuries may be safely discharged home in the presence of a normal abdominal examination and stable hemoglobin, regardless of the grade of injury. This guideline is safe and reduces LOS without increasing morbidity or mortality.

Key Words: Nonoperative management, Liver, Observation, Guideline.

(*J Trauma.* 2011;70: 626–629)

Nonoperative management (NOM) of blunt liver injuries has become the standard of care in hemodynamically stable patients. NOM has been shown to be safe, even in patients with high-grade injuries, and overall success rates are 85% to 98%.[1–4] With the success of NOM, increasingly complex and severe liver injuries are being managed nonoperatively. Hepatic-related complications of NOM such as delayed hemorrhage, prolonged bile leak, biloma, biliary fistula, bile peritonitis, abscess, hemobilia, and hepatic necrosis are low, ranging from 0% to 11%, with the higher grade injuries resulting in most of the complications.[5]

Submitted for publication June 25, 2010.
Accepted for publication December 23, 2010.

From the Department of Surgery, UCSF-Fresno, Fresno, California.
Presented as a poster at the 67th Annual Meeting of the American Association for the Surgery of Trauma, September 24–27, 2008, Maui, Hawaii.
Address for reprints: Nancy A. Parks, MD, Department of Surgery, 1st Floor, Community Regional Medical Center, 2823 Fresno Street, Fresno, CA 93721-1324; email: nparks@fresno.ucsf.edu.

DOI: 10.1097/TA.0b013e31820d1c69

Although there are multiple publications designed to evaluate the safety, efficacy, and potential complications of NOM in blunt liver injuries, there is no published standard on the recommended length of inpatient observation for these patients. Early studies of NOM describe average length of stay (LOS) for blunt liver injuries to be as long as 13 days to 16 days.[6,7] Current practices for the NOM of blunt liver injuries vary widely. A previous study from our institution evaluated guidelines for NOM of splenic injuries.[8] The study showed that LOS based on normal abdominal physical examination and stable hemoglobins was safe. A similar guideline for NOM of liver injuries was developed. Our hypothesis is that, regardless of grade of injury, hemodynamically stable patients with blunt liver injuries do not need further inpatient observation if the clinical examination is normal and serial hemoglobin measurements are stable. The purpose of this study was to evaluate the safety and efficacy of this guideline.

PATIENTS AND METHODS

A retrospective review of the trauma registry at our Level I trauma center was completed, and all patients with blunt liver injuries admitted from August 2002 to March 2009 were included in this study. Patients selected for NOM of blunt liver injury were hemodynamically stable and had no associated injuries requiring laparotomy or visceral angiography at the time of admission. Failure of NOM was defined as angiography or laparotomy after initial attempted NOM.

All patients admitted to the trauma service for NOM of blunt liver injury were then managed according to the following guidelines:

- Patients with grades I and II injuries were admitted with monitoring of vital signs and serial abdominal physical examinations. Serial hemoglobin measurements were done every 6 hours for 24 hours and, if stable, the patient was discharged home (unless additional injuries precluded safe discharge).
- Patients with grades III, IV, and V injuries were admitted for monitoring of vital signs, serial abdominal physical examination, and serial hemoglobin evaluations. Hemoglobin was measured every 6 hours during the first 24 hours and then every 12 hours until stable. Once these patients had normal vital signs, ability to tolerate a diet, a normal abdominal examination, and stable serial hemoglobins, the patients were discharged home.
- All patients were admitted to be at bed rest with bathroom privileges for the first day. After 24 hours, patients

were allowed to ambulate and do light activity. On discharge, patients were instructed to refrain from contact sports for 3 months.
- All patients were admitted with sequential compression devices for initial prophylaxis against deep vein thrombosis. As soon as the patient had stable hemoglobins, chemical deep vein thrombosis prophylaxis was used in addition to the sequential compression devices.
- This guideline should ensure at least 24 hours of inpatient observation for patients with a grade I or II blunt liver injury; patients with a grade III or higher injury should be observed for at least 36 hours.
- A stable hemoglobin was defined as a decrease in the laboratory value of ≤0.5 g from the previous draw. A Sysmex XE2100 analyzer (Sysmex Corporation) was used to determine the hemoglobin values; it has a precision that ensures <1.0% variability in measurements.[9]
- All patients were counseled to return to the hospital immediately if they experienced increasing abdominal pain, lightheadedness, nausea, or vomiting.

Statistical analysis was performed using analysis of variance with significance attributed to a p value <0.05. This study was approved by the Institutional Review Board of Community Regional Medical Center and the University of California, San Francisco.

RESULTS

Between August 2002 and March 2009, 11,913 patients were admitted after blunt trauma. Of these, 827 (7%) sustained blunt liver injuries. Of the patients with liver injury, 166 (20%) were taken directly to the operating room or the angiography suite for hemorrhage control. Patients who underwent initial visceral angiography were excluded to simplify the patient population and study only those patients who received no intervention for their liver injury. Other exclusion criteria were death from other injuries not related to the liver (35 patients, 27 with lethal head injury) or repatriation to another facility before completion of the study guidelines (35 patients). The remaining 591 patients make up the study cohort.

The overall success rate for NOM of blunt liver injuries was 94%. The injury severity scores, which increased significantly with each grade of liver injury, and the NOM success by grade are shown in Table 1.

TABLE 1. Nonoperative Management Success

Liver Injury Grade	Attempted NOM (n)	ISS*	NOM Success (%)	Inpatient Failure	Outpatient Failure
I and II	459	17 ± 10	96	19	0
III	99	22 ± 11†	89	11	0
IV	30	25 ± 10†	87	3	1
V	3	34 ± 22†	67	1	0
All grades	591		94	34	1

ISS, injury severity score.
* ISS is listed as the average for the group ± SD.
† Statistically significant increase with $p < 0.001$.

Thirty-five patients (6%) failed NOM. Nineteen failed secondary to hemorrhage, 15 failed secondary to peritonitis, and 1 patient developed abdominal compartment syndrome requiring decompressive laparotomy. The failures of NOM due to hemorrhage resulted in splenectomy/splenorrhaphy (n = 7), pelvic embolization (n = 1), repair of bleeding ovary (n = 1), repair of bleeding mesenteric injury (n = 1), nontherapeutic exploratory laparotomy (n = 2), and nontherapeutic angiography (n = 3). Only 4 of the 19 patients, who failed secondary to hemorrhage, did so for bleeding directly attributable to the liver injury. Two patients required laparotomy and hepatorrhaphy; one on hospital day (HD) 1 and the other on HD2. The other two patients who failed for liver-specific hemorrhage underwent hepatic embolization on HD2 and HD5.

Of the 15 patients developing peritonitis, 7 patients had bowel injury not diagnosed on the initial computed tomography scan and 2 had pancreatic injuries. Six patients developed bile peritonitis secondary to liver injury (1 patient with a grade III injury, 4 patients with grade IV injuries, and 1 patient with a grade V injury). The single outpatient failure in this series was a 24-year-old woman with a grade IV liver laceration. During her initial hospitalization, she was treated according to the guidelines and discharged home with a normal clinical examination and stable hemoglobins. She returned 2 weeks after discharge with nausea and vomiting and was found to have a bile leak. Endoscopic retrograde cholangiopancreatography did not adequately treat the bile leak and the patient required laparotomy with t-tube drainage 34 days after her initial motor vehicle crash. She recovered without further complication.

A detailed review of all the 35 patients who failed NOM of their liver injuries revealed no morbidity or mortality related to delay in laparotomy with attempted NOM.

Patients who fail NOM of blunt liver injuries secondary to hemorrhage usually do so early in their clinical course. In this study, 89% (17 of 19) who failed secondary to hemorrhage did so within the first 48 hours. The two patients who were late failures were still hospitalized because of multiple associated injuries.

The time course to failure secondary to peritonitis was more variable. Of the nine patients who failed secondary to missed bowel or pancreatic injury, five did so within 48 hours, one failed on HD3, two on HD4, and one on HD15. Of the six patients who failed due to bile peritonitis, one failed on HD3, two on HD4, one on HD9, one on HD12, and one (the outpatient failure) 34 days post injury. Except the one outpatient failure, the other two late failures (on HD9 and HD12) were both symptomatic within the first week and would not have met clinical criteria for discharge.

The patients with isolated blunt liver injuries were analyzed separately. There were 64 patients with isolated blunt liver injuries; three of them failed attempted NOM (Table 2). A 16-year-old boy with an isolated grade III injury failed secondary to hemorrhage and required hepatic embolization within 24 hours of admission. The other two patients failed due to bile peritonitis with grade IV and V injuries and

TABLE 2. Nonoperative Management in Patients With Isolated Blunt Liver Injuries

Isolated Liver Injury Grade	Attempted NOM (n)	NOM Success (%)	LOS (d)*	LOS (d) Successful NOM*
I and II	42	100	1.4 ± 0.8	1.4 ± 0.8
III	16	94	2.6 ± 1.5†	2.5 ± 1.5†
IV	5	80	5.6 ± 3.6†	4 ± 0.8†
V	1	0	13†	n/a
All grades	64	95	2.2 ± 2.2	1.9 ± 1.2

* LOS is listed as the average for the group ± SD.
† Statistically significant increase with $p < 0.001$.

failed on HD4 and HD9, respectively. Our overall success rate of NOM in this subset of patients was 95%.

The average LOS for successful NOM of all grades of isolated liver injuries was 1.9 days (Table 2). The patients with lower grade of injury had statistically significant shorter LOS ($p < 0.001$). The three failures of NOM in this group increased the overall LOS to 2.2 days.

The compliance with the institutional guideline was 90% for the isolated liver injury group. Six patients were discharged home meeting clinical, but not laboratory, criteria. Among them, three patients had an adequate number of hemoglobin determinations, but the last value was >0.5 g drop from the previous hemoglobin. However, closer evaluation showed that the hemoglobin was in fact stable over multiple determinations. The other three patients who were out of guideline did not have an adequate number of serial hemoglobins and should have been followed up for additional measurements. There were no adverse outcomes in these six patients.

DISCUSSION

During the past 25 years, NOM of blunt liver injuries has evolved dramatically[10] to become the current standard of care in hemodynamically stable patients.[6] Originally, NOM was thought to be appropriate for minor liver injuries, but it has been proven to be safe and effective, even in high-grade liver injuries.[7] There are data demonstrating that high-grade injuries requiring operative intervention have worse outcomes than those that are able to be managed nonoperatively.[11] There are studies identifying patients at risk for failure of NOM[12] and describing the potential complications of NOM in severe liver injuries.[13] There are detailed algorithms published to guide the clinician when considering various treatment options for blunt liver injury.[1] However, there are minimal published data regarding exactly what this NOM should entail.

Although early studies described a long average LOS of 13 days to 16 days,[6,7] recent articles have called into question some of the traditional NOM practices. London et al.[14] showed that in 454 patients managed nonoperatively for blunt solid organ injury, early ambulation did not contribute to delayed hemorrhage. In the pediatric surgical literature, studies show that LOS can be shortened, without compromising patient safety, which based the NOM on hemodynamic status and shortened period of bed rest.[15–17] Crawford et al.[18] evaluated the safety of early discharge in adults with blunt splenic injuries and found that early discharge (defined as HD3 in this study) is safe because the patients most likely to experience late failure are severely injured and remain in the hospital for associated injuries. A previous study from our institution showed that similar guidelines that based inpatient LOS on serial hemoglobin measurements and clinical examination are safe and effective in patients with blunt splenic injury.[8]

Evidence-based guidelines for length of inpatient observation after blunt liver injuries are clearly needed; this is a common injury and LOS can have a tremendous impact on patients and hospitals. If patients are not hospitalized and observed for an adequate length of time, there could be increased incidence of outpatient failures of NOM and unacceptable risks to these patients. Conversely, observing patients for an excessive length of time will lead to additional strain on the healthcare system and a waste of limited resources. Evidence-based guidelines to determine when patients are suitable for discharge should minimize overall LOS without compromising patient safety.

Our overall success rate of NOM of blunt liver injuries was 94%. This is consistent with other reports in the literature.[2,3] Similarly, in a study by Velmahos et al.,[19] we found that most patients who fail NOM do so for injuries not related to the liver. In this study of 591 patients, only 4 failed for liver-specific hemorrhage and 6 failed for bile peritonitis. In other words, only 2% failed for reasons directly related to the liver injury. There were no adverse outcomes related to the delay in laparotomy associated with NOM.

The institutional guideline of monitoring patient's clinical status and serial hemoglobins was successful in limiting LOS, without increasing morbidity and mortality. Patients can be safely discharged once these criteria are met with an acceptably low risk of subsequent hemorrhage. However, failure from biliary-related complications and bile peritonitis may occur later in the patient's clinical course. Our only outpatient failure was due to bile peritonitis, would not have benefited from a longer initial inpatient stay, and did not suffer any permanent disability because of the delay to laparotomy. However, on the basis of these results, we recommend educating patients, before discharge, about potential symptoms that may signal a developing biliary complication and ensure that all patients with liver injuries have appropriate follow-up.

Potential limitations of our study include its retrospective design and the traditionally poor follow-up associated with trauma patients. However, our trauma center is the only center within a large five county region of central California. There is a monthly Regional Trauma Audit Committee meeting with representation from all the hospitals in the area and the Coroner's office. These hospitals routinely report back to the Regional Trauma Audit Committee whether any of our trauma patients present to their hospitals, and there was no report of any of our patients sustaining blunt liver injuries presenting to the surrounding facilities.

A second limitation of the study is the relatively low number of high-grade liver injuries in this series. Although

our series includes 591 patients, NOM was attempted only in 30 patients with grade IV liver injuries and 3 patients with grade V liver injuries. This is due to the natural history of these high-grade injuries and that most patients with these injuries are not candidates for attempted NOM. Given this limitation, some caution is advised in treating patients with high-grade liver injuries. Although our guideline is clearly shown to be safe for most patients, sound clinical judgment must still be employed when dealing with those patients with the most severe blunt liver injuries.

The result of this study shows that the length of observation for blunt liver injuries can be based solely on clinical findings (hemodynamic status, physical examination, and serial hemoglobin measurements). Patients who fail NOM of blunt liver injuries secondary to hemorrhage do so early. Time to failure related to bile peritonitis is more variable; however, most of these patients are symptomatic and do not meet clinical criteria for early discharge. In summary, these guidelines are safe for patients, limit overall LOS, and use our limited hospital resources wisely.

REFERENCES

1. Kozar RA, Moore FA, Moore EE, et al. Western trauma critical decisions in trauma: nonoperative management of adult blunt hepatic trauma. *J Trauma*. 2009;67:1144–1149.
2. Malhotra AK, Fabian TC, Croce MA, et al. Blunt hepatic injury: a paradigm shift from operative to nonoperative management in the 1990s. *Ann Surg*. 2000;231:804–813.
3. Meredith JW, Young JS, Bowling J, Roboussin D. Nonoperative management of blunt hepatic trauma: the exception or the rule? *J Trauma*. 1994;36:529–535.
4. Velmahos GC, Toutouzas KG, Radin R, Chan L, Demetriades D. Nonoperative treatment of blunt injury to solid abdominal organs. A prospective study. *Arch Surg*. 2003;138:844–851.
5. Kozar RA, Moore JB, Niles SE, et al. Complications of nonoperative management of high-grade blunt hepatic injuries. *J Trauma*. 2005;59:1066–1071.
6. Croce MA, Fabian TC, Menke PG, et al. Nonoperative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. *Ann Surg*. 1995;221:744–755.
7. 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.
8. McCray VW, Davis JW, Lemaster D, Parks SN. Observation for nonoperative management of the spleen: how long is long enough? *J Trauma*. 2008;65:1354–1358.
9. Sysmex Corporation. Sysmex XE-2100 Operator's Manual, Revised. Sysmex Corporation; 2005.
10. Richardson JD, Franklin GA, Lukan JK, et al. Evolution in the management of hepatic trauma: a 25-year prospective. *Ann Surg*. 2000;232:324–330.
11. 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;138:606–611.
12. Ochsner MG. Factors of failure for nonoperative management of blunt liver and splenic injuries. *World J Surg*. 2001;25:1393–1396.
13. Kozar RA, Moore FA, Cothren CC, et al. Risk factors for hepatic morbidity following nonoperative management. *Arch Surg*. 2006;141:451–459.
14. London JA, Parry L, Galante J, Battistella F. Safety of early mobilization of patients with blunt solid organ injuries. *Arch Surg*. 2008;143:972–976.
15. Mehall JR, Ennis JS, Saltzman DA, et al. Prospective results of a standardized algorithm based on hemodynamic status for managing pediatric solid organ injury. *J Am Coll Surg*. 2001;193:347–353.
16. St Peter SD, Keckler SJ, Spilde TL, Holcomb GW III, Ostlie DJ. Justification for an abbreviated protocol in the management of blunt spleen and liver injury in children. *J Pediatr Surg*. 2008;43:191–194.
17. McVay MR, Kokoska ER, Jackson RJ, Smith SD. Throwing out the "grade" book: management of isolated spleen and liver injury based on hemodynamic status. *J Pediatr Surg*. 2008;43:1072–1076.
18. Crawford RS, Tabbara M, Sheridan R, Spaniolas K, Velmahos GC. Early discharge after nonoperative management for splenic injuries: increased patient risk caused by late patient failure? *Surgery*. 2007;142:337–342.
19. 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;138:475–481.