Nonoperative Management of Splenic Injury in Combat: 2002–2012

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ABSTRACT Background: Selective nonoperative management of combat-related blunt splenic injury (BSI) is controversial. We evaluated the impact of the November 2008 blunt abdominal trauma clinical practice guideline that permitted selective nonoperative management of some patients with radiological suggestion of hemoperitoneum on implementation of nonoperative management (NOM) of splenic injury in austere environments. Methods: Retrospective evaluation of patients with splenic injuries from November 2002 through January 2012 in Iraq and Afghanistan was performed. International Classification of Diseases, 9th Revision, Clinical Modification procedure codes identified patients as laparotomy with splenectomy, or NOM. Delayed operative management had no operative intervention at earlier North American Treaty Organization (NATO) medical treatment facilities (MTFs), and had a definitive intervention at a latter NATO MTFs. Intra-abdominal complications and overall mortality were juxtaposed. Results: A total of 433 patients had splenic injuries from 2002 to 2012. Initial NOM of BSI from 2002 to 2008 compared to 2009–2012 was 44.1% and 47.2%, respectively ($p = 0.75$). Delayed operative management and NOM completion had intra-abdominal complication and mortality rates of 38.1% and 9.1% ($p < 0.01$), and 6.3% and 8.1% ($p = 0.77$). Conclusions: Despite high-energy explosive injuries, NATO Role II MTFs radiological constraints and limited medical resources, hemodynamically normal patients with BSI and low abdominal abbreviated injury scores underwent NOM in austere environments.

INTRODUCTION

Management of blunt splenic injury (BSI) in an austere environment continues to evolve. For example, from 1968 to 1970 in Vietnam, Lieutenant Colonel James E. Oglesby describes encountering 126 splenic injuries that resulted in 126 splenectomies.[1] Currently, the preponderance of civilian literature regarding successful management of BSI through selective nonoperative management (SNOM) challenges the old dictum that equates splenic injury with total splenectomy in an austere environment. Formerly, these splenic injuries would have been found intraoperatively during laparotomy. Currently, our utilization of Focused Abdominal Sonography for Trauma (FAST) at North American Treaty Organization (NATO) Role II and III medical treatment facilities (MTFs) facilitates identification of hemoperitoneum, and computed tomography (CT) at NATO Role III MTFs has allowed deployed general surgeons to increase detection of splenic injuries in theater before discovery at exploratory laparotomy. The U.S. Central Command Joint Theater Trauma System (JTTS) in November 2008 changed the blunt abdominal trauma (BAT) clinical practice guideline (CPG); it stated that BAT patients with a positive FAST or CT abdomen/pelvis suggestive of hemoperitoneum, which were hemodynamically normal, could be managed through SNOM at a NATO Role III MTF.[2] This declaration was a bold departure from prior BAT CPGs initially written in December 2004 stating that a positive FAST or CT scan, suggestive of hemoperitoneum, required exploratory laparotomy in patients suffering BAT.[3]

The objectives of this retrospective study were to (1) analyze the impact this November 2008 change in the BAT CPG had in the application of nonoperative management (NOM) for BSI in OEF and OEF and (2) evaluate the number of patients who had delayed operative management of their splenic injuries, and their subsequent complications and mortality compared to those who successfully completed NOM. Congruous with these objectives, we hypothesized that (1) this November 2008 change in CPG would increase the utilization of initial NOM overall and (2) patients who underwent delayed operative management of BSI would have higher complications and a higher mortality compared to those who have successfully completed NOM.

METHODS

This retrospective study evaluated the military medical records, Department of Defense Trauma Registry, Army Medical Protection System, Armed Forces Health Longitudinal Application, Composite Health Care System, and Joint Patient Tracking Application, on all U.S. soldiers in OIF and OEF, with a diagnosis of splenic injury from November 2002 to January 2012; these patients underwent a laparotomy with splenectomy (LWS), laparotomy with splenorraphy (SPL), laparotomy without splenectomy (LWOS) or NOM for their

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The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

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splenic lacerations. In this study, patients injured during Operation New Dawn in Iraq were categorized with patients from OIF. Casualty medical records during the immediate injury period and posthospitalization course were reviewed using the aforementioned medical databases from NATO Role II to NATO Role V MTFs. Inclusion criteria were all U.S. service members greater than 17 years of age who underwent an evacuation to Landstuhl Regional Medical Center from Iraq and Afghanistan were identified subsequently by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9) coding system enumerated as follows: 41.1 puncture of spleen, 41.2 splenotomy, 41.43 splenectomy partial, 41.5 splenectomy complete, and 865.0 to 865.19 splenic injury/laceration. ICD-9 procedure codes were utilized to categorize all patients into 4 main groups: LWS, LWOS, SPL, or NOM. LWS was defined as patients with an ICD-9 procedure code of 41.5, total splenectomy. LWOS was defined by an ICD-9 operative procedure within the intra- or retroperitoneal cavities without an ICD-9 operative procedure on the spleen. SPL was defined as ICD-9 operative codes 41.41, excision of lesion or tissue of spleen; 41.43, partial splenectomy; 41.95, repair and plastic operations on spleen; and 41.99, other operations on spleen. Successful NOM was defined as patients without identification of an intra- or retroperitoneal abdominal operative procedure. Furthermore, delayed operative management was defined as patients who had no abdominal ICD-9 operative procedures at a documented earlier geographic NATO Role MTF who then received a LWS or SPL at a latter NATO Role MTF. Additionally, several patients had narrative summaries attached within their ICD-9 codes, and if the narrative summary indicated that a LWS or SPL occurred while in theater, which was contradictory to the ICD-9 operative coding, JTTS was contacted to identify the final operative disposition. Patients who successfully completed NOM and underwent delayed operative management of their splenic injury had their intra-abdominal and thromboembolic complications and overall mortality juxtaposed.

The data were collated on a Microsoft Excel (Microsoft, Redmond, Washington, DC) spreadsheet and SAS software (SAS Institute, Cary, North Carolina) was utilized to perform all statistical analysis. Categorical data were analyzed using a χ^2 test, Mantel–Haenszel test or Fischer exact data analysis juxtaposing LWS, LWOS, SPL, completed NOM, and delayed operative management demographic information to evaluate for significance. All continuous data are presented as medians with interquartile ranges (IQR), and *t*-test or Wilcoxon test were used for statistical comparisons. A *p*-value <0.05 was considered significant.

RESULTS

A total of 433 patients met inclusion criteria with 60% (n = 260) undergoing LWS. Overall, 37.4% (n = 162) of patients were initially managed nonoperatively with 38.9% (n = 63) undergoing delayed operative management. Delayed operative management for bullet/gunshot wound (GSW)/firearm and explosive devices was 81.8% (n = 9) and 35.6% (n = 42), respectively ($p < 0.01$). Ninety-eight percent (62/63) of patients initially managed nonoperatively at NATO Role II had their first-operative intervention at NATO Role III. One patient had a total splenectomy at NATO Role V after initially being managed nonoperatively. An abdominal abbreviated injury score (AIS) of 2 or 3 compared to an abdominal AIS of 4 or 5 for BSI resulted in a success rate for completion of NOM of 75.6% (n = 59) compared to 34.5% (n = 10), respectively (Fig. 1; $p < 0.01$).

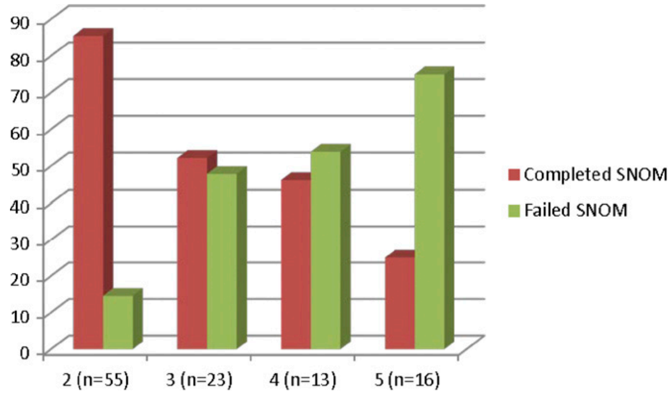

FIGURE 1. Percentage failing initial NOM and completing NOM by abdominal AIS for BSI.

Initial NOM of BSI from 2002 to 2008 for both OEF and OIF, before revision of the BAT CPG, compared to 2009–2012, after revision of the BAT CPG, was 44.1% (n = 82) and 47.2% (n = 25), respectively (Fig. 2; p = 0.75). Broken down by region of conflict, initial NOM of BSI in OEF from 2002 to 2008 compared to 2009–2012 was 44.4% (n = 4) and 52.3% (n = 23), respectively (p = 0.73), and in OIF from 2002 to 2008 compared to 2009–2012 was 44.1% (n = 78), and 22.2% (n = 2), respectively (p = 0.3040). Overall, the incidence of initial NOM in OEF compared to OIF was 50.9% (n = 27) and 43.0% (n = 80), respectively (p = 0.35).

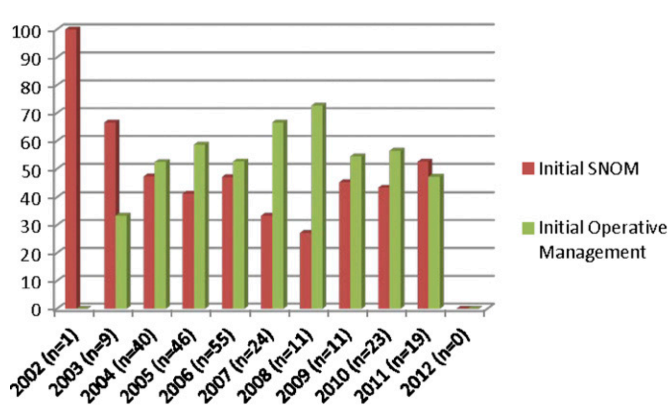

FIGURE 2. Annual percentage of the incidence of initial NOM and operative management in OEF and OIF.

The intra-abdominal complication rates of successfully completed and delayed operative management was 9.1% (n = 9) versus 38.1% (n = 24), respectively ($p < 0.01$). The most common intra-abdominal complications for delayed operative management were wound infections (n = 9), abdominal compartment syndrome (n = 6), intra-abdominal abscess (n = 3), and dehiscence/evisceration (n = 3). The incidence of deep venous thrombosis and pulmonary embolus in patients' who underwent delayed operative management and successfully completed NOM were 3.2% (n = 2) versus 5.1% (n = 5) (p = 0.71) and 7.9% (n = 5) versus 4.0% (n = 4) (p = 0.31), respectively. The overall mortality for completed and delayed operative management was 8.1% (n = 8), and 6.3% (n = 4), respectively (p = 0.77); 91.7% (n = 11) had extra-abdominal AIS ≥ 3.

DISCUSSION

Historically, splenectomy became recognized as the definitive treatment for splenic injury when Dr. Johnston reported 150 splenectomies for trauma in 1908.[4] However, in 1968, Upadhyaya and Simpson proposed NOM in a study of 52 pediatric patients for splenic preservation.[5] Doctor Singer's extensive review of the spleen's immunological function and the relationship to overwhelming postsplenectomy infection resulted in an increasing preference for splenic salvage ranging from nonoperative observation to limited surgical techniques such as splenorraphy, partial splenectomy, and the use of a variety of topical hemostatic agents.

The successful utilization of SNOM for BSI in the civilian literature prompted the creation of the BAT CPG in December 2004. This CPG permitted SNOM of BAT if the patient did not have a head injury mandating craniotomy, was hemodynamically stable, and did not have a CT or FAST suggestive of hemoperitoneum as an indication for the operating room. However, in November 2008, the CPG for BAT was changed to indicate that "rarely" patients with a FAST or CT scan with radiological evidence suggestive of hemoperitoneum could be managed through SNOM if at a NATO Role III MTF who can demonstrate adequate clinical follow-up and evaluation. The most current BAT CPG from June 2012 has been updated to include mandatory splenectomy for patients with an AAST Grade IV or V splenic laceration or an actively hemorrhaging spleen encountered during laparotomy. Furthermore, this update delineates that AAST Grades I to III splenic injuries can undergo SNOM if there is no active extravasation, pseduoaneurysm, or hemoperitoneum on CT scan.[6] Additionally, the updated CPG delineates that the indicators of failure of SNOM are a hypotensive episode and need for a blood transfusion, and that all patients must have a repeat CT scan after 48 hours of SNOM in theater before aeromedical evacuation. Currently, the American[7] and British[8] military utilization of NOM for BSI in Iraq and Afghanistan have been described.

Greater than one-third of all splenic injuries (n = 162) were managed nonoperatively at their initial MTF of care, and overall delayed operative management of 38.9% was identified (n = 63) with subsets of mechanism of injury broken down, bullet/GSW/firearm, and explosive devices were 81.8% (n = 9), and 35.6% (n = 42), respectively ($p < 0.01$). Although there is no civilian correlate to managing explosive device injuries nonoperatively, this successful utilization of NOM in this population may derive from the large continuum of injury severity sustained from the explosive devices that depends upon the contents of the explosive device, distance from the device upon detonation, and upon whether the soldier was mounted or dismounted when sustaining this injury. Each patient must be independently assessed for their application of this unique management on a case by case basis.

Furthermore, abdominal AIS score was identified an independent predictor of the successful implementation of NOM. Although the CT radiological grade was not identified within this manuscript, the abdominal AIS score was found to predict whether initial NOM would be successful, which is compatible with pre-existing published civilian literature, and gives some credence to the current CPG that allows SNOM for lower grade BSI, which should extrapolate to lower abdominal AIS scores.

We discovered that the November 2008 revision of the BAT CPG did not impact the overall initial NOM of BSI. Overall, Bhangu et al[9] in their meta-analysis of the failure of NOM for BSI in the civilian literature report an overall failure rate of 12%. First, our increased delayed operative management rate of BSI in an austere environment is secondary to the diverse population of general surgeons, surgical subspecialists, and trauma critical care specialists that manage patients at NATO Roles II and III MTFs, and who have varying levels of trauma surgery experience and comfort level in the practice of NOM for abdominal trauma, including BSI. Second, the ability to employ NOM of splenic injury in an austere environment is dependent on having sufficient medical personnel and facility space to adequately monitor patients and perform serial abdominal examinations; these characteristics are not always available at the smaller NATO Role II MTFs. Third, surgeons deployed to an austere environment have a lower threshold to choose operative intervention over NOM because of fear of missing a significant injury that could lead to worsened morbidity and/or mortality during the aeromedical evacuation process across thousands of miles without access to appropriate surgical facilities. Fourth, the predominant blunt injury mechanisms responsible for the bulk of civilian BSI (e.g., motor vehicle collisions and falls) are not comparable as the common mechanisms encountered in the deployed military setting (e.g., improvised explosive device [IED], bomb, rocket, and grenade blasts). Although IEDs are categorized as blunt injury mechanisms in this study because of their blast-wave effect, many of these devices impart penetrating fragmentation injuries unparalleled to the civilian experience with BSI. Therefore, the true classification of IEDs as specifically either a penetrating or blunt injury mechanism is a misnomer, as they impart a dual injury mechanism. The unfamiliarity of NOM in the civilian literature from IEDs is largely responsible for deployed military providers opting for initial operative management, as opposed to NOM. Fifth, the NATO Role II MTF does not offer endovascular options and the NATO Role III MTF offers limited endovascular options for splenic angioembolization that is now a common practice in the civilian literature. Therefore, in an austere environment, the intermediate option between laparotomy and NOM is nonexistent, and this may account for higher delayed operative management in an austere environment compared to SNOM in civilian literature. Finally, the higher rate of delayed operative management of BSI relies on the fact that the deployed surgeon at NATO Role II MTF actually identified a splenic injury and that some of these delayed operative management may have represented misdiagnoses at the transferring facility.

Although the incidence of short-term intra-abdominal morbidity was increased for patients who underwent delayed operative management compared to completing NOM likely attributed to an exploratory laparotomy procedure, (38.1% [$n = 24$] versus 9.1% [$n = 9$] [$p < 0.01$]), the overall mortality did not differ for patient's successfully completing NOM, 8.1% ($n = 8$), and patients who underwent delayed operative management, 6.3% ($n = 4$), respectively ($p = 0.77$). Unlike civilian literature data, increased mortality for both those completing and undergoing delayed operative management were likely secondary to the fact that 91.7% ($n = 11$) had extra-abdominal AIS head, chest, or extremity ≥ 3. The severity of extra-abdominal injury and explosive device injury mechanism encountered in OEF and OIF render it difficult to compare civilian and military mortality rates for failed SNOM and completed SNOM for BSI.

This retrospective study is limited by the accurate extraction of documented ICD-9 codes, demographic information, laboratory, and blood product patient information from OIF and OEF databases. Individualized patient records were not available for this study to evaluate the true intentions of each deployed general surgeon; therefore, the words "selective" and "failed NOM" in reference to each patient's clinical management were excluded, and initial NOM and delayed operative management were included to more accurately depict the clinical management from the data obtained. Additionally, this study excludes patients who initially were evacuated directly to NATO Role III MTF who may have been managed initially nonoperatively, as the timing of their surgery relative to their admission cannot be discerned with ICD-9 codes. Thus, the expected rate of initial NOM would be expected to be higher than 37.4% ($n = 162$). Furthermore, resource constraints at the NATO Role II may have not afforded the deployed general surgeon appropriate operative time if the patient was wounded in a concurrent mass casualty.

CONCLUSION

NOM of BSI has been used in an austere environment in hemodynamically stable patients with low abdominal AIS scores that can adequately undergo serial examination by deployed general surgeons. Future documentation by deployed surgeons may call for NOM category to appropriately document and perform quality improvement analysis.

AUTHORSHIP

T.A.M contributed to data analysis, interpretation, and writing manuscript. T.E.W. contributed to the study concept, data acquisition, and analysis. T.E.B. contributed to the data analysis, interpretation, and writing of the manuscript. J.K.A contributed to the data analysis. J.A.B and L.H.B. contributed to study design, data interpretation, and critical editing. C.E. W. contributed to the study concept, data interpretation, and critical editing.

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REFERENCES

1. Oglesby JE: Twenty-two months' war surgery in Vietnam. Arch Surg 1971; 102(6): 607–13.
2. Joint Theater Trauma System Clinical Practice Guideline. "Blunt Abdominal Trauma." November 2008. Available at http://www.usaisr.amedd.army.mil/clinical_practice_guidelines.html; accessed July 18, 2014.
3. Joint Theater Trauma System Clinical Practice Guideline. "Blunt Abdominal Trauma." December 2004. Available at http://www.usaisr.amedd.army.mil/clinical_practice_guidelines.html; accessed July 18, 2014.
4. Hancock GE, Farquharson AL: Management of splenic injury. J R Army Med Corps 2012; 158(4): 288–98.
5. Cirocchi R, Boselli C, Corsi A, et al: Is non-operative management safe and effective for all splenic blunt trauma? A systematic review. Crit Care 2013; 17(5): R185.
6. Joint Theater Trauma System Clinical Practice Guideline. "Blunt Abdominal Trauma." June 2012. Available at http://www.usaisr.amedd.army.mil/clinical_practice_guidelines.html; accessed July 18, 2014.
7. Zonies D, Eastridge B: Combat management of splenic injury: trends during a decade of conflict. J Trauma Acute Care Surg 2012; 73(2 Suppl 1): S71–4.
8. Mossadegh S, Midwinter M, Sapsford W, Tai N: Military treatment of splenic injury in the era of non-operative management. J R Army Med Corps 2013; 159(2): 110–3.
9. Bhangu A, Nepogodiev D, Lal N, Bowley DM: Meta-analysis of predictive factors and outcomes for failure of non-operative management of blunt splenic trauma. Injury 2012; 43(9): 1337–46.