Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Association for Academic Surgery

Interhospital transfer of liver trauma in New Mexico: a state of austere resources

Nova Szoka, MD,[a] Cristina Murray-Krezan, MS,[b] Richard Miskimins, MD,[a] Alissa Greenbaum, MD,[a] David Tobey, DO,[a] Syed Faizi, MD,[a] Sonlee West, MD,[a] Stephen Lu, MD,[a] Thomas Howdieshell, MD,[a] Gerald Demarest, MD,[a] and Itzhak Nir, MD[a,*]

[a] Department of Surgery, University of New Mexico School of Medicine, Albuquerque, New Mexico
[b] Division of Epidemiology, Biostatistics, and Preventive Medicine, Department of Internal Medicine, University of New Mexico Health Sciences Center, Albuquerque, New Mexico

ARTICLE INFO

Article history:
Received 4 January 2014
Received in revised form
13 April 2014
Accepted 16 May 2014
Available online 22 May 2014

Keywords:
Hepatic trauma
Liver injury
Transport
Mortality
Hepatobiliary surgeon

ABSTRACT

Background: There is debate in the trauma literature regarding the effect of prolonged prehospital transport on morbidity and mortality. This study analyzes the management of hepatic trauma patients requiring surgery and compares the outcomes of the group that was transferred to the University of New Mexico Hospital (UNMH) from outside institutions, to the directly admitted group.

Materials and methods: The UNMH Trauma Database was queried from 2005–2012. Of 674 patients who sustained liver injuries, 163 required surgery: 46 patients (28.2%) underwent interhospital transfer, and 117 (71.8%) were directly admitted. Variables examined included transfer status, trauma mechanism, transport type, injury severity score (ISS), liver injury grade, and associated injuries. Outcome variables included length of stay (LOS) and 30-day mortality. Outcomes of the transfer group (TG) and direct admit group (DAG) were compared.

Results: Both TG and DAG had the same median age (31 y, $P = 0.33$). The blunt-to-penetrating ratio was the same for each group (48% blunt: 52% penetrating, $P = 1.0$). Median ISS was 25 for the TG and 26 for the DAG. Grade III or higher injury occurred in 29 (63%) of the TG and in 68 (58%) of the DAG ($P = 0.56$). Median hospital LOS was 14 d for TG and 9 d for DAG ($P = 0.15$). Median intensive care unit LOS was 4 d for both groups ($P = 0.71$). Thirty-day mortality was 20% in each group ($P = 0.27$). Using a multiple logistic regression model for the outcome of mortality, only age, ISS, and liver injury grade, not transfer status or transport type, had a significant effect on mortality.

Conclusions: There was no significant difference in liver injury grade, ISS, LOS, and mortality between TG and DAG. In the patient population of our study, transfer status did not affect outcome.

* *Corresponding author*. Department of Surgery, 1 University of New Mexico, MSC 10 5610, Albuquerque, NM, 87131. Tel.: +1 505 925 0456; fax: +1 505 925 0454.
E-mail address: inir@salud.unm.edu (I. Nir).
0022-4804/$ – see front matter © 2014 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jss.2014.05.043

1. Introduction

Although organized trauma systems have increased survival and reduced morbidity, important questions remain regarding interhospital transfer and the triage of trauma patients. Trauma specialists strive to answer the question of how time and distance from a trauma center, or prior outside hospital care, affects patient outcome. Some studies have shown that prolonged triage time or transfer from an outside hospital negatively impacts mortality, whereas other studies have shown that mortality is unaffected by prolonged transfer. In addition to transfer-related issues, other relevant concerns include triage from urban *versus* rural injury scenes and triage to level I *versus* level II trauma center.

The main purpose of this study was to investigate the contribution that interhospital transfer made to patient outcome. We therefore compared the outcomes of operative hepatic trauma patients with regard to their transfer status: direct admission *versus* transfer from an outside hospital. This study was conducted in New Mexico, which covers 121,356 square miles and has a population of 2.1 million, one third of whom live in a rural area. There are 36 hospitals in the state of New Mexico, 29 of which are located in rural areas, [1]. The University of New Mexico Hospital (UNMH) is the only level I trauma center in the entire state, and there are no level II trauma centers in the state. Additionally, 38% of New Mexicans live more than 1 h away from a level I trauma center. In contrast, 90% of Americans live within 1 hour of a level I or II trauma center [2].

Feero *et al.* [3] examined urban trauma patients and found that shorter transport times increased survival. Sampalis *et al.* [4] compared trauma patients who were directly admitted to a level I trauma center with those who underwent interhospital transfer. They found that the mortality of the transfer group (TG) was nearly twice that of the direct admit group (DAG). In their study of 11,398 trauma patients, Haas *et al.* [5]concluded that risk of mortality was 24% greater in the transferred cohort (odds ratio = 1.24). Crandall *et al.* [6] found that urban trauma patients with gunshot wounds have a 23% higher mortality rate if their injury occurred more than five miles from a trauma center. In contrast, more recent publications suggest there is no association between transfer status and mortality [7–9].

Other factors have been implicated in trauma mortality outcomes including urban *versus* rural site of injury and subsequent triage, as well as triage to a tertiary trauma center *versus* a lower level of care. Several studies show that rural trauma patients with prolonged emergency medical services response times had higher mortality than their urban counterparts [10,11]. With regard to treatment at a level I *versus* level II trauma center, there is disagreement as to whether admission to a level II center negatively affects mortality [12–14].

Trauma patients are highly heterogeneous, thus a hard group to study as their outcomes are influenced by numerous variables. Most studies to date have used a sample of all trauma patients to determine whether interhospital transfer affects outcome. In the present study, we focused on a more selected group, with an injury type hallmarked by bleeding, namely individuals with liver trauma who were eventually taken to the operating room. Our aim was to define with higher resolution the relationship between interhospital transfer and clinical outcomes.

2. Materials and methods

Institutional review board approval was obtained from the University of New Mexico Health Science Center Human Research Review Committee. The University of New Mexico Trauma Database (TraumaBase, Clinical Data Management, Conifer, CO) was queried from 2005–2012 to identify patients with liver injuries admitted to the UNMH Trauma Service. The year 2005 was selected as the data collection starting point because this is when UNMH began using an electronic medical record, thereby facilitating chart review. The inclusion criteria were pediatric and adult trauma patients with operative hepatic injuries. The age range of patients included in this study was 2 to 85 y. The exclusion criteria for this study were trauma patients with no liver injury or a nonoperative liver injury and those patients who were pronounced dead in the trauma bay.

From this larger group, the patients who were taken to the operating room were identified by cross-referencing operative billing data Current Procedural Terminology codes for liver repair and excision. Chart review was performed on the operative hepatic trauma patients.

Variables analyzed included age, sex, date of trauma admission, transfer status, mechanism of trauma, admission vital signs, injury severity score (ISS), and grade of liver injury. Outcome variables included length of stay (LOS), liver-related morbidity, and 30-day mortality. The outcomes of the TG and DAG were compared. Secondary outcomes examined were intraoperative techniques used and involvement of a hepatobiliary (HPB) surgeon.

2.1. Statistical analysis

This was a descriptive study intended to investigate which patient characteristics may be associated with interhospital transfer. For further analysis, a multiple logistic regression model was created to determine whether transfer status had a significant effect on mortality. Summary statistics including medians, quartiles, frequencies, and percents were calculated. All continuous variables exhibited skewness, and therefore, Wilcoxon rank sum tests were used to compare transferred and nontransferred patients on relevant outcome variables. Chi-square tests were used to compare transfer status on categorical outcome variables. The multiple logistic regression model was created for the outcome of mortality to test the effect of transfer status after adjusting for other covariates including mechanism, transport type, liver injury grade, ISS, age, and associated abdominal injuries. All analyses were performed in SAS 9.3 (SAS Institute Inc, Cary, NC, 2011). Significance was held at $\alpha = 0.05$.

3. Results

3.1. Characteristics of the study population

From 2005–2012, a total of 674 patients were treated at UNMH for liver injuries; the majority of these patients (75.8%) were managed nonoperatively (Fig. 1). The median age was 28 y