Trauma with Injury Severity Score of 75: Are These Unsurvivable Injuries?

Jin Peng1,2, Krista Wheeler1, Junxin Shi1, Jonathan Ira Groner1,3,4, Kathryn Jo Haley4, Huiyun Xiang1,2,3,*

1 Center for Pediatric Trauma Research, The Research Institute at Nationwide Children’s Hospital, Columbus, Ohio, United States of America, 2 The Ohio State University, College of Public Health, Columbus, Ohio, United States of America, 3 The Ohio State University, College of Medicine, Columbus, Ohio, United States of America, 4 Trauma Program, Department of Pediatric Surgery, Nationwide Children’s Hospital, Columbus, Ohio, United States of America

* huiyun.xiang@nationwidechildrens.org

Abstract

Trauma patients with an ISS=75 have been deliberately excluded from some trauma studies because they were assumed to have "unsurvivable injuries." This study aimed to assess the true mortality among patients with an ISS=75, and to examine the characteristics and primary diagnoses of these patients. Retrospective review of the 2006-2010 U.S. Nationwide Emergency Department Sample (NEDS) generated 2,815 patients with an ISS=75 for analysis, representing an estimated 13,569 patients in the country. Dispositions from the emergency department and hospital for these patients were tabulated by trauma center level. Survivors and non-survivors were compared using Pearson’s chi-square test. Primary diagnosis codes of these patients were tabulated by mortality status. Overall, about 48.6% of patients with an ISS=75 were discharged alive, 25.8% died and 25.6% had unknown mortality status. The mortality risks of these patients did not vary significantly across different levels of trauma centers (15.6% vs. 13.0%, P = 0.16). Non-survivors were more likely than survivors to: be male (81.2% vs. 74.4%, P < 0.0001), be over 65 years (20.3% vs. 10.2%, P < 0.0001), be uninsured (33.8% vs. 19.1%), have at least one chronic condition (58.0% vs. 43.7%, P < 0.0001), sustain life-threatening injuries (79.2% vs. 49.4%, P < 0.0001), sustain penetrating injuries (42.0% vs. 25.9%, P < 0.0001), and have injuries caused by motor vehicle crashes (32.9% vs. 21.1%, P<0.0001) or firearms (21.9% vs. 4.4%, P<0.0001). The most frequent diagnosis code was 862.8 (injury to multiple and unspecified intrathoracic organs, without mention of open wound into cavity). Our results revealed that at least half of patients with an ISS=75 survived, demonstrating that the rationale for excluding patients with an ISS=75 from analysis is not always justified. To avoid bias and inaccurate results, trauma researchers should examine the mortality status of patients with an ISS=75 before exclusion, and explicitly describe their method of generating ISS scores.
Introduction

Classification of injury by its severity is fundamental to injury research. A number of scales measuring injury severity have been developed since the late 1960s [1]. The Injury Severity Score (ISS), an anatomically based scale for rating the overall severity of multiple injuries, is one of the most commonly used scales in recent decades [2]. To calculate the ISS, the body is divided into six ISS body regions (Head, Face, Chest, Abdomen, Extremities, External). Each injured body region is assigned an Abbreviated Injury Scale (AIS) score ranging from 1 (minor injury) to 6 (maximum injury) [3]. The ISS score is then calculated as the sum of squares of each AIS score for the three most severely injured body regions. If any of the three AIS scores is a 6, the ISS score is automatically set as 75 [1]. AIS scores are assigned by trained coders who consult the medical record. Additionally, because of the widespread use of ISS scores, software programs (e.g. ICDMAP, ICDPIC) have been developed to translate the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes into injury severity scores.

Trauma patients with an ISS = 75 are often considered as sustaining the most severe injuries with the lowest possible survival rate among trauma researchers. However, our prior study on undertriage of major trauma patients indicated that a significant proportion of trauma patients with an ISS = 75 survived [4]. We found that a number of trauma studies excluded patients with an ISS = 75 from analysis without explicitly stating whether or not they examined the mortality status of these patients [5–9]. The exclusion of patients with an ISS = 75 can result in biases if most of these patients survived. Studies that evaluated the effects of interventions on improving trauma outcomes were at the highest risk of yielding biased results. Since patients with an ISS = 75 sustained the most severe injuries, interventions that performed well among patients with an ISS <75 might not be effective among patients with an ISS = 75. Therefore, by excluding patients with an ISS = 75, the effectiveness of those interventions may have been overestimated.

In this study, we aimed to assess the extent to which patients with an ISS = 75 seen at U.S. hospital-based EDs survived and to examine the characteristics and primary diagnoses of patients with an ISS = 75. We evaluated ISS = 75 when assigned by the International Classification of Diseases Program for Injury Categorization (ICDPIC), a statistical program that has been proven to be efficient in extracting injury severity scores from ICD-9-CM codes for large trauma datasets [10]. Our findings have important implications for trauma research quality improvement, especially as decisions are made about excluding patients with an ISS = 75.

Methods

Data Source and Study Population

The Nationwide Emergency Department Sample (NEDS) from 2006 to 2010 was used for analysis. Sampled from the State Emergency Department Databases (SEDD) and State Inpatient Databases (SID), the NEDS is the largest all-payer emergency department (ED) database in the U.S. [11] It contains information on ED visits that both result in an admission, and do not result in an admission (e.g., treat-and-release visits and transfers to another hospital). The NEDS contains data from 30 million discharges (representing 20% of all ED visits in the U.S.) each year, which can be weighted to produce national estimates of hospital-based ED visits. In this study, we used NEDS core files for demographic characteristics, ED disposition and ICD-9-CM diagnosis codes; the hospital files for hospital characteristics; and the inpatient files for inpatient disposition.

The study population was trauma patients with an ISS = 75 who had visited emergency departments (EDs) in the United States from January 1, 2006 to December 31, 2010. We searched all 15 possible diagnoses for each patient and identified trauma patients using ICD-
9-CM diagnosis codes (800 to 959). To be consistent with the definition of a “trauma patient” used widely by trauma centers in the U.S., we excluded trauma patients who only had injuries from late effects (905 to 909), sprains and strains (840 to 848), superficial injuries (910–924) and injuries due to foreign bodies (930 to 939).

**Statistical Analysis**

Data analysis was performed using SAS 9.3 software (SAS Institute, Cary, NC). The Injury Severity Score (ISS) and other injury-related variables (e.g. injury mechanism) were generated using STATA 13 (StataCorp, College Station, TX). The NEDS started using the ICD Programs for Injury Classification (ICDPIC) to generate ISS values for each patient in 2009. The ICDPIC is a publicly available STATA program that translates ICD-9-CM diagnosis codes into AIS 90 and other injury scores [12], and we used this to generate the ISS and other injury-related variables for 2006–2008 NEDS. We then extracted all trauma patients with an ISS = 75 for the years 2006–2010. We also created a new variable that indicated life-threatening injuries using criteria from the American College of Surgeon Committee on Trauma (ACS-COT) (see S1 Appendix) [13]. Using the weighting variables provided in the NEDS, we produced national estimates of ED visits for trauma patients with an ISS = 75. We tabulated the patient and hospital characteristics of trauma patients with an ISS = 75. We also tabulated ED and hospital disposition by trauma center level. We expected that rates of transfer to short-term hospitals from non-trauma centers would be much higher than from trauma centers. The distributions of ED and hospital disposition across different levels of trauma centers were compared using Pearson’s chi-square test. We then divided patients with an ISS = 75 into three groups according to their mortality status. The first group included patients with an ISS = 75 who died either in the ED or in an inpatient unit. The second group consisted of patients with an ISS = 75 who were discharged alive, including patients who were treated and released from the ED or from an inpatient unit, discharged without treatment, or sent to home health care. The third group consisted of patients with an ISS = 75 with unknown mortality status, including patients who were transferred to a short-term hospital or elsewhere (e.g. skilled nursing facility), those who were discharged against medical advice, and those who were not admitted to the hospital but had an unknown destination. We then examined the differences between patients who died and those who were discharged alive by patient and hospital characteristics, using Pearson’s chi-square test. We tabulated the frequency of major ICD-9-CM diagnosis codes by mortality status. The major ICD-9-CM code was identified as the first diagnosis code (out of 15 diagnosis codes) that was assigned by ICDPIC with an AIS = 6. Six patients were excluded from this analysis because they did not have an injury of AIS = 6 (an ISS of 75 is not only given to patients who have a single injury of AIS = 6 but also to those who have three injuries of AIS = 5).

This study was reviewed and considered exempt by the Institutional Review Board of Nationwide Children’s Hospital, because we analyzed publicly available data with all personal identifiers removed.

**Results**

**Patient characteristics**

A nationally representative sample of 2,815 patients with an ISS = 75 was identified in our study. It represented approximately 20% of all patients with an ISS = 75 (13,569) seen at U.S. hospital-based EDs between 2006 and 2010. The average patient age was 40.5 years, with the majority between 18 to 54 years old (63.7%). Pediatric patients and older adults were 11.6% and 24.7% of the sample, respectively. Most patients were males (76.3%) and most patients lived in metropolitan areas (78.2%). Over half had chronic conditions (53.7%). The majority sustained
ACS-COT defined life-threatening injuries (see S1 Appendix) (62.7%), with blunt injuries (72.1%) being more common than penetrating injuries. Private insurance was the most common type of primary payer (35.7%). Motor vehicle traffic was the most common type of injury mechanism (28.3%) (Table 1). Most patients were treated at metropolitan teaching hospitals (55.8%), and about 41.4% were treated at non-trauma hospitals or level III trauma centers (Table 1).

Emergency department and hospital disposition by hospital trauma level
The emergency department (ED) and hospital dispositions among patients with an ISS = 75 differed significantly between lower and higher level of trauma centers (Table 2). Specifically, patients seen at the ED of non-trauma hospitals or level III trauma centers were more likely than those seen at level I or II trauma centers to be routinely discharged (46.1% vs. 14.5%, P < 0.0001), or to be transferred to another hospital (13.9% vs. 0.9%, P < 0.0001). Although patients with an ISS = 75 seen at non-trauma hospitals or level III trauma centers appeared to be at higher risk of mortality, the proportions of patients that died in the ED did not vary significantly between lower level trauma centers and higher level trauma centers (15.6% vs. 13.0%, P = 0.16). Patients with an ISS = 75 admitted as an inpatient at non-trauma hospitals or level III trauma centers were more likely than those admitted to level I or II trauma centers to then be routinely discharged from the hospital (46.6% vs. 35.7%, P = 0.02) (Table 2).

Comparison of survivors and non-survivors
Among patients with an ISS = 75, 48.6% were discharged alive (survivors), 25.8% died (non-survivors) and 25.6% had unknown mortality status. Non-survivors were more likely than survivors to be male (81.2% vs. 74.4%, P < 0.0001), be above 65 years (20.3% vs. 10.2%, P < 0.0001), be uninsured (33.8% vs. 19.1%), have at least one chronic condition (58.0% vs. 43.7%, P < 0.0001), sustain life-threatening injuries (79.2% vs. 49.4%, P < 0.0001), sustain penetrating injuries (42.0% vs. 25.9%, P < 0.0001), and have injuries caused by motor vehicle traffic (32.9% vs. 21.1%, P < 0.0001) or firearm (21.9% vs. 4.4%, P < 0.0001). Non-survivors were also more likely to be seen at metropolitan teaching hospitals (60.7% vs. 52.5%, P = 0.01), and be seen at level I or II trauma centers (41.6% vs. 31.8%, P < 0.0001) (Table 3). Non-survivors and survivors did not differ significantly in patients’ residence location, median household income, and hospital region (Table 3).

Frequently occurring primary diagnosis codes
There were six frequently occurring primary diagnosis codes: 862.8 (Injury to multiple and unspecified intrathoracic organs, without mention of open wound into cavity), 861.13 (Laceration of heart with penetration of heart chambers with open wound into thorax), 806.01 (Closed fracture of C1–C4 level with complete lesion of cord), 929.9 (Crushing injury of unspecified site), 926.8 (Crushing injury of multiple sites of trunk) and 952.01 (C1–C4 level with complete lesion of spinal cord) (Table 4). A significant proportion of patients with certain diagnosis codes survived. Specifically, 86.8% of patients with diagnosis code 929.9 survived, 68.6% of patients with diagnosis code 926.8 survived, and 55.1% of patients with diagnosis code 862.8 survived (Table 4).

Discussion
Ours is the first study to focus on the mortality status of patients with an ISS = 75 who visited U.S. hospital-based emergency departments (EDs). Results of our study indicate that almost
Table 1. Patient and hospital characteristics of trauma patients with ISS 75, NEDS 2006–2010.

| Variable                          | Sample (n = 2815) | National estimates (n = 13569) | Col % |
|-----------------------------------|-------------------|-------------------------------|-------|
| **Patient-Level Characteristics**|                   |                               |       |
| Gender                            |                   |                               |       |
| Male                              | 2133              | 10344                         | 76.3% |
| Female                            | 678               | 3209                          | 23.7% |
| Age group                         |                   |                               |       |
| <18 years old                     | 334               | 1573                          | 11.6% |
| 18–34 years old                   | 917               | 4477                          | 33.0% |
| 35–54 years old                   | 866               | 4165                          | 30.7% |
| 55–64 years old                   | 269               | 1324                          | 9.8%  |
| > = 65 years old                  | 426               | 2015                          | 14.9% |
| Patient’s residence location      |                   |                               |       |
| Large central metropolitan        | 817               | 3894                          | 29.3% |
| Large fringe metropolitan         | 580               | 2723                          | 20.5% |
| Medium metropolitan               | 515               | 2369                          | 17.8% |
| Small metropolitan                | 264               | 1411                          | 10.6% |
| Micropolitan                      | 318               | 1589                          | 12.0% |
| Not metropolitan or micropolitan  | 268               | 1307                          | 9.8%  |
| Median household income quartiles |                   |                               |       |
| 1st quartile (Lowest)             | 888               | 4245                          | 32.7% |
| 2nd quartile                      | 737               | 3617                          | 27.9% |
| 3rd quartile                      | 612               | 2912                          | 22.4% |
| 4th quartile (Highest)            | 463               | 2202                          | 17.0% |
| Primary expected payer            |                   |                               |       |
| Medicare                          | 390               | 1825                          | 13.6% |
| Medicaid                          | 444               | 2138                          | 15.9% |
| Private including HMO             | 980               | 4792                          | 35.7% |
| Self-pay                          | 588               | 2811                          | 20.9% |
| Other                             | 382               | 1872                          | 13.9% |
| Chronic conditions                |                   |                               |       |
| No chronic conditions             | 1306              | 6279                          | 46.3% |
| At least one chronic condition    | 1509              | 7291                          | 53.7% |
| Life-threatening injury            |                   |                               |       |
| Not life-threatening              | 1077              | 5066                          | 37.3% |
| Life-threatening                  | 1738              | 8503                          | 62.7% |
| Blunt/Penetrating injury          |                   |                               |       |
| Blunt injury                      | 1549              | 7456                          | 72.1% |
| Penetrating injury                | 602               | 2884                          | 27.9% |
| Injury mechanism                  |                   |                               |       |
| Motor vehicle traffic             | 703               | 3418                          | 28.3% |
| Firearm                           | 236               | 1155                          | 9.5%  |
| Cut/pierce                        | 366               | 1729                          | 14.3% |
| Fall                              | 326               | 1577                          | 13.0% |
| Struck by, against                | 263               | 1229                          | 10.2% |
| Other categories                  | 612               | 2988                          | 24.7% |
| **Hospital-Level Characteristics**|                   |                               |       |
| Hospital type                     |                   |                               |       |
| Metropolitan non-teaching         | 860               | 3948                          | 29.1% |
half of patients with an ISS = 75 survived their injuries. Non-survivors were more likely than survivors to be male, be above 65 years, be uninsured, have at least one chronic condition, sustain life-threatening injuries and penetrating injuries, and have injuries caused by motor vehicle traffic or firearm. The most frequently occurring ICD-9 diagnosis code was 862.8 (Injury to multiple and unspecified intrathoracic organs, without mention of open wound into cavity).

According to the Association for the Advancement of Automotive Medicine (the parent body of the AIS), an AIS 6 (ISS = 75) is defined as the maximal injury, but this is not equivalent to death [14]. Although an ISS = 75 does not equate with death, it is expected that those patients with an ISS = 75 sustain the most severe injuries with the lowest possible survival rate. The relatively high survival rate among patients with an ISS = 75 could be attributed to the limitations of using computer-based ISS scoring. Some of those with an AIS = 6 in the NEDS survey probably did not deserve an AIS of 6. The STATA-ICDPIC program, which we used to generate AIS/ISS scores, may have overestimated the injury severities of patients with certain ICD-9 diagnosis codes (e.g. 929.9, 926.8, 862.8). Specifically, 46.5% of patients who survived had diagnosis code 862.8 (Injury to multiple and unspecified intrathoracic organs, without mention of open wound into cavity). About 20% of patients who survived had diagnosis code 861.13 (Laceration of heart with penetration of heart chambers with open wound into thorax). About 20% of patients who survived had diagnosis code 929.9 (Crushing injury of unspecified site). As a result, some patients were erroneously given an AIS of 6. The issue of overestimation in STATA-ICDPIC program has been reported in previous studies [15]. In addition, the poor performance of ICDPIC could be attributed to misclassifications in ICD-9 coding. Spinal column lesions/fractures were poorly captured in ICD-9-CM discharge codes [16,17], frequently appearing in the medical discharge abstract even when the injury was chronic, rather than acute. Misclassifications in ICD-9 coding could be caused by many factors, including coders’ inadequate training and experience, lack of facility quality-control efforts, and coders’ unintentional and intentional errors [18]. Higher quality ISS scores can be obtained by having two coders independently assign ISS scores. A third coder may be needed to address any substantial disagreement between those two coders. The inter-rater reliability can be assessed by

### Table 1. Mortality Rate among Patients with Injury Severity Score of 75

| Variable                              | Sample (n = 2815) | National estimates (n = 13569) | Col % |
|---------------------------------------|-------------------|-------------------------------|-------|
| Metropolitan teaching                 | 1570              | 7566                          | 55.8% |
| Non-metropolitan                      | 385               | 2055                          | 15.1% |
| Hospital region                       |                   |                               |       |
| Northeast                             | 504               | 2313                          | 17.0% |
| Midwest                               | 695               | 3482                          | 25.7% |
| South                                 | 951               | 4433                          | 32.7% |
| West                                  | 665               | 3341                          | 24.6% |
| Trauma center designation             |                   |                               |       |
| Non-trauma or level III trauma centers| 1198              | 5617                          | 41.4% |
| Level I or level II trauma centers    | 1052              | 5026                          | 37.0% |
| Other collapsed categories            | 565               | 2926                          | 21.6% |

Abbreviations: NEDS, Nationwide Emergency Department Sample.

- National quartiles for median household income of patient’s home ZIP code.
- Life-threatening injuries were defined by American College of Surgeons Committee on Trauma (ACS-COT).
- Other collapsed categories included trauma level I or II collapsed category and trauma level I, II, or III collapsed category.
- Variables had missing observations.

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calculating intra-class correlation. However, this approach of ISS scoring is not always feasible in trauma studies, especially when using existing national survey data. Computer-based ISS scoring has been proved to be useful when AIS scores are not available in the source data [19].

Though the survival rate of patients with an ISS = 75 could be overestimated in our study, these patients should not be assumed to have unsurvivable injuries. Trauma studies that deliberately excluded patients with an ISS = 75 may be subject to biases [5–9]. Studies that evaluated the effects of interventions on improving trauma outcomes were at the highest risk of yielding biased results. Since patients with an ISS = 75 sustained the most severe injuries, interventions that performed well among patients with an ISS <75 might not be effective among patients with an ISS = 75. Therefore, by excluding patients with an ISS = 75, the effectiveness of those interventions may have been overestimated. Studies that assessed the performance of injury severity scales might have obtained inaccurate estimates. They excluded patients with an ISS = 75 because they believed that cohorts with a large number of very severe cases could dilute the discriminative power of injury severity scales. However, it would be arbitrary to assume that all patients with an ISS = 75 had very severe injuries without examining the approach used to generate the ISS scores and the actual mortality status of these patients. These studies would have lost power of analysis if a significant proportion of the patients with an ISS = 75 actually had non-lethal injuries. Studies that examined the risk factors associated with increased trauma mortality were at the lowest risk of obtaining biased results. This was

| Disposition | Non-trauma or level III trauma centers | Level I or level II trauma centers |
|-------------|--------------------------------------|----------------------------------|
|             | Sample | National estimates | Col % | Sample | National estimates | Col % | P-value |
| ED disposition |         |                     |       |         |                     |       |         |
| Routineb | 576 | 2586 | 46.1% | 158 | 728 | 14.5% | <.0001 |
| Admitted as inpatient to the same hospital | 245 | 1169 | 20.8% | 712 | 3443 | 68.5% | <.0001 |
| Died in the ED | 174 | 878 | 15.6% | 141 | 653 | 13.0% | 0.16 |
| Transfer to short-term hospital | 158 | 780 | 13.9% | <10 | 45 | 0.9% | <.0001 |
| Other transfersc | 22 | 94 | 1.7% | <10 | 10 | 0.2% | 0.01 |
| Not admitted, destination unknown | 17 | 73 | 1.3% | 23 | 116 | 2.3% | 0.52 |
| Against medical advice | <10 | 17 | 0.3% | <10 | 18 | 0.3% | 0.86 |
| Home health care | <10 | 14 | 0.2% | <10 | 14 | 0.3% | 0.93 |
| Discharged alive, destination unknown | <10 | <10 | 0.1% | N/A | N/A | N/A | N/A |
| Total | 1198 | 5617 | 100.0% | 1052 | 5026 | 100.0% | N/A |
| Inpatient disposition |         |                     |       |         |                     |       |         |
| Routineb | 116 | 545 | 46.6% | 256 | 1230 | 35.7% | 0.02 |
| Other transfersc | 58 | 289 | 24.7% | 219 | 1075 | 31.2% | 0.11 |
| Died in the hospital | 45 | 200 | 17.1% | 164 | 801 | 23.3% | 0.05 |
| Home health care | 12 | 60 | 5.2% | 28 | 126 | 3.7% | 0.33 |
| Transfer to short-term hospital | 10 | 48 | 4.1% | 43 | 203 | 5.9% | 0.33 |
| Against medical advice | <10 | 15 | 1.3% | <10 | <10 | 0.1% | <.0001 |
| Discharged alive, destination unknown | <10 | 12 | 1.0% | <10 | <10 | 0.1% | <.0001 |
| Total | 245 | 1169 | 100.0% | 712 | 3443 | 100.0% | N/A |

Abbreviations: NEDS, Nationwide Emergency Department Sample; ED, Emergency Department.

a Data from other collapsed trauma center categories were not shown in the table.
b Routine indicated that patients were treated and released from the hospital.
c Included skilled nursing facility, intermediate care and another type of facility.
Table 3. Patient and hospital characteristics of patients with ISS 75 by mortality status, NEDS 2006–2010a.

| Variable                                      | Died b | National estimates | Col % | Sample (n = 711) | National estimates (n = 3496) | Col % | P-value | Discharged alive c | National estimates (n = 1404) | Col % | P-value |
|-----------------------------------------------|--------|--------------------|-------|------------------|-------------------------------|-------|---------|-------------------|-------------------------------|-------|---------|
| **Patient-Level Characteristics**             |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Gender                                        |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Male                                          | 572    | 2835               | 81.2% | 1037             | 4905                          | 74.4% | <.0001 |                   |                               |       |         |
| Female                                        | 138    | 657                | 18.8% | 365              | 1688                          | 25.6% |         |                   |                               |       |         |
| **Age group**                                 |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| <18 years old                                 | 61     | 286                | 8.2%  | 207              | 967                           | 14.6% | <.0001 |                   |                               |       |         |
| 18–34 years old                               | 223    | 1135               | 32.5% | 461              | 2200                          | 33.3% | 0.72    |                   |                               |       |         |
| 35–54 years old                               | 193    | 937                | 26.8% | 464              | 2177                          | 33.0% | 0.01    |                   |                               |       |         |
| 55–64 years old                               | 86     | 427                | 12.2% | 123              | 586                           | 8.9%  | 0.03    |                   |                               |       |         |
| > = 65 years old                              | 148    | 711                | 20.3% | 149              | 672                           | 10.2% | <.0001 |                   |                               |       |         |
| **Patient's residence location**              |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Large central metropolitan                    | 237    | 1116               | 33.3% | 391              | 1865                          | 28.6% | 0.07    |                   |                               |       |         |
| Large fringe metropolitan                     | 120    | 592                | 17.6% | 300              | 1350                          | 20.7% | 0.24    |                   |                               |       |         |
| Medium metropolitan                           | 141    | 665                | 19.8% | 257              | 1143                          | 17.5% | 0.29    |                   |                               |       |         |
| Small metropolitan                            | 58     | 321                | 9.6%  | 134              | 697                           | 10.7% | 0.50    |                   |                               |       |         |
| Micropolitan                                  | 75     | 386                | 11.5% | 161              | 780                           | 12.0% | 0.81    |                   |                               |       |         |
| Not metropolitan or micropolitan              | 56     | 275                | 8.2%  | 144              | 687                           | 10.5% | 0.16    |                   |                               |       |         |
| **Median household income quartilesd**        |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| 1st quartile (lowest)                         | 244    | 1194               | 36.2% | 450              | 2097                          | 32.8% | 0.19    |                   |                               |       |         |
| 2nd quartile                                  | 192    | 982                | 29.8% | 361              | 1703                          | 26.6% | 0.13    |                   |                               |       |         |
| 3rd quartile                                  | 135    | 635                | 19.3% | 317              | 1486                          | 23.2% | 0.05    |                   |                               |       |         |
| 4th quartile (highest)                        | 103    | 485                | 14.7% | 231              | 1108                          | 17.3% | 0.20    |                   |                               |       |         |
| **Primary expected payer**                   |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Medicare                                      | 114    | 542                | 15.6% | 160              | 719                           | 11.0% | 0.01    |                   |                               |       |         |
| Medicaid                                      | 83     | 406                | 11.6% | 221              | 1042                          | 16.0% | 0.01    |                   |                               |       |         |
| Private including HMO                         | 218    | 1059               | 30.4% | 485              | 2322                          | 35.6% | 0.02    |                   |                               |       |         |
| Self-pay                                      | 232    | 1178               | 33.8% | 273              | 1247                          | 19.1% | <.0001  |                   |                               |       |         |
| Other                                         | 61     | 298                | 8.5%  | 245              | 1189                          | 18.2% | <.0001  |                   |                               |       |         |
| **Chronic conditions**                        |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| No chronic conditions                         | 290    | 1469               | 42.0% | 792              | 3717                          | 56.3% |         |                   |                               |       |         |
| At least one chronic condition                | 421    | 2027               | 58.0% | 612              | 2885                          | 43.7% | <.0001  |                   |                               |       |         |
| **Life-threatening injuries**                 |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Not life-threatening                          | 147    | 726                | 20.8% | 722              | 3342                          | 50.6% |         |                   |                               |       |         |
| Life-threatening                              | 564    | 2769               | 79.2% | 682              | 3260                          | 49.4% | <.0001  |                   |                               |       |         |
| **Blunt/Penetrating injuries**                |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Blunt injuries                                | 358    | 1793               | 58.0% | 726              | 3373                          | 74.1% |         |                   |                               |       |         |
| Penetrating injuries                          | 269    | 1299               | 42.0% | 247              | 1179                          | 25.9% | <.0001  |                   |                               |       |         |
| **Injury Mechanism**                          |        |                    |       |                  |                               |       |         |                   |                               |       |         |
| Motor vehicle traffic                         | 217    | 1088               | 32.9% | 262              | 1214                          | 21.1% | <.0001  |                   |                               |       |         |
| Firearm                                       | 148    | 723                | 21.9% | 50               | 250                           | 4.4%  | <.0001  |                   |                               |       |         |
| Cut/pierce                                    | 121    | 576                | 17.4% | 197              | 928                           | 16.2% | 0.52    |                   |                               |       |         |
| Fall                                          | 69     | 356                | 10.8% | 129              | 586                           | 10.2% | 0.80    |                   |                               |       |         |
| Struck by, against                            | 32     | 153                | 4.6%  | 182              | 851                           | 14.8% | <.0001  |                   |                               |       |         |

(Continued)
because risk factors that were found to be associated with increased trauma mortality among patients with an ISS < 75 were likely to contribute to increased trauma mortality among patients with an ISS = 75. However, the inclusion of patients with an ISS = 75 would not affect the study findings. The rationale for deliberately excluding these patients is not always justified. Trauma researchers should be very cautious when considering excluding patients with an ISS = 75 from analysis. To avoid potential biases, trauma researchers should always examine the mortality status of patients with an ISS = 75 when deciding whether these patients should be excluded. Because the approach used to generate ISS scores may affect the findings in trauma studies, researchers should explicitly describe the approach used to generate ISS scores and discuss the limitations of using that approach. If the AIS/ISS scores are mapped from ICD-9-CM diagnosis codes using a computer program, the limitations of using computer-assigned ISS score should be discussed. If the AIS/ISS scores are assigned by trained coders, errors in using human-assigned ISS scores should be explained, such as misspecification, miscoding, and upcoding [20].

It appeared that the mortality risks of patients with an ISS = 75 did not vary significantly across different levels of trauma centers (15.6% vs. 13.0%, P = 0.16) (Table 2). These results should be interpreted with caution. The adjustment for patient profiles using advanced statistical methodology is needed when making mortality risk comparisons across different levels of trauma centers. We did not conduct mortality risk comparisons because the focus of this study

Table 3. (Continued)

| Variable                          | Died | Discharged alive | P-value |
|----------------------------------|------|-----------------|---------|
|                                  | Sample (n = 711) | National estimates (n = 3496) | Col %   | Sample (n = 1404) | National estimates (n = 6602) | Col %   |         |
| Other categories                 | 84   | 411             | 12.4%   | 400          | 1914             | 33.3%   | <.0001  |
| Hospital-Level Characteristics   |      |                 |         |              |                  |        |         |
| Hospital type                    |      |                 |         |              |                  |        |         |
| Metropolitan non-teaching        | 190  | 878             | 25.1%   | 471          | 2103             | 31.9%   | 0.01    |
| Metropolitan teaching            | 436  | 2121            | 60.7%   | 726          | 3464             | 52.5%   | 0.01    |
| Non-metropolitan                 | 85   | 497             | 14.2%   | 207          | 1035             | 15.7%   | 0.52    |
| Hospital region                  |      |                 |         |              |                  |        |         |
| Northeast                        | 128  | 592             | 16.9%   | 243          | 1108             | 16.8%   | 0.96    |
| Midwest                          | 145  | 728             | 20.8%   | 329          | 1620             | 24.5%   | 0.12    |
| South                            | 248  | 1213            | 34.7%   | 494          | 2204             | 33.4%   | 0.63    |
| West                             | 190  | 964             | 27.6%   | 338          | 1670             | 25.3%   | 0.39    |
| Trauma Center Designation        |      |                 |         |              |                  |        |         |
| Non-trauma or level III trauma centers | 219  | 1078            | 30.8%   | 709          | 3223             | 48.8%   | <.0001  |
| Level I or level II trauma centers | 305  | 1455            | 41.6%   | 446          | 2102             | 31.8%   | <.0001  |
| Other categories                 | 187  | 963             | 27.6%   | 249          | 1277             | 19.3%   | <.0001  |

Abbreviations: NEDS, Nationwide Emergency Department Sample.

* Data on patients with unknown mortality status were not shown in the table.

* Includes patients who died in the ED and those who died in the hospital.

* Includes patients who were treated and released, discharged alive or sent to home health care from the ED, and patients who were treated and released, discharged alive or sent to home health care from the hospital.

* National quartiles for median household income of patient's home ZIP code.

* Life-threatening injuries were defined by American College of Surgeons Committee on Trauma (ACS-COT).

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was to examine the characteristics and hospital disposition of patients with an ISS = 75. Further research is warranted to examine whether trauma centers achieve better outcomes among patients with an ISS = 75 compared to non-trauma hospitals.

Conclusions

Almost half of patients with an ISS = 75 survived their injuries. Patients with an ISS = 75 should not be assumed to have unsurvivable injuries, and trauma researchers should be very cautious when considering excluding patients with an ISS = 75 from analysis. To avoid potential biases, researchers should always examine the mortality status of patients with an ISS = 75 when considering excluding these patients from analysis. Whether trauma centers achieve better outcomes than non-trauma hospitals among patients with an ISS = 75 warrants further research.

Supporting Information

S1 Appendix. Life-threatening injuries defined by the American College of Surgeon Committee on Trauma (ACS-COT).

(DOCX)
Author Contributions
Conceived and designed the experiments: HX KW. Performed the experiments: JP. Analyzed the data: JP. Wrote the paper: JP. Contributed to the writing of the manuscript: KW. Critically reviewed the manuscript, and approved the final manuscript as submitted: JS JIG KJH.

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