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ACS Verified Level I Centers Have Better Clinical Outcomes Than State Designated Level I Trauma Centers

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Abstract

Background: Two systems exist for evaluating the abilities of trauma centers: the American College of Surgeons' (ACS) verification and the State's designation. Given criteria variations between the two systems, we studied clinical outcome variations of the same.
Methods: The National Trauma Databank was queried from 2002 - 2009, 2013 & 2014 for all patients admitted to a State designated (SI) or ACS verified (AI) trauma facility. Centers that were exclusively state or ACS designated were used for analysis. Patient demographics, facility information and physiological variables were obtained. Outcome variables included length of stay, no of patients with complications and mortality. Multivariate logistic or linear regression analyses were employed for assessing outcome variations.
Results: Of the 12,581,375 trauma admissions, 1,504,848 (12%) met the inclusion criteria with 15 AI and 94 SI exclusive facilities identified. Patient demographics were 66% male, 62 - 63% white and 81% blunt injury. Higher length of stay, mortality, and complications were noted in SI vs. AI centers.
Conclusions: Our results indicate ACS verified level I trauma centers have better clinical outcomes than State designated level I trauma centers. This study warrants future prospective studies to determine the impact of level of designation on clinical outcomes.

Keywords: Quality of Health Care, Outcome Assessment (Health Care), Public Health Systems Research

1. Background

The earliest recognition for the need of specialized traumatic care arose from the battlefields of the Civil War (1). As military physicians rushed to treat the traumatically injured, they recognized that prompt attention to the wounded and advanced fluid resuscitation were associated with improved long term clinical outcomes (2-4). It was not until the cold war in 1966 that the National Academy of Science published the accidental death and disability: The neglected disease of the modern society. This publication was the first to recognize traumatic injury as a significant public health problem. This inspired the development of the American College of Surgeon's (ACS) first iteration of the injury care guidelines. Over the next few years, trauma systems rapidly developed across the country and demonstrated a drop in mortality by as much as 15% (5-7). With the above, several thought leaders suggested that a set of guidelines be developed and enforced for delegation of the level of capability of all trauma systems across the country (8, 9). Currently, two processes are in place for assessing this capability of a trauma system namely the State designation and the ACS verification process. Centers can attain designation or verification at level I (highest) to level V (lowest). This process continues to be voluntary, however, is sought after given associated financial incentives (10-13). The purpose of this study was to compare the clinical outcomes of ACS verified level I centers relative to State designated level I centers.

2. Methods

The National Trauma Databank (NTDB) was queried for all patients who were admitted to a State designated level I or ACS verified level I trauma facility from 2002 to 2009, 2013 & 2014. At the time of data analysis, records for 2010 - 2012 were unavailable for review. Only centers with exclusive ACS verified level I State designated level I status were employed for the analysis. Patients dead on arrival

were not included in the analysis. Patient demographics (Age, sex, ethnicity, injury type, injury mechanism), facility specific information (teaching status, bed size and region) and admitting physiological variables (ISS, admitting systolic blood pressure) were attained. Outcome variables included (hospital length of stay, ICU length of stay, number of complications in patients and mortality).

Statistical analysis was performed using SAS software (version 9.4). Multivariate linear regression model for continuous variables and logistic regression for binary outcomes were considered. In detail, clinical outcomes were adjusted for age, sex, race, injury severity score (ISS), injury type, injury mechanism and admitting systolic blood pressure. Odd's ratio with 95% Wald confidence interval and coefficient with standard error were calculated for binary and continuous datasets respectively. A P-value of < 0.05 was considered statistically significant.

3. Results

3.1. Epidemiological Characteristics

Facility specific information for AI vs. SI is summarized in Table 1. 15 AI facilities and 94 SI were found to meet our inclusion criteria. The NTDB included 12,581,376 trauma admissions with 1,504,848 (12%) met the inclusion criteria. The patients were further subdivided into 425,190 admitted to ACS level I (AI) centers alone and 1,069,658 state level I (SI) centers alone. Overall, at both centers, 66% of all admits were male, majority Caucasian and 81% blunt trauma (Table 2). Interestingly, injury mechanism varied between AI centers relative to SI centers. Fall (36%) is the main mechanism of AI centers and motor vehicle accidents (43%) for SI centers.

3.2. Clinical Outcomes of ACS Level I vs. State Level I Trauma Centers

The clinical outcomes of AI vs SI trauma centers are summarized in Table 3. After risk adjustment, a lower ICU length of stay, hospital length of stay, mortality and number of patients who developed complications was noted in AI centers relative to SI centers. The odds of mortality and patients developing complications at SI were 0.94 and 0.88 times respectively higher then AI centers. The coefficient of ICU length of stay and hospital length of stay was 0.20 and 0.30 respective for SI centers relative to AI centers respectively.

The complication profile noted in AI vs. SI centers is captured in Figure 1. SI had lower reported complications for loss of operative reduction/fixation, disseminated fungal infection, cardiac arrest, bacteremia, skin breakdown, acute respiratory distress syndrome, and pneumonia. Contrarily, SI had higher reported complications for progression of original neurological insufficiency, empyema, pneumothorax, aspiration pneumonia, wound infection, deep vein thrombosis, and urinary tract infection.

4. Discussion

The benefits of a trauma system are well established in the medical literature (14, 15). The results of our study demonstrate that ACS verified centers have better clinical outcomes than state designated trauma centers after risk adjustment. To our knowledge, this study is the first of its kind to establish variations in clinical outcomes between ACS relative to state designated trauma centers. Future studies are needed to evaluate criteria variations between ACS and state processes that may contribute to this variation.

Past studies have demonstrated concentrating patients to a single center is essential for optimized clinical outcomes. Helling et al. demonstrated shorter ILOS among traumatic liver patients in high volume level I trauma centers relative to level II trauma centers. Other studies have also demonstrated similar findings with overall better discharge disposition, shorter HLOS, and lower mortality among trauma admits at high volume centers (16-20).

Interestingly, a few studies have previously evaluated the clinical outcomes variations between ACS verified level I vs. ACS verified level II trauma centers. One study by Cudnik et al. indicated that ACS verified level I centers have better survival and functional outcomes compared to level II centers (21). Our study data indicates that ACS level I/II centers additionally have better (improved) clinical outcomes relative to state level I/II centers as well. Corresponding to this study conducted above for ACS verified level I and II trauma centers, several state specific studies on clinical outcomes have also been conducted. One study by Helling et al., evaluated the clinical outcomes of patients with hepatic trauma at state designated level I vs. II centers (16). Interestingly no variations in mortality, delay to OR, or hHLOS was noted between state designated level I or II centers. However, level II center had a longer ILOS among patients with penetrating trauma relative to level I centers. In our study, we found longer ILOS in state level I.

A limitation of our study is that it is a retrospective analysis based on data compiled in the national trauma databank. Retrospective studies are limited by the data quality and availability. Additionally, routine clinical parameters that may additionally impact outcomes are not captured in the national trauma databank limiting our ability on outcome assessment. Finally, given our data

Table 1. Summary of Facility Information Employed in Statistical Analysis[a]

Characteristic	AI (N = 15)	SI (N = 94)
Hospital type		
University	11 (73)	65 (69)
Community	4 (27)	26 (28)
Non-teaching	0 (0)	3 (3)
Bed size		
1 - 100	0 (0)	1 (1)
101 - 250	1 (7)	5 (5)
251 - 350	1 (7)	10 (11)
351 - 500	6 (40)	23 (24)
> 500	7 (47)	43 (46)
Not noted	0 (0)	12 (13)
Region		
Midwest	8 (53)	13 (14)
South	2 (13)	41 (44)
Northeast	4 (27)	32 (34)
West	1 (7)	5 (5)
Not recorded	0 (0)	3 (3)

[a] Values are expressed as No. (%).

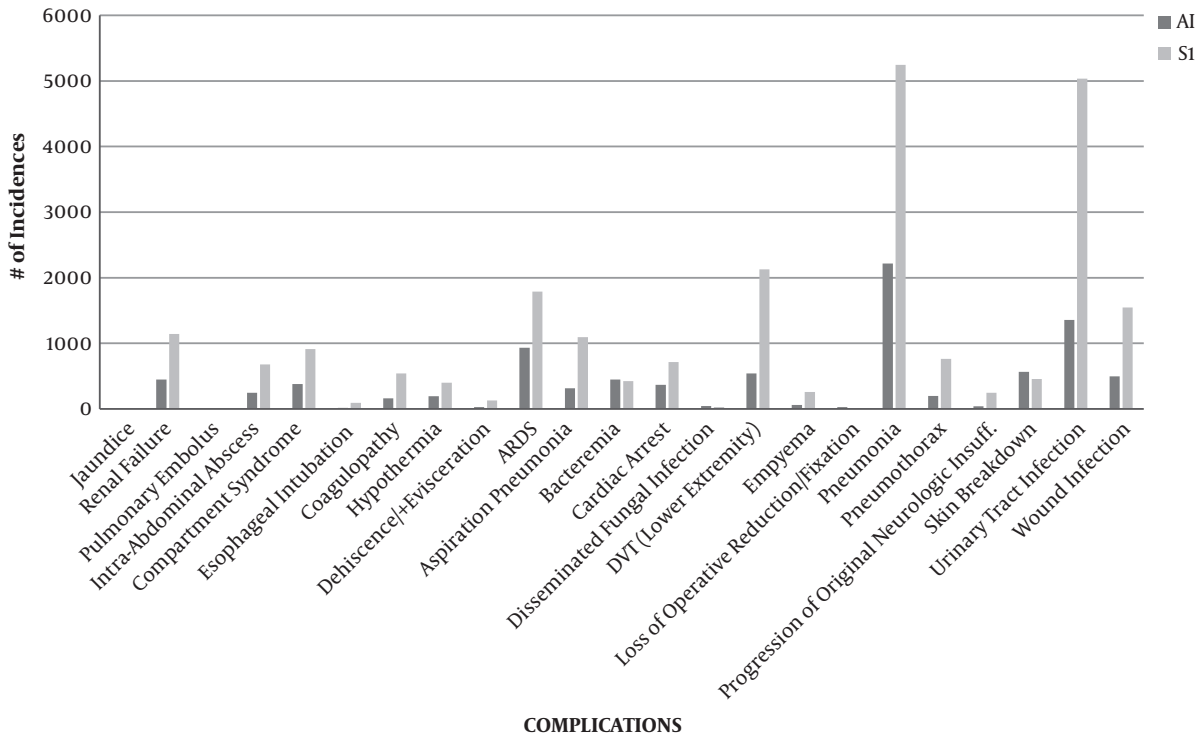

Figure 1. The National Trauma Databank has a predefined list of complications that are captured at each participating site. Complications are defined as any adverse effects that are noted following surgical or non-surgical management of the patient.

Table 2. Summary of Patient Characteristics Admitted to ACS Level I vs. State Level I Facilities

Characteristic	AI	SI
Age (range)	39 ± 23 (0.89)	41 ± 23 (0.89)
Sex[a]		
Male	287.220 (66)	707.089 (66)
Female	147.970 (34)	362.569 (34)
ISS (range)	10 ± 10 (0.75)	11 ± 10 (0.75)
Race[a]		
White	256.824 (62)	669.993 (63)
African American	74.964 (18)	213.204 (20)
Asian	6.974 (2)	13.566 (1)
Hispanic	26.714 (7)	92.289 (9)
Other	24.067 (5)	47.576 (5)
Unknown	24.423 (6)	27.253 (2)
Injury type		
Blunt	348.715 (81)	860.336 (81)
Penetrating	47.062 (11)	118.627 (11)
Burn	14.781 (3)	33.378 (3)
Unspecified	22.445 (5)	51.423 (5)
Injury mechanism		
Fall	75.314 (36)	107.950 (16)
Gunshot wound	21.054 (10)	60.405 (9)
Motor vehicle accident	72.102 (34)	294.936 (43)
Other	45.680 (21)	217.036 (32)
Systolic blood pressure (SBP) at presentation	131 ± 36	135 ± 30

[a] Values are expressed as No. (%) unless otherwise indicated. .

Table 3. Risk Adjusted Clinical Outcomes of Patients Presenting to ACS Level I vs. State Level I Facilities

Characteristics	Unadjusted Value	Adjusted Odd's Ratio (95% CI) or Adjusted Coefficient ± SE	P Value
Mortality[a]		0.94 (0.92 - 0.96)	< 0.0001
AI	15.028 (3)		
SI	39.458 (4)		
ICU LOS		-0.20 ± 0.02	< .0001
AI vs.	3 ± 7		
SI	4 ± 8		
Hospital LOS		-0.30 ± 0.019	< 0.0001
AI vs.	5 ± 9		
SI	6 ± 10		
Yes complications[a]		0.88 (0.87-0.90)	< 0.0001
AI vs.	26.142 (6)		
SI	79.676 (7)		

Abbreviations: ICU, intensive care unit; LOS, length of stay; SE, standard error.
[a] Values are expressed as No. (%).

does not allow us to uniquely identify each state we cannot identify state specific variations in clinical outcomes or identify state specific criteria which assist with improved outcomes. Nationally, complications are largely physician self-reported parameters which may result in the variation noted in the data above. Overall, future prospective studies are needed to address these concerns with the goal to unify trauma care.

Overall, although the benefit of trauma system is well established, the guidelines which result in improved clinical outcomes of patients are yet to be evaluated and validated. With the current two systems of designation and verification, trauma systems across the nation have variations in clinical outcomes. Future studies must evaluate the criteria associated with optimal clinical outcomes among the trauma patients. Our study serves to demonstrate that variations between the two systems do result in poorer clinical outcomes for state centers.

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Footnote

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