



Early impact of American College of Surgeons—verification at a level-1 pediatric trauma center



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ABSTRACT

Purpose: The purpose of this study was to determine the early impact of American College of Surgeons (ACS)-level-1 verification at an established pediatric trauma center.

Methods: Following IRB approval, we conducted a retrospective review of all trauma patients treated at a level-1 state-designated pediatric trauma center, comparing 2 years before (2009–2010) and 2 years after ACS-verification (mid-2012–mid-2014). Statistical significance was defined as $p < 0.05$.

Results: Before verification, 2105 trauma patients were admitted to our institution compared to 2248 patients admitted after ACS-verification. Overall, there were no differences in mean age or injury severity score (ISS). Hospital and pediatric intensive care unit (PICU) length of stay (LOS), ventilator days, and mortality were also unchanged. Through incorporation of clinical pathways, the number of PICU admissions decreased significantly from 17.2% to 13.7%. Morbidity in the form of hospital-acquired conditions (HACS) also decreased following verification, most notably through reduction in pneumonias. Decubitus ulcers and nosocomial infections reached their nadir by 2014. Hospital readmission rates also decreased.

Conclusions: ACS-verification at a level-1 pediatric trauma center is associated with an immediate benefit to patient outcomes. Enhanced tracking and institutional policy changes resulted in fewer HACS. Further cost-saving and improved outcomes because of ACS-verification may be amplified over time.

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The establishment of dedicated trauma centers has been shown to improve patient outcomes [1–4]. While individual states have the authority to designate hospitals as trauma centers, the American College of Surgeons (ACS), a professional national association of surgeons, also offers a verification program to evaluate a hospital's resources for trauma care and provides objective external review of institutional capacity and performance based on ACS published guidelines [5]. Hospitals that have met these guidelines are designated as ACS-verified trauma centers.

Although ACS-verification of trauma centers requires an investment of resources, personnel, and training, there are several advantages. It provides a national standard with review by experts who ensure consistency and adherence to best practice guidelines. Additionally, ACS-verified adult trauma centers have been shown to improve patient outcomes with decreased mortality, length of stay, and greater cost savings per patients [6–12].

In 2006, the ACS began the process of verifying pediatric-specific trauma centers. Multiple studies have demonstrated an improved outcome for injured children managed at pediatric trauma centers when compared to adult trauma centers [13–15]. However, there have been few studies elucidating the potential benefit of ACS-verification for

pediatric trauma centers. Osler et al. found that regardless of pediatric credentials, children had better survival at ACS-verified trauma centers than at non-verified centers [16]. Nortricia et al. reported a correlation in which states with higher ratios of level-1 ACS-verified pediatric trauma centers per population had lower mortality rates [17].

The purpose, therefore, of our study was to analyze the immediate impact of ACS-verification by reviewing our own pediatric trauma patient population and outcomes before and after our institution achieved level-1 ACS-verification.

1. Methods

1.1. ACS verification

St Louis Children's Hospital is a free-standing pediatric hospital and has been a level-1 state-designated pediatric trauma center since 1981. An ACS consultation review was performed in 2010 to initiate the process of ACS-verification. Among the major changes recommended as a result of the review were the addition of new personnel including a dedicated trauma advanced practice nurse, prehospital outreach coordinator, trauma nurse coordinator, performance improvement specialist, several trauma registry data analysts, and a surgical director of the pediatric intensive care unit (PICU). Other non-personnel changes recommended included improved attending response time for trauma

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STATS (our highest level of trauma activation), establishment of a massive transfusion protocol as well as clinical pathways for solid organ injury, and implementation of a multidisciplinary trauma performance improvement review committee. Our institution was officially awarded ACS-verification as a level-1 pediatric trauma center in April 2012.

1.2. Study design

Following IRB approval (#201,306,049), we conducted a retrospective review of all trauma patients who have been treated at our institution from January 1st 2009 to December 31st 2010 (2 years before the process of ACS verification was initiated) and from April 1st 2012 to April 30th 2014 (2 years after ACS-verification). Patients who were discharged from the emergency room were excluded. Data abstracted included patient demographics, injury severity score (ISS), hospital and intensive care length of stay (LOS), ventilator days, mortality, and complications. Continuous variables were analyzed with a Student's t-test while categorical variables were analyzed with a chi-square test. Statistical significance was defined as $p < 0.05$.

2. Results

Overall, there were 2105 trauma patients admitted to our institution (1052 patients per year) during the two years prior to ACS-verification, compared to 2248 trauma patients (1124 patients per year) in the two years following ACS-verification (Table 1). There were no statistically significant differences in age, gender, or race. There was also no difference in injury severity score (ISS). Following verification, we observed more patients insured through Medicaid (38.3% to 49.6%, $p < 0.001$) and secondary transfers from outside hospitals (45.1% to 49.9%, $p = 0.004$).

There were no differences in overall hospital and PICU length of stay as well as ventilator days (Table 1). Overall mortality was low and also remained unchanged (1.6% to 1.7%, $p = 0.97$) following ACS-verification. More patients required operative intervention after verification (9% to 11.3%, $p = 0.02$); however, fewer patients were admitted to the PICU (17.2% to 13.7%, $p < 0.001$).

Patients with significant injuries, defined as an ISS greater than 15, were compiled and analyzed separately (Table 2). There were 208 patients who fit this criteria in both groups, representing 9.9% and 9.3% of all patients before and after ACS-verification, respectively. There were no significant differences in age or ISS between groups. Additionally, there were no differences in the number of PICU admission, patients who required operative intervention, hospital/PICU LOS, ventilator days, or mortality. However, more critically injured patients were transferred from outside hospitals after ACS-verification (51.4% to 68.8%, $p < 0.001$).

Table 1
Demographics and Outcomes for All Admitted Trauma Patients.

	Before (2009–2010)	After (2012–2014)	P-value
Total patients	2105 (1052/year)	2248 (1124/year)	-
Age	8.4 ± 0.1	8.04 ± 0.1	0.05
Gender			
Male	1392 (66.1%)	1428 (63.5%)	0.07
Race			
White	1357 (64.5%)	1451 (64.5%)	0.9
Black	673 (32.0%)	668 (29.7%)	0.10
Medicaid	806 (38.3%)	1115 (49.6%)	<0.001
Injury severity score	6.4 ± 0.2	6.4 ± 0.1	0.9
Transfers from outside hospital	950 (45.1%)	1122 (49.9%)	0.004
PICU admits	363 (17.2%)	307 (13.7%)	<0.001
OR	190 (9.0%)	255 (11.3%)	0.02
Hospital LOS	3 ± 0.2	2.9 ± 0.2	0.6
PICU LOS	3.8 ± 0.2	3.7 ± 0.1	0.8
Ventilator days	1.9 ± 0.2	1.9 ± 0.1	0.9
Mortality	34 (1.6%)	38 (1.7%)	0.9

PICU, pediatric intensive care unit; OR, operating room; LOS, length of stay.

Table 2
Trauma Patients With Significant Injuries (ISS > 15).

	Before (2009–2010)	After (2012–2014)	P-value
Number of patients	208 (9.9%)	208 (9.3%)	0.5
Age	8.3 ± 0.4	8.0 ± 0.4	0.7
Injury severity score	22.9 ± 0.8	25.0 ± 1.0	0.09
Transfers from outside hospital	107 (51.4%)	143 (68.8%)	<0.001
PICU admits	140 (67.3%)	132 (63.5%)	0.4
OR	32 (15.4%)	25 (12.0%)	0.3
Hospital LOS	11.2 ± 1.4	10.1 ± 1.2	0.5
PICU LOS	4.8 ± 0.7	4.1 ± 0.4	0.5
Ventilator days	3.8 ± 0.8	2.9 ± 0.4	0.4
Mortality	30 (14.4%)	32 (15.4%)	0.8

PICU, pediatric intensive care unit; OR, operating room; LOS, length of stay.

To better define outcomes, we also examined complications and readmissions within our trauma population (Table 3). Following verification, the number of hospital-acquired pneumonias decreased from 18 to 7 (0.9% to 0.3%, $p = 0.02$). The overall number of infections and decubitus ulcers were unchanged from before and after ACS-verification. However, the frequency of all hospital-acquired conditions were at their lowest by 2013–2014 (Fig. 1). While readmissions to the PICU were rare and unchanged, there was a significant decrease in the hospital readmissions after discharge (16 to 7, $p = 0.04$).

3. Discussion

Achieving ACS-verification involves a considerable investment with the addition of new personnel and implementation of new systems to fit the standards of the ACS Committee on Trauma. There are 108 essential criteria for ACS level-1 trauma center designation. The process involves a consultation visit from the ACS as well as a commitment from hospital administration, surgery, emergency medicine, and ICU teams.

It has been well established in the adult trauma population that ACS-verification improves patient outcomes. DiRusso et al. found an overall decrease in mortality, particularly in patients with an ISS >30, as well as a decrease in LOS [7]. Maggio et al. similarly noticed a significant decrease in hospital mortality in patients with an ISS >24 [11]. Demetriades et al. conducted a National Trauma Databank (NTDB) study including 130,154 patients more than 10 years and determined that patients with severe injuries (ISS > 15) had increased mortality at non-verified centers compared to level-1 ACS-verified centers [9]. However, this study notes that non-verified centers included those who are state-verified as well as those who had no trauma designation at all. Biff et al. compared outcomes at their institution before and after ACS-verification and observed decreases in both hospital and ICU length of stay [10]. Using the NTDB, Smith et al. found that trauma patients with ARDS had significantly greater survival at a level-1 ACS center compared to level-1 state centers, even after adjusting for injury severity [8]. Another report by Brown et al. using the NTDB found that ACS verification also improved survival in level-2 trauma centers [12].

ACS-verification has only recently become available for pediatric trauma centers. At the time of publication, there are 45 ACS-verified level-1 pediatric trauma centers in the United States. Notricia et al.

Table 3
Hospital-Acquired Conditions and Readmissions.

	Before (2009–2010)	After (2012–2014)	P-value
Urinary tract infection	8	4	0.2
Wound infections	10	11	0.9
Other infections	5	4	0.70
Pneumonias	18	7	0.02
Decubitus ulcers	8	8	0.9
Readmission to hospital	16	7	0.04
Readmission to PICU	3	5	0.5

PICU, pediatric intensive care unit.

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