Surgical Education

Implementing acute care surgery at a level I trauma center: 1-year prospective evaluation of the impact of this shift on trauma volumes and outcomes

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KEYWORDS: Acute care surgery; Trauma volume; Outcomes; Preventable and potentially preventable deaths and complications; Mortality

Abstract

BACKGROUND: The purpose of this study was to evaluate the impact of the transition to acute care surgery (ACS) on trauma volumes and outcomes.

METHODS: All admissions from 2 1-year periods from June 2008 to May 2010 (1 year before ACS and 1 year after ACS) to the LAC+USC Medical Center were prospectively collected. In anticipation of this change, trauma patient demographics, clinical data, and outcomes (trauma volume and preventable and potentially preventable deaths and complications) were prospectively collected.

RESULTS: Before ACS, there were 5,378 trauma admissions. After ACS, there were 5,726 (66.5%) trauma and 2,886 (33.5%) nontrauma admissions. There were no demographic or clinical differences between trauma patients in the 2 groups. There was no significant difference in overall mortality (3.8% before ACS vs 3.3% after ACS, P = .292). Similarly, there were no differences in the rates of preventable and potentially preventable deaths or complications observed (1.2% vs 1.0%, P = .374) during the study period.

CONCLUSIONS: Despite a 60% increase in total patient volume and a 233% increase in operative volume over the study period, the addition of emergency surgery to a trauma service did not compromise trauma patient outcomes.

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Trauma care, along with surgical critical care and emergency general surgery, has now been incorporated at many centers in North America into a contemporary acute care surgery (ACS) model. This new specialty has improved patient access to quality surgical care and enhanced the scope of practice for future generations of generalist surgeons.1,2

The benefits of this expanded scope of practice are becoming ever more important to attract the highest quality of trainee to this area of specialization and to maintain viable and satisfying professional careers for the current generation of trauma surgeons. This is especially true in the...
face of decreasing trauma volumes and increasing nonoperative management of injury. Trauma surgeons have the skill set to manage these emergencies, and the system is designed to handle these patients, because they are very similar in many ways to acutely injured patients. Both lack the luxury of a leisurely workup and optimization before making critical decisions, both require resuscitation, and both have similar operative goals with a critical care intensive recovery phase. The case loads are often complementary, with many emergency nontrauma cases being assessed during the day and increasingly higher trauma volumes being seen in the evening and overnight. Thus, logistically, this expansion to include emergency nontrauma surgery is feasible. What is not clear, however, is the impact of this expansion in focus and its attendant increase in workload on patient safety. The purpose of this study was to prospectively evaluate the impact of this transition on trauma patient outcomes at a major academic level I trauma center by specifically cataloging the rate of errors resulting in preventable and potentially preventable (P/PP) deaths and complications before and after the implementation of an ACS program.

Methods

After institutional review board approval was obtained, all trauma admissions from June 2008 to May 2010 and emergency nontrauma surgical admissions from June 2009 to May 2010 to the LAC+USC Medical Center were prospectively collected.

For trauma patients, variables collected included age, gender, injury mechanism, systolic blood pressure and Glasgow Coma Scale score at admission, Injury Severity Score (ISS), need for trauma intracavitary surgery (thoracotomy, thoracoscopy, laparotomy, and laparoscopy), intensive care unit (ICU) length of stay (LOS), hospital LOS, and P/PP deaths and complications. For nontrauma patients, variables collected included age, gender, systolic blood pressure at admission, primary diagnosis, and patient disposition after initial evaluation.

At our institution, all deaths and complications are captured on a daily basis by the house staff and are independently verified by a trauma registry nurse. They are comprehensively reviewed at weekly morbidity and mortality (M&M) conferences. This is mandatory for all attending surgeons and fellows in the Division of Trauma and Surgical Critical Care as well as those services, such as neurosurgery, orthopedics, anesthesia, and radiology, that may have been directly involved in each case. Each death or complication is reviewed and is classified by consensus according to preventability. All decisions as to whether the death or complication is preventable, potentially preventable, or not preventable are made by the attending surgeons present as a panel review decision at the M&M conference. An attending trauma surgeon documents each death or complication, its root causes, outcomes, and loop closure recommendations.

For deaths specifically, the data gathered during the M&M analysis generates a quality improvement death form that includes data on epidemiology, vital signs, injury severity, type of injury, probability of survival with Trauma and Injury Severity Score methodology, preventability, errors in the evaluation and management of the patient, and classification of errors (system, judgment, knowledge). All corrective actions, such as counseling, education, new protocols, and resultant loop closures, are documented on the quality improvement death form. All findings are then subsequently analyzed for a second time by the Combined Trauma Death Review Committee, a multidisciplinary committee (trauma surgery, critical care, emergency medicine, neurosurgery, nursing, and forensic pathology) chaired by the coroner responsible for evaluating all deaths. This committee examines all clinical patient data, including the prehospital emergency medical service notes, emergency room documentation, operative reports, imaging, electronic laboratory results, and inpatient charts. This is combined with pathology and autopsy results to determine both the cause of death as well as any contributing factors and to assign a classification to each patient according to preventability.

Data were entered into a computerized spreadsheet (Excel 2003; Microsoft Corporation, Redmond, WA) and analyzed using SPSS for Mac version 18.0 (SPSS, Inc, Chicago, IL). Continuous variables were dichotomized using the following clinically relevant cut points: age ($\geq 55$ vs $<55$ years), systolic blood pressure at admission ($<90$ vs $\geq 90$ mm Hg), Glasgow Coma Scale score at admission ($\leq 8$ vs $>8$), and ISS ($\geq 16$ vs $<16$). The outcomes analyzed in this study were the number of trauma admissions, rates of intracavitary surgery, overall mortality, and P/PP deaths and complications. Demographics, clinical data, and outcomes were compared before (June 2008 to May 2009) and after (June 2009 to May 2010) transition into an ACS service.

The LAC+USC Medical Center, an American College of Surgeons--verified academic level I trauma center, is 1 of the highest volume trauma centers in North America. During the past 10 years, the number of trauma patients admitted to our facility has remained constant. Before implementation of the ACS service line, there were 2 distinct services responsible for all surgical emergencies. There was a trauma service staffed by an in-house board-certified surgeon with fellowship training in trauma and added qualification in critical care. There was also an in-house nontrauma service staffed by a board-certified surgeon with no added qualifications in critical care. In the after model, the staffing of the ACS service is as follows: from 7 AM to 7 PM Monday to Friday, an in-house board-certified surgeon with added qualification in critical care assesses all trauma and nontrauma general surgical emergencies along with a team consisting of a senior resident, 2 midlevel residents (postgraduate year 2 or 3), an intern, 4 medical students, and a physician assistant. There are 2 critical care fellows under the supervision of a separate critical care attending physician responsible for
all surgical ICU admissions and ongoing cases. At 7 PM and
on Saturdays and Sundays, a 2nd board-certified surgeon
without added qualifications in critical care is available in
house to primarily assess all nontrauma emergencies. The
critical care attending physician is available from home,
and a 2nd backup surgeon is also available from home. During
the study period, there was no quantitative or qualitative
change in the trauma staffing. There were no quantitative
changes in the complement of residents, physician assistants,
or medical students rotating through the service. No
working-hours regulations were changed during the study
period.

Chi-square and Fisher’s exact tests were used to compare
proportions, and unpaired Student’s t and Mann-Whitney
U tests were performed to compare means. The summary
data are presented as raw percentages or as mean ± SD.
P values were significantly different at P < .05.

Results

From June 2008 to May 2009 (1 year before ACS), there
were 5,378 trauma admissions to the LAC+USC Medical
Center. From June 2009 to May 2010 (1 year after ACS),
admissions totaled 8,612. Of those, 5,726 (66.5%) were
trauma and 2,886 (33.5%) were nontrauma patients. Before
ACS, the average age of the trauma patients was 36.7 ±
19.6 years, and 75.2% were men. The mechanism of injury
was blunt in 74.8%. After ACS, the average age of the
trauma patients was 35.9 ± 19.6 years, and 74.6% were
men. The mechanism of injury was blunt in 74.2%. No
statistically significant differences in demographics and
clinical data were found between trauma patients admitted
before and after transition to ACS (Table 1). For nontrauma
patients, the average age was 41.0 ± 16.0 years, and 41.0% were
men (Table 1).

Of nontrauma patients evaluated by the ACS service
during the study period, 18.5% were diagnosed with
acute cholecystitis, 17.0% with acute appendicitis, and
11.2% with other biliary or pancreatic diseases such as
choledocholithiasis, chronic cholecystitis, and acute,
chronic, or gallstone pancreatitis; 27.1% of patients were
diagnosed as having other conditions (Fig. 1).

When the disposition of nontrauma patients was ana-
lyzed, 38.6% remained under the ACS service (56.2% of
whom were operated on), 17.1% were referred to an
elective general surgical service, 13.3% were referred to
internal medicine, and 10.2% were discharged home after
initial evaluation (Fig. 2).

When trauma patient outcomes were analyzed, there was
a significant increase in the number of trauma admissions
(448.2 ± 63.2 vs 477.1 ± 83.5 patients/month, P < .001).
No significant difference was found between the rate of in-
tracavitary surgery for trauma patients (before ACS, 4.0%;
after ACS, 4.2%; P = .565; Table 2).

Because of the increase in numbers of admissions, the
total number of operations including both trauma and
nontrauma patients increased significantly after the transi-
tion to ACS (from 215 [trauma] to 501 [243 trauma and 258
nontrauma]).

The mean ISS remained stable over the study period (7.4
± 8.2 before ACS vs 7.1 ± 8.3 after ACS, P = .762). When
overall trauma mortality rates were analyzed, there was
no significant difference between the 2 time periods (3.8% be-
fore ACS vs 3.3% after ACS, P = .292; Table 2). There
were also no significant differences in the rates of trauma
P/PP deaths during the study period (Table 2). For trauma
P/PP complications, again there was no difference (1.2%
before ACS vs 1.1% after ACS, P = .374). No statistically
significant differences in ICU LOS or hospital LOS were
found (Table 2).

Comments

As ACS programs are implemented across North
America, the effects of this change in focus and its
attendant increase in workload remain poorly understood.
To date, only a few retrospective studies have examined the
impact of the addition of emergency general surgery to a

### Table 1 Demographics and clinical data of the study population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before ACS (June 2008 to May 2009) (n = 5,378)</th>
<th>After ACS (June 2009 to May 2010) (n = 8,612)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age ≥ 55 y</td>
<td>18.3% (984)</td>
<td>17.8% (1,021)</td>
</tr>
<tr>
<td>Men</td>
<td>75.2% (4,044)</td>
<td>74.6% (4,248)</td>
</tr>
<tr>
<td>Blunt</td>
<td>74.8% (4,022)</td>
<td>74.2% (4,248)</td>
</tr>
<tr>
<td>SBP on admission (mm Hg)</td>
<td>132.1 ± 26.3</td>
<td>132.3 ± 26.2</td>
</tr>
<tr>
<td>SBP on admission &lt;90 mm Hg</td>
<td>2.2% (118)</td>
<td>2.4% (132)</td>
</tr>
<tr>
<td>GCS score on admission ≤ 8</td>
<td>4.7% (252)</td>
<td>4.8% (272)</td>
</tr>
<tr>
<td>ISS</td>
<td>7.4 ± 8.2</td>
<td>7.1 ± 8.0</td>
</tr>
<tr>
<td>ISS ≥ 16</td>
<td>10.1% (543)</td>
<td>9.5% (543)</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± SD or as percentage (number). No statistically significant differences were observed between trauma patients admitted before and after transition to ACS (P < .05).

ACS = acute care surgery; GCS = Glasgow Coma Scale; ISS = Injury Severity Score; SBP = systolic blood pressure.
trauma service and its effects on trauma patient outcomes. In 2000, Spain et al.\(^3\) published an outcomes review of all patients admitted to the trauma service from 1992 to 1998. The primary outcome in that study was operative volume as measured by the number of major and minor operations such as laparotomy, diagnostic peritoneal lavage, and ICU bedside procedures. During the study period, nontrauma patients accounted for 34% of all trauma service admissions. When trauma outcomes were analyzed, there was no change in the number of major operative or ICU procedures. Similarly, morbidity and mortality remained constant over time.\(^3\) Four years later, Pryor et al.\(^4\) published a before-and-after study evaluating the transition from trauma to ACS at the University of Pennsylvania, which occurred in August 2001. During the 30-month study period (15 months before and 15 months after ACS), a total of 2,904 admissions (1,400 before ACS and 1,504 after ACS) were evaluated by the trauma service and logged into the statewide database. No significant difference in mortality was identified between the 2 time points (12.7% before ACS vs 11.9% after ACS, \(P = \text{NS}\)). The investigators concluded that despite an increase in trauma volume over the study period, the addition of emergency surgery to a trauma service did not affect the care of injured patients.\(^4\) Two years later, the same group reviewed all injured patients evaluated by their service from 1999 to 2003. Although the purpose of that study was to examine the impact of the increasing load of emergency general surgery cases on “case management team” performance, the investigators were still able to demonstrate an increase in the volume of injured patients treated despite the addition of emergency general surgery cases.\(^5\) Finally, a recent study by Matsushima et al.\(^6\) reported on 3,359 trauma and emergency general surgery patients admitted to Parkland Health and Hospital System over a 6-month period ending in May 2008. Although no control data before the full integration of an ACS model

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**Figure 1**  Primary diagnoses of nontrauma patients evaluated by the ACS service. Other diagnoses included inflammatory bowel disease, diverticulitis, cirrhosis, abdominal wall hematoma, compartment syndrome, intestinal volvulus, sepsis, hemorrhoids, rectal prolapse, fistulas, arterial aneurysms or dissection, pneumothorax, pneumoperitoneum, gastrointestinal bleed, and limb ischemia.

**Figure 2** Disposition of nontrauma patients after initial evaluation by the ACS service. Other services included gastrointestinal, thoracic and foregut, plastic surgery, breast, burn, pediatrics, pediatric surgery, and obstetrics and gynecology. OR = operating room.
were available, the investigators were able to conclude that increased workload during combined trauma and emergency general surgery call in an ACS model did not affect time to operating room, complications, or mortality in that patient cohort.

The present study was a prospective before-and-after evaluation of the impact of the transition from a trauma-only program to an ACS program on trauma volumes and outcomes. The main variables of interest were the number of trauma admissions, the number of operations, trauma patient mortality, and specifically P/PP deaths and complications. These variables were prospectively captured daily at our morning pass-on rounds and weekly M&M conferences. During the study period, there were no quantitative or qualitative changes in our trauma attending staffing. The numbers of trauma and critical care fellows, residents, and medical students rotating through our service also remained constant. From June 2008 to May 2009 (before ACS) to June 2009 to May 2010 (after ACS), in addition to the integration of nontrauma emergency cases, an increase in trauma volume occurred. This finding is in contrast to a previous study demonstrating a decrease in trauma volume when emergency general surgery was integrated into a trauma service due to the addition of emergency nontrauma surgery, the rate of preventable or potentially preventable deaths and complications may have been affected by seasonal variations, including weather and other confounders. To mitigate such variations, however, the exact same months were included in both study periods. In addition, we did not prospectively capture minor procedures, such as diagnostic peritoneal lavage, tracheostomy, central line placement, and tube thoracostomy. These have also been shown to be important outcome variables when assessing operative experience. Finally, and perhaps most importantly, trauma care is constantly evolving; therefore, it is possible that other factors may have affected the outcomes of interest because of the before-and-after study design.

A significant potential barrier to the implementation of emergency general surgery into a trauma service is the effect this might have on the care of the injured. It is clear that committing a trauma service to a wider scope of practice will demand more resources and detract from the time spent on each injured patient. Nevertheless, in this single-center examination, we were unable to demonstrate a negative impact of the incorporation of these patients into an ACS model.

### Conclusion

Despite a 60% increase in total patient volumes and a 233% increase in operative volumes over the study period due to the addition of emergency nontrauma surgery, the implementation of an ACS service did not negatively affect the rate of preventable or potentially preventable deaths and complications in the injured patients. The addition of emergency surgery to a trauma service increased operative volume without compromising trauma patient care.

### References


