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In Support of Ensuring Additions to the Trauma Team Activation Criterion are Evidence-Based: One Center's Experience with the Extremity Gunshot Wounds Proximal to the Knee and Elbow Criterion

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Abstract

Objective: The purpose of this study was to observe the incidence and outcomes of Trauma Team Activations (TTAs) secondary to gunshot wounds (GSWs) to the extremity proximal to the knee and elbow to determine utility of this triage category.

Methods: An IRB exempt, retrospective chart review was performed at Regions Hospital, an American College of Surgeons (ACS)-verified Level I Trauma Center in St. Paul, Minnesota from September 1, 2016 to August 31, 2017.

Results: A total of 800 TTAs occurred during this time, with 46 (5.75%) having injuries only in the proximal extremities. Median age was 25-years (Range: 4yr-62yr). Sixteen (35%) were discharged directly from the Emergency Department (ED) and 30 (65%) were admitted to inpatient services. Of those admitted, 19 were discharged after 1-day or less; 3 had same-day discharge. No patients were sent to Interventional Radiology. Thirteen patients (28%) underwent operations at some time during hospitalization. There were no patient deaths prior to discharge.

Conclusions: This series of single-institution gunshot wounds to the proximal extremities shows that patients rarely require immediate surgical intervention and the majority who are admitted to surgical services have a short length of stay (LOS). Few of these patients would have required a TTA by other mandatory criteria. These data suggest that any future additions to the mandatory criteria should be supported by evidence prior to implementation to avoid unnecessary TTAs.

Introduction

Background

"Trauma Center Verification" is determined by The American College of Surgeons (ACS) Committee on Trauma (COT) and is a voluntary process verifying that facilities are delivering optimal trauma care as indicated by the manual Resources for Optimal Care of the Injured Patient, which is updated periodically to reflect the changing body of knowledge of trauma care delivery [1].

The 2006 edition of the "Resources for the Optimal Care of the Trauma Patient" stated that criteria for the highest level of activations were not clearly defined and recommended programs develop and regularly evaluate their own criteria [2]. In 2007 the Committee on Trauma (COT) released six items that met minimally acceptable criteria for the highest level of trauma team activation, considered required criteria for institutions to be verified as a Level 1 trauma center (Figure 1).

The 2014 edition added "gunshot wounds.... to the extremities proximal to the elbow/knee" to the mandatory criteria (Figure 1). The rationale and evidence behind this addition was not clear. Previous evidence suggests that mechanism-based criteria fail to adequately and consistently identify seriously injured patients [3]. Furthermore, additional criteria set by individual institutions typically capture those patients who would need a full activation, regardless of the addition of these criteria. Figure 2 illustrates full criteria for Regions Hospital. The 2018 ACS clarification document removes the "gunshot wounds...to the extremities proximal to the elbow/knee" criterion, effective August 13, 2018 [4].

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- Confirmed blood pressure <90 at any time in adults and age-specific hypotension in children
- *Gunshot wounds to the neck, chest, or abdomen
- **GCS <8 with mechanism attributed to trauma
- Transfer patients from other hospitals receiving blood to maintain vital signs
- aIntubated patients transferred from the scene - OR -
- ***bPatients with respiratory compromise or obstruction - Includes intubated patients who are transferred from another facility, with ongoing respiratory compromise (does not include patients intubated at another facility and are now stable from a respiratory standpoint)
- Emergency physician's discretion

Figure 1: ACS COT 2007 fact Sheet Trauma Team Activation Criteria.

*Gunshot wounds to neck, chest, abdomen, or extremities proximal to elbow/knee].

**GCS <9.

***Patients with respiratory compromise or obstruction [or are in need of an emergent airway...].

Importance

Though trauma activations should not be underutilized, a TTA occupies the time and resources of multiple departments throughout a hospital, potentially impacting care for other patients. Currently there is no evidence supporting the physiologic necessity or the risk of under-triage for the addition of this criterion to full trauma team activation, and there has been little evaluation of the associated change in patient outcomes or hospital costs.

Goals of this investigation

The purpose of this study was to determine the incidence of TTAs called only for proximal extremity GSWs, to observe patient outcomes from these injuries, and to evaluate the need for immediate trauma surgery involvement for victims of such injuries.

Materials and Methods

Study design and setting

A retrospective chart review was performed at Regions Hospital, an ACS- designated Level 1 adult and pediatric trauma center in St. Paul, Minnesota.

Selection of subjects

Data were identified by manual review of all TTAs in the trauma registry with primary diagnosis of "gunshot wound". Patients were further reviewed to identify injury proximal to knee and elbow. Patients satisfying these criteria between September 1, 2016 and August 31, 2017 were included. Those with additional ballistic injury to neck, chest, or abdomen were excluded. There was no specific age criterion for inclusion.

Measurements and outcomes

Extracted variables included: age; sex; number of wounds; location; initial systolic blood pressure (SBP) from EMS ; initial Glasgow Coma Score (GCS) from EMS; initial SBP in ER; initial GCS in ER; operating room (OR; y/n); time to OR (hours after arrival); Interventional Radiology (IR y/n); time to IR (hours after arrival); transfusion (y/n); number of units required; requirement of Massive Transfusion Protocol (y/n); inpatient admission (y/n); disposition; and hospital length of stay (length of admission- days; length of stay in ED- hours). Vitals were obtained from the EMS run sheet and from the trauma flow sheet. If clarification of wound location was required, the Acute Care Surgery "History and Physical" note was reviewed. Finally, each patient chart was reviewed for total facility charges associated with TTA code and any critical care documentation.

Analysis

Descriptive statistics, including percentages and quartiles, were calculated for variables of interest. Additional descriptive information regarding each patient's need for trauma-level services based on other criterion was summarized.

Results

Characteristics of study subjects

A total of 800 TTAs occurred during the study period, with 47 (5.75%) activations due solely to the 2014 proximal extremity criterion. One chart was excluded from review due to transfer to a different facility. Included patients consisted of 38 males and 8 females. Median age was 25-years (Range: 4-62 years) (Table 1).

Main results

Sixteen (35%) patients were discharged directly from the ED and 30 (65%) were admitted to inpatient services. For those discharged directly from the ED, median length of stay was 3 hours. For those admitted to the hospital, the median length of stay was 1 day.

Forty-five patients prompted XR imaging. 16 prompted CT scans. 38 prompted bedside FAST ultrasound evaluation (routine in all TTAs at Regions Hospital). One patient triggered activation of massive transfusion protocol (MTP) based on a paramedic report of "lots of blood at the scene," however ultimately did not receive more than two units of blood. Of those admitted, 19 were discharged after 1-day or less of inpatient care; three had same-day discharge. No patients were sent to Interventional Radiology. Thirteen patients (28%) went to the OR. One went immediately, the other twelve went between 1 and 36 hours after arrival, with mean time to OR of 9.6 hours. Nine surgical patients received orthopedic interventions [external fixation (2), ORIF (3), medullary nail (4)]. Two patients received general surgery intervention (wound exploration with washout; bullet removal for pain relief). Two received vascular repair (superficial femoral artery repair and embolectomy with vein graft). Overall mortality was zero (defined as survival to discharge).

Sixteen patients did not have recorded blood pressure via EMS, either due to arrival by private car or lack of clear documentation in the chart. Of the remaining 31 patients, median pre-hospital systolic blood pressure was 132mmHg (Q1=123, Q3=148). Median systolic blood pressure for patients upon arrival to the ED was 142mmHg (Q1=129, Q3=154). GCS of all patients in the field and upon arrival to ED was 15. There were two patients for which a TTA was activated inadvertently for distal extremity injury (hand). One patient was

- Traumatic arrest
- Intubated patients transferred from scene OR patients with respiratory compromise OR in need of an emergent airway. Includes intubated patients who are transferred from another facility with ongoing respiratory compromise does not include patients intubated at another facility who are now stable from a respiratory standpoint)
- Flail chest/major chest injury
- Sustained BP <90 or sustained < age-appropriate (pediatric)
- Stab wound to torso (neck-to-genitalia)
- GSW to the neck, chest, abdomen, or extremities proximal to the elbow/knee
- Penetrating injury to head and face (major)
- Depressed skull fracture
- GCS < 14
- Focal deficits (unilateral pupil, paralysis)
- Major extremity vascular injury
- 2 or more proximal long bone fractures (i.e. femur, humerus, etc.)
- Amputation proximal to wrist and ankle
- Severe burn patient arriving to ED with >20% (adult) or >15% (pediatric) TBSA 2nd or 3rd degree burns; high-voltage burns; significant burns and trauma; inhalation-injured burn patient requiring advanced airway support
- Hanging (pediatric)
- Transfer patients from other hospitals receiving blood to maintain vital signs
- EMS judgment
- MD judgment

Figure 2: Expanded Trauma Team Activation Criteria - Regions Hospital.

Table 1: Demographic and outcome data.

Variable	N = 46
Age – Median (Q1, Q3)	25 (20, 31.5)
Gender	
Male	38 (82.6%)
Female	8 (17.4%)
Qualifying Extremity Injury Sites	
Proximal to Elbow	9
Proximal to Knee	36
Incorrect Inclusion via Hand	2
Number of Wounds (Range, Mean)	1-5; 2
Transfer from OSH	0
EMS GCS – Median (Q1, Q3)	15 (15, 15)
Arrival GCS – Median (Q1, Q3)	15 (15, 15)
EMS BP – Median (Q1, Q3)	132 (123, 148)
Arrival BP – Median (Q1, Q3)	142 (129, 154)
Imaging (# patients with each type)	
XR	45
CT/CTA	16
FAST	38
Disposition	
Discharged from ER	16
Length of Stay (Hours) – Median (Q1, Q3)	3 (2.4, 3.8)
Admitted	30

Ward	30
Length of Stay (Days) – Median (Q1, Q3)	1 (1, 3)
ICU	0
Transferred to OSH	1
Interventions	
OR	13
Hours to OR (Mean, Median, Q1, Q3)	9.6, 4, 2.5, 16
IR	0
Hours to IR (Mean, Median, Q1, Q3)	N/A
Transfusion in ER	1
MTP Requested	1
Total Units Received	2
Mortality	0

ER: Emergency Room; OR: Operating Room; IR: Interventional Radiology; MTP: Massive Transfusion Protocol; OSH: Outside Hospital.

activated due to a wound at the axilla.

Further evaluation of the study population found that none of the patients met any other mandatory ACS-COT activation criteria. Current ACS-COT guidelines are unclear in delineation between trunk and proximal upper extremity, so argument can be made for calling a TTA for GSW to the axilla.

Facility financial charges were available for 45 of 48 patients. These patients were found to have generated a mean of an additional \$421,100 in charges due to coding as a TTA.

Limitations

Given the small sample size drawn from a single institution, the results of this study lack the statistical power to generate generalizable conclusions. However, the purpose of this work was not to develop powerful statistical data, rather to provide a qualitative reflection on our experiences with this new criterion in the absence of clear supportive evidence for such changes, with the hope to provoke further empiric investigation from other institutions regarding this and future proposed changes to TTA criterion.

Discussion

It is unclear why the proximal extremity GSW criterion was added to the 2014 ACS-COT list of minimum mandatory elements for certification. There are no studies cited in the Guide supporting the change, nor can any validating data be ascertained via literature search., unlike for previous versions of the ACS-COT guidelines prior to the 2014 revision [5,6]. *Lossius et al.* looked at the effect of definitions of major trauma and found that "expanding the purely anatomic definition of major trauma by including proximal penetrating injury...did not significantly influence the perceived triage precision [at their institution]" [7]. Similarly, *Edmundson et al.* found a "relative scarcity of cases, exceedingly low mortality rate, and apparently low injury burden...which do not support ACS-COT's mandate to activate such patients" in an evaluation of data from the National Trauma Data Bank from 2013-2014 [8]. In a recent retrospective study of penetrating proximal extremity wounds, *Martin et al.* concluded that, "under current recommendations these patients are often overtriaged" [9].

There are clear resource utilization challenges that come with the activation of unnecessary TTAs. The massive resources that these patients draw is often at the expense of other patients. Trauma and ED clinicians and nurses, laboratory services, imaging equipment and radiologists are pulled from other activities to address the needs of these trauma patients who might not need that many resources at a single time. Arguments could be made as to the causality implied here and indeed, these issues are typically multifactorial in nature.

Additionally, the process of broadening or narrowing our catchment criteria for patients in need of trauma services has clear economic implications and must include a balanced consideration of both non-maleficence and beneficence, not only for the trauma victims themselves, but also for the rest of our ED patients.

In summary, in the realm of medical triage decision-making the clear ethical impetus to err on the side of caution and over-inclusion to save the most lives possible must be balanced with the costs and harms associated with over-triage and subsequent over-utilization of resources, including indirect impact to other patients. To this end, it is imperative to create guidelines granular enough to ensure capture of patients in need, but also allowing for refinement and flexibility for efficient treatment.

The addition and subsequent removal of the 2014 criterion to activate the trauma team for GSWs proximal to the knee and elbow supports the importance of adding TTA criteria only after evidence-based evaluation. The results of this study further evidence the need for robust scientific support of new criteria prior to addition as mandatory. It is our opinion that the benefit of avoiding under-triage does not always outweigh the multiple costs of over-triage.

Recognitions

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