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Managing moderately injured pediatric patients without immediate surgeon presence: 10 years later

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ABSTRACT

Purpose: Beginning in 2003, the pediatric emergency medicine (PEM) physician replaced the surgeon as the team leader for all level II trauma resuscitations at a busy pediatric trauma center. The purpose was to review the outcomes 10 years after implementing this practice change.
Methods: Trauma registry data for all level II activations requiring admission were extracted for the 21 months (April 1, 2001–December 31, 2002) prior to policy change (period 1, $^{**}n = 627$) and compared to the admitted patients from the 10 subsequent years (2003–2013; period 2, $n = 2694$). Data included demographics, length of stay (LOS), injury severity score (ISS), readmissions, complications, and mortality.
Results: Mean ISS scores for admitted patients during period 1 (8.5) were higher than during period 2 (7.8). During period 1, 53.6% of patients underwent abdominal CT versus 41.8% in period 2 ($p < .001$), and the median ED LOS was 135 versus 191 minutes in period 2. From 2000 to 2003, 91% of patients seen as level II trauma alerts were admitted compared to 56.6% of patients in period 2 ($p < 0.001$). There were no missed abdominal injuries identified, and readmission rate was low.
Conclusions: We conclude that level II trauma resuscitations can be safely evaluated and managed without immediate surgeon presence. Although ED LOS increased, admission rate and CT scan usage decreased significantly without an increase in missed injuries.

Trauma remains the most common cause of morbidity and mortality in children [1,2]. Up to 10–15% of injured children brought to a pediatric trauma center require urgent evaluation and treatment [3]. These more seriously injured children require the activation of a "trauma team" to provide a rapid resuscitation. In most traditional adult and pediatric trauma centers, the standard trauma team includes the immediate presence of a surgeon of at least post-graduate year (PGY) 4 or higher, who functions as the trauma team leader. The American College of Surgeons Committee on Trauma (ACSCOT) has required this presence for pediatric patients with limb-threatening and life-threatening injuries [4]. Many pediatric trauma centers have instituted a two-tiered system of trauma team activation with different teams for severely injured patients and moderately injured patients. However, both tiers typically include the involvement of a surgical resident at initial evaluation [2].

Decreased resident availability in our free-standing pediatric hospital following the implementation of the duty hour regulations in 2003 made it necessary to seek new methods of staffing our trauma teams. Therefore, the decision was made to replace the surgeon with the pediatric emergency medicine (PEM) physician as the team leader for all second tier or "level II" trauma resuscitations of children with moderate injuries. We have previously reported the initial experience with this paradigm change in 2006 and 2007 [5,6]. The purpose of this study was to review our experience and outcomes 10 years after implementing this practice change.

1. Methods

This study was performed at a free standing level 1 pediatric trauma center within a statewide trauma system. The trauma center admits approximately 1300 injured children per year. Seriously injured trauma patients are triaged using a two-tiered system based on information provided by emergency medical services (EMS) personnel caring for the child [2,7]. Level I trauma activations (major resuscitations) are implemented based on the criteria shown in Table 1. Level II trauma activations (minor resuscitations) are implemented based on the criteria shown in Table 2. Patients that do not meet criteria for level I or level II activation are seen by the PEM physician, and pediatric surgery may be consulted to see those patients should they meet criteria for admission. Prior to January 1, 2003, all trauma activations (level I and level II) were run by a surgical resident (PGY 4 or above), fellow, or a pediatric surgery attending physician. After this date, the surgeon was replaced by a PEM physician for all level II trauma activations. The PEM physician was responsible for all

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Table 1
Level I trauma activation criteria.

Trauma arrest
Airway and breathing
• Airway or respiratory compromise
• Airway or breathing maintained maneuvers, adjuncts, or ETT
• Pneumothorax
• Facial or neck injury with potential for airway or cervical spine injury
Circulation
• Tachycardia with poor perfusion
• Hypotension
• Need for more than 2 fluid boluses or 40 ml/kg fluid resuscitation (from time of injury)
• Patients who have received or are receiving blood products
Disability
• Neurologic compromise with GCS <9, or 'P' or 'U' on AVPU scale
• Paralysis
Smoke inhalation with any of the above criteria
2° or 3° burns (thermal, chemical, or electrical) >30% BSA
Penetrating wounds to the head, neck, torso, abdomen, thigh, buttocks, or 2 proximal upper extremities
Limb-threatening injuries as evidenced by:
• Amputation, near amputation, or de-gloving injury (any of these to more than fingers or toes)
• Signs of decreased perfusion including any of the following: absent pulse, duskiness/cyanosis, coolness, delayed capillary refill, paralysis
Consider high-risk mechanisms of injury, including:
• Ejection from vehicle and/or
• Death of occupant in the same vehicle

**Any other reason the surgical trauma attending, ED attending, TNL, ED charge nurse or EMS providers believe the patient requires resources of a level 1 trauma alert.
ETT = endotracheal tube; GCS = Glasgow Coma Scale; AVPU = Awake, Verbal, Painful, Unresponsive; BSA = body surface area.

Table 2
Level II trauma activation criteria.

Head
Neurologic injury, as evidenced by:
• GCS 9–14, and/or combativeness, disorientation, or confusion
Abdomen
Blunt abdominal trauma with suspicion for intra-abdominal injury:
• Abdominal pain and/or tenderness, or
• Abdominal bruising or seat-belt marks
Penetrating wounds through 2 or more distal extremities other than fingers and toes
Burns
• 2° and 3° burns (thermal, chemical, or electrical) 15–30% BSA
Extremity
• Suspected or confirmed femur fracture with high risk mechanism of injury (see below)
Transfer patients: Transfer patients with high-risk injuries, including but not limited to:
Head injury:
• Open or depressed skull fracture
• Intracranial bleed
Thoracic injury:
• Pulmonary contusion
Abdominal injury:
• Known or suspected intra-abdominal injury
Orthopedic
• Complex pelvic fractures
High risk
Consider trauma alert for high-risk mechanisms of injury, such as:
• Struck, dragged, or run over by a vehicle
• Motor vehicle collision (MVC) with high speed impact or rollover of vehicle
• Falls >20 ft in height
• Motorized cycle/dirt bike/bicycle
• ATV (all terrain vehicle)

**Any other reason the ED attending, TNL, ED charge nurse, or EMS providers believe the patient requires resources of a level 2 trauma alert.
GCS = Glasgow Coma Scale; BSA = body surface area.

aspects of care, including decision to admit or discharge these patients. When the PEM physician determines that a patient requires admission, the pediatric surgical service has agreed to admit all of these patients immediately. Occasionally, the PEM physician makes the decision to admit the patient to another service. These decisions may be made independent of pediatric surgical team involvement. Finally, there are cases in which the PEM physician feels the patient is most appropriately managed by another service, but the admitted service requests a pediatric surgery consultation. There was no change to the composition of the level I trauma activation team or leadership during the study.

After approval from the Institutional Review Board (#13-00385), a retrospective analysis of the trauma registry data for all level II activations was performed. The previously collected and published data from April 1, 2001 through December 31, 2002 prior to the policy change (period 1, $n = 627$) was used as a historical comparison [5,6]. January 1, 2003 through March 31, 2003 was a transition period for the level II trauma activations and these patients were excluded from the analysis. Beginning on April 1, 2003 all of the level II alerts were run by PEM physicians. Data from the trauma registry from April 1, 2003 through March 31, 2013 were then extracted for additional comparison (period 2; $n = 2694$).

Data elements included demographics (age, sex), mechanism of injury, length of stay (LOS), injury severity score (ISS), numbers of computed tomography (CT) scans, number of admissions, ED LOS, time to destination [floor, pediatric intensive care unit (PICU) and operating room (OR)], and the following outcomes: readmissions, complications, delays in diagnosis and mortality. T-tests were performed to compare periods 1 and 2 for continuous variables. Categorical variables were compared using chi-square tests and when variable counts were less than 5 in number a Fisher's exact tests was performed to determine significance. A p value of <.05 was considered statistically significant.

2. Results

During the 21 months preceding the policy change, 714 patients admitted met criteria for trauma activation, 87 (12.2%) were level I activations, and 627 (87.8%) were level II activations. During the 10 years since the policy change (period 2), 7355 patients met trauma alert criteria, 1594 (22%) were level I trauma activations, and 5761 (78%) were level II trauma activations. Of the admitted patients in period 2, 1501 (30%) were activated as level I and 3474 (70%) were activated as level II. Of those patients initially triaged to a level I activation that required admission during period 2, 10% of those were downgraded after arrival to a level II alert and 2.6% were downgraded to non-alert status. Of the 78% of patients that were initially seen as a level II activation during period 2, 7% were upgraded to level I alerts and 8% were downgraded to non-alerts.

Data are collected by the trauma registry on patients that were not called trauma alerts, but met criteria (missed activations). In period 1, there were 118 missed activations (5.6 per month), whereas in period 2 there were 124 missed activations (1 per month). The level II activation data are demonstrated by year along with data regarding total emergency department (ED) census in Fig. 1. Further analysis was only performed for those patients that were seen as part of a level II trauma activation. Patients that were initially seen as a level I trauma and then downgraded were excluded from this analysis since we were primarily examining the effect of the surgeon not being immediately present at time of activation.

The total number of patients seen in period 2 was 4736, of which 2694 (56.9%). The patients seen throughout the study were predominantly male with a mean age of 10 years. Blunt trauma was the predominant mechanism of injury. The summary of the patient demographics and mechanism of injury for admitted patients seen during period 1 and period 2 is shown in Table 3. There were no significant differences in the population demographics in the two different periods.

Outcome data results are shown in Table 4. When examining abdominal CT usage, 336 of 627 (53.6%) patients underwent abdominal CT during period 1 compared to 1127 of 2694 (41.8%) in period 2 ($p < .001$). Injury severity scores (ISS) were slightly higher in period 1