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Trauma surgeon utilization of computerized tomography scanning: Room for improvement?

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ABSTRACT

Background: We aimed to evaluate computerized tomography (CT) utilization and yield rates for trauma team activations (TTA).
Methods: A retrospective review of all TTAs was conducted over nine months. TTAs consisted of two levels–trauma alert (TAL) and trauma response (TR). Yields of CT for significant findings (SF) for four CT types (brain, cervical, chest, abdomen/pelvis) were recorded.
Results: 647 patients were included. There was no difference in the utilization rates of CTs except for brain CTs (TAL, 98% vs TR, 94%, $p = 0.008$). There was no difference in the yield rates except for cervical spine CTs (TAL, 8% vs TR, 4%, $p = 0.03$). Over 80% received a pan scan regardless of TTA level; 63% who had any CT had no SF. The median ratio of scans with SF to the total number of scans per patient was 0.
Conclusions: Regardless of activation level, CT seems to be over utilized. More selective use of CT should be evaluated.

1. Introduction

Computed tomography (CT) is utilized liberally in the evaluation of injuries in emergency departments (ED) for several reasons: Firstly, CT is readily available and high resolution images can be expeditiously generated with the current imaging technology. Secondly, CT may expedite triage and disposition. Thirdly, health care providers, cognizant of the limitations of the physical examination and plain radiographs in trauma, are justifiably concerned about medicolegal repercussions arising from missed injuries.

The liberal use of CT has come under scrutiny because of concerns about acute kidney injury, contrast-induced allergic reactions and malignancy.[1] What constitutes appropriate usage of CT in trauma evaluations is an unsettled issue. How trauma surgeons are utilizing CT scans for different trauma activation levels has also not been well studied. As there were two trauma team activation (TTA) levels based on predefined criteria in our institution, we aimed to study whether there was a difference in utilization and yield of significant findings (SF) on CT for the two activation levels. In addition, we sought to study if there were predictors of SF that might guide future CT utilization. Our hypothesis is that because of our liberal use of CT, there would be no difference in CT utilization and yield rates for the two activation levels, and that yield rates for CT would generally be low.

2. Methods

A retrospective review of hospital medical records from January to September 2014 was conducted. Patients were identified by the trauma registry. We studied patients aged 13 and older who were seen in the ED as TTAs after blunt trauma. The two TTA levels were: "Trauma Alert (TAL)" (or the highest activation level) and "Trauma Response (TR)". Patients with burns, arrival in cardiac arrest, those taken urgently to the operating room, and those transferred from an outside hospital were excluded from this analysis.

Criteria for TAL included a systolic blood pressure of <90 mmHg, heart rate of <60 or >120/min, Glasgow Coma Scale (GCS) score of 13 or less, witnessed arrest, receiving blood en route, respiratory distress and clinical findings such as facial injury having a high potential for airway compromise, flail chest, paralysis, two or more proximal long bone fractures, pelvic deformity or unstable pelvis, active hemorrhage, mangled extremities or amputation proximal to

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the wrist or ankle, or penetrating trauma to the head, neck, torso and extremities above the knee or elbow.

For patients not meeting TAL criteria, the next activation level (TR) had the following criteria: GCS of 14, persistent vomiting, history of loss of consciousness in a patient on antiplatelet agents or anticoagulants, falls greater than 20 feet, motor vehicle crash with fatality in the vehicle, intrusion > 12 inches, or ejection, pedestrian struck by vehicle travelling at > 20 mph or who was >65 years old, or any expanding or large hematoma (>4 cm) on antiplatelet agents or anticoagulants.

CT yields for SF were analyzed separately for four body regions: brain, cervical spine, chest, abdomen/pelvis. The following were used to define a SF on CT: (1) Brain: intracranial hemorrhage, fracture, pneumocephalus, ocular hemorrhage/globe injury; (2) cervical spine: fracture, acute subluxation, air in soft tissues; (3) Chest: rib or sternal fracture, hemothorax, pneumothorax, air in soft tissues, injury to heart or great vessels, mediastinal hemorrhage, chest wall contusion with contrast extravasation, spine fracture (4) Abdomen/pelvis: solid organ injuries, suspected hollow viscus injury, intra-abdominal or retroperitoneal hemorrhage, fracture of the spine or pelvis/acetabulum (excluding femoral fractures), abdominal wall contusion with contrast extravasation. "Pan scan" was defined as receiving simultaneously a CT brain, CT cervical spine, CT abdomen/pelvis and CT chest. A "significant mechanism of injury" was dichotomized as present if the injury involved a motorized vehicle, whether the subject was present in or out of the vehicle, as well as falls of greater than 20 feet. The rest were considered as not having a significant mechanism of injury. A chest X ray (CXR) was considered positive if any if the following was present: fractures of ribs, scapula or clavicle, hemothorax, pneumothorax, soft tissue air, pulmonary contusion.

For each category of CT, the association of SF with the following variables was analyzed: age≥ 65 years, SBP <110 mmHg, pulse>100/min, lactic acid >2.5 mmol/L, significant mechanism of injury, use of antiplatelet agents, use of anticoagulants, requiring intubation in the ED, positive Focused Assessment of Sonography in Trauma (FAST), positive Chest X ray (CXR). Logistic regression analysis was used to assess for independent predictors of SF for each CT category. Variables with a p value of <0.1 by univariable analysis were entered into each regression model. In addition, regardless of the p value, the following plausible variables were entered as fixed predictors in the respective models: CT brain – GCS <15, antiplatelet agents and anticoagulants; CT chest – positive CXR, SBP<110 mmHg; CT abdomen/pelvis – positive FAST, SBP<110 mmHg. Statistical analysis was performed using Minitab 16 (State College, Pennsylvania). A p value of 0.05 was considered statistically significant.

3. Results

In this study period, there were 647 TTAs after blunt trauma, of which 223 (34.5%) were at the highest level of activation, TAL. Mean (±standard deviation) age was 50.8 (±23.0) years, and median (interquartile range, [IQR]) Injury severity score (ISS) was 4 (1–10). The proportion of patients with ISS of 16 or greater was 11%. Thirty percent were 65 years and above, 31% had a presenting GCS of <15 and 16% had an initial SBP of <110 mmHg. Twenty eight percent and 7% respectively were using antiplatelet agents and warfarin or other anticoagulants.

Table 1 shows the proportions of patients receiving each type of CT for all TTAs and yield rates for any SF. Overall, CTs of the brain and neck were requested for >90% of patients respectively while torso CTs were requested in >85% of patients. Only 1.7% did not receive any CT scans. By number of scans, the vast majority (85%) received four scans per patient (pan scan) (Table 1).

Comparing the two TTA levels, mean age (53 vs 50 years, $p = 0.1$) and median ISS was similar (TAL, 4 vs TR, 3, $p = 0.9$) but the proportion of patients with ISS ≥ 16 was significantly different (TAL, 16% vs TR, 8%, $p = 0.003$). There was no difference in the rates of CTs performed except for CTs of the brain (TAL, 98% vs TR, 94%, $p = 0.008$). There was no difference in the yield rates for SF by type of CT performed, except for CTs of the cervical spine (TAL, 8% vs TR, 4%, $p = 0.03$). There was no difference in the proportion of patients receiving a pan scan.

The majority of patients (402/636, 63%) who underwent CT scanning had no CT scans positive for any SF (Table 1). These 636 patients had a median (IQR) ratio of scans positive for any SF to the total number of scans per patient of 0 (0–0.25). There was no difference between this ratio between TR and TAL activations ($p = 0.19$).

For patients who underwent panscan (n = 533), 62% has no scans with a SF and 27% had only one positive scan for a SF, thus giving a total of 89% of pan-scanned patients with one or fewer scans with a SF.

Table 2 shows the variables associated with SF in patients who underwent any CT scanning. By univariable analysis, GCS <15 was associated with SF on CT brain, while significant mechanism of injury was associated with SF on CT cervical spine, chest and abdomen/pelvis. In addition, requiring intubation in the ED was associated with SF in all CT types.

A logistic regression model was built for each CT category based on variables significant at $p < 0.1$ (Table 2). For CT head, the variables entered were.

Logistic regression analysis found the following independent predictors for SF for each type of CT: CT brain – GCS<15 (OR 2.2, 95% CI 1.3–3.7), need for intubation in the ED (OR 2.9, 95% CI 1.3–6.7); CT cervical spine – significant mechanism of injury (OR 5.4, 95% CI 2.0–14.8), lactic acid > 2.5 mmol/L (OR 2.6, 95% CI 1.1–6.1); CT chest—mechanism of injury (OR 3.6, 95% CI 2.2–5.9), positive CXR (OR 11.4, 95% CI 5.5–23.8); CT abdomen pelvis – mechanism of injury (OR 2.0, 95% CI 1.1–3.4), positive FAST (OR 10.2, 95% CI 1.9–55.4).

Refitting the above models to include only independent predictors, for CT brain, if all of the abovementioned independent predictors (GCS<15, intubation in ED) were absent, the predicted probability of a SF would be 9%, whereas if both predictors were present, the corresponding probability would be 40%. Similarly, for CT spine, the respective probabilities for SF would be 1% when none of the independent predictors were present versus 14% when all were present. For CT chest, the respective probabilities would be 10% and 82%, and for CT abdomen/pelvis the predicted probabilities would be 11% and 75%.

There were no missed injuries in this cohort. One patient had a delay in diagnosis where free fluid without solid organ injury was identified on CT. He required laparotomy the next day for a jejunal perforation. Overall 30-day mortality was 4% in the TAL group compared to 1% in the TR group ($p = 0.003$).

4. Discussion

The principal findings of this study were that: (1) the majority of patients in both activation levels were not severely injured, but there was a slightly higher proportion with ISS ≥16 in the TAL group; (2) there was a high utilization rate of CT, especially in the use of the "pan scan" regardless of the activation level; (3) yield rates varied by type of CT, but did not differ between the two activation levels, except for the cervical spine CT, where there was a slightly increased yield rate for TAL; (4) over 60% of patients who underwent CT scanning had no SF detected; (5) 89% of those who had panscans had one or no positive scans for a SF; and (5)