



Retrospective Cohort Study

Criteria for level 1 and level 2 trauma codes: Are pelvic ring injuries undertriaged?

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Abstract

AIM: To determine the association of unstable pelvic ring injuries with trauma code status.

METHODS: A retrospective review of all pelvic ring injuries at a single academic center from July 2010 to June 2013 was performed. The trauma registry was used to identify level 1 and level 2 trauma codes for each injury. The computed tomography scans in all patients were classified as stable or unstable using the Abbreviated Injury Scale. Pelvic injury classifications in level 1 and level 2 groups were compared. Patient disposition at discharge in level 1 and level 2 groups were also compared.

RESULTS: There were 108 level 1 and 130 level 2 blunt trauma admissions. In the level 1 group, 67% of pelvic injuries were classified as stable fracture patterns and 33% were classified as unstable. In the level 2 group, 62% of pelvic injuries were classified as stable fracture patterns and 38% were classified as unstable. level 1

trauma code was not associated with odds of having an unstable fracture pattern (OR = 0.83, 95%CI: 0.48-1.41, $P = 0.485$). In the level 1 group with unstable pelvic injuries, 33% were discharged to home, 36% to a rehabilitation facility, and 32% died. In the level 2 group with unstable pelvic injuries, 65% were discharged to home, 31% to a rehabilitation facility, and 4% died. For those with unstable pelvic fractures ($n = 85$), assignment of a level 2 trauma code was associated with reduced odds of death (OR = 0.07, 95%CI: 0.01-0.35, $P = 0.001$) as compared to being discharged to home.

CONCLUSION: Trauma code level assignment is not correlated with severity of pelvic injury. Because an unstable pelvis can lead to hemodynamic instability, these injuries may be undertriaged.

Key words: Pelvic ring; Trauma code; Triage; Unstable pelvis; Abbreviated injury scale

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Core tip: The assignment of trauma level is important as it dictates the urgency of response and the size of the responding team. Because of the high morbidity and mortality from pelvic fractures, especially unstable pelvic fractures, it is critical that these injuries be appropriately triaged once discovered or suspected. Our study did not show an association between the severity of the pelvic ring injury and the trauma code level. This lack of an association suggests patients with significant pelvic injuries may be under-triaged. These injuries may benefit from a more severe trauma code status to prevent any undue morbidity or mortality.

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INTRODUCTION

At all accredited trauma centers, patients are triaged into a level 1 or level 2 trauma code based on specific criteria. The composition of the trauma team and the urgency of the trauma response can then be tailored to meet the needs of the patient based on the trauma code level^[1]. Patients with the most serious injuries are designated a level 1 trauma, indicating a need for a larger trauma team and faster response time^[2]. The determination of trauma code criteria varies between hospitals and is based on elements such as physiologic data, types of injury, and mechanism of injury. Specific field criteria for a level 1 designation have been pre-

Table 1 Inclusion criteria for designation as a level 1 trauma code at the author's home institution

Level 1 adult trauma code criteria

Cardiac arrest (secondary to trauma)
Airway compromise, poor ventilation, or high potential for same (includes assisted ventilations, field intubation, referring facility intubation compromise, or inability to intubate)
Hypotension or shock (Systolic BP < 90 mmHg adults and age specific hypotension)
GCS ≤ 8 (Presumably due to trauma)
GSW to neck or torso (chest, back, abdomen, or groin), or extremity proximal to the elbow/knee
Receiving blood transfusion at any time prior to arrival to maintain vital signs (transfer patients, air transport)
Emergency physician discretion
Patients who develop any level 1 criteria during their
Emergency Department stay should be upgraded to a level 1 trauma code

GCS: Glasgow coma scale; GSW: Gunshot wound.

viously investigated. Criteria that are commonly used include hypotension in the field^[3], truncal gunshot wounds^[4], field Glasgow coma scale (GCS) < 15^[5], and age > 70^[6].

Pelvic ring injuries are associated with a high rate of morbidity, with a short-term complication rate ranging from 50%-80%^[7], and a high rate of mortality of over 8%^[8]. Our primary purpose was to determine if there is any association between trauma code level and the severity of pelvic ring injuries. Specifically, our hypothesis was that unstable pelvic ring injuries would have a higher association with level 1 trauma code status due to the hemodynamic compromise often seen with these severe injuries. Our secondary purpose was to compare post-hospital disposition associated with pelvis fractures for level 1 and 2 trauma codes to determine if the trauma code status correlated with different outcomes for these injuries.

MATERIALS AND METHODS

A retrospective review of all pelvic ring injuries at a single academic center from July 2010 to June 2013 was performed. The trauma registry was used to determine the trauma codes for each patient. Criteria from our home institution were used to define code status for each patient (Tables 1 and 2).

A single fellowship-trained orthopedic trauma surgeon retrospectively reviewed the computed tomography (CT) examinations of all patients and classified the injuries as stable or unstable using Abbreviated Injury Scale codes. This system was chosen because it is commonly used, is relatively simple, and has high reliability^[9]. For the purpose of this study, an intact posterior arch or an incomplete disruption of the posterior arch was considered stable and a complete disruption of the posterior arch was considered unstable. The pelvic injury classifications from the level 1 and level 2 groups were then compared. Patient disposition at discharge in level

Table 2 Inclusion criteria for designation as a level 2 trauma code at the author's home institution

Level 2 adult trauma code criteria
Heart rate < 50 or > 125 (> 100 if age > 65 yr)
Systolic BP < 110 mmHg (only if age > 65 yr)
Respiratory rate < 10 or > 29
GCS ≤ 10
Stab to neck or torso (chest, back, abdomen, or groin)
GSW head (without airway compromise)
Amputation proximal to knee or elbow
Two or more proximal long bone fractures
Crush injury to chest or pelvis
Paralysis/suspected spinal cord injury
Neurovascular compromise of an extremity
Age > 65 yr + anticoagulant use + significant trauma
Intubation at outside hospital (transfer patients)
Multisystem trauma on outside imaging (transfer patients)
Emergency physician discretion

GCS: Glasgow coma scale; GSW: Gunshot wound.

1 and level 2 groups were also compared.

Relationships between assignment of level 1 and level 2 trauma codes and pelvic injury stability and patient disposition at discharge were analyzed using logistic regression models in SAS 9.3.

RESULTS

There were 108 level 1 and 130 level 2 blunt trauma admissions. The mean age was 41 years, age range 15-90 years. In the level 1 group, 72/108 (67%) of pelvic injuries were stable and 36/108 (33%) were unstable. In the level 2 group, 81/130 (62%) of pelvic injuries were stable and 49/130 (38%) were unstable.

In the level 1 group with stable pelvic injuries, 27/72 (38%) were discharged to home, 28/72 (39%) to a rehabilitation facility, and 17/72 (24%) died. In the level 2 group with stable pelvic injuries, 63/81 (77%) were discharged to home, 14/81 (17%) to a rehabilitation facility, and 4/81 (5%) died. In the level 1 group with unstable pelvic injuries, 12/36 (33%) were discharged to home, 13/36 (36%) to a rehabilitation facility, and 11/36 (32%) died. In the level 2 group with unstable pelvic injuries, 32/49 (65%) were discharged to home, 15/49 (31%) to a rehabilitation facility, and 2/49 (4%) died (Table 3).

Assignment of a level 1 trauma code was not associated with odds of having an unstable fracture (OR = 0.83, 95%CI: 0.48-1.41, $P = 0.485$) ($n = 238$). There is an association between trauma code level and patient discharge status with higher rates of mortality in level 1 trauma activation (28 deaths in the level 1 group and 6 in the level 2 group). For all participants ($n = 238$), assignment of a level 2 trauma code was associated with reduced odds of death (OR = 0.09, 95%CI: 0.03-0.23, $P < 0.0001$) or being dispatched to a rehabilitation center (OR = 0.29, 95%CI: 0.16-0.53, $P < 0.0001$) as compared to being dispatched to home. For those with

Table 3 Numbers of unstable and stable pelvic fractures in level 1 compared to level 2 trauma code patients. Further stratified percentages of the outcomes of these patients (discharged home, discharged to rehabilitation facility, or died)

Trauma level	Stable or unstable	Discharged home	Discharged to rehabilitation facility	Died
Level 1	Stable	38%	39%	24%
108 patients	(72/108) 67%			
	Unstable	33%	36%	32%
	(36/108) 33%			
Level 2	Stable	77%	17%	5%
130 patients	(81/130) 62%			
	Unstable	65%	31%	4%
	(49/130) 38%			

stable pelvic fractures ($n = 153$), assignment of a level 2 trauma code was associated with reduced odds of death (OR = 0.10, 95%CI: 0.03-0.33, $P < 0.0001$) or being dispatched to a rehabilitation center (OR = 0.21, 95%CI: 0.10-0.47, $P < 0.0001$) as compared to being dispatched to home. For those with unstable pelvic fractures ($n = 85$), assignment of a level 2 trauma code was associated with reduced odds of death (OR = 0.07, 95%CI: 0.01-0.35, $P = 0.001$) as compared to being dispatched to home, with a trend towards reduced odds of being dispatched to a rehabilitation center as well (OR = 0.43, 95%CI: 0.16-1.17, $P = 0.099$).

DISCUSSION

The criteria used to determine trauma code status is not consistent across institutions. Although there are guidelines set by the American College of Surgeons (ACS), each institution modifies these guidelines for their own environment and patient population. Kouzminova *et al.*^[10] evaluated a two-tiered trauma activation system based on ACS field trauma center triage criteria. Their approach was effective in identifying patients with potentially serious injuries as all evaluated indicators of severe injury (including intubation, transfer to ICU or OR, and death) were significantly different between the level 1 and level 2 group ($P < 0.0001$)^[10]. Another study by Kaplan *et al.*^[11] compared a three-tiered system with a two-tiered system. This three-tiered system resulted in earlier involvement of the trauma service and decreased time in the emergency department. They also found that the amount of overtriage was decreased as defined by the number of patients who were not admitted to the hospital after Emergency Department evaluation. Eastes *et al.*^[12] evaluated patient outcomes in a tiered response system. They found that although this system led to a prolonged length of stay in the emergency department for those patients designated as a "partial trauma code", it did not compromise quality of patient care. These three studies all had their own criteria for defining a

level 1 trauma, however, many of these indications were similar, including hemodynamic instability, penetrating trauma, and altered consciousness. The use of other criteria such as breathing difficulty, focal neurological deficit, proximal extremity fracture, and paralysis varied among the three studies^[10-12]. Additionally, only one of the above studies included pelvic instability as an indicator for severe trauma^[12]. Although each of these studies had their own criteria for level 1 trauma activation, all were found to be effective at categorizing incoming traumas.

At our institution, pelvic ring instability is not included in the criteria for level 1 trauma code designation. Yoshihara *et al.*^[13] studied patients with unstable pelvic fractures and found an in-hospital mortality rate of 8.3%. Another study reported that patients with complex pelvic injuries have a mortality rate of 31.1%, and patients with pelvic fracture without concomitant soft tissue injury have a mortality rate of 10.8%^[14]. Due to the high morbidity and mortality from pelvic fractures, especially unstable pelvic fractures, the main purpose of this study was to determine if there is any association between trauma code level and the severity of pelvic ring injuries. In other words, the relationship of these injuries to adverse outcomes suggests a benefit for including them in level 1 criteria, leading to a larger trauma team and faster response time to manage these complex injuries.

An association between pelvic fractures and an increased injury severity score has been evaluated previously. Cordts Filho Rde *et al.*^[15] compared injury severity scores between trauma patients with a pelvic fracture and those without a pelvic fracture. They found that pelvic fractures were associated with a worse prognosis, including a 27.9% mortality rate in those with a pelvic fracture compared to a 1.8% mortality rate in those without a pelvic fracture. Our study is the first to evaluate the relationship between trauma code levels and pelvic fractures. Although previous studies have investigated patient disposition to validate the efficacy of their trauma criteria^[2,10,12], no study has directly examined how patient disposition compares between level 1 and level 2 trauma activations.

Our study did not show an association between the severity of the pelvic ring injury and the trauma code level. Because of the high morbidity and mortality from pelvic fractures, this lack of an association suggests patients with significant pelvic injuries may be under-triaged. Additionally, for the level 2 group with less severe injuries, patients with unstable pelvic injuries were less likely to be discharged home and more likely to be discharged to a rehabilitation facility compared to patients with stable pelvic injuries. Our data suggest that patients placed into the level 2 group with unstable pelvic injuries may have been under-triaged.

As expected, we found higher rates of mortality in level 1 trauma activations. Many of these patients

would have sustained significant injuries (e.g., neurologic) that placed them into the level 1 trauma group, irrespective of their pelvis status. Our study shows the need to continually assess the trauma code criteria. For example, unstable pelvic fractures can rapidly lead to many of the criteria used by institutions for level 1 trauma designation, such as hemodynamic instability, but these criteria may not be present at the initial classification. In other words, because of the potential for morbidity and mortality, an unstable pelvic fracture should be used as a stand-alone criterion for categorizing a patient as a level 1 trauma.

Physical assessment of the pelvis should be performed in an emergency or prehospital setting to determine if a pelvic injury is likely present. This information could then be used to guide the trauma code level assignment. Important aspects of the evaluation include presence of pelvic pain or tenderness, pelvic deformity, and assessment of pelvic stability with gentle lateral compression (any gross motion should be considered a sign of instability). Shlamovitz *et al.*^[16] studied the probability that these parameters will accurately indicate the presence of a pelvic injury. They determined that the sensitivity and specificity of pelvic pain or tenderness in patients with GCS > 13 were 0.74 (95%CI: 0.64-0.82) and 0.97 (95%CI: 0.96-0.98), respectively for diagnosing any pelvic fractures, and 1.0 (95%CI: 0.85-1.0) and 0.93 (95%CI: 0.92-0.95), respectively for diagnosing mechanically unstable pelvic fractures. The sensitivity and specificity of the presence of pelvic deformity were 0.30 (95%CI: 0.22-0.39) and 0.98 (95%CI: 0.98-0.99), respectively for detection of any pelvic fracture and 0.55 (95%CI: 0.38-0.70) and 0.97 (95%CI: 0.96-0.98), respectively for detection of mechanically unstable pelvic fractures. Instability to pelvic ring compression had a sensitivity and specificity of 0.08 (95%CI: 0.04-0.14) and 0.99 (95%CI: 0.99-1.0), respectively, for detection of any pelvic fracture and 0.26 (95%CI: 0.15-0.43) and 0.999 (95%CI: 0.99-1.0), respectively, for detection of mechanically unstable pelvic fractures. While these findings are not highly sensitive, they are specific for pelvic fractures - particularly unstable fractures. Therefore, if any of these are found upon the prehospital assessment the likelihood of unstable pelvic fracture is high and could potentially be investigated for its utility as part of the criteria for level 1 trauma code assignment.

This study has some limitations, including the inherent flaws of any retrospective study. The use of a database relies on the quality of input, which may include inaccurate data or inaccurate data entry. Pelvic CT classification can be difficult^[17-19], however, we purposely chose a commonly used and reproducible scale to decrease errors in classification.

The assignment of trauma level is important as it dictates the urgency of response and the size of the

responding team. Because of the high correlation of internal injuries with unstable pelvic ring injuries, it is critical that these injuries be appropriately triaged, perhaps with a more severe trauma code status to prevent any undue morbidity or mortality.

COMMENTS

Background

At all accredited trauma centers, patients are triaged into a level 1 or level 2 trauma code based on specific criteria. The composition of the trauma team and the urgency of the trauma response are tailored to meet the needs of the patient based on the trauma code level. Patients with the most serious injuries are designated a level 1 trauma, indicating a need for a larger trauma team and faster response time. The determination of trauma code criteria varies between hospitals and is based on elements such as physiologic data, types of injury, and mechanism of injury. Because of the high morbidity and mortality from pelvic fractures, especially unstable pelvic fractures, it is thought that these injuries would likely be associated with a higher trauma code status.

Research frontiers

This study assessed the correlation between the severity of pelvic ring injury and the trauma code level. The authors found that patients with significant pelvic injuries may be under-triaged because of the lack of association with high trauma code status. This conclusion is supported by data analysis of patients with pelvic ring injuries compared to their trauma code level and disposition at discharge.

Innovations and breakthroughs

Data regarding the utility of using the severity of pelvic ring injury as criteria for higher trauma code level has not previously been assessed. This study describes a lack of association between the severity of the pelvic ring injury and the trauma code level. This suggests patients with significant pelvic injuries may be under-triaged potentially increasing the likelihood of morbidity or mortality.

Applications

Patients with suspected or confirmed unstable pelvic ring injury will benefit from higher trauma code status in order to allow for a more urgent response and therefore prevent undue morbidity and mortality. Inclusion of unstable pelvic ring injury in the criteria for level 1 traumas may lead to improved outcomes in this population.

Terminology

Trauma Code response in the Emergency Department is a standardized procedure used at trauma centers that dictates the initial management of trauma patients. This response may vary by timing and team size depending upon the perceived urgency indicated by the trauma code level. Upon arrival, trauma patients are evaluated clinically and with imaging by the general surgery team. After initial assessment, subspecialty services are consulted based upon the injuries found. General trauma surgeons do not typically manage pelvic fractures, so they would consult the orthopaedic surgery team in that circumstance. Assigning trauma code level determines which patients have the most severe injuries and therefore would benefit from the most rapid evaluation in order to allow for earliest intervention and best possible outcome.

Peer-review

The authors provide an interesting retrospective study on the relevance of pelvic injuries for the assignment of a trauma code level.

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