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Patient Characteristics and Temporal Trends in Police Transport of Blunt Trauma Patients: A Multicenter Retrospective Cohort Study

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Abstract

Background—Police transport (PT) of penetrating trauma patients has the potential to decrease prehospital times for patients with life-threatening hemorrhage and is part of official policy in Philadelphia, Pennsylvania. We hypothesized that rates of PT of bluntly injured patients have increased over the past decade.

Methods—We used Pennsylvania Trauma Outcomes Study registry data from 2006–15 to identify bluntly injured adult patients transported to all 8 trauma centers in Philadelphia. PT was compared to ambulance transport, excluding transfers, burn patients, and private transport. We compared demographics, mechanism, and injury outcomes between PT and ambulance transport patients and used multivariable logistic regression to identify independent predictors of PT. We also identified physiological indicators and injury patterns that might have benefitted from prehospital intervention by EMS.

Results—Of 28 897 bluntly injured patients, 339 (1.2%) were transported by police and 28 558 (98.8%) by ambulance. Blunt trauma accounted for 11% of PT and penetrating trauma for 89%. PT patients were younger, more likely to be male, and more likely to be African American or Asian and were more often injured by assault or motor vehicle crash. There were no significant differences presenting physiology between PT and EMS patients. In multivariable logistic

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regression analysis, male sex (OR 1.89, 95%CI 1.40–2.55), African American race (OR 1.71 95%CI 1.34–2.18), and Asian race (OR 2.25, 95%CI 1.22–4.14) were independently associated with PT. Controlling for injury severity and physiology, there was no significant difference in mortality between PT and EMS. Overall, 64% of PT patients had a condition that might have benefited from prehospital intervention such as supplemental oxygen for brain injury or spine stabilization for vertebral fractures.

Conclusions—PT affects a small minority of blunt trauma patients, and did not appear associated with higher mortality. However, PT patients included many who might have benefited from proven, prehospital intervention. Clinicians, EMS providers, and law enforcement should collaborate to optimize use of PT within the trauma system.

Keywords

police transport; prehospital transport; blunt trauma

Introduction

The debate regarding which patients are appropriate for rapid prehospital transport without interventions (the “scoop and run” approach) and which benefit from transport with prehospital interventions (the “stay and play” approach) has been ongoing in the trauma literature for over 30 years.[1,2] Proponents of prehospital intervention argue that the advanced training of prehospital providers may save lives by allowing early treatment of potentially life-threatening conditions such as unstable airways[3] and external hemorrhage and may prevent exacerbation of injuries such as spinal cord and vertebral column injuries.[4] Supporters of prehospital transport without interventions argue that although interventions such as intubation, intravenous line placement, and fluid administration aim to stabilize injured patients in the field, their cost in increased transit time to definitive care might outweigh their benefit.[5] Studies of specific prehospital interventions have often failed to find benefit.[5] Likewise, patients transported by private vehicles, with no prehospital intervention, have similar or better outcomes than those transported by Emergency Medical Services (EMS).[6,7]

There are no effective prehospital interventions for patients with thoracoabdominal hemorrhage. As police may reach the scene of an injury before EMS, the city of Philadelphia has allowed police to transport penetrating trauma patients to trauma centers since 1996 (Philadelphia Police Department Directive 3.14, available online at http://www.phillypolice.com/accountability). The goal of this policy is rapid transport, and police training and equipment for prehospital intervention are limited to basic first aid and the use of tourniquets, which were introduced in 2013.[8] The two studies of this practice have found that penetrating trauma patients had equivalent outcomes when transported by police relative to EMS.[1,9,10] While the focus has been on penetrating trauma, increased use of police transport (PT) may lead to bluntly injured patients being transported by police as well. Bluntly injured patients may have multiple injuries that are difficult for non-medical providers on scene to identify, and transport without stabilization could exacerbate their injuries.

Media coverage of police transport has generally been positive, but public concern was raised after the 2015 mass casualty derailment of an Amtrak train in northeast Philadelphia. During this mass casualty event, local trauma centers received 185 blunt trauma patients, including 46 that were seriously injured. According to the National Transportation Safety Board (NTSB) investigation report of this incident only 24 of these patients were transported by EMS. The remainder arrived by PT or bus, resulting in concentration of patients at a single, local trauma center while leaving other resources underutilized.[11] While the NTSB report did not identify any negative outcomes related to the lack of EMS transport, there is a paucity of literature on the incidence and outcomes of PT of blunt trauma patients. We hypothesized that PT of blunt trauma patients in Philadelphia is a rare occurrence but that the incidence may have increased over the past decade secondary to familiarity among police with the practice of transporting injured patients, and the favorable public perception of PT of penetrating trauma patients. We sought to characterize the demographics and mechanisms of injury of blunt trauma patients transported by police to define the population most likely to be affected by this practice. Finally, we examined the proportion of blunt trauma patients transported by police whose injury patterns indicated that they could have benefited from prehospital interventions provided by EMS.

Methods

We performed a retrospective cohort study of all injured patients presenting to all level I and II trauma centers in the metropolitan Philadelphia area from 2006–15. Patients were included if they were age ≥18 and met inclusion criteria for the Pennsylvania Trauma Outcomes Study (PTOS). The PTOS registry is a large single-state trauma database containing demographic, physiologic, injury, and outcomes data for all injured patients presenting to accredited trauma centers in the state of Pennsylvania. This registry includes all patients includes all patients with an injury diagnosis (International Classification of Disease, 9th Edition (ICD-9) injury codes 800–995) admitted to the ICU or the step-down unit, as well as all patients remaining in house for ≥48 hours or for 36–48 hours with an injury severity score (ISS) ≥ 9; all deaths including dead on arrival; and all transfers in or out. Isolated hip fractures are excluded. Data collection is compulsory and linked to center accreditation. Center and state level checks for integrity and completeness help ensure the quality of this data. Data for this work were provided by the Pennsylvania Trauma Systems Foundation (Mechanicsburg, PA), which specifically disclaims responsibility for any analyses, interpretations, or conclusions presented herein. This project was reviewed and approved by the Institutional Review Board.

We excluded patients <18 years old, those transported to the trauma center by private vehicle or helicopter, and those transferred from another facility. To determine changes in rates of overall PT, as well as penetrating and blunt trauma PT rates separately during the study period we used the nonparametric test of trend of Cuzick, an extension of the Wilcoxon rank sum test.[12] To examine patient characteristics associated with PT, we first inspected the data for missingness. Variables necessary for analysis with >5% missingness were imputed using chained multiple imputation to reduce bias associated with case wise deletion.[13] Basic demographic information, injury severity (as measured by ISS), mechanism of injury, maximum Abbreviated Injury Scales (AIS), physiologic parameters (systolic blood pressure

<90 mmHg and/or admission Glasgow Coma Score (GCS) < 14) were extracted from the PTOS registry. The Center for Disease Control-recommended framework for external-cause-of-injury-codes[14] was used to determine the major mechanism and intention of injury. Baseline variables were compared for blunt trauma patients transported by EMS and PT using chi-squared test for categorical variables, Mann-Whitney for non-parametric continuous variables, and t-test for parametric continuous variables. Those factors found to be associated with PT in univariate analysis with $p < 0.2$ were included in a multivariable logistic regression model to define patient factors associated with PT of blunt trauma patients. As a secondary endpoint, we compared risk-adjusted mortality between PT and EMS groups.

We also looked at specific injuries likely to be amenable to prehospital interventions as well as physiologic data to define the subset of PT blunt trauma patients who might have benefitted from EMS transport. We framed this in the Airway-Breathing-Circulation-Disability-Exposure approach commonly used in the Prehospital Trauma Life Support[15] to evaluate and manage the injured patient. Table 1 shows these conditions along with corresponding potential prehospital interventions and trauma center indicators. For conditions defined by physiology, including respiratory distress (respiratory rate < 8 or >30), hypotension (systolic blood pressure < 90 mmHg), and decreased mental status (GCS ≤ 8), vital signs on arrival to the trauma bay were used as a proxy of transport vital signs because no field vital signs are recorded by police transporters. Specific injuries and trauma center interventions to treat them were defined using ICD-9 diagnosis and procedure codes as follows: spinal cord injuries −952.[0–9] [0–9]; vertebral column injuries 805.[0–9][0–9], vertebral column fixation − 81.0[0–9], 81.3[0–9], 81.6[0–9], 84.[0–9][0–9], 85.5[2–9], 03.53; packed red blood cell transfusion −99.04; craniotomy −01.2, 01.2[3,4,5,8], 01.3, 01.3[1–9], 02.0, 02.0[1–9], 02.12; long bone fractures (humerus, radius/ulna, femur, tibia/fibula) −812.[0–5][0–9], 813.[0–9][0–9], 820.[0–9][0–9], 823.[0–9][0–9]; long bone operative fixation −79.[0–9][1,2,5,6], 78.[0–9][2,3,5,6]. The numbers and frequency of each condition were compared between the EMS and PT groups using chi squared tests. All statistical comparisons were performed using Stata v14.0 (College Station, TX).

Results

Overall, 36 460 patients met inclusion criteria with no exclusion criteria, of which 33 421 (92.7%) were transported by EMS while 3039 (8%) were transported by PT (Figure 1). The median age in the overall cohort was 46 (IQR 28–64) years, 68% were male, and the racial composition was nearly evenly divided between African Americans (49%) and Caucasians (44%). Blunt mechanism was the cause of injury for 80% of the overall cohort, and the median ISS was 10 (IQR 5–17). Over the course of the study period, the number of patients arriving at Philadelphia trauma centers by EMS and PT remained approximately stable, ranging from 3407–3995 patients per year. The annual proportion of the overall trauma population transported by police over the course of the study period increased from 293/3670 (8%) in 2006 to 450/3,995 (11.3%) in 2015, ($p < 0.001$), (Figure 2A). This finding was driven by an increase in the annual proportion of penetrating trauma patients transported by police, which increased from 245/898 (27%) in 2006 to 409/715 (57%) in 2015 ($p < 0.001$) (Figure 2B).

In the subset of 28 897 blunt trauma patients, the vast majority (28 558,98.8%) were transported by EMS. Relative to EMS transports, patients with blunt trauma transported by police were younger, more likely to be male, and more likely to be African American (Table 2). Patients transported by police were much more likely than those transported by EMS to have injuries caused by interpersonal violence (40% vs. 10%, $p < 0.001$). Mechanisms of injury differed between the two groups as well, with the most frequent mechanisms of injury transported by police being assault (33%) and motor vehicle crash (MVC, 27%) compared to falls (46%) and MVC (35%) for EMS ($p < 0.001$). There were no significant differences in the physiology as measured by proportion of patients with a GCS < 14 or a systolic blood pressure <90 mmHg between PT and EMS transports. In multivariable logistic regression analysis, after controlling for age, injury severity, mechanism of injury and intention of injury, male sex (OR 1.89, 95%CI 1.40–2.55), African American race (OR 1.71 95%CI 1.34–2.18), and Asian race (OR 2.25, 95%CI 1.22–4.14) remained strong independent risk factors for PT (Table 2). In univariate logistic regression analysis, PT was strongly associated with decreased odds of mortality (OR 0.34, 95%CI 0.16–0.73) but after controlling for age, sex, ISS, injury mechanism, injury intention, hypotension (SBP < 90 mmHg), and admission GCS (Table 3), this relationship was no longer associated with a mortality benefit (OR 0.47, 95% CI 0.15–1.43).

The frequency of trauma bay proxies of field conditions that may have benefitted from prehospital interventions are in Table 4. Overall, 217/339 (64%) of patients transported by police had a trauma bay proxy of a prehospital condition that may have been amenable to EMS intervention. While the rate of spinal cord injury was not different between groups, vertebral column fractures were significantly less frequent in the group transported by police (9.1% vs. 17.5%, $p < 0.001$). Additionally, compared to the EMS transports, long bone fractures were significantly less frequent in the PT group (13.6% vs. 25.2%, $p < 0.001$), as was the corresponding need for fixation (13.3% vs. 24.8%, $p < 0.001$).

Discussion

In this multicenter, retrospective cohort study of prehospital police transport of blunt trauma patients, we found that although the incidence of PT increased through time, the proportion of police transports that had sustained blunt injury remained roughly stable. While overall only <2% of bluntly injured patients were transported by police, 11% of patients transported by police had a blunt mechanism of injury. Since in the city of Philadelphia there is no directive for police to transport injured patients with a blunt mechanism of injury, it is encouraging that the overall percentage of transports that these patients transported by police is quite small. Despite the small numbers, efforts to better understand the circumstances surrounding these transports are warranted.

The preponderance of the evidence supporting rapid prehospital transport without intervention stems from studies of penetrating trauma. A recent military study found that truncal exsanguination was responsible for 67% of potentially survivable prehospital deaths, with junctional hemorrhage accounting for another 19%.[16] Given that there are no widely-available, effective interventions to arrest truncal or junctional bleeding in the prehospital setting, rapid transport is the priority, and transport by non-medical personnel may be

appropriate.[7,9,10] In blunt trauma, however, time to death is usually longer, and cause of death is often due neurological or respiratory compromise, rather than hemorrhage. Multiple injuries, including head and spine injury and long bone fractures are common causes of morbidity and mortality In blunt trauma patients, the benefits of prehospital stabilization with support for airway, breathing, circulation, and immobilization to prevent worsening of injury may warrant possible delays that could be associated with more advanced care.

After adjusting for demographics, injury severity, and admitting physiology, PT was not associated with mortality, but since our dataset included only seven deaths in the PT group, it is likely that we are under-powered to assess mortality. Alternatively, this finding may indicate that police on scene are identifying patients with time-critical injuries who require immiediate transport, as well as others who might benefit from EMS stabilization. Despite the fact that we found no differences in mortality, we did find that patients in the PT cohort had injuries that may have benefited from stabilizing intervention by EMS, including respiratory distress, hypotension, pneumothorax, decreased mental status, and traumatic brain injury. Moreover, vertebral column injuries that might have benefitted from prehospital stabilization were present in 9.1% of PT patients. Of note, some patients in the PT group had vertebral or spinal cord injuries severe enough to require operative fixation, a finding that is particularly concerning given the inherent lack of spinal immobilization associated with police transport.

We also found some that some injuries were more common in the EMS group than the police transport group, such as long bone fractures and vertebral column injures. Since the clinical manifestations of these injuries may be quite apparent, it is likely that a form of “implicit triage” is occurring at the scene of injury. Because police transport of penetrating trauma patients in Philadelphia is routine, prehospital providers may be comfortable enough with this practice to at times consider whether the benefits of rapid transport may outweigh the risks of transporting a blunt trauma patient who could benefit from EMS provision of prehospital procedures. Clinicians, EMS providers, and police have the opportunity to work together to develop appropriate prehospital triage guidelines to aid in appropriate patient assignment to PT or EMS.

We also identified specific demographic factors associated with PT, including African American or Asian race, male sex, and younger age. Of note, these demographics characteristics align with populations known to be at increased risk of police exposure[17,18] and in some studies worse outcomes after trauma.[19] These findings may represent a disparity in access to EMS services, and further investigation into the causes of differential modes of prehospital transport in this population is needed.

Limitations

As police transport is codified as a mechanism of prehospital transport in only a minority of cities in the United States, the generalizability of this work to metropolitan regions beyond Philadelphia may be limited. However, for those cities permitting or considering enactment of PT policies, we believe this work can provide insight into ways of optimizing this practice given the potential for mission creep. Moreover, police departments around the country are increasingly involved in the delivery of medical care, beyond police transport. Many officers

now carry tourniquets and are trained to apply these to control extremity hemorrhage.[20] Police officers also carry naloxone and have been trained to administer this lifesaving medication to treat opioid overdoses.[19,21] We assume that police transport was rapid, in keeping with the goals of this policy. However, we cannot directly account for delays due to time spent by officers at the scene or in transit. Likewise, police may have brought arrested patients to the ED for medical clearance, but we expect that the majority of such visits would have had minor or no injuries and would not have met registry criteria. Police policy requires patients to be transported to trauma centers, but we cannot account for any patients mistakenly taken to a non-trauma center hospital. Due to the limitations of registry data, we cannot account for patients treated at non-trauma centers, or for out-of-hospital deaths. Likewise, we cannot completely define those patients who might have benefitted from prehospital interventions and thus our estimates are likely to be conservative. For instance, oxygen saturation is not captured in the PTOS registry, making it difficult to define all those who benefited or could have benefited from prehospital supplemental oxygen. Additionally, the presence of bleeding wounds is not reliably captured and thus we are unable to say how many patients may have benefitted from hemostatic techniques in the field. Conversely, there are some conditions for which use of trauma bay proxies may overstate the need for prehospital interventions. For instance, although we describe patients who arrived by PT and had pneumothorax requiring chest tube placement, the decision to place a chest tube in the trauma bay does not necessarily imply that the pneumothorax would have been detected in the field or that needle decompression would have been necessary or effective. These proxies serve only to illustrate conditions for which prehospital interventions might be beneficial. In our regression analysis, we adjusted for admitting physiology. However, patients transported by EMS may have received interventions that improved physiological indicators by the time they arrived at the hospital. We are unable to account for this directly, which may have masked an advantage of EMS transport. While we found no difference in mortality rates among patients transported by police vs. EMS, we were not able to assess outcomes that might be more likely to be affected by means of transport, such as degree of neurological injury and functional recovery. Further research should focus on patient-centered outcomes as they pertain to prehospital transport after traumatic injury. Finally, as the focus of this work was on comparing police and EMS transport, we did not include patients transported by private vehicle and so we cannot offer commentary on outcomes after this mode of prehospital transport.

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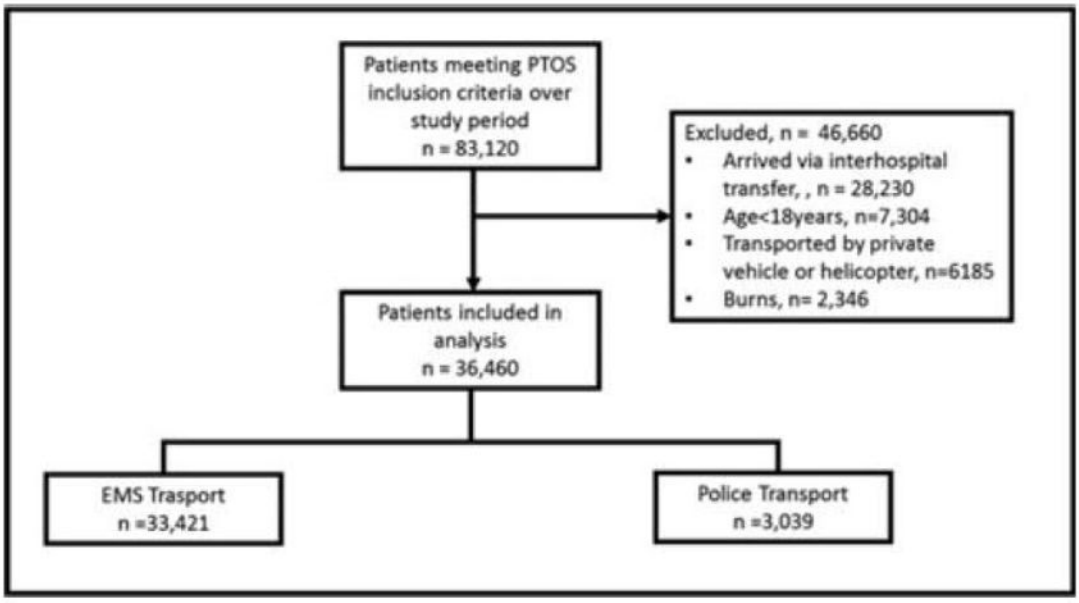

Figure 1.
Flow chart of patients who met inclusion/exclusion criteria for the study population.

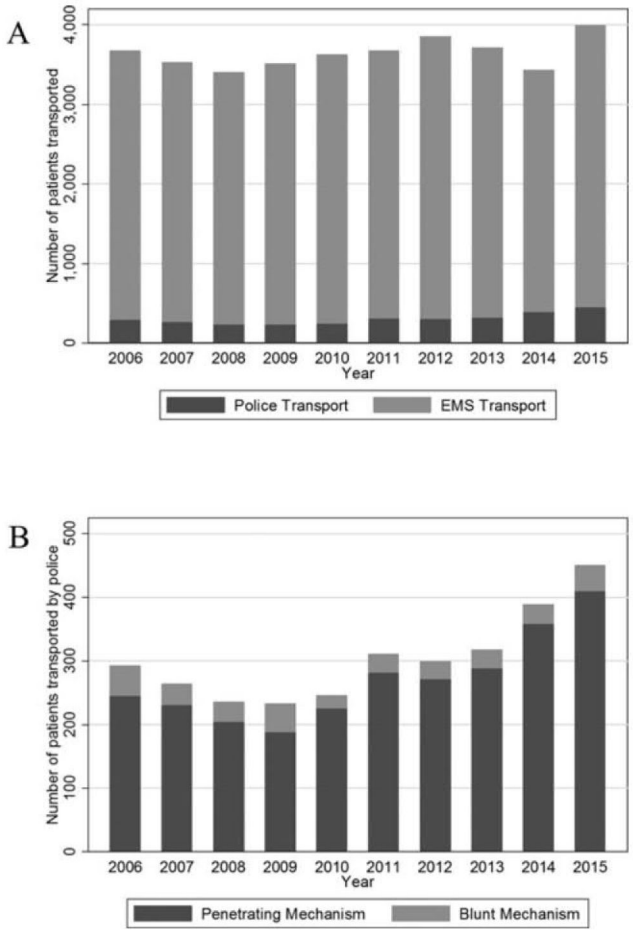

Figure 2.

A) Volume of patients transported by EMS and Police over the course of the study period. B) Mechanism of injury for patients transported by Police by year.

Table 1

Conditions which may be present as a sequelae of trauma; potential pre-hospital interventions which may be of benefit; and proxies of these condition as measured on arrival to the trauma center

	Element of Primary Survey	Potential Pre-hospital Interventions	Trauma Center Proxies
Airway	Airway compromise	Endotracheal intubation; supplemental oxygen administration	Intubation on arrival to trauma bay
	Vertebral column/Spinal cord injury	Spinal motion restriction	Vertebral column/Spinal cord injury; Vertebral column/spinal cord injury requiring operative fixation
Breathing	Respiratory distress	Supplemental oxygen administration; endotracheal intubation	Respiratory Rate <8 or >30 on arrival to trauma bay
	Pneumothorax	Needle thoracostomy; supplemental oxygen administration	Pneumothorax; Pneumothorax requiring thoracostomy tube placement
Circulation	Hypotension	Intravenous fluid administration	Hypotension (SBP < 90) on arrival to trauma bay; Hypotension requiring blood product transfusion
Disability	Decreased mental status	Supplemental oxygen administration; endotracheal intubation	GCS ≤ 8
	Moderate or worse TBI	Supplemental oxygen administration; endotracheal intubation	AIS head≥ 3; AIS head≥ 3 requiring craniotomy
Exposure	Long bone fractures	Splint application	Long bone fractures (humerus, radius/ulna, femur, tibia/fibula); Long bone fractures requiring operative fixation

Table 2

Baseline variables of patients transported by EMS vs. Police: Demographics, injury severity, mechanism and intent of injury, and presenting vital signs upon trauma center presentation for blunt trauma patients transported by EMS or police

Characteristic	EMS Transport *n* = 28,558	Police Transport *n* = 339	*p*
Age in years	52 (IQR 34–70)	36 (IQR 26–47)	<0.001
Male sex	17,703 (62%)	284 (84%)	<0.001
Race			
Caucasian	13,831 (48%)	94 (28%)	<0.001
African American	10,800 (37%)	189 (56%)	
Asian American	734 (3%)	12 (4%)	
Other	992 (3%)	17 (5%)	
Missing	2,201 (8%)	27 (8%)	
Ethnicity			
Non-Hispanic	23,760 (71%)	2,165 (71%)	0.070
Hispanic	2,345 (7%)	243 (8%)	
Missing	7,316(22%)	631 (21%)	
Injury Severity Score	9 (IQR 5–16)	6 (IQR 4–13)	<0.001
Mechanism			<0.001
Fall	13,046 (46%)	45 (13%)	
MVC	9,883 (35%)	90 (27%)	
Assault	2,436 (8%)	111 (33%)	
Other	3,203 (11%)	93 (27%)	
Interpersonal violence	2,982 (10%)	138 (41%)	<0.001
SBP < 90 mmHg	1,092 (4%)	12 (4%)	0.780
GCS < 14	5,030 (18%)	55 (16%)	0.500

Data for nonparametric continuous variables expressed as median (Interquartile Range). Categorical values expressed as *n* (%). P values are for Mann-Whitney test for continuous variables and chi square test for categorical variables.

Table 3

Patient and injury characteristics associated with police transport after blunt trauma patients

Characteristic	OR	95%CI	p
Age in years	0.97	(0.97–0.98)	<0.001
Male Sex	1.89	(1.40–2.55)	<0.001
Race			
Caucasian	ref		
African American	1.71	1.34–2.18	<0.001
Asian American	2.25	1.22–4.14	<0.001
Other	1.56	0.91–2.68	0.100
Injury Severity Score	0.97	0.95–0.98	<0.001
Mechanism			
Fall	ref		
MVC	1.54	1.06–2.26	0.030
Assault	4.03	2.41–6.75	<0.001
Other	4.00	2.69–5.94	<0.001
Interpersonal Violence	1.59	1.08–2.34	0.020

Table 4

Incidence of trauma bay proxies of prehospital conditions that may benefit from prehospital interventions in blunt trauma patients transported by EMS and police.

Element of primary survey	Trauma Bay Proxy	EMS *n* = 28,558	PT *n* = 339	p
Airway	Intubation on arrival to ED	4,229 (15.5%)	65 (19.2%)	0.060
	Vertebral column injury	5,001 (17.5%)	31 (9.1%)	<0.001
	Spinal cord injury	599 (2.1%)	5 (1.5%)	0.500
	VCI/SCI requiring operative fixation	917 (3.2%)	10 (3.0%)	0.800
Breathing	Respiratory distress (rate < 8 or > 30)	2,175 (7.6%)	31 (9.1%)	0.300
	Pneumothorax	2,304 (8.1%)	25 (7.4%)	0.600
	Requiring thoracostomy tube	1,215 (4.3%)	11 (3.2%)	0.400
Circulation	Hypotension (SBP < 90 mmHg)	1,092 (3.8%)	12 (3.5%)	0.800
	Requiring PRBC transfusion	419 (1.5%)	4 (1.2%)	0.600
Disability	Decreased mental status (GCS ≤ 8)	2,458 (8.6%)	20 (5.9%)	0.100
	Moderate or worse TBI (AIS head ≥ 3)	7,135 (25.0%)	70 (20.7%)	0.070
	Requiring craniotomy	317 (1.1%)	4 (1.2%)	0.900
Exposure	Long bone fracture	7,184 (25.2%)	46 (13.6%)	<0.001
	Requiring operative fixation	7,070 (24.8%)	45 (13.3%)	<0.001
	Any Proxy	**21,541 (75.4%)**	**217 (64.0%)**	**<0.001**