Injury-adjusted Mortality of Patients Transported by Police Following Penetrating Trauma

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Abstract

Background: More than a decade ago, the city of Philadelphia began allowing police transport of penetrating trauma patients.

Objectives: The objective was to determine the relation between prehospital mode of transport (police department [PD] vs. Philadelphia Fire Department (PFD) emergency medical services [EMS]) and survival in subjects with proximal penetrating trauma.

Methods: The authors performed a retrospective cohort study of prospectively collected trauma registry data. All subjects who sustained proximal penetrating trauma and who presented to a Level I urban trauma center over a 5-year period (January 1, 2003, to December 31, 2007) were included. Mortality for subjects presenting by EMS was compared to that of those who arrived by PD transport in unadjusted and adjusted analyses. Unadjusted analyses were performed using the chi-square test, Wilcoxon rank sum test, and Student's t-test. Adjusted analyses were performed using logistic regression using the Trauma Injury Severity Score (TRISS) methodology. Data are presented as percentages, odds ratios (ORs), and 95% confidence intervals (CIs). Total hospital length of stay was examined as a secondary outcome.

Results: Of the 2,127 subjects, 26.8% were transported to the emergency department (ED) by PD, and 73.2% by EMS. The mean (± standard deviation [SD]) age of PD subjects was 26.3 (±9.1) years and 92% were male versus EMS subjects whose mean (±SD) age was 31.5 (±11.8) years and of whom 87% were male. Overall, 70.8% sustained a gunshot wound (GSW), and 29.2% sustained a stab wound (SW). Overall Injury Severity Score (ISS) was 11.21 (ISS for PD, 14.2 ± 17.5; for EMS, 10.1 ± 14.5; $p < 0.001$), and 16.6% of the subjects died (PD, 21.4 ± 0.41%; EMS, 14.8 ± 0.36%; $p < 0.001$). In unadjusted analyses, PD subjects were more likely to die than EMS subjects (OR = 1.6, 95% CI = 1.2 to 2.0; $p < 0.001$). When adjusting for injury severity using TRISS, there was no difference in survival between PD and EMS subjects (OR = 1.01, 95% CI = 0.63 to 1.61). Median length of hospital stay was 1 day and did not differ according to mode of prehospital transport ($p = 0.159$).

Conclusions: Although unadjusted mortality appears to be higher in PD subjects, these findings are explained by the more severely injured population transported by PD. The current practice of permitting police officers to transport penetrating trauma patients should be continued.

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There are nearly 18 million individuals transported to the emergency department (ED) by ambulance in the United States annually,[1] with nearly 40% of these being transported for injury.[2] Rapid transport of trauma victims to definitive care within the ''golden hour'' has been the goal for decades,[3] but the validity of

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this time benchmark has been questioned.[4,5] There has been substantial debate about whether injured adults should receive advanced interventions in the prehospital setting (''stay and stabilize'') or simply be rapidly transported to definitive care (''scoop and run''). Several studies have suggested that delays in definitive care by emergency medical services (EMS) providers can negatively affect patient care, worsening both morbidity and mortality.[6–11] However, benefit has been demonstrated with prehospital notification and treatment of specific disease states, such as myocardial infarction (MI)[12] respiratory arrest,[13] and with prehospital treatment of cardiac arrest.[14]

Penetrating trauma represents a subset of all major trauma and is recognized as a condition requiring rapid definitive surgical care. There is a clear time tradeoff associated with delivering advanced medical care in the prehospital setting,[15] and the consequences of an incremental increase in prehospital time in hemorrhagic shock can have lethal outcomes.[6,8,16,17]

Nearly two decades ago, the city of Philadelphia implemented a policy allowing for police department (PD) transport of victims of penetrating trauma. Short-term outcomes were demonstrated to be equivalent for PD-transported patients.[18] Given the substantial evolution of trauma care over time, we sought to examine the effect of this policy change on mortality.

In 2006 the Institute of Medicine (IOM) published a report outlining the state of emergency care in the United States and made specific recommendations for improving care delivery.[19] One of the key recommendations was a call for the standardization of emergency care; specifically, the IOM report calls for the federal government to ''support the development of national standards for: emergency care performance measurement; categorization of all emergency care facilities and protocols for the treatment, triage, and transport of prehospital patients.''[19] Thus far, few studies have assessed which is the safest, most economically feasible way to deliver timely and appropriate care to trauma patients in the out-of-hospital setting. In the wake of this national call to action by the IOM, there is an increased urgency to develop an evidenced-based foundation to methodically improve the delivery of prehospital care.[20]

We sought to determine the relation between prehospital mode of transport (PD vs. EMS) and survival in victims of proximal penetrating trauma. Based on previous work,[18] we hypothesized that severity adjusted mortality among penetrating trauma patients would be similar for individuals transported to the ED by police and by EMS.

METHODS

Study Design

We performed a retrospective cohort study of prospectively collected trauma registry data. This study was approved by the institutional review board of the University of Pennsylvania with waiver of informed consent.

Study Setting and Population

The trauma registry is maintained as part of the state-mandated trauma reporting system and is a comprehensive database kept and maintained by an administrator at the Hospital of the University of Pennsylvania (HUP). HUP is an urban, tertiary care teaching hospital and Level I trauma center with over 60,000 ED visits per year and is one of six Level I trauma centers within the city of Philadelphia. The trauma center at HUP sees nearly 3000 trauma contacts per year, of whom 20%–25% are penetrating.

Philadelphia is the sixth largest city area in the country, with a population just under 1.5 million. Annually, there are nearly 250,000 calls for emergency service in Philadelphia, and all are answered by the Philadelphia Fire Department (PFD)-EMS ambulances that are part of the multitiered service provided by the PFD. During the study period, there were between 40 and 50 ambulances operating in the city. Most of the ambulances are staffed by crews that consist of either two paramedics or one paramedic and a firefighter/emergency medical technician. Near the end of the study period, a small number of basic life support ambulances were added to the response structure to augment existing service.

Just over 20 years ago, the Philadelphia regional EMS system developed trauma triage protocols for PD transport of individuals with penetrating trauma.[18] At the time our study commenced, this was a well-established practice, with hundreds of subjects being delivered to trauma centers throughout the city of Philadelphia each year. The protocol for who transports which penetrating trauma patients is less clear: if EMS is on the scene first, they will transport the individual; however, if PD is on the scene first, depending on expected time of arrival of EMS, and their judgment of the severity of the injury, they may or may not elect to transport to the closest trauma center. No formal policy outlines how care should be provided to injured patients transported by police, and in practice (based on our observations) individuals transported by police are typically rendered no care, including even direct pressure on bleeding extremity wounds.

Study Protocol

We retrospectively searched the trauma registry to identify all subjects presenting to our Level I trauma center by PD or EMS during a 5-year study period (January 1, 2003, to December 31, 2007) with proximal penetrating trauma (any penetrating wound proximal to the elbow or knee), regardless of whether they had signs of life (SOL) on arrival to the hospital. Subjects who were transported by private vehicle or arrived to the ED by other means were excluded from the analysis as they were thought to represent a diverse subset of patients dissimilar to the PD or EMS cohorts.

We compared in-hospital mortality for subjects presenting by EMS to those who presented by PD in unadjusted and adjusted analyses. As a secondary outcome, we examined total hospital length of stay.

Data Analysis

The intent of this analysis was to explore the effect of mode of transport on outcome following proximal penetrating trauma. We used standard assumptions about alpha (0.05) and information from our data including baseline (EMS) mortality rate (14.9%), ratio of

EMS-transported patients to police transported patients (3), relative risk of death for police transported patients (1.57), and number of deaths (353) to calculate our estimated power. Unadjusted analyses were performed using the chi-square test for categorical variables. The Wilcoxon rank sum test and Student's t-test for independent samples were used for nonnormally distributed and normally distributed data, respectively. Adjusted analyses were performed using direct logistic regression. To adjust for injury severity, we used the Trauma Injury Severity Score (TRISS) methodology.[21,22] The TRISS score incorporates both a physiologic scoring system (the Revised Trauma Score and an anatomic injury scoring system (the Injury Severity Score [ISS]). TRISS is a standard and comprehensive comparator used to correct for severity in outcome analysis and to predict survival in trauma patients.[21,22] TRISS coefficients appropriate for penetrating trauma were used, and the Z, W, and M statistics were calculated.[21] The Z statistic measures the statistical significance of differences between the actual number of survivors in the sample and the expected number of survivors according to standardized norms. Thus, Z is a measure of statistical significance. The W statistic measures clinical significance by describing the number of survivors more (or less) than expected per 100 patients treated. The M statistic measures the degree to which the severity of injury for the study patients is similar to the standardized patient population.[23–25] Severe injury was defined as ISS > 15. Given our concern about multiple comparisons causing an increased likelihood of Type I error in our unadjusted analyses, we have defined significance conservatively by dividing the traditional p-value of 0.05 by the number of analyses performed ($n = 10$) to arrive at a threshold for significance of $p < 0.005$.

RESULTS

Description of Study Population

Our power to detect an overall effect for transport type was 0.94 given the inputs we describe. A total of 2,429 subjects who had sustained proximal penetrating injuries were identified. A total of 302 subjects, who otherwise met enrollment criteria but arrived at the ED via private vehicle, were excluded from the analysis, leaving 2,127 for analysis. Demographics of the population are in Table 1. Overall, 71% (1,506/2,127) of the subjects sustained gunshot wounds (GSWs) while 29% (621/2,127) sustained stab wounds (SWs). Among subjects transported by PD, 500 of the 569 (88%) were GSWs, and 69 of the 569 (12%) were SWs. Of the subjects transported by EMS, 1,006 of the 1,558 (65%) were GSWs, while 552 of the 1,558 (35%) were SWs. Overall ISS was 11.2 (SD ±15.5). Overall mortality was 16.6%. About a quarter of patients with GSW (22.4%) died while only a fraction (2.4%) of patients with SW died. Median length of hospital stay was 1 day and did not significantly differ according to mode of prehospital transport.

Unadjusted Analysis (Table 1)

Police were more likely to transport more severely injured subjects overall (ISS = 14.2 ± 17.5 vs. 10.1 ± 14.5; $p < 0.0001$) and more severely injured subjects with GSWs (ISS = 15.3 ± 17.9 vs. 12.9 ± 15.9; $p < 0.005$), but not more severely injured individuals with SWs (6.2 ± 1.3 vs. 5.0 ± 0.4; $p = 0.16$). Overall, patients transported by PD were more likely to die compared to patients transported by EMS (21.4% vs. 14.8%, odds ratio [OR] = 1.57, 95% confidence interval [CI] = 1.22 to 2.01; $p < 0.001$). The association between police transport and increased odds of death persisted when the analysis was restricted to subjects with SOL on arrival to the ED (12.9% vs. 8.4%, OR = 1.61, 95% CI = 1.15 to 2.23; $p = 0.003$). This relationship, however, was no longer found to be significant when the analysis was restricted to the severely injured (44.5% vs. 41.91%, OR = 1.11, 95% CI = 0.79 to 1.57; $p = 0.55$).

Table 1
Characteristics of the Population and Unadjusted Analyses

Patient Characteristics	Police Transport ($n = 569$)	EMS Transport ($n = 1,558$)	p-value
Mean age, years (±SD)	26.3 (±9.1)	31.5 (±11.8)	<0.001
Sex (% male)	91.9	86.7	<0.001
GSW, *n* (%)	500 (87.9)	1,006 (64.6)	<0.001
Mean ISS (±SD)	14.2 (±17.5)	10.1 (±14.5)	<0.001
Death (%)	21.4	14.8	<0.001
Death, GSW (%)	24	21.6	NS
Death, SW (%)	2.9	2.4	NS
Death with SOL on ED arrival (%)	12.9	8.4	0.003
Death, ISS >15 (%)	44.5	41.9	NS
Median hospital LOS [IQR]	1 [1–6]	1 [1–4]	NS

GSW = gunshot wound; IQR = interquartile range; ISS = Injury Severity Score; LOS = length of stay; SOL = signs of life; SW = stab wound.

Subjects who sustained GSWs were significantly more likely to die than those who were stabbed (OR = 11.69, 95% CI = 6.90 to 21.30; $p < 0.001$). This was true independent of the mode of prehospital transport (PD 24% vs. 2.9%, OR = 10.58, 95% CI = 2.55 to 43.82, $p < 0.001$; EMS 21.6% vs. 2.4%, OR = 11.47, 95% CI = 6.49 to 20.29; $p < 0.001$). Among those who sustained GSWs, there was no difference in mortality between PD and EMS transports (24% vs. 21.7%, OR = 1.14, 95% CI = 0.89 to 1.47; $p = 0.307$). Among SW subjects, analysis also demonstrated that there was no difference in mortality (2.9% vs. 2.4%, OR = 1.24, 95% CI = 0.27 to 5.60; $p = 0.782$).

Adjusted Analyses (Table 2)

The Z statistic in our sample was 1.73 and the W statistic was 0.72. These are both within the acceptable range. The M statistic for our sample was 0.90, indicating an excellent match between our study group and baseline patient groups.[21]

We used logistic regression to compare the effect of mode of transport on injury-adjusted mortality following penetrating trauma. The final model included mechanism of prehospital transport and TRISS as predictor variables and death as the dependent variable. In this injury-adjusted model, PD subjects were not significantly

Table 2
Adjusted Analyses

	Police OR	EMS	95% CI
Overall	1.01	Reference	0.63–1.61
GSW	0.80	Reference	0.49–1.30
ISS >15	0.82	Reference	0.47–1.44

GSW = gunshot wound; ISS = Injury Severity Score; OR = odds ratio.

more likely to die (OR = 1.01, 95% CI = 0.63 to 1.61) compared to EMS-transported patients. This relationship persisted in subgroup analysis of patients with GSW (OR = 0.80, 95% CI = 0.49 to 1.30) and with severe injuries (OR = 0.82, 95% CI = 0.47 to 1.44).

DISCUSSION

In this study, we retrospectively analyzed a large population of patients with proximal penetrating trauma to explore the effect of difference in mode of transportation (PD vs. EMS) on outcome. We found that patients transported by PD had a higher mortality rate but that they were also more likely to be shot and more likely to be severely injured compared to patients transported by EMS. Although we demonstrated an overall higher mortality rate among patients transported by police, we found no difference between transport groups in subgroup analyses examining patients by mechanism of injury (GSW or SW). Similarly, we also found that adjustment for injury severity removed the effect of mode of transport on outcomes. Both of these analyses suggest that although police transported patients may appear to be associated with a greater risk of dying, this observed difference is largely attributable to case mix. We are left with the conclusion that police transport of patients with proximal penetrating injuries is not associated with lower survival when compared to EMS-transported patients.

Our findings are even more interesting when compared to those of the study by Branas et al.,[18] which used data from a similar patient population collected between 11 and 17 years prior to ours. Their data collection period came immediately after the adoption of a policy (specific to this city) that empowered the PD to transport victims of penetrating trauma. Although the Philadelphia Police Department (PPD) formalized its trauma transport policy fairly recently, the PPD had been transporting trauma patients for well over 20 years.[18] In the study by Branas et al., mortality was lower for patients transported by PD. After adjusting for TRISS in our study, we found no difference in survival between patients transported by PD compared to EMS. It is interesting that similar conclusions were drawn in both of these studies and suggests that further research in this area could significantly affect policy.

Our findings challenge the current standard of EMS transport of critically injured patients and add to the ongoing debate about the preferred approach to injured adults in the prehospital setting. For decades, researchers have described the uncertainty associated with the decision to engage in aggressive prehospital interventions (''stay and stabilize'') or to rapidly transport (''scoop and run'') patients with severe injury. There is mounting and compelling evidence that acute life support interventions do not improve survival in the critically injured patient,[8,9,11,26,27] but there remains much to understand about the relationship between prehospital time and outcomes for injured patients. Several recent studies have suggested an inverse relationship between on scene time, out-of-hospital time, and outcomes.[8,9,27–31] This makes sense in the context of our findings that adjusted outcomes are similar for patients brought to the hospital by EMS and PD.

There are a few policy implications associated with our findings. We believe that these findings suggest that implementation of police transport for this patient population is safe and may help to decompress overwhelmed EMS systems or those without any significant EMS structure either in rural areas or in resource-poor countries. There are implications for dispatch policy, as well, in that proximity of the prehospital provider to the injury scene should outweigh the level of training when making decisions about dispatch for penetrating injury.

The ability of these data to inform a formal dispatch policy within the United States is limited, as individual systems may not have well-integrated police and fire/EMS services. However, during EMS ''out-of-service'' times, our data suggest that alternate (police) means of transport may be both safe and efficient. Additionally, these data reassure us that in instances when EMS response is delayed, we are doing the right thing for the patients by getting them to the appropriate, definitive care as quickly as possible.

Furthermore, the scene and transport logistics of patients with penetrating trauma in an urban environment like Philadelphia are often problematic. Scene instability and limited ambulance availability are common contributing factors that make these scenes difficult to manage. In an ideal situation, there would always be adequate police and EMS resources immediately available that would arrive on the scene simultaneously, with EMS units staging until the police have assured scene safety. However, when an ambulance is not on the scene, and a police vehicle is readily available, the use of police transport to a trauma center is a viable option to deliver the patient rapidly to definitive care. In situations where both police and EMS are on the scene, the patient should always be transported by EMS while police continue to maintain scene safety and initiate their investigation. This approach is further supported by our collective observational experience that patients transported by police rarely receive any medical care during transport, including the lack of any basic bleeding control measures.

Our study differs in some important ways from previous work. Our overall mortality rate was higher than in the study conducted by Branas et al.,[18] and mortality for patients transported by PD has increased from 13.3% to 21.4%. This is surprising given advances in surgical technique and surgical critical care, but several possible explanations exist. This phenomenon may be due to the fact that improved communication has facilitated improved notification and response times and thus the

fact that more patients are surviving to hospital arrival rather than being pronounced dead in the field. It may also be possible that that weaponry and injury patterns have evolved significantly to become more lethal in the nearly two decades since the earlier study.[32–36] We found that police transport more patients with GSWs than SWs, and this may explain the initial unadjusted differences in mortality that we observed.

It should be noted that we chose this unique population of prehospital transports because of their critical nature and high mortality and our desire to improve prehospital care. We hold in the highest regard and maintain the utmost respect for the highly trained and dedicated professionals of the PFD. These men and woman are our colleagues who tirelessly and resolutely serve the citizens of Philadelphia and this study in no way is a critique of their practice. Our ultimate goal is to develop an evidence-based approach that builds on the heritage and foundation established by the PFD, this nation's first fire department. We do this in an effort to improve prehospital care for all, especially in the setting of increasingly limited health care resources.

This study and others like it should provoke thought as to how we manage and transport critically injured individuals with penetrating trauma from the prehospital environment. Although these findings support the scoop and run paradigm, they are in no way definitive. Further study is needed to prospectively evaluate the effect that mode of transportation, provider, out-of-hospital time, and prehospital intervention has on the outcomes of patients suffering from penetrating trauma and other time-sensitive conditions. We believe that the effect of the policy implications described above could be prospectively and systematically measured in regions considering the inclusion of police officers as prehospital providers for the injured.

LIMITATIONS

Our results are not definitive because there may be limitations associated with our analysis. We performed several unadjusted analyses, and despite performing a Bonferroni adjustment by setting our p-value at 0.005 to decrease the likelihood of making a Type I error, it is possible that our unadjusted analyses may be erroneous. Our logistic regression model included variables thought to be the most relevant covariates and severity adjusters, but we were limited in that our TRISS calculations were based on presenting vital signs. These scores therefore fail to reflect any variations in physiologic parameters that resulted directly from care (or lack of care) that occurred in the field. We believe, however, that any unaccounted-for interventions in the field would have biased our findings toward the null, if there was a difference in PD and EMS groups.

Additionally, we excluded patients transferred to our facility or delivered by private vehicle. Unlike the two study cohorts, this is a highly heterogeneous group because there is no reliable way to assess the care of these patients, what treatments may have been rendered to them, or if they had first gone to another facility or had some other, undetermined delay in their transport to our trauma center.

The conclusions generated from this work should be interpreted within the constraints of a retrospective, albeit, large data set. This study was performed at a single tertiary academic medical center and within one large, urban EMS system, and therefore these results may not be generalizable to other institutions and EMS systems with different geography, infrastructure, or resources. However, we view this in some ways as a strength of our study. We demonstrated no difference in adjusted odds of death by mechanism of prehospital transport in a single system. This single system study eliminates many of the potential confounders of merging data from different EMS systems and trauma centers. As with most other out of hospital studies, the exact time of injury is unknown, and in turn we are unable to draw any specific conclusions about rapidity of transport and arrival to definitive care. We also do not know the duration of scene times or the interventions performed in the prehospital setting for the EMS- or PD-transported populations. We thus cannot draw definitive conclusions about the effect of care in the prehospital environment on mortality. However, we do believe that procedures were not performed on patients transported by PD and that arrival on scene is less limited by staging for scene safety. Although PD may wait for additional back-up, they are usually first to arrive on scene. This may result from the fact that there are simply more police units and that they are more likely to be roaming when dispatched, rather than dispatched from their quarters, as is often the practice for EMS.

CONCLUSIONS

From these data we conclude that there is no difference in adjusted survival rates between patients who have suffered a proximal, penetrating traumatic injury and are brought to the hospital by either the police department or the EMS. Although unadjusted mortality appears to be higher in patients transported by police, these findings are explained by the more severely injured population transported by the police. The current practice of permitting nonmedical police officers to transport patients with penetrating trauma should be continued. Future research should investigate this finding across multiple EMS systems and trauma centers, both at the state and at the national level.

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