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## Racial and gender disparities in violent trauma: Results from the NEMSIS database

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## ABSTRACT

**Background:** Barriers to EMS care can result in suboptimal outcomes and preventable morbidity and mortality. Large EMS databases such as the National Emergency Medical Services Information System (NEMSIS) dataset provide valuable data on the relative incidence of such barriers to care.

**Methods:** A retrospective cross-sectional analysis was performed using the NEMSIS database. Cases of violent trauma were collected based on gender and racial group. Each group was analyzed for the ratio of cases that involved an EMS barrier to care. Chi-square testing was used to assess associations, and the relative risk was used as the measure of strength of association. For all tests, statistical significance was set at the 0.05 level.

**Results:** 719,812 cases of violent trauma were analyzed using the NEMSIS dataset. EMS encountered barriers to care for white and non-white patients was found to be 4.9% and 4.0% respectively. The difference between groups was found to be 0.9% (95% CI [0.7%, 1.1%]  $p < 0.0001$ ). RR was 1.23 for white patients (95% CI [1.19, 1.26]), and 0.82 (95% CI [0.79, 0.84]) for non-white. EMS barriers to care for male and female patients was found to be 6.03% and 3.34%, respectively. The difference between groups was found to be 2.7% (95% CI [2.6%, 2.8%]  $p < 0.0001$ ). RR for male patients was 1.80 (95% CI [1.76, 1.84]) while RR for female patients was 0.55 (95% CI [0.54, 0.57]).

**Conclusions:** Racially white patients and male patients have a statistically significant higher risk of encountering an EMS barrier to care in cases of violent trauma.

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## 1. Introduction

Trauma comprises a large portion of the total caseload seen in U.S. healthcare systems on an annual basis. Per the National Trauma Data Bank, a non-exhaustive trauma database, there were over 800,000 patients admitted for trauma as a primary diagnosis at 747 institutions in 2016 [1]. That is roughly the entire population of San Francisco County being admitted for a trauma every year [2]. The cost and complications alone of such trauma care amounts to \$671 billion dollars a year in management and lost productivity [3]. Unfortunately, despite advances in technology and evidence based medicine, mortality rate among trauma cases remains high at 4.3% [1]. In younger adults this is particularly evident, as trauma remains the number one cause of death in individuals age 1–46 [4]. Of particular concern is violent trauma – defined here as any assault, either physical or with a weapon – as mortality rates tend to be the highest in such trauma [1].

**Abbreviations:** EMS, emergency medical services; NEMSIS, National Emergency Medical Services Information System; NHTSA, National Highway Traffic Safety Administration.

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One factor that revolutionized trauma care in the United States (U.S.) has been the advent and subsequent improvement in emergency medical services (EMS). The rapid assessment and response, initial stabilization, and quick transit to trauma centers via EMS has been paramount in improving mortality outcomes from trauma. Improvements of such services have been attributed to up to a 23% reduction in mortality from trauma in some cases [5]. Unfortunately, these systems do not always operate effectively, and EMS barriers to patient care frequently occur. EMS barriers to care are broadly defined as any situation that limits the evaluation and stabilization of patients in the pre-hospital setting. These barriers can be due to any number of variables, but the most commonly encountered barriers are patient and family language barriers, physical barriers, unsafe environments, lack of cultural competency, geographic location, terrain limitations, lack of training or equipment for personnel, and low educational levels of patients and bystanders [6–13]. Due to the nature of EMS care – serving any patient in any environment – any number of variables can be encountered in each EMS trauma case. Although some of these commonly encountered barriers to care may seem benign, they can be particularly catastrophic in the violent trauma patient where field-assessment-to-trauma-resuscitation-bay time is essential. Barriers to care results in delays in treatment of trauma patients, which can ultimately lead to preventable death [14]. Taken with the fact that ethnic disparities in trauma outcomes have

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been shown to exist, it is possible that certain demographics may experience barriers to EMS care at a higher rate than others [15]. This is particularly relevant in a nation that has seen rapid changes in demographics served by EMS agencies over the last 50 years [16].

To provide data on the quality of trauma and EMS care large databases exist that allow researchers and stakeholders to monitor variables associated with such care. The National Emergency Medical Services Information System (NEMSIS) is a national database managed by the National Highway Traffic Safety Administration's (NHTSA) office of EMS that is used to store U.S. EMS data [17]. This dataset is valuable in that it provides a standardized population-based registry of all EMS responses in the U.S. that can be analyzed in aggregate to identify trends and variables in EMS care. The NEMSIS database has been utilized in multiple scholarly studies to generate valuable data on how EMS care can be improved in the U.S. [18–20].

The purpose of this study was to utilize the NEMSIS database to preliminarily determine if there is a difference in the rate of EMS encountered barriers in cases of violent among white vs non-white racial groups and male vs. female patients. A continuation of this study would be to focus on more detailed collection of data to better understand which specific barriers to care effect various individuals in differing locations across the country.

## 2. Materials and methods

A retrospective cross-sectional analysis was performed using the NEMSIS database (Salt Lake City, UT). Data was preselected based on case details. Cases from 2016 were selected if they involved violent trauma, defined as any assault, either physical or with a weapon. Of the cases of violent trauma reported in the NEMSIS database, data was divided into cases involving a barrier to EMS care, and those that did not. "Barrier to EMS care" is a sorting option within the NEMSIS database defined as any case specific difficulty in serving the patient at the scene. There was no ability to stratify "Barrier to EMS Care" into specific barriers as data from EMS agencies were only reported in a "yes/no" fashion. Data from each group was then stratified by race and gender. Non-whites included American Indian or Alaska Native, Asian, and Black or African American, as defined by the U.S. Office of Management and Budget (OMB). Hispanic or Latino was not reported as a separate racial category in the NEMSIS dataset, but rather as an ethnic group and thus could not be included in the analysis as inclusion would have resulted in multiple data points for the same patient; for example, a racially white Latino patient. Cases of violent trauma that did not report demographics were excluded from analysis. Descriptive statistics and confidence intervals were used to present group characteristics. For categorical variables, chi-square testing and Fisher's exact testing were used to assess associations, and the relative risk (RR) was used as the measure of strength of association. All statistical analysis was done using Microsoft Excel (Redmond, WA) and MedCalc (Ostend, Belgium). For all tests, statistical significance was set at the 0.05 level.

## 3. Results

719,812 cases of violent trauma incidents were analyzed in the NEMSIS dataset. Of the total cases, 479,129 included racial data, with 306,071 cases involving white patients, and 173,058 involving non-white patients. 4.9% (14,986/306,071) cases of violent trauma involving white patients had an EMS reported barrier to care, while 4.0% (6916/173,058) cases involving non-white patients encountered an EMS-reported barrier to care (Table 1). The difference between barriers to care for white and non-white patients was 0.9% (95% CI [0.7%, 1.1%]  $p < 0.0001$ ) (Table 1). The calculated RR for white patients encountering a barrier to care in cases of violent trauma was 1.23 (95% CI [1.19, 1.26]), while RR for non-white patients was 0.82 (95% CI [0.79, 0.84]).

719,812 cases of violent trauma included gender data, with 427,936 cases involving male patients and 291,876 involving female patients.

**Table 1**

Incidence of barriers to EMS care based on race and gender.

	White	Non-white	Total	Male	Female	Total
No barrier to care	291,085	166,142	457,227	402,143	282,117	684,260
Barrier to care	14,986	6916	21,902	25,793	9759	35,552
Total	306,071	173,058	479,129	427,936	291,876	719,812
% Barrier to care	4.9	4.0		6.03	3.34	

Male victims of violent trauma with an EMS reported barrier to care was found to be 6.03% (25,793/427936), while 3.34% (9759/291876) of females experienced a barrier to care (Table 1). The difference between the percent barriers to care for male and female patients was 2.7% (95% CI [2.6%, 2.8%]  $p < 0.0001$ ) (Table 1). The calculated RR for male patients to encounter a barrier to EMS care in cases of violent trauma was 1.80 (95% CI [1.76, 1.84]) while RR for female patients was calculated as 0.55 (95% CI [0.54, 0.57]).

## 4. Discussion

This data suggests that among cases of violent trauma, there is a statistically significant difference in the rate of EMS encountered barriers to patient care in non-white vs. white racial groups, and male vs. female genders. Among these different patient populations, white patients and males are more likely to experience a barrier to EMS care in cases of violent trauma than their non-white or female counterparts, respectively.

One of the possible explanations for this data is that patients in rural areas lacking highly trained EMS and adequately equipped trauma centers are more likely to be racially white [21]. However, it is important to keep in mind that these findings are based upon a data source that only allows the characterization of white and non-white. Thus, the white subgroup from our dataset is not necessarily synonymous with Caucasian and can be inferred to include a large component of racially white Latinos. The Latino population is the largest minority group in the United States and brings with it a host of unique healthcare needs [22]. Additionally, research has shown language and cultural barriers are a common obstacle faced by Latino patients seeking emergency care [23–25]. Thus, in our study the "white" racial group which includes racially white Latinos, may be more likely to encounter a barrier to EMS care, such as a language barrier, which would ultimately result in our finding of higher EMS reported barriers to care among white compared to non-white patients. Although our data suggests racially white patients are more likely to experience barriers to EMS care in cases of violent trauma, it is important to acknowledge that non-white, specifically black patients, have been shown to experience worse outcomes in trauma [26].

The higher incidence of barriers to EMS care in cases of violent trauma involving males can potentially be explained by the nature of the violent trauma. Male patients are more likely to be victims of assault by a stranger and with a weapon [27,28]. Male violent trauma patient are also more likely to die in the prehospital setting [28]. Taken together, this could explain why there is a higher rate of EMS experienced barriers to care in male patients of violent trauma, as scenes are more complex, the patients are often less stable, and the safety of the scene could be questionable. Interestingly enough, male patients have been documented to receive higher priority pre-hospital care as compared to their female counterparts who experience the same trauma [29].

Few studies have utilized a national EMS database to analyze the demographics and complications of EMS care of violent trauma. Grow et al. undertook a similar study where an EMS database was utilized to determine the frequency of treatment delays secondary to language barriers between patients and EMS. They found a small yet significant number of patients who experienced delays in care due to language barriers [8]. Although similar methods were utilized in their study, their database was limited to a single state, and patient demographics were not

reported as done in this study. Language barriers are one of the most commonly encountered limitations to EMS care, among others such as unsafe environments and undertrained or under-equipped personnel. Many EMS initiatives have aimed at confronting these common barriers to care, including the use of telecommunication translation services, stronger partnerships with law enforcement agencies in securing unsafe scenes, increased funding for EMS personnel, training, equipment, and maintenance of national EMS databases to help direct quality improvement projects [30,31].

This study is limited in that specific barriers to care could not be elucidated from the analyzed data. Additionally, outcomes of patients who experienced barriers to EMS care were not able to be tracked due to the nature of the database. As the NEMSIS database is an aggregate of national data, there could be regional differences in EMS barriers to care that would provide additional context to the reported data. Despite these limitations, this study shows a clear difference in rates of EMS barriers to care among certain demographics in cases of violent trauma. Future studies should look at ethnic disparities in EMS barriers to care, such as stratifying patient data by Hispanic and non-Hispanic parameters. Further research should be dedicated to analyzing patient outcomes who experienced an EMS barrier to care.

## 5. Conclusion

Racially white and male victims of violent trauma have a statistically significant higher risk of encountering a barrier to their EMS care. This data has important implications in the quality improvement of EMS care in cases of violent trauma. Despite recent improvements in EMS training and care, disparities still exist in the EMS care of certain patient demographics in cases of violent trauma. In-service trainings, changes in EMS education and continuing medical education courses should be shifted to include content aimed to address the most commonly encountered barriers to EMS care such as language barriers and cultural competency. Further study into a detailed breakdown of types of barriers to care and locations in which they are encountered would provide valuable information to better EMS training and care.

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