

Emergency Medical Services Experience With Barb Removal After Taser Use By Law Enforcement: A Descriptive National Study

Mazen El Sayed, MD, MPH;^{1,2} Chady El Tawil, MD;¹ Hani Tamim, PhD, MPH;³ Aurelie Mailhac, MPH;¹ N. Clay Mann, PhD, MS⁴

1. Department of Emergency Medicine, American University of Beirut Medical Center, Beirut, Lebanon
2. Emergency Medical Services and Prehospital Care Program, American University of Beirut Medical Center, Beirut, Lebanon
3. Department of Internal Medicine, American University of Beirut Medical Center, Beirut, Lebanon
4. Department of Pediatrics, University of Utah School of Medicine, Salt Lake City, Utah USA

Correspondence:

Mazen J. El Sayed, MD, MPH, FACEP, FAEMS
Associate Professor of Clinical Emergency Medicine
Director of Emergency Medical Services & Prehospital Care
Department of Emergency Medicine
American University of Beirut Medical Center
P.O.Box - 11-0236 Riad El Solh
Beirut, Lebanon 1107 2020
E-mail: melsayed@aub.edu.lb

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Keywords: conducted electrical weapons; Emergency Medical Services; law enforcement; NEMSIS; prehospital; taser

Abbreviations:

ALS: Advanced Life Support
BLS: Basic Life Support

Abstract

Background: Conducted electrical weapons (CEWs), including Thomas A. Swift Electric Rifles (TASERs), are increasingly used by law enforcement officers (LEOs) in the US and world-wide. Little is known about the experience of Emergency Medical Service (EMS) providers with these incidents.

Objectives: This study describes EMS encounters with documented TASER use and barb removal, characteristics of resulting injuries, and treatment provided.

Methods: This retrospective study used five combined, consecutive National Emergency Medical Services Information System (NEMSIS; Salt Lake City, Utah USA) public-release datasets (2011–2015). All EMS activations with documented TASER barb removal were included. Descriptive analyses were carried out.

Results: The study included 648 EMS activations with documented TASER barb removal, yielding a prevalence rate of 4.55 per 1,000,000 EMS activations. Patients had a mean age of 35.9 years (SD = 18.2). The majority were males (80.2%) and mainly white (71.3%). Included EMS activations were mostly in urban or suburban areas (78.3%). Over one-half received Advanced Life Support (ALS)-level of service (58.2%). The most common chief complaint reported by dispatch were burns (29.9%), followed by traumatic injury (16.1%). Patients had pain (45.6%) or wound (17.2%) as a primary symptom, with most having possible injury (77.8%). Reported causes of injury were mainly fire and flames (29.8%) or excessive heat (16.7%). The provider's primary impressions were traumatic injury (66.3%) and behavioral/psychiatric disorder (16.8%). Only one cardiac arrest (0.2%) was reported. Over one-half of activations resulted in patient transports (56.3%), mainly to a hospital (91.2%). These encounters required routine EMS care (procedures and medications). An increase in the prevalence of EMS activations with documented TASER barb removal over the study period was not significant ($P = .27$).

Conclusion: At present, EMS activations with documented TASER barb removal are rare. Routine care by EMS is expected, and life-threatening emergencies are not common. All EMS providers should be familiar with local policies and procedures related to TASER use and barb removal.

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CEW: conducted electrical weapons

ED: emergency department

EMS: Emergency Medical Services

LEO: law enforcement officer

NEMSIS: National Emergency Medical Services Information System

TASER: Thomas A. Swift Electric Rifle

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Background

Conducted electrical weapons (CEWs) are considered non-lethal weapons that are increasingly used by law enforcement officers (LEOs), in the United States and world-wide, to control unruly suspected criminals or to neutralize violent situations.¹ The CEWs have two modes of charge deployment: the “drive stun” mode that works by direct contact, and the “probe mode” that fires two probes from the weapon.¹ The “Thomas A. Swift Electric Rifle” or TASER (TASER International; Scottsdale, Arizona USA) belongs to the latter category and is the most widely available “with more than 140,000 TASERs in use by police officers in the field in the US, and an additional 100,000 TASERs owned by civilians world-wide.”^{2,3} A TASER fires two metal barbs and delivers, once embedded in the individual’s skin, high voltage (50,000 V) and low current through 19 electrical pulses per second over a period of five seconds. These pulses cause involuntary muscle contractions, pain, and non-lethal incapacitation.^{2–5}

The TASERs are considered relatively safe when used with proper deployment protocols that include compliance with “use-of-force policies, training requirements, operational protocols, and safety procedures.”² In fact, the reported overall risk of serious injury to TASERed subjects is around 0.25% (mainly from blunt trauma related to falls), and the overall risk of death that is potentially associated with TASER use is around 0.09%.^{6,7} However, TASERs still cause a wide variety of injuries that range from simple abrasions to acute medical emergencies such as stroke and death. There are several published case reports from emergency department (ED) and in-hospital settings regarding different types of injuries associated with TASER use. These include: ocular injuries,^{8–11} skin and bone injuries,^{12,13} testicular injuries,¹⁴ pharyngeal perforation,¹⁵ pneumothorax,¹⁶ neurological injuries ranging from intracranial probe penetration^{17,18} to acute agitated delirious state,¹⁹ and stroke.²⁰ Additionally, cardiac injuries and dysthymias have been reported, including implantable cardioverter defibrillator oversensing,²¹ atrial fibrillation,²² myocardial infarction,²³ and ventricular fibrillation or asystole.^{24,25}

Little, however, is known about the experience of Emergency Medical Service (EMS) providers with these incidents. To date, there are no prehospital studies examining this topic, and the relatively few out-of-hospital studies are law enforcement agency-based or are focused on cardiac arrests after use of CEWs.⁶

The National Emergency Medical Services Information System (NEMSIS; Salt Lake City, Utah USA) is a US national EMS database that collects EMS activations from EMS agencies in 48 states and territories.²⁶ Its public-release dataset allows for the examination of evolving patterns and changes in emergency medical conditions that result from implementation of new policies or regulations such as the use of TASERs by LEOs. This study uses five consecutive releases of the NEMSIS dataset (2011–2015) to describe EMS encounters with documented TASER barb removal, characteristics of resulting injuries, and treatment provided by EMS providers.

Methods

Study Design

This was a retrospective study using combined five consecutive NEMSIS public-release research datasets (2011–2015; NEMSIS Version 2.2.1). An exemption for the use of this de-identified dataset was obtained from the Institutional Review Board at the American University of Beirut (Beirut, Lebanon).

Study Setting

The NEMSIS database is a large convenience sample of EMS activations in the US covering 48 states and territories. It includes approximately 83 variables using standardized definitions and formats for patient care reports.²⁶ Data collected by EMS agencies are aggregated at the state level and submitted to the NEMSIS national database.²⁶ Submission rates and inclusion criteria vary by state.^{26–29} Every record in the database represents a single EMS activation that is submitted by a single responding vehicle. Thus, the NEMSIS database represents a collection of EMS activations for emergency care rather than a collection of unique patients.^{26–29}

Study Population

The combined NEMSIS public datasets include information on 114,142,520 EMS activations. The study included only EMS activations with confirmed TASER use and where TASER barb removal was documented. Activations were excluded if “call cancelled” or where no patient was found or if the patient refused treatment. Activations with no information (or missing information) on procedures performed were also excluded from analysis. Figure 1 shows the exclusions done at every step of the analysis, which yielded a total of 648 activations that were included in the final analyses.

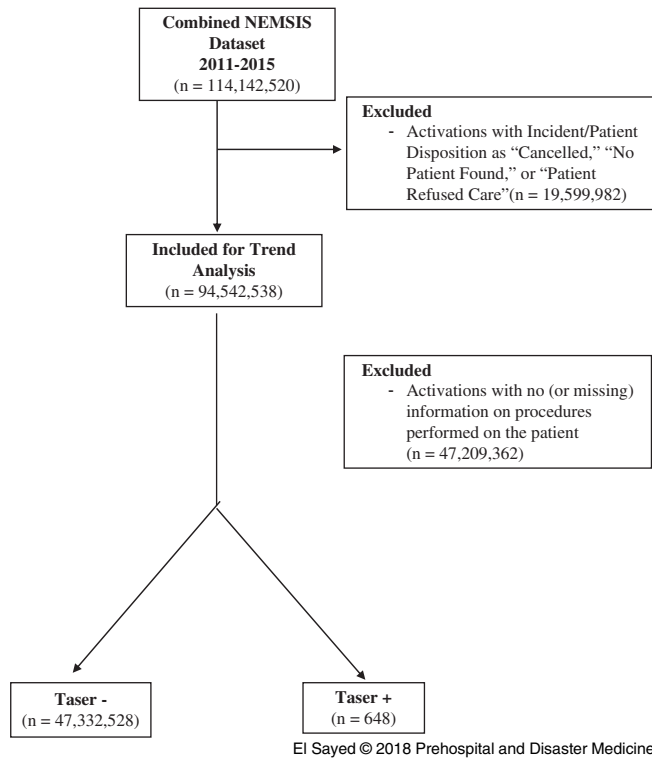
Available Data

Standardized definitions in the NEMSIS manual were used; TASER use is reported under procedures performed to the patient as “Wound Care - TASER Barb Removal.”²⁶ Additional variables that were analyzed included EMS agency information such as: EMS service area urbanicity (population setting using United States Department of Agriculture [USDA; Washington, DC USA] and Office of Management and Budget [OMB; Washington, DC USA] definitions)^{27–29} and reported Center for Medicare and Medicaid Services (CMS; Baltimore, Maryland USA) service level (mainly Basic Life Support [BLS; BLS and BLS emergency] and Advanced Life Support [ALS; ALS Level 1, Level 1 emergency, and Level 2]), in addition to primary role of unit, incident location type, response mode to scene, and transport mode from scene.

Additional event-related information was collected, including patient age and sex, ethnicity, race, complaint reported by dispatch, chief complaint characteristics, provider’s primary impression, barriers to patient care, clinical management information (medications and procedures), and type of destination. Time intervals related to events were also collected, mainly total pre-hospital time (Public Safety Answering Point to “arrived at destination”).

Data Analysis

Data were extracted from the NEMSIS files and imported into the Statistical Analysis Software (SAS) version 9.1 (SAS Institute; Cary, North Carolina USA), which was used for data management and analyses. Descriptive analyses were carried out with number and percent presented for categorical variables, and mean and standard deviation presented for continuous variables. A comparison of the proportion of EMS activations where TASER use with barb removal was reported was done over the study years using the Cochran–Armitage trend test with P value set at < .05 for statistical significance. Absolute numbers and valid percent are presented in the tables.



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Figure 1. Constitution of the Study Population.

Abbreviation: NEMSIS, National Emergency Medical Services Information System.

Results

During the study period, there were 648 EMS activations for which TASER barb removal was documented, yielding a prevalence rate of 4.55 per 1,000,000 EMS activations. Patients had a mean age of 35.9 years (SD = 18.2). The majority were males (80.2%) and mainly white (71.3%). Most EMS activations were in urban or suburban areas (78.3%). Over one-half received ALS-level of service (58.2%). Home or residence was the most common incident location (47.7%; Table 1).

The most common chief complaints reported by dispatch were burns (29.9%), followed by traumatic injury (16.1%) and “unknown problem man down” (12.6%; Table 2). In terms of anatomic location of chief complaint, general/global was most common (22.9%), followed by extremity (upper; 22.5%), back (14.4%), head (11.3%), chest (11.2%), and extremity (lower; 11.0%). Skin was the most common organ system involved (51.8%), followed by musculoskeletal (22.1%). Patients had pain (45.6%) or wound (17.2%) as primary symptom with most reporting possible injury (77.8%). The reported causes of injury were mainly fire and flames (29.8%) or excessive heat (16.7%). The provider’s primary impressions were traumatic injury (66.3%) or behavioral/psychiatric disorder (16.8%). There was only one activation with a reported cardiac arrest (0.2%).

There were no reported barriers to patient care in most activations (63.1%; Table 3). Alcohol use was documented in 23.6% and illicit drugs in 6.6% of EMS activations, respectively. In addition to barb removal, procedures performed by EMS providers included assessment (47.2%), venous access (21.8%), and cardiac monitor (21.5%). Intravenous fluid was the most common

	TASER + (n = 648)
Age (n = 563)	35.9 (SD = 13.5)
Gender (n = 645)	
Male	517 (80.2)
Female	128 (19.8)
Ethnicity (n = 391)	
Not Hispanic or Latino	363 (92.8)
Hispanic or Latino	28 (7.2)
Race (n = 478)	
White	341 (71.3)
Black or African American	106 (22.2)
Others	31 (6.5)
Urbanicity (n = 643)	
Urban	336 (52.3)
Suburban	168 (26.1)
Rural	121 (18.8)
Wilderness	18 (2.8)
Level of Service (n = 208)	
Advanced Life Support	121 (58.2)
Basic Life Support	87 (41.8)
Primary Role of Unit (n = 648)	
Transport	527 (81.3)
Non-Transport	108 (16.7)
Rescue	13 (2.0)
Incident Location Type (n = 618)	
Home/Residence	295 (47.7)
Street or Highway	132 (21.4)
Public Building (Schools or Government Offices)	50 (8.1)
Trade or Service (Business, Bars, Restaurants, etc.)	48 (7.8)
Other Location	25 (4.0)
Health Care Facility (Clinic, Hospital, Nursing Home)	23 (3.7)
Place of Recreation or Sport	16 (2.6)
Residential Institution (Nursing Home, Jail/Prison)	13 (2.1)
Others	16 (2.6)
Time Interval Total Prehospital Time (min) (n = 163)	43.72 (SD = 30.96)

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Table 1. Study Population General Characteristics

Chief Complaint Organ System (n = 456)	
Skin	236 (51.8)
Musculoskeletal	101 (22.1)
Global	61 (13.4)
Psych	31 (6.8)
Central Nervous System/Neuro	9 (2.0)
Others	18 (3.9)
Primary Symptom (n = 524)	
Pain	239 (45.6)
Wound	90 (17.2)
Mental/Psych	57 (10.9)
Bleeding	56 (10.7)
None	39 (7.4)
Change in Responsiveness	12 (2.3)
Swelling	10 (1.9)
Others	21 (4.0)
Cause of Injury (n = 329)	
Fire and Flames	98 (29.8)
Excessive Heat	55 (16.7)
Electrocution (Non-Lightning)	39 (11.9)
Struck by Blunt/Thrown Object	36 (10.9)
Falls	32 (9.7)
Stabbing/Cutting Assault	19 (5.8)
Motor Vehicle Traffic Accident	17 (5.2)
Stabbing/Cutting Accidental	15 (4.6)
Others	18 (5.5)
Cardiac Arrest (n = 511)	
No	510 (99.8)
Yes, Prior to EMS Arrival	1 (0.2)
Provider's Primary Impression (n = 400)	
Traumatic Injury	265 (66.3)
Behavioral/Psychiatric Disorder	67 (16.8)
Poisoning/Drug Ingestion	18 (4.5)
Electrocution	18 (4.5)
Others	32 (8.0)

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Table 2. Clinical Characteristics.

Abbreviation: EMS, Emergency Medical Services.

medication administered (12.1%), followed by Oxygen (8.3%) and pain medications (narcotic; 8.2%).

Over one-half of activations resulted in patient transports (56.3%), mainly to a hospital (91.2%). In 14.0% of activations, patients were treated and transported by law enforcement. The reason for choosing destination was dictated by LEOs in 14.1% of activations.

The reported prevalence of EMS activations with TASER use and barb removal increased over the study period from 4.55 per 1,000,000 EMS activations in 2011 to 6.92 per 1,000,000 EMS activations in 2015. This increase, however, was not statistically significant ($P = .27$; Table 4).

Discussion

This study is the largest to date to describe the EMS experience with documented barb removal after TASER use. Traditionally, EMS constitutes the initial medical contact with patients on-scene, and familiarity with new weapons/restraints methods used by law enforcement agencies is essential for both training and preparedness of prehospital providers for potential medical emergencies when TASERs are used.

The prevalence rate of 4.55 per 1,000,000 EMS activations for encounters with documented barb removal after TASER use is low, despite the widespread deployment of TASERs in the US with over 15,000 law enforcement and military agencies using them.³⁰ This rate might be an under-estimate of the actual rate of TASER use since the EMS activations that were included in this study involved only those with TASER barbs removal. Some activations where TASER barbs were not removed might not have been included in this study. Most prehospital treatment protocols require leaving in place TASER probes if embedded in sensitive tissues such as the eyes or the genitals.³¹ In fact, TASER barbs are often left in place until arrival to EDs, with some cases requiring surgical removal of barbs in the operating room.^{3,8,9,13,17,18} Standard operating procedures of different law enforcement agencies may have also affected this prevalence rate; some law enforcement agencies “provide officers with the discretion to remove TASER barbs themselves” without activating EMS or to request an EMS response for medical assessment.² Other agencies require officers to transport all affected individuals to a hospital for TASER barb removal. An EMS response is requested in this case only “for life threatening needs or when medical treatment is needed” on-scene.² Additionally, part of the safety procedures of most law enforcement agencies that use TASERs is to require medical assessment in the ED prior to barb removal for all individuals with barb impact to face or neck area (in all patients) or to breast and groin areas (in female patients).² These policies align with findings of a previous study by Hailyesus, et al that examined non-fatal injuries related to CEWs in US EDs, where most subjects (76.8%) were brought to the ED by a police vehicle and only 13.5% out of the 816 cases were transported by EMS or fire rescue.³²

Most EMS activations with documented barb removal after TASER use involved middle-aged patients (mean age 35.9 years [SD = 18.2]), mostly of male gender (80.2%). The CEW-related injuries in the US are most common in males (90.1%) and among those in the 20-24-year age group.³² Use of TASERs is also strongly discouraged for children and pregnant subjects.² Most patients were white (71.3%), which might be related to demo-

Barriers to Patient Care (n = 648)	
None	409 (63.1)
Physically Restrained	40 (6.2)
Physically Impaired	5 (0.8)
Language	4 (0.6)
Developmentally Impaired	2 (0.3)
Speech Impaired	1 (0.2)
Alcohol/Drug Use Indicators (n = 648)	
None	202 (31.2)
Patient Admits to Alcohol Use	98 (15.1)
Smell of Alcohol on Breath	55 (8.5)
Patient Admits to Drug Use	24 (3.7)
Alcohol and/or Drug Paraphernalia at Scene	19 (2.9)
Procedures (n = 648)	
Wound Care-Taser Barb Removal	648 (100.0)
Venous Access-Extremity	141 (21.8)
Cardiac Monitor	139 (21.5)
Pulse Oximetry	104 (16.0)
Wound Care-General	86 (13.3)
Blood Glucose Analysis	54 (8.3)
Restraints-Physical	27 (4.2)
Spinal Immobilization	22 (3.4)
Wound Care-Irrigation	19 (2.9)
12 Lead ECG-Obtain	18 (2.8)
Patient Cooling (Cold Pack, etc.)	16 (2.5)
Temperature Measurement	13 (2.0)
Others	51 (7.9)
Medications (n = 648)	
Intravenous Fluids	80 (12.3)
Oxygen	54 (8.3)
Pain Medication/Narcotic	53 (8.2)
Others	18 (2.8)
Benzodiazepine	13 (2.0)
Antiemetic	12 (1.9)
Antipsychotic	5 (0.8)
Naloxone	3 (0.5)

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Table 3. Event Management and Outcomes (*continued*)

Barriers to Patient Care (n = 648)	
Other Sedative	3 (0.5)
Paralytics	2 (0.3)
Pain Medication/Non-Narcotic	1 (0.2)
None	1 (0.2)
Incident/Patient Disposition (n = 648)	
Treated, Transported by EMS	365 (56.3)
Treated and Released	149 (23.0)
Treated, Transported by Law Enforcement	91 (14.0)
Treated, Transferred Care	37 (5.7)
No Treatment Required	6 (0.9)
Type of Destination (n = 408)	
Hospital	372 (91.2)
Police/Jail	22 (5.4)
Others	14 (3.4)

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Table 3 (*continued*). Event Management and Outcomes
Abbreviation: EMS, Emergency Medical Services.

graphics characteristics of the population where these incidents took place. Previously reported figures on 676 use-of-force incidents out of Seattle's (Washington USA) police department where TASERs and pepper spray were used showed a predominance of male subjects (95.0%) with over one-half being non-white (52.0%).³⁰ The observed difference between the age group and race of this study subjects compared to those from other studies examining CEW use might be related to the fact that other studies covered additional modes of CEWs ("drive stun") and used additional inclusion criteria without restriction to barb removal.

Additionally, TASERs are also used on individuals who are "impaired by alcohol, drugs, or mental illness."³⁰ In this study, alcohol or drug use was reported in 30.2% of activations with documented barb removal after TASER use. This is similar to a previously reported rate of substance use among subjects with CEWs injuries (28.8%).³² Most activations (63.1%), however, did not report any barriers to patient care, which might be due to the fact that EMS are involved at a later stage in the encounter when the suspect is subdued.

Complaints reported by dispatch for activations with barb removal after TASER use included mainly burns (29.9%), traumatic injury (16.1%), unknown man down (12.6%), and psychiatric problem (7.8%), among others. Injuries associated with TASERs result from direct impact of barbed probes or from falls after incapacitation. Very few reports of burns from TASER use exist in the literature.³³ Minor burns are expected from TASERs probe impact.³² Likewise, TASERs are not to be used near flammable liquids or fumes² because of the risk of ignition. In this study, fire and flames were, however, the most common cause of injury (29.8%), followed by excessive heat (16.7%). This finding is

likely related to the limited element values available in NEMSIS to describe this type of an injury. Traumatic injury was identified as a common complaint reported by dispatch and as the most common provider's primary impression (66.3%). This was expected since various TASER-associated injuries have been previously reported in the literature, including puncture wounds, contusions, abrasions, and falls.³²

This study also identified procedures done and medications administered by providers during EMS activations with barb removal after TASER use. These were routine procedures such as assessment, venous access, and cardiac monitoring. Few patients (4.2%) required additional physical restraints. Routine medications were also administered, mainly Oxygen and pain medications (ie, narcotics). Few patients required additional chemical restraints such as benzodiazepines and other sedatives (2.5%). Only one case was identified as a cardiac arrest (0.2%) that took place before EMS arrival. Death in this case might not be related to CEW use, as previous studies that examined the link between CEWs and deaths³⁴ found that death that occurs in excited delirium patients requiring restraints is associated with intake of stimulants or psychoactive active drugs, or with other factors including "evidence for forceful struggle, established natural disease states, and obesity."^{34,35} Cardiac arrest in EMS activations with barb removal after TASER use is therefore rare, and most encounters require only routine prehospital care.

Limitations

The study used data from a national database that collects patient care information from EMS agencies across the US. Information submitted to this database vary in reporting compliance, which explains the missing documentation for some variables. All reported injuries in this study population were described without restriction to those directly related to TASER use, since a variable reporting on direct cause of injury is not available in the NEMSIS public dataset. This study also examined only activations with TASERs as CEWs and where

barb removal was documented. Currently, TASER is, however, the only available CEW with probes in the US. Additionally, cases where the probes were not removed (specific locations: face, neck, groin, spinal column, or any area deemed to be problematic) might have been missed because of the way the study population was selected (procedure: "TASER Barb Removal"). This selection process might have biased the results of the study.

This study is, however, important in describing the experience of EMS providers in the US with prehospital encounters where TASERs are used by LEOs. Its findings are important for familiarizing the EMS community with current clinical practice in such encounters and are generalizable to US communities where TASERs are being used by law enforcement agencies. This study also highlights the need for better injury descriptors, such as "TASER Exposure" or "CEW Exposure," and the addition of specific data elements related to CEWs in EMS software and in state and national EMS data sets to capture all cases with CEWs use.

Conclusion

Ultimately, EMS activations with documented TASER barb removal are rare. Although safety and training procedures for TASER use are available for law enforcement agencies, EMS providers do respond to such incidents when medical assessment is needed. Routine care is expected and life-threatening emergencies such as cardiac arrest are not common. All EMS providers should, however, be familiar with local policies and procedures related to TASER use and with other new, non-lethal weapons that might be introduced to the field.

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Years																
	2011			2012			2013			2014			2015			
	(n = 11,869,988)			(n = 16,358,690)			(n = 19,748,545)			(n = 21,422,727)			(n = 25,142,588)			
	Taser +	Total	Per 10 ⁻⁶	Taser +	Total	Per 10 ⁻⁶	Taser +	Total	Per 10 ⁻⁶	Taser +	Total	Per 10 ⁻⁶	Taser +	Total	Per 10 ⁻⁶	P Value
Overall	54	11,869,988	4.55	135	16,358,690	8.25	135	19,748,545	6.84	150	21,422,727	7	174	25,142,588	6.92	.27

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Table 4. Trends for EMS Activations with Documented Barb Removal After TASER Use
 Abbreviation: EMS, Emergency Medical Services.