ORIGINAL RESEARCH

Incidence of Fatal Airway Obstruction in Police Officers Feloniously Killed in the Line of Duty: A 10-Year Retrospective Analysis

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Abbreviations:
CLS: combat lifesaver
CSH: combat support hospital
FBI: Federal Bureau of Investigation
LEOKA: law enforcement officers killed and assaulted
LODDs: line-of-duty deaths
LSI: Life-saving interventions
NPA: nasopharyngeal airway
OEF: Operation Enduring Freedom
OIF: Operation Iraqi Freedom
REACH: registry of emergency airways arriving at combat hospitals
TCCC: tactical combat casualty care
UCR: uniform crime reporting
WDMET: wound data and munitions effectiveness team

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Abstract

Background: According to US military data, airway obstruction is the third leading cause of possibly preventable death in combat. In the absence of law enforcement-specific medical training, military experience has been translated to the law enforcement sector. The purpose of this study was to determine whether airway obstruction represents a significant cause of possibly preventable death in police officers, and whether current military combat lifesaver training programs might have prevented these fatalities.

Methods: De-identified, open-source US Federal Bureau of Investigation (FBI) Uniform Crime Report Law Enforcement Officers Killed and Assaulted (LEOKA) data for the years 1998-2007 were reviewed. Cases were included if officers were on duty at the time of fatal injury and died within one hour from time of wounding from penetrating face or neck trauma. After case identification, letters requesting autopsy reports were sent to the departments of victim officers. Reports were abstracted into a Microsoft Excel database.

Results: During the study period, 42 of 533 victim officers met inclusion criteria. Departmental response rate was 85.7%. Autopsy reports were provided for 29 officers; 23 (54.8%) cases remained in the final analysis. All officers died from gunshot wounds. No coroner specifically identified airway obstruction as either a direct cause of death or contributing factor. Based upon autopsy findings, three of 341 officers possibly succumbed to airway trauma (0.9%; 95% CI, 0.0%-1.9%). Endotracheal intubation was the most common advanced airway management technique utilized during attempted resuscitation.

Conclusion: The limited LEOKA data suggests that acute airway obstruction secondary to penetrating trauma appears to be a rare cause of possibly preventable death in police officers. Based upon the nature of airway trauma, nasopharyngeal airways would not be expected to be an effective lifesaving intervention. This study highlights the requirement for a comprehensive mortality and "near miss" database for law enforcement officers.

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Introduction

The primacy of airway management in the hierarchy of civilian advanced life support remains largely unchallenged.[1,2] Generations of care providers have been instructed in the ABCs of resuscitation. In contrast, modern combat medicine has relegated airway management to a tertiary priority, after management of exsanguinating extremity hemorrhage and tension pneumothorax.[3,4] This re-prioritization was derived in part from a study that used data from the US Army's Wound Data and Munitions Effectiveness Team (WDMET), which identified the leading causes of possibly preventable death in combat.[5] Based upon WDMET data, only 1% of total deaths, and 6% of possibly preventable deaths, occurred due to airway obstruction.

Law enforcement remains a dangerous profession. In 2011, 163 US officers died in the line of duty, up from 154 in 2010. According to US Department of Justice statistics, 72 of these officers died as a result of felonious assault, a 28% increase over 2010.[6] Fifteen of the 72 officers were killed in ambushes. Given these grim statistics, and a paucity of law enforcement-specific medical training, police agencies have turned to their military counterparts for medical guidelines when providing care under circumstances of active

threat. Among the training programs increasingly being adapted for law enforcement use is the combat lifesaver (CLS), a bridging program designed to provide focused care for the leading causes of combat death at a level between basic first aid and combat medic training. The civilian Committee for Tactical Emergency Casualty Care (C-TECC) is currently adapting the CLS program to meet the needs of high-threat civilian prehospital care, with particular focus upon law enforcement officers.[7]

A previous study of law enforcement line-of-duty deaths (LODDs) indicated apparent discrepancies between law enforcement and military injury patterns.[8] Only two of 341 officers during a 10-year period died from exsanguinating extremity hemorrhage, in contrast to the 31 predicted based upon military data. During the same period, 21 officers died as a consequence of penetrating neck trauma, representing 6% of all deaths and 17% of 123 possibly preventable deaths. If correct, this would suggest that the skill sets developed for the TCCC CLS program may need to be modified and expanded for US law enforcement.

As part of the Violence Against Law Officer Research (VALOR) Project, the purpose of the current study was to determine the incidence and nature of airway compromise in officers dying from penetrating face and neck trauma, and to evaluate the potential utility of CLS training interventions in preventing these fatalities.

Methods

Study Format

This study was based upon retrospective analysis of autopsy reports for officers killed in the line of duty between 1998-2007 inclusive, as determined from open-source data available through the US Federal Bureau of Investigation (FBI). This study was reviewed by the Mayo Foundation Institutional Review Board and determined to be exempt.

Open Source FBI Data Set

Under the Uniform Crime Reporting (UCR) Program, the FBI obtains data from nearly 17,000 law enforcement agencies across the United States and its protectorates and territories. The FBI receives information on line-of-duty deaths (LODDs) via multiple sources, including: direct agency participation in the UCR program, FBI field division reports, and data provided through the US Department of Justice, Bureau of Justice Assistance; the Public Safety Officers' Benefits Program; and nonprofit organizations. Upon notification of a LODD, the FBI's Law Enforcement Officers Killed and Assaulted (LEOKA) staff contact the fallen officer's employing agency and request additional details about the incident. Data is compiled and presented in an annual UCR LEOKA report; the majority of LODDs in the report also include a brief de-identified narrative summary of events, including nature of injury. Open-source LEOKA reports were accessed online at www.fbi.gov/ucr/ucr.htm#leoka.

Re-identification and Department Contact

At publication, UCR LEOKA narratives are de-identified, but they do provide information regarding the date of the LODD, the department involved, the age and gender of the officer, and the nature of the incident. Using this data, cases were temporarily re-identified using open-source information available at the Officer Down Memorial Page (www.odmp.org). After case identification, letters were sent to the departments of victim officers explaining the nature of the research and requesting autopsy reports.

Inclusion Criteria

Re-identified decedent officers were eligible for inclusion in the study if they were on duty at the time of their fatal wounding, died within one hour from time of wounding, and the cause of death was identified as penetrating trauma to the face and/or neck regions.

Data Analysis

Reports were abstracted into a secured Microsoft Excel (version 12.3.6, Microsoft Corporation, Redmond, Washington) database. Final data entries in the database were de-identified. Descriptive statistics were performed.

Results

Of the 533 line-of-duty deaths reported during the study period for which LEOKA narratives were available, a total of 42 met inclusion criteria (Figure 1). Of the total, 21 involved penetrating trauma to the face and 21 involved penetrating trauma to the neck. Two cases were excluded due to inability to re-identify the decedents. Altogether, 36 departments responded to written requests for autopsy reports (85.7%). Reports were provided for 29 officers (Figure 1). After review, a further six reports were excluded. In the final analysis, 23 cases (54.8%) remained.

All 42 officers died as a consequence of gunshot wounds. Of the 23 cases in the final analysis, eight officers died from gunshot wounds to the neck while 15 died from gunshot wounds to the face. Assault rifles were used in four of the 23 cases, handguns in 10 cases, and shotguns in nine cases. Nineteen officers were specifically noted to be wearing ballistic armor at the time of injury; data were not provided in four cases. No coroner or medical examiner specifically identified airway obstruction as either a direct cause of death or a contributing factor.

Of the eight patients who died from gunshot wounds to the neck, seven (87.5%) sustained injuries to vascular structures; five (62.5%) sustained injuries to intrathoracic structures; four (50.0%) sustained injuries to cervical vertebrae; and two (25.0%) sustained injuries to the spinal cord. Three (37.5%) officers suffered tracheal injuries; all three also sustained non-survivable trauma to intrathoracic structures or the high cervical spinal cord. One officer sustained complex trauma to the oral cavity (mouth, tongue, posterior oropharynx) as a consequence of a close-range shotgun wound to the neck. Other than non-displaced cervical vertebrae trauma without spinal cord involvement, this officer had no other injuries. While the nature of the autopsy reports precludes definitive attribution of cause of death to airway compromise, the apparent cause of death in this officer is isolated airway trauma. Therefore, the apparent incidence of isolated airway trauma as a cause of death from gunshot wound to the neck was 12.5%.

Fifteen officers died from gunshot wounds to the face. Eleven (73.3%) officers sustained fatal penetrating trauma to the brain. Vascular structures in the neck were injured in three cases (20.0%). No intrathoracic trauma was noted. Four (26.7%) patients sustained cervical spine fractures; cervical spinal cord transection occurred in two of these patients. Injuries to the oral cavity occurred in six patients (40.0%). The epiglottis was injured in four (26.7%) patients; two (13.3%) sustained tracheal transections. Of patients with potentially life-threatening airway trauma, two also sustained a high cervical spinal cord transection; two sustained vascular injury; and three sustained injuries to the brain. No patient died from isolated airway trauma. Assuming that the cause of death in the two patients with airway

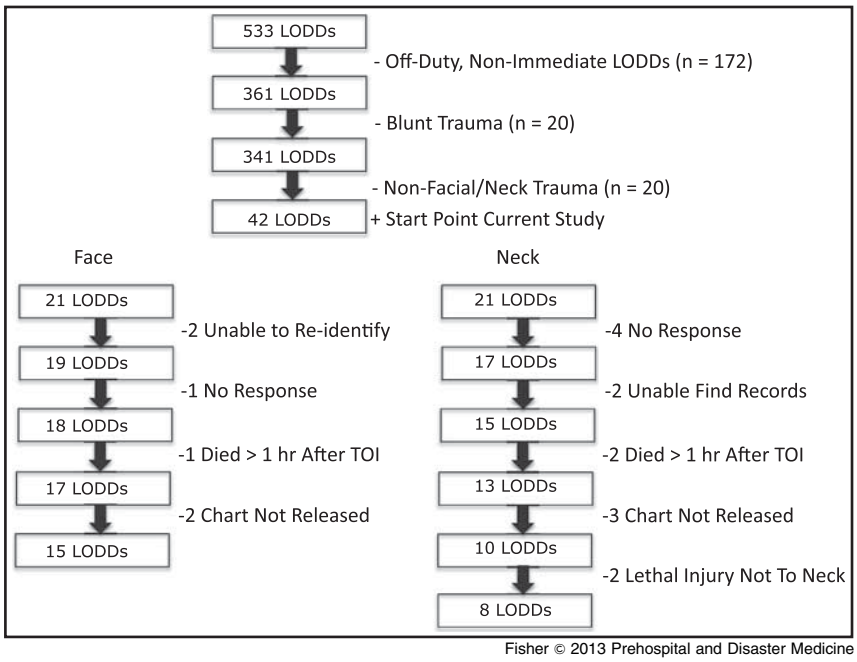

Figure 1. Case exclusion criteria for final study analysis. From an initial cohort of 533 LODDs, a total of 42 charts were identified as meeting the initial selection criteria of on-duty status, immediate fatality (time of death within one hour from TOI), and penetrating trauma to the face and/or neck. After applying subsequent exclusion criteria, 15 of 21 facial trauma and eight of 21 neck trauma LODDs remained in the final study analysis.
Abbreviations: LODD, line-of-duty death; TOI, time of injury

compromise and vascular injury was due to the former, the incidence of airway trauma as a cause of death from gunshot wound to the face was 13.3%.

Based upon these data, at most three of 23 (13.0%; 95% CI, 0.0%-27.3%) officers who sustained penetrating trauma to the face or neck died of apparent airway compromise over the study period. When considering all officers killed in the line of duty who died within one hour from point of wounding, based upon data from previous study analyses, three of 341 officers succumbed to airway trauma (0.9%; 95% CI, 0.0%-1.9%).[8]

Resuscitation was attempted in 13 of the 23 officers. Two patients received chest tubes, while four received emergency department thoracotomies. Nine (69.2%) officers were endotracheally intubated. One officer, who suffered a shotgun wound to the lateral neck injuring the trachea, c-spine, cervical spinal cord, and intrathoracic structures, was managed with a surgical cricothyrotomy. No patient was managed with a supraglottic airway (SGA).

Discussion

In 1954, Elam et al, demonstrated that expired air contained sufficient oxygen to maintain adequate oxygenation in paralyzed patients ventilated using a mouth to mask method.[9] Mouth-to-mouth resuscitation was developed by Elam and Safar in 1956, and adopted by the US military in 1957.[10] That same year, Safar published *ABC of Resuscitation*, which defined the priorities in emergent patient care for the next five decades. Airway management remains a fundamental aspect of emergent patient life support. The initial assessment of the injured patient continues to place airway at the top of the patient care hierarchy.[2] In the 2010 revised advanced cardiac life support guidelines, the American Heart Association placed chest compressions before airway management in prioritizing immediate patient care in sudden cardiac death.[1] However, while airway management was deferred for the initial two minutes, airway interventions still remain critical elements of advanced cardiac life support.

After the 1993 Battle of Mogadishu, Somalia, in which 18 US Special Operations Force personnel were killed and another 80 injured, the US military reviewed its approach to combat medical care.[11] Although the US military was the first organization to adopt the concept of mouth-to-mouth resuscitation, data from the Wound Data and Munitions Effectiveness Team (WDMET) study suggested that airway issues were of minor importance in the immediate management of combat casualties. Despite this, prior to the events of October 3-4, 1993, airway management remained the priority intervention for combat medical care.[12]

The new approach developed by the military, termed tactical combat casualty care (TCCC), focused upon rapid identification and management of possibly preventable causes of death at the point of wounding.[3,4] Data from WDMET indicated that only 1% of soldiers died from airway obstruction.[5] In contrast, 9% of soldiers killed in action died from isolated extremity hemorrhage (circulation), and 5% died from tension pneumothorax (breathing). When focusing solely upon possibly preventable combat deaths, untreated airway obstruction accounted for only 6.7% of fatalities. As a consequence of this data, TCCC emphasized control of exsanguinating isolated extremity hemorrhage and needle decompression of presumed tension pneumothorax. In direct contradistinction to its civilian counterparts, TCCC specifically de-emphasized airway management in combat under conditions of active threat. This approach has proven very effective, and continues to save lives in combat.[13-15]

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More recent data have suggested that the incidence of airway compromise in combat is similar to that reported in the WDMET study. Autopsy data from two periods in Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) in Iraq identified 982 fatalities, including 232 cases with potentially survivable injuries.[16] Of these, 18 cases were felt to have airway compromise as the primary cause of death, representing 1.8% and 7.8% of total and possibly preventable deaths. The Registry of Emergency Airways Arriving at Combat Hospitals (REACH) study collected data on soldiers in OIF presenting to combat support hospitals (CSH) from January 2005 through March 2007.[17] During the study period, 6,875 combat casualties presented to participating CSHs. Of those patients, 293 received advanced prehospital airways, representing 4.2% of combat casualties. A study of out-of-hospital lifesaving interventions performed by combat medical personnel in central Iraq analyzed 318 patients presenting from March 31, 2004 through February 15, 2005.[18] Airway management was required in 16 patients (5.0%). There was no difference in survival based upon successful airway management as a lifesaving intervention. An analysis of causes of death among 82 special operations forces killed in action between October 2001 and November 2004 classified 12 deaths as potentially survivable.[19] In this group, 16 causes of death were identified, including one case of airway obstruction (6%).

Law enforcement is an inherently dangerous profession, resulting in an average of 53 deaths annually from felonious assault. In 2011, 72 US law enforcement officers were murdered in the line of duty; 15 of these deaths occurred during ambushes.[6] Despite these figures, no law enforcement-specific medical training currently exists. In order to fill this void, law enforcement has turned to the military and the TCCC program to develop tactical medical training. In contrast to the evidence-driven military experience, however, little is known about actual causes of law enforcement death while under conditions of active threat and assault.

A previous study reviewed the anatomic location of all law enforcement deaths reported to the FBI through the Law Enforcement Officers Killed and Assaulted (LEOKA) program over a 10-year period.[8] This study limited analysis to penetrating trauma and deaths occurring within one hour from point of wounding in order to evaluate the utility of the TCCC skill set for law enforcement personnel. Compared with military data, the incidence of causes of possibly preventable death among law enforcement officers killed in the line of duty was significantly different. Of the 341 officers included in the study, 198 (58.1%) died from head trauma. These deaths were deemed non-preventable after the fact. By comparison, 31% of deaths in combat are secondary to central nervous system (CNS) trauma.[5] In retrospective review, 123 law enforcement officer deaths were classified as possibly preventable, based upon anatomic location. Upon analysis, though, the majority of these deaths were non-preventable. Only two patients (1.6%) died from isolated extremity hemorrhage, compared with military figures of 60% who died from the same cause.

In the current study, a total of 42 officers met inclusion criteria, including the 21 officers with penetrating neck trauma and 21 officers originally categorized as head trauma who on secondary classification had penetrating trauma to facial structures. The majority of patients with facial trauma (73.3%) died from immediately lethal penetrating trauma to the brain. Trauma to the oral cavity was commonly encountered in these patients; however, no patient with penetrating facial trauma died from isolated airway trauma. Two of six patients with airway trauma sustained vascular injuries which might not have led to immediate death, and the two therefore likely succumbed to airway compromise. In patients with penetrating trauma to the neck, one patient died from apparent airway obstruction. Based upon these findings, three of 341 officers (0.9%; 95% CI, 0.0%-1.9%) died from airway obstruction, a figure in keeping with military data. When considering possibly preventable deaths, these three cases of presumed fatal airway obstruction represented 2.4% of fatalities.

An analysis of combat life-saving interventions identified delays in airway placement as the most common proximate cause of potentially survivable death.[18] The nature of airway compromise in penetrating facial trauma typically involves significant disruption to anatomic airway structures and surrounding tissue. In the analysis of Special Operations Forces deaths, 28% of injuries occurred due to gunshot wounds, while 43% were due to blast trauma.[19] An analysis of 18 likely airway deaths of military combatants in OIF and OEF demonstrated multiple associated injuries and a paucity of isolated airway trauma.[16] The majority of these cases involved trauma to the oral cavity, supraglottic, and glottic structures. In the current study, all three cases had associated soft tissue trauma at the level of the oral cavity or below. Current military CLS training employs the nasopharyngeal airway (NPA) as the primary intervention for airway management.[4] Based upon the degree and location of anatomic disruption, the NPA would not be anticipated to provide effective airway management or lifesaving intervention in casualties with significant maxillofacial trauma.

In the REACH analyses of airway management, the majority of emergent airways were direct endotracheal intubations (97.3%).[16] A smaller proportion involved supraglottic airways (7.5%) and cricothyrotomies (5.8%). A subgroup analysis of the REACH study, evaluating airway management at point of injury, demonstrated endotracheal intubation as the most common method of definitive airway management, followed by cricothyrotomy and supraglottic airway placement.[20] Given the degree of facial trauma, it has been suggested that cricothyrotomy might be more effective than endotracheal intubation in the combat setting.[3] However, a case series analysis of five airway deaths in OIF and OEF found that cricothyrotomy was unsuccessful in all cases.[16] Case reports have demonstrated additional complications with surgical cricothyrotomy in combat care.[21] As such, the optimal combat airway management algorithm has not yet been determined.

In the current study, endotracheal intubation was the most common advanced airway intervention (90%) performed. This most likely reflects current trends in civilian advanced airway management. Unfortunately, it is impossible to determine whether these LSIs were performed in the prehospital environment or emergency department. A study of airway management in the tactical setting suggested that supraglottic airways were more appropriate in the tactical setting, resulting in less exposure to operators.[22] However, this was a mannequin-based study, and did not take into account the presence of blood or significant upper airway trauma. A recent study of combat airway management determined that tolerating invasive airway management without sedation predicted subsequent high mortality rates.[20] As such, the ability to tolerate a supraglottic airway in the tactical setting in the absence of sedation would suggest a futility to the use of this technique. In the current study, no patient was managed with a supraglottic airway.

Although military CLS training focuses upon the NPA as the primary advanced airway intervention, the majority of US law enforcement personnel are trained to either basic first aid or first responder levels. Neither of these levels of training currently permits the use of NPA devices. This discordance between military and civilian sectors provides an additional obstacle to knowledge translation of CLS skill sets to law enforcement personnel. The REACH study determined the incidence of complications was highest among care providers with lesser amounts of training operating in higher risk environments.[16] Presumably, similar findings would occur during on-scene tactical medical care in high threat environments. Moreover, data on critically ill trauma patients suggest that each prehospital intervention is associated with a 2.63-fold increase in mortality.[23] As such, minimizing time in the threat zone performing unnecessary procedures, such as NPA placement in a casualty with massive facial trauma, may be warranted.

Limitations

This study suffers from the traditional limitations inherent in retrospective case series analyses. In addition, this study has several important limitations. First, the FBI LEOKA database does not capture all law enforcement deaths. While it does capture 90% of law enforcement deaths, and is currently the best tool available for such research, the LEOKA database was never developed as a medical investigative tool.

The results of the current study were based upon autopsy reports. Autopsy reports were available for only 23 officers. As such, information is missing on 45.2% of identified cases and thus the nature of their injuries remains unknown. It was also difficult to definitely ascribe fatalities to airway compromise based upon information available in the autopsy reports. The decision was based upon plausibility due to nature of injury and lack of other explanation for fatal outcome. This same difficulty was encountered in military analyses of airway fatalities.[16]

The most important limitation of the current study is selection bias. The study analyzed only officers who died of their wounds. It did not capture those officers who sustained airway obstruction due to penetrating facial or neck trauma but survived, the so called "near misses."[24] Given the robust Emergency Medical Services system in the continental US, the low incidence of fatal airway obstruction in the decedent officers may reflect the delivery of lifesaving interventions, including advanced airway management, by Emergency Medical Services.

Centralized collection of regional trauma registry data, and rapid identification of police officers within the registry, would allow further assessment of prehospital interventions performed, and therefore identify those with possible utility as part of a law enforcement-specific medical skill set.

Conclusion

Acute airway compromise is an uncommon cause of early death in law enforcement officers with facial or neck trauma murdered in the line of duty. Due to the nature of the traumatic events, significant soft tissue trauma was associated with the majority of these injuries. Current military first responder airway interventions, including the nasopharyngeal airway, would not be expected to alter the outcome in law enforcement officer patient population. Further study of non-fatal "near miss" events is required to determine the optimal approach to airway management in the tactical setting, and the most appropriate law enforcement-specific medical training in conditions of active threat.

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