**Retrospective Study**

# Gunshot wounds in military working dogs in Operation Enduring Freedom and Operation Iraqi Freedom: 29 cases (2003–2009)

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### Abstract

**Objective** – To describe the patient population, injuries, and treatment received on the battlefield, and ultimate outcome of U.S. military working dogs that incurred gunshot wound (GSW) injury in Operation Enduring Freedom (Afghanistan) or Operation Iraqi Freedom (Iraq).
**Design** – Retrospective study between January 2003 and December 2009.
**Animals** – Twenty-nine military working dogs from the U.S. military with confirmed GSW injuries incurred in combat in Operation Enduring Freedom or Operation Iraqi Freedom.
**Interventions** – None.
**Measurements and Main Results** – Clinical data from battlefield treatment, which includes care from the point of injury through arrival to, but not including, a designated veterinary treatment facility. Twenty-nine dogs were injured between 2003 and 2009. All but one of the injuries were from high caliber, high velocity weapons. Of the 29 injured dogs, 11 survived the injuries and 18 died (38% survival rate). Of the dogs that died, all but 1 died from catastrophic nonsurvivable injuries before treatment or evacuation could be instituted. The thorax was the most common site of injury (50%) followed by extremity wounds (46%). The leading cause of death from GSWs was from thoracic wounds, followed by head wounds. Dogs with extremity wounds as their only injury were most likely to survive, and dogs with multiple injuries were least likely to survive. All surviving dogs received treatment at the point of injury by military medics and dog handlers consistent with Tactical Combat Casualty Care guidelines for combat injuries in human service members. Of the 11 that survived, all dogs returned to full duty with subsequent deployment to combat zones. Location of wounds and injury severity at the time of presentation to veterinary care was not correlated with length of time until return to duty.

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**Keywords:** ballistic wound, combat injuries, penetrating injury, trauma

### Abbreviations

| | |
|---|---|
| ATT | Animal Trauma Triage |
| DOW | died of wounds |
| GSW | gunshot wound |
| HBOC | hemoglobin-based oxygen carrier |
| ISS | injury severity score |
| KIA | killed in action |
| MWD | Military Working Dogs |
| OEF | Operation Enduring Freedom |
| OIF | Operation Iraqi Freedom |
| RTD | Return to duty time |
| TACEVAC | tactical evacuation |
| TCCC | Tactical Combat Casualty Care |
| WIA | wounded in action |

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### Introduction

Military Working Dogs (MWDs) have been used extensively in current military areas of operation, including Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) in Iraq, and these dogs face the same battlefield dangers as their human

counterparts. These life-threatening injuries must be treated immediately at point of injury to increase an injured dog's chance of survival. Although veterinary care is provided in combat theaters by veterinarians and veterinary technicians from the U.S. Army Veterinary Corps, these veterinary providers are located sparsely at bases throughout the area and medical evacuation times to veterinary care vary, and at times may exceed 24 hours. Combat medics and other human medical providers on patrol with military units have provided extensive immediate, life-saving care to injured dogs, which significantly impacted their survival from potentially fatal injury.

Optimal management of gunshot wounds (GSWs) in dogs in a civilian, peacetime setting has been well reported in the literature including retrospective studies, case series, case reports, and comprehensive review articles.[1–6] In addition, multiple experimental studies have described anatomical disruption and patterns of injury, surgical repair techniques, and complication of GSW in dogs.[7–12] The purpose of this study was to characterize the unique aspects of prehospital care of MWDs injured in a combat environment, which has not been described before in the literature. This study provides descriptions of injuries, battlefield treatment, and outcome in 29 working dogs from the U.S. Military that incurred GSW as a result of hostile enemy action while deployed to Iraq and Afghanistan.

### Materials and Methods

Data were collected from veterinary records of dogs incurring GSW in either OEF in Afghanistan or OIF in Iraq, and in many cases also from interviews with military personnel involved with their care from the time of injury to return to duty. Data were limited to U.S. MWDs from 2003 through 2009. Data from non-U.S. and non-military dogs were excluded due to difficulty with follow-up. All treatments provided by medics or dog handlers prior to receiving veterinary care were noted, along with operational conditions, including theater of operation (OEF or OIF), tactical evacuation (TACEVAC) platform (helicopter or ground vehicle), evacuation time, and whether the dogs' handlers were injured in the same event. Evacuation time was considered time from initial injury to time of arrival at a dedicated veterinary treatment facility in the combat theater. Information that was missing from veterinary records was obtained by interview with military dog handlers and medical personnel involved with the dog's care.

Based on nomenclature for human combat casualties, dogs were considered wounded in action (WIA) if they survived their wounds and were discharge from veterinary care; dogs that did not survive were categorized as "killed in action" (KIA) if they died before reaching a VTF; and "died of wounds" (DOW) if they survived to arrive at a VTF but subsequently died as a result of their injuries prior to discharge. Dogs were assigned an injury severity score based on an Animal Trauma Triage (ATT) scoring system previously described by Rockar et al.,[13] with an ATT score of 0 indicating little or no injury, and the highest possible score of 18 indicating severe injury.[13] Dogs that were KIA were not scored. Injuries were recorded by body region, with a single ballistic round possibly causing more than one injury. Return to duty(RTD) time was based on the U.S. Army Veterinary Corps classification of deployment category for MWDs, a hierarchical score based on a dog's ability to perform its duties and deploy to areas with limited veterinary care.[14] Dogs were considered RTD when a military veterinarian scored them at the same deployment category as they held before their injury.

### Statistical Analysis

Comparison of medians was performed using a Wilcoxon Rank Sum test and associations were assessed using the Fisher's exact test or the Chi-squared test. Statistical significance was assessed at $P < 0.10$, and $P$ values approaching 0.1 were discussed as well since the sample size was small. The Shapiro–Wilk test for Normality was used to assess RTD and ATT scores from the 11 observations. Correlation was assessed using the Spearman Correlation Coefficient at a level of significance of 0.05. A Kruskal–Wallis rank equality test was used to assess the relationship between wound location and RTD. Analyses were performed using commercially available software.[a,b]

### Results

Twenty-nine MWDs incurred GSW injuries between 2003 and 2009 during deployments in support of OEF and OIF. Case data are summarized in Table 1. All dogs except one (Table 1, case 3) were shot with high powered, high-velocity weapons. Case 3 was shot with a small caliber handgun. No dog handlers were injured along with their canine partners. Sixteen of 29 (55.2%) of the dogs incurring GSW were in OIF and 13 of 29 (44.8%) were in OEF. The overall number of dogs deployed to these areas that were unwounded was not available, so proportional comparisons of this data were not possible. However, of the 16 dogs with GSW in OIF, 5 of 16 (31%) survived; while of the 13 dogs with GSW in OEF, 6 of 13 (54%) survived their wounds. A total of 11/29 (38%) of animals were WIA and 17 (59%) were KIA. One dog (0.03%) died of his wounds within an hour of arrival to veterinary care and thus was classified as DOW (Table 1,

**Table 1:** Military working dogs with GSW injuries by theater of operations, location of wounds, injury severity score, and time to return of duty

| Case no. | Theater of operation | Wound location | Status | Injury severity score | RTD (days) |
|---|---|---|---|---|---|
| 1 | OIF | Thorax | WIA | 9 | 21 |
| 2 | OIF | Extremity (R thigh) | WIA | 2 | 14 |
| 3 | OEF | Head | WIA | 9 | 120 |
| 4 | OEF | Thorax | WIA | 11 | 20 |
| 5 | OIF | Extremity (R shoulder) | WIA | 8 | 125 |
| 6 | OEF | Extremity (RF lower) | WIA | 4 | 120 |
| 7 | OIF | Pelvis | WIA | 6 | 63 |
| 8 | OEF | Extremity (R thigh) | WIA | 6 | 91 |
| 9 | OEF | Extremity (L thigh), lumbar musculature | WIA | 5 | 90 |
| 10 | OEF | Extremity (R front) Thorax | WIA | 12 | 120 |
| 11 | OIF | Thorax | WIA | 13 | 30 |
| 12 | OEF | Extremity (R shoulder), thorax | DOW | 12 | N/A |
| 13 | OIF | No information available | KIA | N/A | N/A |
| 14 | OIF | Body not recovered | KIA | N/A | N/A |
| 15 | OIF | Thorax, abdomen, extremities | KIA | N/A | N/A |
| 16 | OIF | Thorax | KIA | N/A | N/A |
| 17 | OIF | Thorax, abdomen, extremities | KIA | N/A | N/A |
| 18 | OIF | Body Not Recovered | KIA | N/A | N/A |
| 19 | OIF | Thorax, abdomen, extremities | KIA | N/A | N/A |
| 20 | OIF | Thorax | KIA | N/A | N/A |
| 21 | OIF | Head, extremities (bilateral front) | KIA | N/A | N/A |
| 22 | OEF | Extremity (R shoulder) thorax | KIA | N/A | N/A |
| 23 | OIF | Neck | KIA | N/A | N/A |
| 24 | OEF | Thorax | KIA | N/A | N/A |
| 25 | OEF | Thorax | KIA | N/A | N/A |
| 26 | OEF | Head | KIA | N/A | N/A |
| 27 | OIF | Neck, head, extremities, (LR, LF upper) | KIA | N/A | N/A |
| 28 | OEF | Neck, extremities (RR, RF upper) | KIA | N/A | N/A |
| 29 | OEF | Head | KIA | N/A | N/A |

OIF, Iraq; OEF, Afghanistan; KIA, killed in action; WIA, wounded in action; DOW, died of wounds; RTD, return to duty time.

case 12). The locations of wounds were not significantly associated with the outcome, but all dogs that received wounds to the neck or abdomen died (Table 1).

## Wound locations
Of the 29 MWDs with GSW, 26 had complete data available on wound location for analysis. A summary of distribution of wounds in provided in Table 1.

**Table 2:** Wound location and RTD time in MWDs during OIF and OEF

| Wound location | Median RTD (days) | IQR |
|---|---|---|
| Thorax | 21 | 20,30 |
| Extremity | 105.5 | 52.5,122.5 |
| Head | 120 | 120, 120 |
| Pelvis | 63 | 63,63 |
| Extremity and thorax | 120 | 120,120 |
| Extremity and lumbar region | 90 | 90,90 |

IQR, interquartile range.

The bodies of 2 dogs were not recovered due to hazardous conditions and information was not available on 1 other dog other than a record of death by GSW in OIF (Table 1, case 13, 14, and 18). Of these, 10/26 (39%) had wounds in multiple locations. Dogs with extremity wounds or abdominal wounds were significantly more likely to have multiple wounds ($P = 0.10$ and $P = 0.03$, respectively). In the dogs for which information was available, the most common sites of injury were the thorax with 13/26 (50%) dogs and 12/26 (46%) dogs receiving injuries in these locations respectively. In addition, all but 1 dog with extremity wounds had extremity fractures associated with the GSW.

## RTD
Of the MWDs that survived (11), all of them RTD. Median RTD time for all survivors was 90 days, with a range of 7 to 120 days. There was no correlation between ATT and RTD (correlation coefficient 0.03; $P = 0.94$). There was also no association found between wound location and RTD ($P = 0.34$).

## Treatment in the field

Statistical analysis of the medical outcome of the wounded MWD compared to treatment was negated by the fact that, of the dogs that died, 17/18 (94%) died within minutes of injury from catastrophic, nonsurvivable wounds before receiving treatment. However, treatments for those dogs that were WIA are further described.

None of the dogs with extremity wounds had massive hemorrhage requiring application of a tourniquet; pressure bandages provided adequate hemostasis. A hemostatic dressing[c] was applied to a soft tissue entry wound in the upper rear extremity in 1 case and was effective in control of bleeding (Table 1, case 2). Gauze packing and pressure dressing with an elastic bandage was used effectively to control arterial bleeding in the shoulder muscle of 1 dog with a large exit wound (Table 1, case 5). Only 1 of the 11 surviving dogs lost enough blood to require blood transfusion. In that case, blood loss was from noncompressible internal hemorrhage to the thorax. All 4 dogs that were non-KIA dogs that incurred thoracic wounds developed tension pneumothorax and 3 of the wounded dogs were treated with needle decompression of the chest in the field, prior to receiving care by a veterinarian. The 1 dog who did not receive needle decompression for tension pneumothorax died shortly after arriving at the VTF. An occlusive bandage was applied over the thoracic wounds in all 4 cases and held in place with medical tape and elastic bandage around the thorax. At least 4 dogs received flow-by oxygen (human oxygen mask held in proximity to the dog's face or taped to a basket-style muzzle) during evacuation to the VTF.

None of the WIA dogs received IV crystalloid fluids prior to arrival at the VTF. An IV catheter was placed in 1 dog prior to arrival to veterinary care, and the dog was administered 250 mL of a hemoglobin-based oxygen carrier (HBOC).[d] Unfortunately, this dog subsequently died of unrecognized/untreated tension pneumothorax after arrival at veterinary care (Table 1, Case 3). Unsuccessful attempts to place IV catheters occurred in 2 others during evacuation, and in one of these, (Table 1, case 5) 500 mL of subcutaneous fluids were administered as an alternative method of fluid administration.

All dogs were evacuated to veterinary care by helicopter. Complete data were not available for all of the dogs regarding TACEVAC, but all of the evacuation times were estimated to be between 20–180 min from the time of injury to arrival to veterinary care. One dog received treatment in-flight with needle decompression of the thorax (Table 1, Case 1). Other in-flight treatments included flow-by oxygen administration, administration of subcutaneous fluids, and measures to prevent or treat hypothermia using active warming blankets or reflective thermal blankets.

## Discussion

This is the first study of combat injuries in MWDs in the current combat conflicts. The limited number of cases prevents thorough statistical analysis and may limit the power to detect statistically significant associations. However, this report provides a characterization of GSW injuries and overall outcomes that may be beneficial to planning for emergency treatment to working dogs that sustain traumatic injuries.

More dogs incurred GSW in OIF versus OEF, 19 (55%) compared to 13 (45%) respectively, but there were more dogs deployed to OIF than to OEF during this time period. In addition, there was a higher rate of death in OIF versus OEF, 9/16 (69%) ad 5/13 (38%), respectively. The higher rate of death in OIF versus OEF is likely a factor of operational conditions such as the nature of the hostile action, including types of weapons used and proximity of the shooter to the dog. Since the majority of the KIA dogs died within minutes of injury from catastrophic, nonsurvivable wounds, this difference is not likely due to the type of emergency care provided on the battlefield.

Two recent studies reported that between 16 and 23% of human casualties in OIF and OEF between 2001 and 2005 were caused by GSWs.[15,17] Since combat injuries in MWD as a whole are not currently being tracked, similar data are not available for canine casualties. A comprehensive retrospective study of GSW by Fullington and Otto in 1997 showed that 66 of 77 dogs (86%) with GSW survived to discharge from the hospital.[3] The authors assessed that most dogs with GSW that receive adequate treatment can be expected to survive. However, their study was based only on cases that were alive at presentation, thus this could be restated that most dogs with GSW who survive to receive veterinary care can be expected to survive if they receive adequate treatment. This study of MWDs, with a much smaller sample size, mirrors their findings, suggesting that dogs that incur GSW in combat that survive to receive veterinary care can also be expected to survive if all life-threatening wounds are identified at point of injury and treated appropriately. Moreover, the 100% RTD rate of surviving dogs in this study suggests that most dogs that survive GSW in combat can return to service following their recovery.

The lack of correlation between ATT and RTD in this group of dogs is likely due to the wide variety of wound locations in a small sample size. However, although not statistically significant, there was an interesting trend of dogs with the highest ATT scores having shorter RTD times compared to dogs with the lower ATT scores. This can be explained by the fact that soft tissue wounds such as thoracic wounds, which had the highest ATT scores, take less time to heal than bone as in extremity fractures, which had generally lower ATT scores. RTD has not

previously been assessed in canine trauma patients, so there is no basis for comparison if these rapid RTD times are typical.

The thorax and extremities were the most common sites of injury for dogs in this study. These 2 sites were also the most common sites for dogs that did not survive. However, all of the dogs that had extremity wounds as their only injury survived, and extremity wounds were not determined to be the cause of death in any of the KIA or DOW dogs. Also worth noting is that, although all dogs with abdominal wounds died, all dogs with abdominal wounds also suffered other life-threatening wounds, and the abdominal wounds themselves were not determined to be the cause of death. In human service members, the most common location of GSWs is the extremities, and thoracic injuries are relatively less common.[15,17] The higher rate of thoracic injuries in MWDs compared to the rate in human service members is likely due to the fact that the thorax in human service members is usually protected by body armor. None of the dogs in this study were wearing body armor. However, due to the precise location of entry wounds in the dogs incurring thoracic GSWs in this study, currently available canine body armor, which has limited coverage over a small area of the thorax would not have been protective in most of these cases.

Combat injuries to the extremities in people have the potential for significant blood loss, and in fact, in 2 analyses of cause of death in OIF and OEF in people, hemorrhage from extremity wounds was found to be the second most common cause of death, second to internal hemorrhage from thoracic wounds.[17,18] In this study of MWDs, none of the dogs with extremity wounds had significant blood loss and none were treated with tourniquets. In addition, MWDs with extremity wounds were the most likely to survive compared to dogs with other injury locations. In a 1997 retrospective study of 82 dogs presenting with GSWs, Fullington and Otto found that dogs with GSWs to the extremities showed the least cardiovascular compromise compared to injuries in any other location of injury.[3] In that study, of the 32 dogs that had only extremity injuries, 29 (90.3%) displayed only mild or no cardiovascular compromise, and only 3 (9.7%) had moderate cardiovascular compromise. This is noteworthy compared to human combat casualties where aggressive hemorrhage control with tourniquets is often necessary for GSW to the extremities. None of the MWDs who incurred extremity wounds in this study required tourniquets to control bleeding. In all cases, pressure bandages were adequate. This vast difference in hemorrhage control and blood loss in canine versus human extremity injuries is likely due to the scant muscle mass of canine extremities compared to humans. This anatomical difference results in less hemorrhage and less resistance to

compression making direct pressure sufficient to compress damaged blood vessels.

Tension pneumothorax was common among dogs with thoracic wounds, occurring in 27% of the surviving dogs and in 100% of dogs with GSW to the thorax who were not KIA. Needle decompression by the medics or handlers prior to receiving veterinary care was essential in saving the lives of three dogs and emphasizes the need for training canine handlers and tactical medics in this emergency procedure for canine casualties. Although needle thoracotomy for the treatment of tension pneumothorax is the standard according to Tactical Combat Casualty Care (TCCC) guidelines,[20] there is ongoing discussion as to its effectiveness in relieving tension pneumothorax in human casualties,[21–24] mainly due to variations in chest wall thickness and body size. This problem is apparently not encountered among MWDs likely due to the relatively uniform body conformation in the population of MWDs.

None of the surviving dogs received IV fluids prior to receiving care by a veterinarian. The concept of "permissive hypotension" for penetrating combat injuries is the standard of care with human combat casualties,[20] and although this sample size is too small for statistical significance, the canine data suggest that in this patient population, IV crystalloid fluid administration in the prehospital phase of treatment did not appear to be a factor in survival, similar to findings in human casualty data.[25]

Official military doctrine for TACEVAC of injured MWDs consists of a single paragraph in an Army field manual that states that dogs may be transported by human evacuation resources.[26] Despite vague guidelines, all of the dogs incurring GSW in this study were afforded the same evacuation resources as their human counterparts, and initiation of evacuation was handled through the same military channels as would have been used for evacuation of a human casualty. Evacuation time was not a significant factor in outcome, because, similar to all other treatments, all of the dogs who were KIA died before treatment or evacuation could be initiated.

### Conclusion

This initial data suggest that dogs that incur serious, but potentially survivable GSW injury in combat that receive immediate and appropriate treatment at the point of injury are likely to survive and return to full duty. Distribution of wounds is relatively similar to human combat GSW casualties, however, based on this limited dataset, severity of extremity wounds appears to vary greatly from human casualties with similar injuries. All of the surviving dogs were treated on the battlefield using guidelines from human TCCC, prior to receiving care

by a veterinarian, suggesting that human TCCC procedures can be adapted successfully for working dogs incurring GSW in combat.

## Footnotes

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