Causes of death or reasons for euthanasia in military working dogs: 927 cases (1993–1996)

George E. Moore, DVM, MS, DACVPM, DACVIM; Kay D. Burkman, DVM, MPH, DACVPM;
Margaret N. Carter, DVM, MS, DACVPM; Michael R. Peterson, DVM, DrPH

Objective—To determine causes of death or reasons for euthanasia in a population of military working dogs.

Design—Retrospective study.

Animals—927 military working dogs.

Procedure—Records of all military working dogs that died during the period from 1993 to 1996 were evaluated for cause of death or reason for euthanasia by review of necropsy and histopathology reports, death certificates, and daily clinical treatment sheets. A single primary cause of death or euthanasia was determined.

Results—Although sexually intact male dogs were more numerous in the study population, castrated male dogs typically lived longer than spayed females or sexually intact males. Leading causes of death or euthanasia (76.3% of all dogs) were appendicular degenerative joint disease, neoplasia, spinal cord disease, nonspecific geriatric decline, and gastric dilatation-volvulus. Compared with German Shepherd Dogs, Belgian Shepherd Dogs were at increased risk for death attributable to neoplasia, behavior, and respiratory tract disease. German Shepherd Dogs had nearly twice the risk for death associated with spinal cord diseases, compared with Belgian Shepherd Dogs.

Conclusions and Clinical Relevance—For most military working dogs, death or euthanasia results from a few diseases commonly associated with advanced age. Some breed differences in risk for these diseases may exist, which clinicians should consider in the procurement and long-term management of these dogs. (*J Am Vet Med Assoc* 2001;219:209–214)

The United States Department of Defense maintains more than 1,700 **military working dogs (MWD)** to provide force-protection support in security and contraband (narcotic and explosive) detection. Because of their initial cost, extensive training, and valuable role in force-protection, these dogs are maintained to provide the highest possible quality of service for the longest possible period of time. Veterinary care for MWD is directed through military regulation, and all MWD receive comprehensive medical care throughout their service lives, including mandatory semiannual physical examinations.

The MWD population is composed primarily of adult large-breed dogs of herding or working breeds. These breeds are trained for security and patrol work or, more commonly, are dual-trained in detection and security work, creating a capable dog that may be worked in a variety of situations. Sporting and hound breeds are less commonly purchased and are only used for narcotic or explosive detection. All dogs are purchased between 12 and 36 months of age, although the US military service does not require registration papers or other proof of age or lineage for any dog. Belgian Shepherd Dogs and German Shepherd Dogs predominate within the MWD population. Most MWD categorized as Belgian Shepherd Dogs resemble the Belgian Malinois, although Belgian Tervuren are not uncommon.

Procurement and replacement planning for this force-protection asset is based on prediction of losses as determined by age and prevalence of diseases within the population. Unexpected deaths result in replacement shortfalls, shortages of MWD in security units, and reductions in force-protection capabilities. The MWD population and its readiness are influenced by morbidity and mortality, and inventory shortages result in great demands for those dog-handler teams that remain operational.

Military working dogs' utility and longevity are presumably affected by diseases common to the specific sizes, breeds, and functions of these dogs, as well as by procurement standards. Although diseases that affect MWD have been identified in previous studies,[1,2] advances in veterinary diagnostic and therapeutic capabilities should correlate with advancing quantity and quality of life for these valuable dogs. Determination of those diseases that shorten a working dog's service life would ideally allow the implementation of preventive medicine and management practices to improve longevity. The purposes of the study reported here were to determine cause-specific mortality rates and causes of death or reasons for euthanasia in MWD.

Criteria for Selection of Cases

Records of all deceased MWD, archived at the Department of Defense Military Working Dog Veterinary Service, Lackland Air Force Base, Tex, were reviewed for the period from Jan 1, 1993 through Dec 31, 1996.

From the Department of Defense Military Working Dog Veterinary Service, 1219 Knight St, Lackland Air Force Base, Texas 78236 (Moore, Burkman); and the Armed Forces Institute of Pathology, 14th St & Alaska Ave NW, Washington, DC 20306 (Carter, Peterson).

Dr. Moore's current address is the Department of Veterinary Science, Attn: MCCS-HV, Suite 266, 2250 Stanley Rd, Fort Sam Houston, TX 78234-6145.

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Procedures

Information was retrieved from the medical records as follows: dog identification, dates of birth and death, breed, sex, died or euthanatized, attending clinician's stated reason for euthanasia or cause of natural death, primary gross pathologic findings reported on necropsy report, and important histopathologic findings as determined by board-certified veterinary pathologists at the Armed Forces Institute of Pathology. The underlying primary cause of death or euthanasia was determined after evaluation of the recorded clinical signs at time of evaluation, death certificate, gross necropsy findings, and histopathology report. Many dogs had more than 1 ongoing pathologic process at the time of death, but only a single predominant disease process was selected for each dog. All causes of death or euthanasia were determined by a single board-certified clinician (GEM), and categorization was based on the underlying disease process and not a terminal complication, if present. Cause of death or euthanasia was primarily categorized by the affected anatomic structure except that all cases of neoplasia were grouped together regardless of anatomic location. Diseases affecting the cauda equina were classified as spinal cord diseases because of potential for concurrent spinal cord diseases and similar clinical signs. Dogs that were euthanatized or died after a marked decline in performance or quality of life and that did not have substantial gross or histologic findings to explain their decline but did have incidental histologic findings common to old dogs were classified as geriatric. Environmental causes of death such as heat stroke and trauma were categorized separately. Anesthesia-related deaths were categorized separately if there was no evidence of underlying organic disease. Cause of death in dogs in which there was insufficient information to conclusively determine a cause for euthanasia or death was categorized as indeterminable.

Statistical analyses—Analyses were performed to determine significance of differences in cause of death or reason for euthanasia between breeds, ages, and sexes. The Student *t*-test for independent means was calculated for comparison between groups of discrete data, and the χ^2 test was used for comparison of 2 or more proportions of nominal data. **Odds ratios (OR)** and 95% **confidence intervals (CI)** were calculated by use of 2 × 2 tables with a statistical software program.[a] For all analyses, values of $P < 0.05$ were considered significant.

Results

Records of 927 MWD were identified for the study, and the population was equitably distributed (23.6 to 26.8%/y) over the 4-year period. Mean age at death was 10.06 years and increased each year from 1993 (mean ± SD, 9.87 ± 2.13 years) through 1996 (10.38 ± 2.11 years). Median age at death was 10.28 years, and the range was 2.04 to 14.71 years. Euthanatized MWD constituted 85.2% (790/927) of the population, and these dogs lived significantly ($P < 0.001$) longer than MWD that died naturally (10.32 ± 1.89 vs 8.54 ± 2.41 years).

Sexually intact male dogs constituted the majority (641/927 [69.1%]) of the study population, but castrated male dogs lived significantly ($P < 0.01$) longer (10.49 ± 2.06 years) than spayed females or sexually intact males (10.01 ± 2.06 and 9.97 ± 2.1 years, respectively). There were no sexually intact female dogs in the study population.

Belgian Shepherd Dogs represented the majority (570/927 [61.5%]) of the study population; 284 German Shepherd Dogs composed 30.6% of the population. Mean age at death for Belgian Shepherd Dogs was significantly ($P = 0.037$) less than that of German Shepherd Dogs (9.87 ± 2.06 vs 10.18 ± 2.01 years, respectively; **Table 1**). Eleven other breeds or crossbreeds were represented by < 20 dogs each. Mean age at death of all dogs of the sporting and hound breeds (Labrador Retriever, Golden Retriever, Pointer, and Beagle) was significantly ($P < 0.001$) greater than mean age of dogs of the herding or working dog breeds.

Breed distribution within the study population changed during the 4-year period as the percentage of Belgian Shepherd Dogs increased each year from 42.8% in 1993 to 72.6% in 1996. Conversely, the number and percentage of German Shepherd Dogs and dogs of all other breeds decreased annually. German Shepherd Dogs and dogs of all other breeds composed 45.0 and 12.2%, respectively, of the population in

Table 1—Breed distribution and age at death or euthanasia in military working dogs, 1993 to 1996

Breed	No. (%)	Mean age (y [SD])	Range (y)
Belgian Shepherd Dog	570 (61.5)	9.87 (2.06)	2.07–14.34
German Shepherd Dog	284 (30.6)	10.18 (2.01)	2.04–14.44
Dutch Shepherd Dog	18 (1.9)	10.07 (2.24)	4.62–12.40
German Shepherd Dog cross	13 (1.4)	10.84 (2.66)	4.26–13.73
Labrador Retriever	13 (1.4)	12.56 (1.06)	11.12–14.41
Rottweiler	10 (1.1)	10.87 (1.34)	9.07–12.68
Bouvier des Flandres	9 (1.0)	10.70 (1.04)	8.95–12.35
Giant Schnauzer	3 (0.3)	9.69 (1.30)	8.61–11.14
Beagle	2 (0.2)	13.97 (1.05)	13.22–14.71
Labrador Retriever cross	2 (0.2)	14.28 (0.41)	13.99–14.57
Doberman Pinscher	1 (0.1)	8.83 (NA)	NA
Golden Retriever	1 (0.1)	14.03 (NA)	NA
English Pointer	1 (0.1)	12.32 (NA)	NA
Total	**927 (100)**	**10.06 (2.08)**	**2.04–14.71**

NA = Not Applicable.

Table 2—Causes of death or reasons for euthanasia in military working dogs, 1993 to 1996

Cause of death or euthanasia	No. (%)	Mean age (y [SD])	Range (y)
Appendicular DJD	178 (19.2)	10.37 (1.69)*	2.77–14.20
Neoplasia	170 (18.3)	10.02 (1.79)	4.08–14.71
Spinal cord-cauda equina disease	145 (15.6)	10.35 (1.57)	6.05–14.44
Geriatric	131 (14.1)	11.31 (1.40)*	5.68–14.57
Gastric dilatation-volvulus	84 (9.1)	8.88 (2.24)†	2.07–13.41
Cardiac disease	34 (3.7)	9.72 (2.75)	2.67–14.03
Behavior	19 (2.0)	8.36 (3.06)	2.44–12.69
Urogenital disease	17 (1.8)	10.22 (3.06)	2.04–13.65
Gastrohepatic disease (nonGDV)	16 (1.7)	9.32 (2.31)	2.85–12.48
Ophthalmologic disease	11 (1.2)	9.90 (1.90)	6.74–12.53
Anesthetic arrest	10 (1.1)	7.34 (1.99)†	3.57–10.23
Axial skeletal DJD	9 (1.0)	9.02 (2.59)	3.95–12.46
Respiratory tract disease	9 (1.0)	9.74 (2.62)	5.31–12.95
Trauma	9 (1.0)	9.09 (2.30)	6.36–13.64
Dermatologic disease	8 (0.9)	8.98 (1.65)	6.17–11.09
Brain disease	8 (0.9)	9.51 (2.00)	6.71–12.67
Heat stroke	6 (0.6)	5.80 (1.99)†	2.97–8.75
Endocrine disease	5 (0.5)	11.61 (1.65)	9.07–13.49
Miscellaneous	16 (1.7)	9.15 (2.83)	3.04–14.41
Indeterminable	42 (4.5)	9.92 (2.13)	4.02–13.41
Total	**927 (100)**	**10.06 (2.08)**	**2.04–14.71**

DJD = Degenerative joint disease. GDV = Gastric dilatation-volvulus. Miscellaneous = Splenic hematoma (n = 5), splenic torsion (2), coccidiomycosis (2), anaphylaxis (2), septicemia (1), autoimmune hemolytic anemia (1), vestibular disease (1), deaf-geriatric (1).
*Significantly ($P < 0.05$) greater than population mean. †Significantly ($P < 0.05$) less than population mean.

Table 3—Causes of death or reasons for euthanasia in military Belgian Shepherd Dogs and German Shepherd Dogs, 1993 to 1996

	Belgian Shepherd Dog		German Shepherd Dog	
Cause of death or euthanasia	**No. (%)**	**Mean age (y)**	**No. (%)**	**Mean age (y)**
Neoplasia	118 (20.7)*	9.81	36 (12.7)	10.01
Appendicular DJD	111 (19.5)	10.32	58 (20.4)	10.47
Spinal cord disease	78 (13.7)	10.12	55 (19.4)†	10.34
Geriatric	75 (13.2)	11.29	43 (15.1)	11.16
Gastric dilatation-volvulus	50 (8.8)	8.70	29 (10.2)	9.19
Behavior	17 (3.0)*	8.16	2 (0.7)	10.06
Cardiac disease	15 (2.6)	9.01	13 (4.6)	9.90
Anesthetic arrest	9 (1.6)	7.35	1 (0.4)	7.28
Respiratory tract disease	9 (1.6)*	9.74	NA	NA
Ophthalmologic disease	9 (1.6)	10.22	2 (0.7)	8.47
Gastrohepatic disease (nonGDV)	9 (1.6)	9.23	6 (2.1)	9.56
Trauma	8 (1.4)	8.83	1 (0.4)	11.19
Urogenital disease	8 (1.4)	10.02	8 (2.8)	10.34
Axial skeletal DJD	7 (1.2)	9.72	2 (0.7)	6.57
Brain disease	6 (1.1)	9.30	1 (0.4)	8.60
Heat stroke	5 (0.9)	5.93	1 (0.4)	5.17
Dermatologic disease	4 (0.7)	9.66	3 (1.1)	9.01
Endocrine disease	1 (0.2)	11.93	2 (0.7)	12.94
Miscellaneous	10 (1.8)‡	9.25	4 (1.4)§	7.41
Indeterminable	21 (3.7)	9.60	17 (6.0)	10.25
Total	**570 (100)**	**9.87**	**284 (100)**	**10.18** *

*Odds ratio significantly ($P < 0.05$) increased for Belgian Shepherd Dogs. †Odds ratio significantly ($P < 0.05$) increased for German Shepherd Dogs. ‡Splenic hematoma (n = 4), coccidiomycosis (2), splenic torsion (1), anaphylaxis (1), septicemia (1), vestibular disease (1). §Splenic torsion (n = 1), anaphylaxis (1), autoimmune hemolytic anemia (1), deaf-geriatric (1).
See Table 2 for remainder of key.

1993 and 21.9 and 5.5%, respectively, of the population in 1996.

Degenerative joint disease of the appendicular skeleton was the leading cause of death or euthanasia in the study population, affecting 178 (19.2%) dogs, with a mean age at death of 10.37 years (**Table 2**). Dogs in this category were more likely to be older than the study populations mean age (OR, 1.55; 95% CI, 1.10 to 2.20; $P = 0.012$). Neoplasia was the second leading cause of death or euthanasia, resulting in a loss of 18.3% of the population. Spinal cord diseases resulted in a mean age at death of 10.35 years.

Geriatric conditions were the fourth leading cause of death or euthanasia and represented 1 of only 2 categories with mean age > 11.0 years. Dogs that died or were euthanatized for geriatric reasons were nearly 4

times as likely to be older than the study population mean age (OR, 3.83; 95% CI, 2.47 to 6.07; $P < 0.001$). Although 1 dog had a reported age of 5.68 years at death, 19 geriatric dogs had reported ages of 8.25 to 9.97 years, and the remaining 111 dogs were all 10 years of age or older.

As the fifth leading cause of loss, **gastric dilatation-volvulus (GDV)** or its complications caused the death of approximately 1 of every 11 (9.1%) MWD. Dogs in the GDV category were nearly 3 times as likely to be younger than the study population mean age (OR, 2.73; 95% CI, 1.63 to 4.61; $P < 0.001$). This particular cause of death or euthanasia was also the only category in the study population in which significant ($\chi^2 = 28.63$; $P < 0.001$) differences among sexes were detected. For GDV-related mortality, the OR of spayed females (OR, 2.5; 95% CI, 1.36 to 4.48; $P = 0.002$) and the OR of castrated males (OR, 1.95; 95% CI, 1.04 to 3.54; $P = 0.03$) were each approximately 2 times that of sexually intact males.

The only 2 categories of death or euthanasia in which dogs were < 8 years old and significantly ($P < 0.001$ and $P < 0.002$, respectively) younger than the population mean were anesthetic arrest and heat stroke. All but 1 dog in these 2 categories were younger than the population mean age, and all were younger than the population median age.

For most variables, significant differences among data for each year of the 4-year study were not detected. The only variable for which a significant ($P = 0.002$) difference among years of the study was detected was the percentage of indeterminable causes of death, which declined.

The 2 most common breeds in the study, Belgian Shepherd Dog and German Shepherd Dog, were evaluated for causes of death or euthanasia (**Table 3**). Compared with German Shepherd Dogs, Belgian Shepherd Dogs were at increased risk for mortality related to neoplasia (OR, 1.84; 95% CI, 1.21 to 2.83; $P = 0.004$) and behavior (OR, 4.33; 95% CI, 1.02 to 38.9; $P = 0.032$). Belgian Shepherd Dogs also had increased risk ($P = 0.034$) for respiratory-related mortality, compared with German Shepherd Dogs. German Shepherd Dogs had nearly twice the risk of Belgian Shepherd Dogs for spinal cord disease-related mortality (OR, 1.72; 95% CI, 1.14 to 2.57; $P = 0.008$). Significant differences between the 2 breeds for mean age at death for any of the disease categories were not detected.

Discussion

Mean age at death for the MWD population reported here was greater than or similar to that reported for civilian-owned German Shepherd Dogs and military dogs of similar breeds.[2-5] Correlations between our results and those of a civilian population of dogs may be limited, however, because longevity in our study population was presumably influenced by procurement standards for MWD, regular provision of medical care to MWD, and the workload and management practices common to MWD.

The increased longevity of neutered male dogs, compared with females or sexually intact males, has been reported before, although differences were not significant.[6] In a more recent study[7] of British dog breeds, neutered females lived significantly longer than males or sexually intact females. Because the reasons for neutering often increase with age, study population distributions may reflect census distributions rather than sex-related mortality. Nevertheless, neutering may impact mortality as a result of prophylactic or therapeutic influences on the urogenital system.

The finding that Belgian Shepherd Dogs overall did not typically live as long as German Shepherd Dogs supports a similar finding in a smaller cohort of MWD,[3] although the age differential between the breeds was much less in the larger population of our study. Because significant differences in mean age between these 2 breeds were not detected for individual categories, the overall finding cannot be attributed to any disease process. Notwithstanding the increasing popularity of the Belgian Shepherd as a working dog in the United States, little is documented about breed morbidity and mortality, compared with other breeds.

Dogs of sporting and hound breeds lived to a significantly older mean age than dogs of herding or working breeds, but conclusions regarding cause-specific mortality could not be drawn because of the small sample size. Sporting and hound breeds are used by the military for contraband detection, whereas herding and working breeds are dual-trained to also perform patrol-attack roles. This workload differential between MWD may influence longevity, or breed differences in disease risk may favor sporting breed dogs. Conversely, young dogs of sporting breeds may have been adopted and excluded from the MWD study population.

Degenerative joint disease of the appendicular skeleton was the most common disease associated with mortality in this study. Osteoarthritis usually affected the coxofemoral joints, but stifle, shoulder, and elbow joint arthritis were also reported. Canine hip dysplasia and secondary osteoarthritis of the coxofemoral joints has been reported to be the primary reason for procurement rejection and the most common reason for departure from active service for MWD.[2,8] Dogs with any radiographic evidence of hip, stifle, or elbow joint osteoarthritis are not procured for military service, but dogs with mild dysplasia may be accepted. Dogs with moderate dysplasia have been accepted into the MWD program in previous years, and degenerative joint disease secondary to hip dysplasia has not been found to have a substantial effect on the number of months that these dogs worked.[9] This low impact on service longevity was confirmed by our finding that MWD euthanatized because of debilitating degenerative joint disease typically lived longer than the population overall. Low morbidity from degenerative joint disease is nonetheless desirable, and the prudent use of procurement restrictions, potential benefits of nutriceuticals, and medical management of arthritis are areas of critical interest to military veterinarians.

Neurologic disease of the spinal cord or cauda equina was suspected clinically and confirmed histologically in many working dogs in the study. Chronic progressive posterior paresis is a common finding in

aging MWD, and degenerative myelopathy and lumbosacral spondylopathy were concurrently confirmed at necropsy in some Belgian Shepherd and German Shepherd MWD. Neurologic disease, potentially accompanied by orthopedic disease, presents a diagnostic and therapeutic challenge to clinicians of working dogs. Approximately 15% of MWD had a decline in performance or quality of life but did not have substantial gross or histologic lesions associated with a single anatomic system. These dogs did have incidental histologic findings common to old dogs, were documented or appeared to be advanced in age, and were classified as geriatric. In some dogs, steroidal or nonsteroidal antiinflammatory products had been used briefly in an attempt to improve the quality of life.

Gastric dilatation-volvulus, a potentially preventable or curable disease, caused the death of almost a tenth of the study population. This rate is more than twice the GDV cause-specific mortality rate reported in an almost equally sized population of MWD that died from 1987 to 1989,[10] and in both studies the mean age of death for dogs with GDV was less that of the overall study population. This devastating disease is of great concern because MWD are generally large breed male dogs fed 1 meal daily; these 3 factors are all recognized risk factors for GDV.[11] Prevalence of GDV within the MWD population is unknown, but continued identification of predisposing factors will ideally lead to changes in kennel management that will reduce the prevalence and fatality rate of this disease.

Results of previous studies differ and indicate that the risk of GDV is not associated with sex or neuter status and is greater for male dogs but not different between sexually intact and neutered dogs.[11-13] Mortality rates associated with GDV in dogs of various sex and neuter status have not been reported. Although increased risk for GDV-related mortality in neutered male and female dogs was detected in our study, a cause and effect relationship between neutering and GDV cannot be presumed. All females procured as working dogs by the military are neutered before training; therefore, there are no sexually intact females for a comparison group. To be successfully trained in detection or security work, female dogs must have strong personality traits such as intensity and capacity for work; these characteristics may result in increased risk for GDV, compared with the overall population. In privately-owned dogs, temperament has been correlated with increased risk of GDV.[11] Just as the risk for GDV increases with age in all dogs,[12] the likelihood of being neutered increases with age in male MWD. The reasons for neutering were not evaluated in this study, but physiologic or behavioral factors that may have prompted neutering may be confounding variables in the assessment of increased risk for GDV in a population of dogs with high-intensity personalities.

Deaths associated with anesthesia and heatstroke are potentially preventable, and dogs in these categories died at a younger mean age than MWD in other categories. This study did not evaluate the risk associated with different anesthetic agents, types of procedures performed, monitoring methods employed during anesthesia, nor their distribution by age of patient. The category sample population for anesthesia-related deaths may have been biased if older dogs were more likely to be categorized under concurrent underlying disease. In our study, the low mean age of MWD that succumbed to heat stroke may be related to greater intensity in exercise and subsequent heat generation in younger dogs, compared with older dogs. Heat stress in MWD is often primarily exertional in origin, rather than simply caused by prolonged exposure to extreme environmental temperatures.

The increased risk for neoplasia-related mortality in Belgian Shepherd Dogs, compared with German Shepherd Dogs, confirms a recent finding in a smaller group of MWD.[3] To the authors' knowledge, increased risk for death related to behavior and respiratory tract diseases has not been reported before; this finding was detected in a small subset of the total population. Although hip dysplasia and epilepsy are recognized problems in Belgian Shepherd Dogs,[14] behavioral disorders and respiratory tract disease may actually reflect temperament-related selection bias (ie, selecting for aggressive dogs) or kennel management problems that cause respiratory diseases, rather than true breed-associated risks.

Compared with results of previous studies of MWD,[1] dogs in our study had fewer infectious diseases, which may reflect improvements in medical and surgical care. Awareness of the diseases common to this population and continued improvements in diagnostics and applied therapeutics should further reduce morbidity and mortality, improve quality of life, and extend the lifespan of these working dogs.

[a] Epi Info, v.6.04, Centers for Disease Control and Prevention, Atlanta, Ga.

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