

Mortality and morbidity due to gastric dilatation-volvulus syndrome in pedigree dogs in the UK

OBJECTIVES: To estimate breed-specific risk of death due to, and prevalence of, gastric dilatation-volvulus (GDV) in UK pedigree dogs.

METHODS: Data were available on the reported cause of and age at death and occurrence of and age at diagnosis of disease from the 2004 purebred dog health survey. A total of 15,881 dogs of 165 breeds had died in the previous 10 years; GDV was the cause of death in 65 breeds. There were 36,006 live dogs of 169 breeds of which 48 breeds had experienced ≥ 1 episodes of GDV. Prevalence ratios were used to estimate breed-specific GDV mortality and morbidity risks.

RESULTS: Gastric dilatation-volvulus was the cause of death for 389 dogs, representing 2.5% (95% CI: 2.2-2.7) of all deaths reported and the median age at death was 7.92 years. There were 253 episodes in 238 live dogs. The median age at first diagnosis was five years. Breeds at greatest risk of GDV mortality were the bloodhound, Grand Bleu de Gascogne, German longhaired pointer and Neapolitan mastiff. Breeds at greatest risk of GDV morbidity were the Grand Bleu de Gascogne, bloodhound, otterhound, Irish setter and Weimaraner.

CLINICAL SIGNIFICANCE: These results suggest that 16 breeds, mainly large/giant, are at increased risk of morbidity/mortality due to GDV.

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INTRODUCTION

Gastric dilatation (GD) and gastric dilatation-volvulus (GDV) syndromes are acute, life-threatening conditions most commonly affecting large and giant-breed dogs (Ward and others 2003). They feature rapid accumulation of air in the stomach, malposition of the stomach to a varying degree, a rise in intragastric pressure and frequently lead to the development of cardiogenic shock (Glickman and others 2000a). It is often impossible to distinguish between GD and GDV on clinical signs alone, but it is thought that both conditions may be manifestations of

the same disease process (Glickman and others 1998).

The exact cause is still not clearly understood although several risk factors have been identified (Monnet 2003). These risk factors include being a purebred and of a large or giant breed (especially one with a deep and narrow thorax) and having a first-degree relative that had GDV (Glickman and others 1994). Glickman reports that the relatively high case-fatality rate of approximately 30%, together with the high incidence of GDV in large and giant breed dogs, results in GDV being a leading cause of death for these breeds in North America (Glickman and others 2000b).

The purpose of this study was to describe the breed-specific risk of death due to GDV and to estimate the prevalence of GDV in UK pedigree dogs. There have been numerous retrospective studies considering characteristics of dogs that have developed GDV, and prospective studies of individuals of breeds considered to be at high risk of developing GDV, but this is the first cross-sectional study of a large sample of pedigree dogs from which the proportion of cases of morbidity in live dogs due to GDV is reported.

METHODS

Data were available on the reported cause of death and occurrence of disease from the 2004 Kennel Club/British Small Animal Veterinary Association Scientific Committee Purebred dog health survey (Adams and others 2010). This survey was administered via breed club secretaries of 170 breeds of dogs recognised by The Kennel Club (KC) in the UK. Owners were asked to anonymously complete a questionnaire for all dogs they owned of the relevant breed, and return it in a pre-paid reply envelope. The questionnaire contained three sections pertaining to the health status of all dogs including questions covering the body systems, breeding

of females and occurrence of birth defects. A fourth section dealt with dogs that had died in the last 10 years. The questionnaire was designed and pre-tested in two breeds, the Norfolk terrier and German spitz. The questionnaire is available on the Kennel Club website (The Kennel Club 2006).

The proportion of deaths due to GDV was estimated as the number of deaths due to GDV divided by the total number of deaths reported for that breed and expressed as a percentage (Table 1). Breed-specific prevalence of GDV morbidity

was estimated as the number of cases of GDV for the breed divided by the total number of live dogs of each breed and expressed as a percentage (Table 2). The association between exposure to a particular risk factor (in this case, breed) and the occurrence of death or disease in a cross-sectional study can be estimated using two parameters: the prevalence ratio (PR) and the odds ratio (OR). Although the OR is often reported for cross-sectional studies, it overestimates the value of the association between the exposure factor and cause of death or disease (especially

when the cause of death disease is not rare). The PR is therefore the preferred estimate and it is reported with 95% confidence intervals (CIs). When the value of PR is equal to 1, then it is said that no association exists between occurrence of exposure and the cause of death or occurrence of disease. When the value of the PR is greater than 1, then the exposure is said to be positively associated with the cause of death or occurrence of disease and it is interpreted as a risk factor. Finally, when the value of the PR is less than 1, then the exposure is said to

Table 1. For a total of 389 deaths due to gastric dilatation-volvulus (GDV), the number of deaths due to GDV, the total number of deaths reported and the proportion of deaths due to GDV for each of 65 breeds that reported any deaths due to GDV

Breed	Deaths due to GDV	Total deaths	% Deaths	Breed	Deaths due to GDV	Total deaths	% Deaths
Akita	3	28	10.7	Hungarian wirehaired vizsla	1	15	6.7
Alaskan Malamute	1	14	7.1	Irish red & white setter	14	179	7.8
Anatolian/Karabash	1	23	4.4	Irish setter	24	451	5.3
Basset hound	12	142	8.5	Irish water spaniel	1	95	1.1
Bearded collie	1	278	0.4	Irish wolfhound	12	112	10.7
Bernese mountain dog	14	394	3.6	Italian greyhound	1	46	2.2
Bloodhound	25	82	30.5	Italian spinone	3	47	6.4
Borzoi	8	87	9.2	Komondor	1	10	10.0
Bouvier des Flandres	1	39	2.6	Labrador retriever	3	574	0.5
Boxer	7	130	5.4	Large Munsterlander	3	69	4.4
Briard	1	71	1.4	Manchester terrier	1	32	3.1
Bulldog	2	180	1.1	Mastiff	13	80	16.3
Bullmastiff	7	96	7.3	Neapolitan mastiff	2	7	28.6
Chesapeake Bay retriever	2	45	4.4	Newfoundland	15	269	5.6
Chow chow	16	80	20.0	Norfolk terrier	1	189	0.5
Clumber spaniel	1	69	1.5	Old English sheepdog	5	65	7.7
Curly coated retriever	3	40	7.5	Otterhound	4	54	7.4
Dachshund (all)	2	245	0.8	Pointer	1	145	0.7
Dalmatian	7	199	3.5	Pyrenean sheepdog	1	66	1.5
Deerhound	20	287	7.0	Rhodesian ridgeback	8	183	4.4
Dobermann	3	100	3.0	Samoyed	6	223	2.7
English setter	5	384	1.3	Shar-Pei	2	60	3.3
English springer spaniel	1	90	1.1	Siberian husky	2	129	1.6
Flatcoated retriever	22	610	3.6	Soft coated wheaten terrier	2	111	1.8
French bulldog	1	71	1.4	St Bernard	8	53	15.1
German longhaired pointer	1	2	50.0	Standard poodle	7	118	5.9
German shorthaired pointer	1	159	0.6	Sussex spaniel	2	42	4.8
German wirehaired pointer	1	41	2.4	Weimaraner	28	242	11.6
Golden retriever	5	927	0.5	Welsh springer spaniel	2	157	1.3
Gordon setter	2	157	1.3	Pembroke Welsh corgi	1	116	0.9
Grand Bleu de Gascogne	3	6	50.0	West Highland white terrier	1	127	0.8
Great Dane	32	171	18.7	Whippet	1	486	0.2
Greyhound	2	69	2.9				

Table 2. Breed-specific prevalence of gastric dilatation-volvulus (GDV) morbidity for the 44 breeds which reported cases

Breed	Cases of GDV	Total number of live dogs	Prevalence	Breed	Cases of GDV	Total number of live dogs	Prevalence
Afghan hound	2	193	1.0	Hovawart	1	49	2.0
Akita	3	87	3.5	Hungarian Vizsla	1	123	0.8
Alaskan Malamute	1	111	0.9	Irish red & white setter	10	337	3.0
Basset hound	6	226	2.7	Irish setter	49	680	7.2
Beagle	1	507	0.2	Irish wolfhound	2	123	1.6
Bernese mountain dog	10	629	1.6	Italian spinone	8	222	3.6
Bloodhound	16	112	14.3	Labrador retriever	3	1341	0.2
Borzoi	6	133	4.5	Large Munsterlander	1	180	0.6
Bracco Italiano	1	19	5.3	Leonberger	4	223	1.8
Bull terrier	1	293	0.3	Manchester terrier	1	117	0.9
Curly coated retriever	1	81	1.2	Newfoundland	10	506	2.0
Dalmatian	3	452	0.7	Norfolk terrier	1	458	0.2
Deerhound	14	442	3.2	Otterhound	5	56	9.0
Dobermann	1	129	0.8	Pekingese	1	174	0.6
English springer spaniel	1	258	0.4	Siberian husky	1	797	0.1
Flatcoated retriever	21	926	2.3	Soft coated wheaten terrier	1	505	0.2
Giant Schnauzer	2	113	1.8	St Bernard	4	87	4.6
Golden retriever	3	1717	0.2	Standard poodle	7	255	3.1
Gordon setter	4	293	1.4	Sussex spaniel	2	121	1.7
Grand Bleu de Gascogne	3	14	21.4	Tibetan spaniel	2	379	0.5
Great Dane	5	225	2.2	Weimeraner	28	558	5.0
Greyhound	1	113	0.9	Whippet	2	1214	0.2

be negatively associated with the cause of death or disease and it is interpreted as a preventive factor. The breed-specific PRs for GDV deaths were estimated as (the number of dogs of the breed of interest that died due to GDV divided by the total number of dogs of the breed of interest that died) divided by (the number of dogs of the other breeds that died due to GDV divided by the total number of dogs in the survey that died) so that the total number of dogs included in the calculation was 15,881 (Table 3, Fig 1). The breed-specific PRs for morbidity due to GDV were estimated as (the number of cases of GDV reported in live dogs of the breed of interest divided by the total number of live dogs of the breed of interest) divided by (the number of cases of GDV reported in live dogs of the other breeds divided by the total number of live dogs in the survey) such that the total number of dogs included in the calculation was 36,006 (Table 4). The estimated PRs were considered to be statistically significant when the P-value was less than the Bonferroni corrected level of significance of 0.05/k

for multiple comparisons (where k is the number of comparisons).

RESULTS

Data on cause of death and age at death for dogs that had died in the last 10 years were available for 15,881 dogs of 165 breeds. Data on the occurrence of disease and age at diagnosis of one or more episodes of disease were available for 36,006 live dogs of 169 breeds. Unfortunately there were no data on the German shepherd dog, which is consistently in the top 10 breeds registered with the UK Kennel Club, because the British Association for German shepherd dogs declined to take part in the survey.

GDV was reported as the cause of death for 389 dogs of 65 breeds, representing 2.5% (95% CI: 2.2 to 2.7) of all deaths reported. The median age at death due to GDV was 7 years and 11 months (minimum 8 months, maximum 16 years 6 months). The two breeds that had the most deaths due to GDV were the great

Dane (32 of 389=8%) and the Weimeraner (28 of 389=7%, Table 1). The two breeds with the greatest proportion of deaths due to GDV were the Grand Bleu de Gascogne and the German longhaired pointer, although each of these breeds had very few reported deaths in total. Data on sex and neuter status of dogs which had died due to GDV were not available.

GDV was reported as a cause of morbidity for dogs of 44 breeds (Table 2). There were 253 cases of GDV in 238 live dogs of 44 breeds with 224 dogs reported to have had one episode, 13 dogs had two episodes and 1 dog had three episodes. The prevalence of GDV morbidity was 0.7% (238 dogs affected out of 36,006 total live dogs). The median age at first diagnosis of GDV was five years (minimum three months, maximum 15 years 5 months, n=186 dogs with age reported). Considering the 238 live dogs which were reported to have suffered one or more episodes of GDV, 131 (55%) were female and 66 of these had been neutered. The 107 male dogs reported to have suffered one or

Table 3. Prevalence ratios (PRs) for gastric dilatation-volvulus (GDV) deaths in 23 breeds selected from Table 1 with three or more deaths due to GDV and more than 7% of deaths in that breed due to GDV

Breed	Number deaths due to GDVs	Total number of deaths	PR	95% Confidence interval	P-value (significance <0.002)*
Akita	3	28	4.4	1.5 to 12.9	0.03
Basset hound	12	142	3.5	2.0 to 6.1	<0.0001
Bloodhound	25	82	13.2	9.4 to 18.6	<0.0001
Borzoi	8	87	3.8	2.0 to 7.4	0.0002
Boxer	7	130	2.2	1.1 to 4.6	0.06
Bullmastiff	7	96	3.0	1.5 to 6.2	0.006
Chow chow	16	80	8.5	5.4 to 13.3	<0.0001
Curly coated retriever	3	40	3.1	1.0 to 9.2	0.12
Deerhound	20	287	3.0	2.0 to 4.6	<0.0001
German longhaired pointer	1	2	20.5	9.2 to 46.1	0.04
Grand Bleu de Gascogne	3	6	20.6	5.1 to 82.1	<0.0001
Great Dane	32	171	8.2	5.9 to 11.4	<0.0001
Irish red & white setter	14	179	3.3	2.0 to 5.5	<0.0001
Irish setter	24	451	2.3	1.5 to 3.4	0.0001
Irish wolfhound	12	112	4.5	2.6 to 7.7	<0.0001
Mastiff	13	80	6.8	4.1 to 11.3	<0.0001
Neapolitan mastiff	2	7	11.7	3.6 to 38.0	0.0012
Newfoundland	15	269	2.3	1.4 to 3.8	0.0016
Old English sheepdog	5	65	3.2	1.4 to 7.4	0.02
Otterhound	4	54	3.1	1.2 to 7.9	0.06
St Bernard	8	53	6.3	3.3 to 12.0	<0.0001
Standard poodle	7	118	2.5	1.2 to 5.1	0.03
Weimaraner	28	242	5.0	3.5 to 7.3	<0.0001

Example calculation of PR: (3 of 28)/(389 to 3 of 15881 to 28) = 4.4.

* Bonferroni corrected level of significance for multiple comparisons: $\alpha=0.05/k$ where k =number of comparisons, in this case 0.05 of $23=0.002$.

more episodes of GDV showed a less even distribution of neuter status, with only 36 of them having been neutered. The four breeds with the highest prevalence of GDV were the Grand Bleu de Gascogne, bloodhound, otterhound and Irish setter (Table 2).

The breeds which appeared to be at most risk of dying due to GDV were the bloodhound, Grand Bleu de Gascogne, German longhaired pointer and Neapolitan mastiff (Table 3). As mentioned earlier, very few deaths were reported in the Grand Bleu de Gascogne and German longhaired pointer, and the P-values greater than 0.002 and the wide confidence limits for the PRs in these two breeds reflect this. The Grand Bleu de Gascogne and bloodhound also appeared to be at the highest risk of morbidity due to GDV. In contrast to the other breeds at most risk of dying due to GDV, the breeds at most risk of morbidity due to GDV were the otterhound, Irish setter and Weimaraner (Table 4). All the

breeds which appeared to be at increased risk of morbidity or mortality due to GDV were large or giant breeds except the basset hound and chow chow.

DISCUSSION

A retrospective study by Glickman and others (1994) which is widely referred to on health information websites aimed at dog breeders/owners reported ORs which show the probability of a dog of a particular breed having been admitted to one of 12 state veterinary institutions in the USA with GDV compared to the probability of a German shepherd dog having been admitted to the same institutions with GDV (Glickman and others 1994). They reported that six breeds were at significantly increased risk and these were the great Dane (OR=10.0), Weimaraner (4.6), St Bernard (4.2), Gordon setter (4.1), Irish setter (3.5) and standard poodle (2.9). The

PRs estimated in this study suggest that 23 breeds were at significantly increased risk of death due to GDV compared to dogs of other breeds. These include five of the six breeds reported by Glickman and others (1994), although the Gordon setter was not at significantly greater risk. It is unfortunate that there were no data for German shepherd dogs in this study. Because the study by Glickman and others was a case-control study the authors could only report ORs (Petrie and Watson 2006). As this study was cross-sectional and several of the breed-specific prevalences/proportions were such that GDV could not be considered to be rare, we chose to report PRs in order to avoid overestimating the risk. Care must be taken when interpreting these data to consider how the risks were estimated and also the width of the 95% CIs for the reported risks. One can put more weight on a PR with relatively narrow 95% CIs such as the bloodhound than one with relatively wide 95% CIs

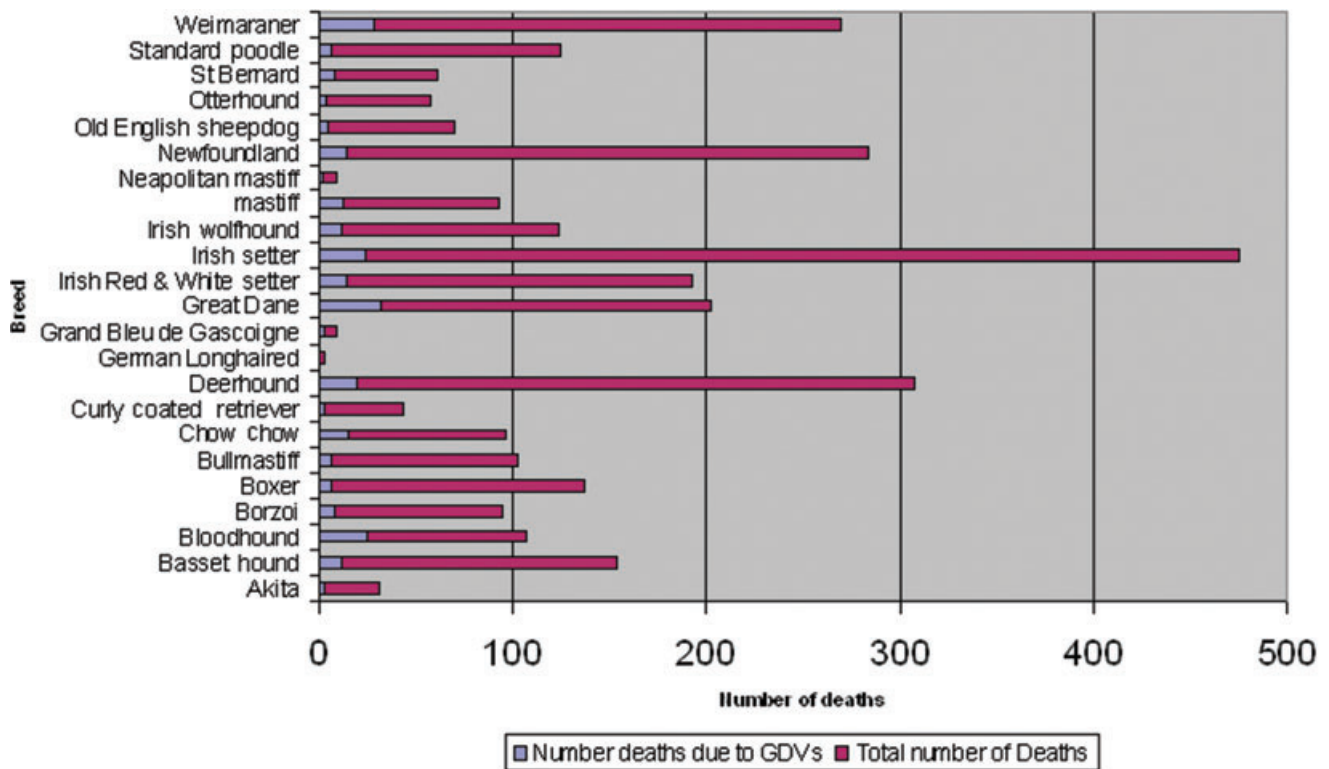


FIG 1. Total number of deaths due to GDV for 23 breeds of dog with three or more deaths due to GDV and more than 7% of deaths in that breed due to GDV

Table 4. Prevalence ratios (PRs) for gastric dilatation-volvulus (GDV) morbidity in four breeds selected from Table 2 with three or more cases of GDV and more than 7% of dogs affected by GDV in that breed

Breed	Number of GDVs	Number of live dogs	PR	95% Confidence intervals	P-value (significance <0.0125)*
Grande Bleu de Gascogne	3	14	31.1	11.32 to 85.45	<0.0001
Bloodhound	16	112	21.8	13.62 to 34.95	<0.0001
Otterhound	5	56	13.1	5.601 to 30.40	<0.0001
Irish setter	49	680	12.6	9.31 to 17.06	<0.0001

Example calculation of PR: (16 of 112)/(251 to 16 of 36006 to 112)=21.8.
 * Bonferroni corrected level of significance for multiple comparisons: alpha=0.05/k where k=number of comparisons, in this case 0.05 of 4=0.0125.

such as the Grand Bleu de Gascogne in the present study.

A retrospective study at Pennsylvania Veterinary Hospital of 295 cases of GDV affecting dogs of 35 breeds reported a breed predisposition in German shepherd dogs (21% of GDV cases), great Danes (14%), large mixed breed dogs (10%) and standard poodles (5.1%) (Brockman and others 1995). Our results agree with this study in that both great Danes and standard poodles were at increased risk of morbidity and mortality due to GDV.

A total of four breeds were at significantly increased risk of morbidity due to

GDV compared to dogs of other breeds. Of the two breeds that appeared to be at significantly increased risk of morbidity or mortality due to GDV which are not large or giant breeds, the basset hound has been suggested to be at increased risk by other authors (Burrows and Ignaszewski 1990, Glickman and others 1994) but the chow chow has not been mentioned in this context prior to this study.

Rawlings and others (2002) suggest that several years without any signs of gastrointestinal tract problems in a dog that may be susceptible to GDV does not guarantee that this dog will not develop

GDV as shown by the acute onset of GDV unexpectedly in middle-aged or older dogs (Rawlings and others 2002). The median age at first diagnosis of five years in this study, and more strikingly the maximum reported age of 15 years and 5 months at first diagnosis, appears to support this suggestion. As this study was an anonymous cross-sectional study, it was impossible to tell whether the live dogs which had been reported to have had one or more episodes of GDV had subsequent episodes or have even died due to GDV since the survey. It was also not possible to differentiate between cases of GD without volvulus and cases of GDV.

Much has been written about possible risk factors for GDV apart from those associated with breeding. These include dietary factors such as feeding a large volume of food at each meal (Raghavan and others 2004), small particle size of food (Theyse and others 1998), feeding a single food type and the occurrence of aerophagia (Elwood 1998). Other non-dietary risk factors include increasing age (Glickman and others 1994) and recent kenneling or a car journey (Elwood

1998). Many other potential risk factors have been suggested in the results of some studies while being considered to be of little importance from the results of other studies. Falling into this category are gender and neuter status, having a low body condition score, temperament, speed of eating, frequency of feeding and height of food bowl (Glickman and others 1994, 1997, 2000a,b).

The results of this study suggest that in the UK 16 breeds of dog are at increased risk of morbidity or mortality due to GDV. All but two of these are large or giant breeds – the basset hound and chow chow being the exceptions. The breeds at highest risk are the bloodhound, Grand Bleu de Gascogne, German longhaired pointer, Neapolitan mastiff, otterhound and Irish setter, although there were relatively few cases of deaths or morbidity due to any causes reported for the Grand Bleu de Gascogne and the German longhaired pointer. Cases of morbidity due to GDV were quite evenly distributed between males and females, and among the males more cases occurred in dogs which had

not been neutered, but these data were not available for deaths.

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