

# **TRANSIENT COLLAPSE IN DOGS AND CATS, IN A CARDIORESPIRATORY REFERRAL POPULATION**

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## ABBREVIATIONS

|        |                                                 |
|--------|-------------------------------------------------|
| ARVC   | Arrhythmogenic right ventricular cardiomyopathy |
| AS     | Aortic Stenosis                                 |
| BPM    | Beats per minute                                |
| CI     | Confidence Interval                             |
| cTnI   | Cardiac troponin I                              |
| CUO    | Collapse of unknown origin                      |
| CVD    | Chronic valve disease                           |
| DCM    | Dilated cardiomyopathy                          |
| DLH    | Domestic longhair                               |
| DRVOTO | Dynamic right ventricular cardiomyopathy        |
| DSH    | Domestic shorthair                              |
| ECG    | Electrocardiogram                               |
| EIC    | Exercise induced collapse                       |
| HCM    | Hypertrophic cardiomyopathy                     |
| HM     | Holter monitor                                  |
| HR     | Heart rate                                      |
| IPF    | Interstitial pulmonary fibrosis                 |
| IQR    | Interquartile range                             |
| KM     | Kaplan Meier                                    |
| LVH    | Left ventricular hypertrophy                    |
| MVD    | Mitral valve dysplasia                          |
| PE     | Pericardial effusion                            |
| PH     | Pulmonary hypertension                          |
| RTA    | Road traffic accident                           |
| SVT    | Supraventricular tachycardia                    |
| TLOC   | Transient loss of consciousness                 |
| TTT    | Tilt table test                                 |
| UCM    | Unclassified cardiomyopathy                     |
| VPC    | Ventricular premature complex                   |

# MASTERS RESEARCH PROJECT

## 1 INTRODUCTION

### 1.1 DEFINITION OF TERMS

Collapse and transient loss of postural tone is a notoriously difficult topic to investigate in human and veterinary medicine, since there are many possible underlying aetiologies, clinical signs may be transient and therefore rely on owner/patient description, and the diagnoses are often largely reliant on the clinician's opinion. Additionally, there are many descriptive/diagnostic terms used and only some of them have robust definitions, leading to misuse by practitioners and confusion within the literature.

Transient loss of consciousness (TLOC) describes a clinical sign, rather than a disease, and encompasses syncope and all other causes of TLOC, such as seizure, hypoglycaemia and concussion (minor traumatic brain injury) (Puppala et al., 2014). Syncope is defined as a transient (self-limited) loss of consciousness due to cerebral hypoperfusion (Moya et al., 2009; Puppala et al., 2014), however it is often misused to broadly describe TLOC from any non-traumatic aetiology (Kapoor, 2002). This may be due to the fact that differentiating true syncope from non-syncopal conditions, with real or apparent loss of consciousness can be difficult (Moya et al., 2009). It is also why the term 'collapse' is commonly used to describe sudden, transient, unintentional recumbency, regardless of the underlying cause and/or pathophysiological mechanism. TLOC and syncope are terms used in human medicine, however they are not directly applicable to the veterinary setting, as owners are often not certain whether their pet lost consciousness; typically they use subjective descriptions such as 'dazed', 'glazed' or 'out of it'. Additionally, in the clinical setting, we do not perform provocative testing (such as the tilt table test or active standing) on our veterinary patients and therefore we should not legitimately use the term 'syncope' or 'TLOC'. That being said, there are situations in veterinary medicine where the terminology is in widespread use (in spite of a

lack of provocative testing) and therefore arguably used correctly. These are the reflex syncope, such as 'vasovagal syncope' and 'tussive syncope', which describe disorders of autonomic control. Weakness, in the medical setting, is used to describe a lack of muscle strength. Collapse is difficult to define and there is no good agreement between practitioners, with some clinicians preferring to reserve 'collapse' for circulatory failure. In the Oxford English Dictionary, collapse is defined as "to suddenly fall down or give way" (Oxford University Press, 2013) and in this study, will be used to describe transient, unintentional prostration (with or without loss of consciousness), without any observed trauma; in order to avoid any misuse of more defined terms, such as syncope, TLOC and seizure. Seizure has similar problems with definition; as it can be used in colloquial language, e.g. a 'heart seizure'. An epileptic seizure is defined as "a transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain" (Fisher et al., 2005); in this study, seizure will be used to describe an epileptic seizure.

#### **1.1.1 Tilt Table Testing**

The tilt table test (TTT) is a non-invasive test used in human medicine, aimed at reproducing syncope whilst monitoring a patient electrophysiologically. It was first described in 1986 (Kenny et al., 1986) and is particularly useful at identifying dysfunction of the autonomic nervous system as a cause of the syncope (Moya et al., 2009). The patient is attached to blood pressure and electrocardiography monitors and lies flat on the tilt table for a rest period of 5-20 minutes. The table is then tilted to 60-70 degrees until their syncope is reproduced or for a maximum of 45 minutes. Typically there is a drop in heart rate and/or blood pressure, which is restored by returning the patient to a supine position. If there is no response, intravenous isoproterenol or sublingual nitroglycerine can be administered, to produce a tachycardia or vasodilatory reduction in blood pressure respectively, and improve the sensitivity of the test (Moya et al., 2009).

## **1.2 AETIOLOGY**

The body requires co-ordinated, effective activity in many systems in order to maintain posture against the force of gravity. Broadly, the central nervous system (brain and spinal cord) and the peripheral nervous system (efferent/motor and afferent/sensory subsystems) are required to control consciousness, muscle tone and homeostasis; the musculoskeletal system provides the scaffolding for the rest of the body; the cardiovascular system maintains tissue perfusion; the respiratory system primarily provides oxygen; the endocrine system is needed to regulate tissue metabolism and function, the gastrointestinal system provides nutrients; the hepatic system primarily affects metabolism and energy production; the renal system maintains the volume and composition of body fluids within normal limits; and the haematopoietic system produces blood cells. Therefore, any condition which affects one or more of these systems can cause collapse.

### **1.2.1 Common mechanisms of collapse seen in a cardiorespiratory caseload**

#### **1.2.1.1 *Disorders of autonomic control***

There are many reflex-mediated syncopal conditions, including vasovagal syncope (also called neurocardiogenic syncope, vasodepressor syncope and fainting (Calkins and Zipes, 2008)), tussive syncope, micturition syncope and defaecation syncope. The reflex is triggered by an inciting event and the response is an increase in vagal tone and withdrawal of sympathetic tone. This leads to bradycardia and vasodilation, which causes hypotension and reduced cerebral perfusion. The metabolism of the brain is dependent on perfusion, so even a brief reduction in perfusion leads to a loss of consciousness (Calkins and Zipes, 2008). Although the trigger may vary depending on the situation; for example, micturition syncope is triggered by mechanoreceptors in the bladder wall and defaecation syncope is triggered by tension receptors in the gut wall (Calkins and Zipes, 2008), the clinical effect is similar.

Vasovagal syncope is primarily caused by vasodilation and hypotension (with/without enhancement of parasympathetic tone causing bradycardia) (Grubb, 1999); this has been demonstrated in a study by Lewis (1932) who found that administration of atropine abolished the bradycardia but did not prevent the hypotension or fainting. Vasovagal syncope is initiated by a reduction in ventricular filling or a surge in sympathetic activity, as demonstrated by increased plasma epinephrine levels; followed by a decrease in sympathetic tone, evidenced by a reduction in norepinephrine levels at the onset of syncope (Grubb, 1999; Kikushima et al., 1999). Prior to the syncope, a reduced ventricular preload caused by peripheral venous pooling is thought to cause an increase in sympathetic tone, which sensitises the cardiac mechanoreceptors (or C-fibres) and arterial baroreceptors. The sympathetic surge then causes the heart to contract strongly against an under-filled ventricle, leading to activation of the mechanoreceptors (in susceptible patients), the sudden increase in neural signals along the afferent C-fibres (which project to the dorsal vagal nucleus of the medulla) (Grubb, 1999; Calkins and Zipes, 2008) leads to an abrupt withdrawal of sympathetic tone and an increase in parasympathetic/vagal tone. Sometimes vasovagal syncope is not caused by activation of mechanoreceptors, rather it arises from a central mechanism, which is not yet clearly understood (Grubb, 1999; Calkins and Zipes, 2008). Endogenous opiates and the neurotransmitter serotonin (5-hydroxytryptamine) are thought to play a role (Grubb, 1999).

In dogs, vasovagal syncope is typically caused by sudden excitement/exertion/being startled which triggers the sympathetic surge (Johnson et al., 2007; Thomason, 2009; Thomason et al., 2011). It can be seen in healthy dogs, or in dogs with chronic valve disease (CVD) (Thomason, 2009). In dogs with CVD, it is thought that stretch receptors in the left atrium/pulmonary vein junctions are sensitised, along with volume loading of the left ventricle and rapid systolic emptying due to the mitral regurgitation (Thomason, 2009).

#### 1.2.1.2 *Reduced cardiac output*

Any condition causing a reduction in cardiac output can lead to reduced tissue perfusion, and therefore a reduction in oxygen/nutrient delivery to the brain and other tissues. Cardiac output is determined by heart rate and stroke volume. Tachyarrhythmias, e.g. supraventricular tachycardia (SVT), can allow insufficient time for diastolic filling and a reduction in stroke volume and bradyarrhythmias, e.g. third degree atrioventricular block, cause a reduction in heart rate. Conditions causing systolic dysfunction, such as dilated cardiomyopathy (DCM) or myocarditis, cause a reduction in contractility (and therefore stroke volume); and conditions causing diastolic dysfunction, such as pericardial effusion (PE) and restrictive cardiomyopathy, result in decreased ventricular filling and a reduced stroke volume. Obstruction to the flow of blood out of either side of the heart can be caused by a number of conditions, such as aortic stenosis (AS) or hypertrophic obstructive cardiomyopathy.

#### 1.2.1.3 *Pulmonary hypertension*

Syncope due to pulmonary hypertension (PH) tends to occur with exertion. The literature is not forthcoming regarding the mechanism of syncope in patients with PH. If there is right ventricular hypertrophy evident, then it is logical to assume that cardiac output would be affected. It is thought that hypoxaemia may play a role (Saunders, 2013), or that high pulmonary vascular resistance could limit cardiac output (Howarth and Lowe, 1953), which may be especially relevant during exercise/exertion (when the heart typically increases cardiac output in order to maintain tissue perfusion and meet the increased metabolic demands). A now dated study by Howarth (1952) reports that systolic failure of the right ventricle may be responsible. Poor left ventricular output (due to pressure overload of the right heart and consequent reduced left ventricular preload) have also been thought to contribute (Johnson et al., 1999).

#### 1.2.1.4 Hypoxia/hypoxaemia

Disorders of the upper and lower respiratory tract which result in reduced blood oxygenation can also cause collapse, most commonly on exertion, e.g. brachycephalic obstructive airway syndrome, laryngeal paralysis and left sided congestive heart failure. The mechanism is due to reduced oxygen inspiration (e.g. altitude), alveolar hypoventilation (e.g. major airway obstruction, primary lung pathology), ventilation-perfusion mismatch (e.g. severe parenchymal disease), impairment of gas diffusion (e.g. pulmonary oedema), right-to-left shunt (e.g. tetralogy of Fallot) or abnormal haemoglobin (e.g. methemoglobinemia secondary to ibuprofen toxicity) (King, 2004).

### 1.3 PREVALENCE

There is no published information on the prevalence of TLOC, syncope, collapse or weakness in cats or dogs. In people it is estimated that up to 50% of the population experience syncope during their lifetime (Fitzpatrick and Cooper, 2006). However, both collapse and transient weakness are uncommon presenting histories in cats (Lievesley, 1989), although it is reported that weakness is encountered more frequently than collapse (Lievesley, 1989; Gruffyd-Jones, 1991).

### 1.4 PROGNOSIS/RISK STRATIFICATION

Collapse can be a benign clinical sign, the only indicator of serious underlying disease, or a warning that the next collapse may be a sudden death. Consequently, it is important to try and stratify risk, which largely relies on identifying the underlying cause. However, reaching a diagnosis can be challenging due to the intermittent nature of the clinical signs and the wide variety of potential underlying causes. In human patients exhibiting syncope a definitive diagnosis is not made in 19-41% of cases (Kapoor, 2002; Mitro et al., 2011) and in a report of dogs presenting with collapse/weakness/exercise intolerance a diagnosis was not reached in 33% of cases (Barnett et al., 2011). Furthermore, even if a diagnosis is made the mechanism of the collapse can be multifactorial, making prediction of outcome difficult.

There are very few published studies in the veterinary literature which primarily address outcome in cases presenting with a history of TLOC/syncope/collapse/weakness. One study reported that 16% of dogs died or their condition deteriorated (in relation to their collapse/exercise intolerance) however this study only included dogs for which a diagnosis could not be made (Barnett et al., 2011).

Given these challenges, any method of identifying animals at greater risk of a poor outcome would help establish the prognosis in these cases.

## **1.5 VETERINARY LITERATURE OVERVIEW**

### **1.5.1 Cats**

In cats, there is very little published on the subject; a review article (Lievesley, 1989), along with reports in the proceedings from two conferences (Gruffyd-Jones, 1991; Ferasin, 2011), provide a summary of collapse/weakness in cats. Two practitioner articles describe the clinical approach to the weak cat (focusing on neuromuscular causes) (Nghiem et al., 2009; Volk et al., 2011) and there are case reports of weakness and/or collapse associated with SVT (Harwood, 1970; Ferasin, 2009b), atrioventricular block (Ferasin et al., 2002; Penning et al., 2009), cardiac lymphoma (Meurs et al., 1994), muscular dystrophy (Poncelet et al., 2003), heartworm (Malik et al., 1998), arrhythmogenic right ventricular cardiomyopathy (ARVC) (Harvey et al., 2005) and defaecation syncope (Whitley and Stepien, 2001).

Additionally, there is a letter describing periodic weakness in Burmese kittens (Blaxter et al., 1986), a study of the use of cardiac event recorders in dogs and cats (which includes 2 cats with syncope which were both diagnosed with cardiac disease) (Bright and Cali, 2000) and a paper by Chetboul et al. which found that 2 of 45 cats with an atrial septal defect experienced syncope (2006). Finally, episodic syncope due to ventricular flutter has been described in a tiger (DeLillo et al. 2013).

### **1.5.2 Dogs**

In dogs, Barnett et al (2011) has published on the outcome of 153 dogs presenting with undiagnosed collapse/syncope/exercise intolerance and Thomason et al (2008) reported on 7 Boxers with syncope; otherwise, there are only practitioner review articles (Davidow et al., 2001; Platt and Garosi, 2004; Wray, 2005). There have been manuscripts published on exercise induced collapse (EIC) (Patterson et al., 2008; Taylor et al., 2008; Taylor et al., 2009; Minor et al., 2011; Takanosu et al., 2012), ambulatory electrocardiography recording of dogs presenting with collapse/weakness/syncope (Miller et al., 1999; Bright and Cali, 2000; James et al., 2008; MacKie et al., 2010), a case report of tussive syncope in a pug (Davies et al., 2011) and conference proceedings of neurocardiogenic bradycardia-related syncope (Thomason, 2009; Thomason et al., 2011).

## 2 STUDY AIMS

As outlined above, there is a myriad of potential aetiologies of collapse. However, difficulties in diagnosis only arise for conditions that have transient clinical signs. Practitioners can generally diagnose diseases that produce sustained clinical signs and/or changes on physical examination or readily available diagnostic tests. For example, systemic diseases which produce a prolonged change on serum biochemistry/haematology, e.g. hypoadrenocorticism, anaemia; orthopaedic disease resulting in sustained motor dysfunction and/or pain, e.g. cruciate rupture, intervertebral disc protrusion; and diseases for which there is a readily available confirmatory test, such as myasthenia gravis (positive serum antibody titre to acetylcholine receptors). Additionally, should a veterinary surgeon elect to refer an animal, the discipline to which they choose to refer it is based upon the history and presenting clinical signs; as is the reason given for referral. For example, an animal which is lame would not be referred to a cardiologist for investigation of collapse; patients presenting with clinical signs consistent with seizures (tonic clonic limb movement, pre-/post-dromal phase, jaw chomping) are most likely to be referred to a neurologist for the investigation of seizures (although there are reports of human patients with cardiac disease being misdiagnosed with seizures (Zaidi et al., 2000) and exercise-induced seizures in a dog (Motta and Dutton, 2013). This leaves a subset of patients which display no clinical signs at presentation, without a history suggestive of seizure-like activity and/or orthopaedic disease, and whose primary presenting complaint is collapse, which are most often referred to cardiologists (especially if the collapse occurs on exertion and/or a murmur/arrhythmia is auscultated); and this is the group of patients this study aims to investigate.

The aim of this study, therefore, was to review the case history, diagnosis (if found) and outcome of cats and dogs presenting with collapse to referral cardiology centre(s). The second aim, was to identify key parameters from the signalment, history, clinical examination and diagnostic investigations which negatively impact on survival in dogs presenting with collapse to referral cardiology centre(s).

### **3 MATERIALS & METHODS**

#### **3.1 ETHICAL APPROVAL**

Prior to the study ethical approval was obtained from the ethics committee of the University of Nottingham School of Veterinary Medicine and Science (identified by project title) and the study was carried out in accordance with the University of Nottingham's research code of ethics and data protection policy.

#### **3.2 CATS**

A retrospective study of clinical records and telephone follow-up data, of cats presenting with collapse or weakness (either generalised or of the hindlimbs) was conducted. In this manuscript, 'collapse' in the cat population will also include cats with transient weakness.

The cases included in this study came from two sources:

- 1) All cases presenting to a cardiorespiratory referral veterinary practice were recorded in a database (Microsoft Access). The database (December 2001 – November 2012) was searched for cats with a presenting complaint of 'weakness', 'collapse', 'syncope', 'faint', 'seizure' and 'fit'.
- 2) All cases examined by the primary author (cardiorespiratory cases, at a first opinion and referral veterinary hospital) were recorded in a database (Microsoft Excel 2007). The database was used to identify all cats examined from November 2009-December 2012. The computerised records of these cats were individually searched for 'collapse', 'syncope', 'faint', 'seizure', 'fit' and 'weakness'. Cats were included if at least one of these search terms was identified during their presenting examination.

Cases were excluded if clinical records were not available. The case records of included cats were reviewed for history, signalment, clinical examination findings, serum biochemistry and haematology results, the results of electrocardiographic recording (ECG), Holter monitor recording (HM), echocardiography and radiography, diagnosis, diagnosed cause for the collapse(s) (when achieved) and outcome (including time to death from all causes). In all cases, diagnostic investigations were selected and performed as deemed appropriate by the attending veterinary surgeons, based on the history obtained and findings following clinical examination. 'Death' was defined as mortality from all causes, including euthanasia. For cases in which the exact date of death/birth was not known, it was taken as the first day of the month.

Follow-up data was gathered by telephoning the referring veterinarians; where the case records and/or referring veterinarian's information was incomplete, the owners of the cats were telephoned (twice) and/or emailed (once) and asked the same set of questions (Appendix 1). The answers were manually recorded.

Health problems at presentation were grouped as follows: none, anaemia, cardiac disease, endocrine disease, gastrointestinal disease, musculoskeletal disease, neurological disease and upper respiratory disease. Unless otherwise stated, the results of diagnostic tests were assessed against published reference ranges (Boon, 1998; Schwarz et al., 2008; Tilley and Smith, 2008; Ferasin, 2009a) or the external laboratories' reference ranges. Left ventricular hypertrophy, identified on echocardiography, was defined as any area of left ventricular wall thickness  $\geq 6\text{mm}$  (Ferasin, 2003).

‘Diagnosis’ refers to any disease identified by diagnostic investigations, irrespective of whether it was thought to be the cause of the collapse. Cats were grouped according to the diagnosis as follows: cardiomyopathy, other cardiac disease, hyperthyroidism, neurological disease and no diagnosis made. ‘Cause for collapse’ refers to the condition identified by diagnostic investigations which was thought to be the underlying cause for the collapse, as recorded in the clinical records and either presumptively diagnosed (based on the available evidence) or definitively diagnosed.

Cats were grouped as follows: collapse of unknown origin (CUO), cardiac disease (including cardiac disease and arrhythmia) and non-cardiac disease. The group ‘non-cardiac disease’ included cats with a presumptive diagnosis of neurological disease, based on suggestive history and/or clinical signs (i.e. they did not undergo confirmatory diagnostic tests, such as magnetic resonance imaging and/or cerebrospinal fluid analysis, during their work-up under the cardiorespiratory service, and referral to a neurologist was advised) along with all other non-cardiac diseases.

### **3.3 DOGS**

A retrospective study reviewing the medical records of dogs referred with a history of collapse, to a cardiorespiratory referral-only veterinary practice was conducted. All cases at the practice were searched between 2001 and 2009 for all of the following terms: ‘faint’, ‘collapse’, ‘fit’, ‘seizure’, ‘syncope’ and ‘weakness’.

The case files were reviewed for: history, breed, age, sex, clinical examination findings, serum biochemistry and haematology results and the results of ECG, echocardiography, radiography, HM, diagnosis and time to death. In all cases, diagnostic investigations were selected and performed as deemed appropriate by the attending veterinary surgeons, based on the history obtained and findings following clinical examination.

The owners and referring veterinarians were contacted by telephone to obtain follow-up data (Appendix 2). The final dataset for analysis was based on the clinical records and follow up information. Cases were excluded if case records were unavailable or if there was no follow-up data available.

‘Unrelated health problems’ included any previous or concurrent health problems, which were unrelated to the collapse, and had required hospitalisation or long term medication (30 days or more). On clinical examination and ECG, bradycardia was defined as a heart rate less than 50 beats per minute (BPM) and tachycardia as a heart rate greater than 160 BPM (Höglund et al., 2012).

For clinical examination, bradyarrhythmia described a heart rhythm at a rate less than 50 BPM, and tachyarrhythmia described a heart rhythm at a rate greater than 160 BPM. For ECG and HM, ‘arrhythmia’ was defined as any rate or rhythm abnormality which would not be expected in a healthy dog. Therefore, on HM ‘arrhythmia’ did not include: isolated ventricular premature complexes (VPC) (less than 50 per 24 hours) (Hall et al., 1991; Ulloa et al., 1995; Rasmussen et al., 2011), sinus pauses at rest (Hall et al., 1991; Ulloa et al., 1995; Rasmussen et al., 2011) and/or sinus tachycardia during exercise (Van Citters and Franklin, 1969). For ‘ongoing collapse’, dogs were separated into two groups: those that did not experience another collapse following their presenting appointment and those that did experience one or more episodes of collapse after their presenting appointment.

‘Cause for collapse’ refers to the condition identified by diagnostic investigations which was thought to be the underlying cause for the collapse, as recorded in the clinical records and either presumptively diagnosed (based on the available evidence) or definitively diagnosed. Dogs were grouped according to the ‘cause of collapse’, as follows: CUO, cardiac disease (including cardiac disease and arrhythmia) and non-cardiac disease. The group ‘non-cardiac disease’ included dogs with a diagnosis of vasovagal syncope, EIC, tussive syncope, splenic mass and PH (defined as pulmonary arterial pressure  $\geq 50$ mmHg (Johnson et al., 1999)). The category ‘vasovagal syncope’ included dogs with a diagnosis confirmed by collapse during HM (transient sinus tachycardia, followed by transient sinus bradycardia, with an appropriate history (Johnson et al., 2007)) and/or dogs with a history strongly suggestive of vasovagal syncope (collapse preceded by sudden excitement/exertion/startle, with no abnormalities identified on resting ECG (Thomason, 2009; Thomason et al., 2011)). The results of all diagnostic tests were based on published reference ranges (Buchanan and Bücheler, 1995; Boon, 1998; Schwarz et al., 2008; Tilley and Smith, 2008) or by external laboratories.

‘Death’ was defined as mortality from all causes, including euthanasia. Cases which were still alive at the end of the follow-up period were right-censored. For cases in which the exact date of death/censor/birth was not known, it was taken as the first day of the month. Follow-up data included whether the collapse(s) had resolved and the date of death.

### 3.4 STATISTICS

Data from the records, referring veterinarians and owners was combined, coded and entered into the software programme SPSS Statistics 20 (IBM, Portsmouth). Descriptive statistics are expressed as mean  $\pm$  standard deviation for normally distributed continuous variables, as median  $\pm$  interquartile range (IQR) for non-normally distributed continuous variables and as percentages for categorical variables. Normality was assessed by kurtosis, skewness and the Kolmogorov-Smirnov test. Kaplan Meier (KM) analysis was used to describe median survival times (and 95% confidence intervals (CI)) for all cats included in the study, all dogs included in the study and the dog categories for 'cause of collapse', with/without ongoing collapse and risk score (see explanation below).

In dogs, statistical analysis was used to identify parameters that were associated with decreased survival time as follows. Univariable Cox regression survival analysis was used to identify individual variables that were associated with survival to carry forward to the multivariable analysis ( $p < 0.25$ ). Multivariable analysis comprised a Cox proportional hazards model and variables remained in the final model when the significance probability was  $P < 0.05$ . The cox proportional hazards model was repeated using the packages "survival" (Therneau, 2015) and "survminer" (Kassambara and Kosinski, 2019) in the R statistical software (R Core Team., 2014), to confirm that the assumption of proportional hazards was not violated. This was done using the conventional method with Schoenfeld residuals (Grambsch et al., 1994; Schoenfeld, 1980) to demonstrate that there were no systematic changes over time, which is consistent with hazards being proportional. A global test of proportionality of hazards using the 'cox.zph()' function was used to confirm that there was no clear evidence of a lack of proportionality of hazards in the model. To provide even more evidence of the safety of the model, further diagnostics checks were conducted, specifically to test for influential observations. The delta-betas were calculated (changes in the regression coefficients when deleting each observation one by one).

## 4 RESULTS

### 4.1 CATS

#### 4.1.1 Case inclusion

The database search identified 44 cats, case records were not available in 11, leaving 33 cases included for analysis (Figure 1). One hundred and fifty-three cats were referred to the primary author during the study period and the primary complaint in 13 of these cats (8%) met the search terms. The median follow-up period was 600 days (IQR 132-906 days, range 3–2208 days).

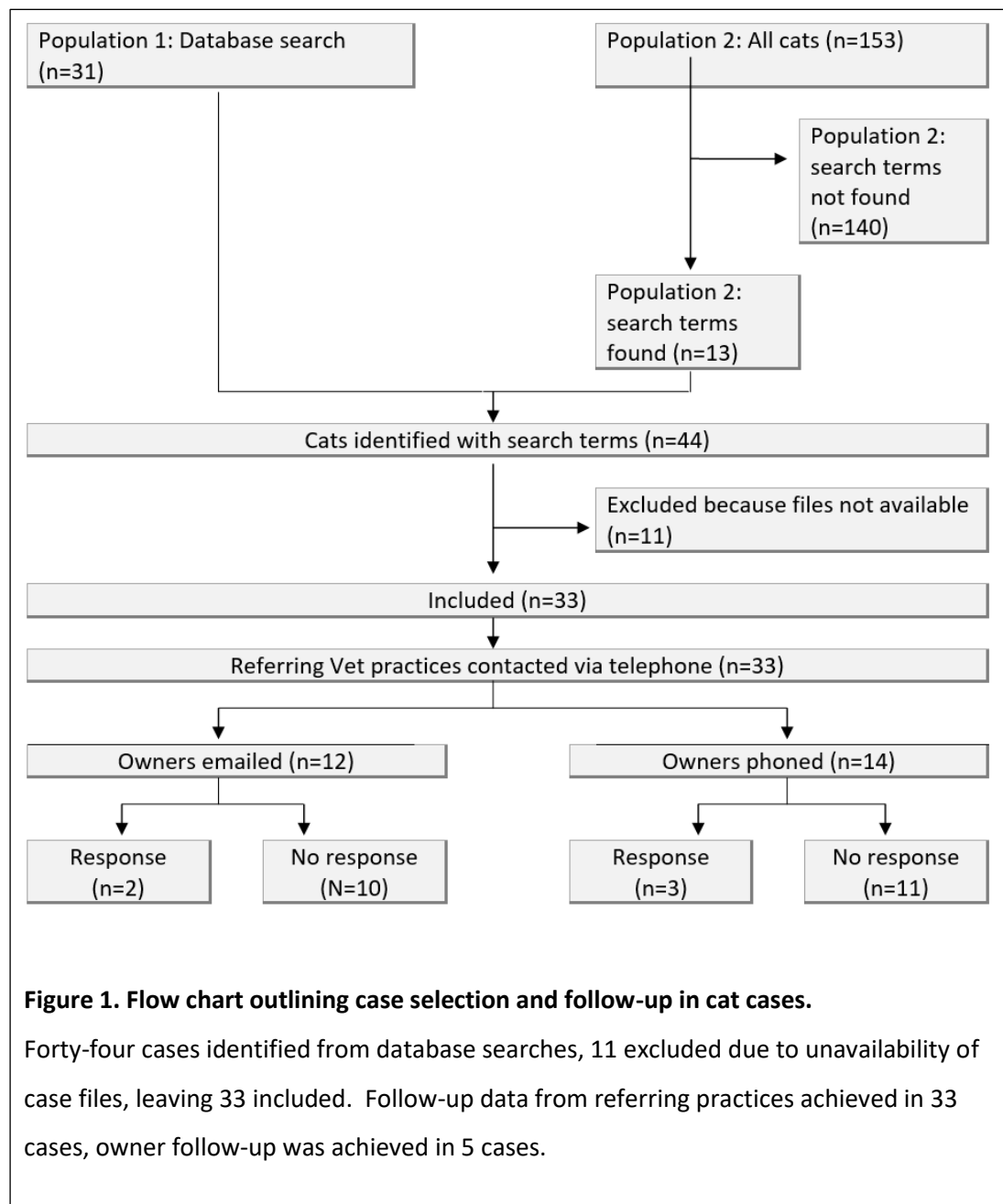


**Figure 1. Flow chart outlining case selection and follow-up in cat cases.**

Forty-four cases identified from database searches, 11 excluded due to unavailability of case files, leaving 33 included. Follow-up data from referring practices achieved in 33 cases, owner follow-up was achieved in 5 cases.

#### 4.1.2 Signalment

The mean age of cats included in the study was 7 years 10 months (SD 4 years 9 months; range 10 months – 17 years 7 months) (Figure 2). The most common breed represented was Domestic Shorthaired (DSH) (n=21, 64%) followed by Domestic Longhaired (DLH) (n=4, 12%). Pedigree breeds included Devon Rex, Main Coon, Persian (2 of each), British shorthair and Siamese (1 of each). Males were more common than females (70% and 30% respectively).

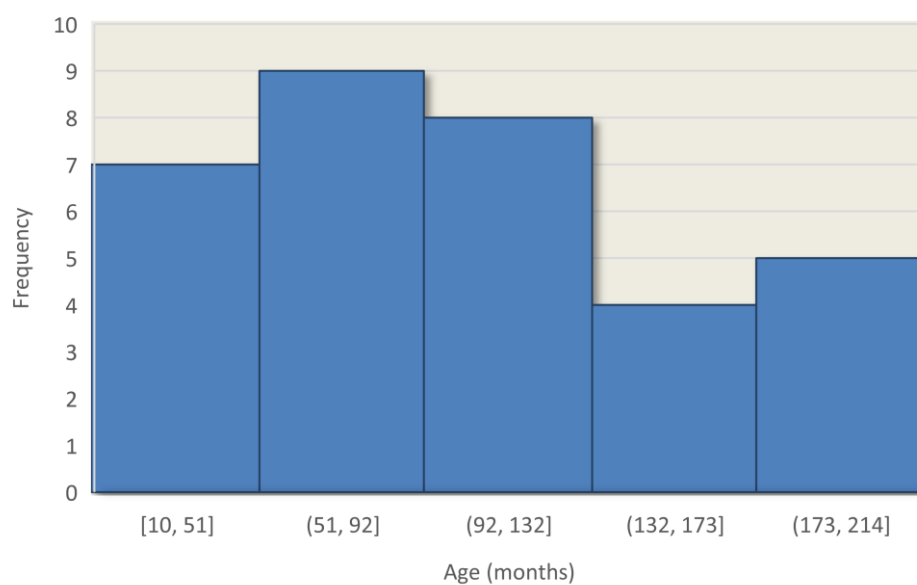


**Figure 2. Histogram displaying the ages of the cats in the study.**

The mean age of cats included in the study was 7 years 10 months (SD 4 years 9 months; range 10 months – 17 years 7 months).

#### **4.1.3 History and diagnostic investigations**

Data for health problems noted at presentation for referral was available for 17 cats (Appendix 3). The most common problem was cardiac disease (n=3, 18%), followed by endocrine and musculoskeletal disease (each n=2, 12%).

A description of the collapse was available for 28 cats, and of these sudden recumbency was reported in 71% of cases (n=20) and weakness in 29% (n=8) (Table 1). In the 21 cats for which data was available, the collapse was associated with a preceding event in 62% (n=13); and of these 13 cats, the most common association given was exercise/exertion (n=5, 38%). All owners reported that their cats were unaware of an impending collapse (i.e. there were no pro-dromal signs) and none demonstrated seizure-like activity (jaw-chomping and tonic-clonic limb movement). Information regarding responsiveness during the collapse was available for 26 cats, and of these 27% were unresponsive (n=7). Twenty two cases had a description of the recovery from the collapse and of these, 77% experienced a complete and rapid recovery (n=17). Data for the duration of the collapse was available for five cases; three owners reported 'a few minutes', one 'five minutes' and another '10 minutes'.

|                                                                                   | <b>Finding</b>                                          | <b>Number</b> | <b>Percentage*</b> |
|-----------------------------------------------------------------------------------|---------------------------------------------------------|---------------|--------------------|
| <b>Collapse Description</b>                                                       | Sudden recumbency                                       | 20            | 71                 |
|                                                                                   | Weakness – hindlimbs                                    | 5             | 18                 |
|                                                                                   | Weakness - generalised                                  | 3             | 11                 |
|                                                                                   | Total                                                   | 28            |                    |
| <b>Collapse pre-<br/>ceding event</b>                                             | Not associated with any event                           | 8             | 38                 |
|                                                                                   | Exercise/exertion                                       | 5             | 24                 |
|                                                                                   | Rising from rest                                        | 4             | 19                 |
|                                                                                   | Coughing, retching or vomiting                          | 2             | 10                 |
|                                                                                   | Following eating                                        | 2             | 10                 |
|                                                                                   | Total                                                   | 21            |                    |
| <b>Collapse pro-<br/>dromal phase</b>                                             | Unaware impending collapse                              | 16            | 100                |
|                                                                                   | Aware impending collapse                                | 0             | 0                  |
|                                                                                   | Total                                                   | 16            |                    |
| <b>Responsiveness<br/>during collapse</b>                                         | Responsive                                              | 19            | 73                 |
|                                                                                   | Unresponsive                                            | 7             | 27                 |
|                                                                                   | Total                                                   | 26            |                    |
| <b>Seizure-like<br/>activity</b>                                                  | No tonic-clonic limb movements and/or<br>jaw chomping   | 25            | 100                |
|                                                                                   | Tonic-clonic limb movements and/or jaw<br>chomping      | 0             | 0                  |
|                                                                                   | Total                                                   | 25            |                    |
| <b>Recovery from<br/>collapse</b>                                                 | Complete and rapid recovery                             | 17            | 77                 |
|                                                                                   | Remained weak                                           | 3             | 14                 |
|                                                                                   | Neurological signs persisted for 7 days                 | 1             | 5                  |
|                                                                                   | Painful spine (fell off piano stool during<br>collapse) | 1             | 5                  |
|                                                                                   | Total                                                   | 22            |                    |
| <b>Table 1. Description of collapse for cat cases.</b>                            |                                                         |               |                    |
| *Some percentage totals add to 99 or 101 because of rounding up/down of decimals. |                                                         |               |                    |

Clinical examination data was available for 31 cats (Appendix 4). Seventy-four percent of cats had a murmur auscultated during clinical examination (n=23), and the loudest was grade IV/VI. Forty-two percent of cats had a heart rate greater than 180 BPM (n=13) and none had a heart rate less than 120 BPM. Eighty-seven percent of cats had a regular heart rhythm (n=27) and 90% had normal femoral pulse quality (n=28). Ten percent of cats were tachypnoeic (respiratory rate greater than 40 breaths/minute) (n=3).

Systolic blood pressure was measured indirectly in 17 cases (using a Doppler method). The mean systolic blood pressure was 137 mmHg (SD 22, range 95– 172).

Serum biochemistry was analysed in 29 cats, of these four cats (14%) had increased alanine aminotransferase activity ( $>12$  U/L), three cats (10%) were hypokalaemic ( $<3.5$  mmol/L) and one cat (3%) was hypercalcaemic (ionised calcium  $>1.4$  mmol/l). Total thyroxine concentration was analysed in 16 cats, of which two cases (13%) had an increased concentration ( $>60$  nmol/L). Feline pancreatic lipase was measured in one case and it was found to be increased ( $>3.5$   $\mu$ g/L), this cat had presented with a history of collapse associated with vomiting. Twenty-six cases had either packed cell volume or haematocrit recorded, in three of these cats (12%) this was less than 30%.

ECG data was available for 22 cats and HM data for 7 cats (Appendix 5). VPCs were the most common abnormality identified, seen in 28% of ECG/HM (n=2, 9% ECG; n=6, 86% HM). Heart rate was more often increased than decreased (n=5, 17% and n=1, 3% respectively). HM identified isolated VPCs in 4 of the 7 cats (57%); VPCs and supraventricular premature complexes in one cat, VPCs and ventricular tachycardia (VT) in one cat and VPCs, VT and increased mean overall rate in one cat.

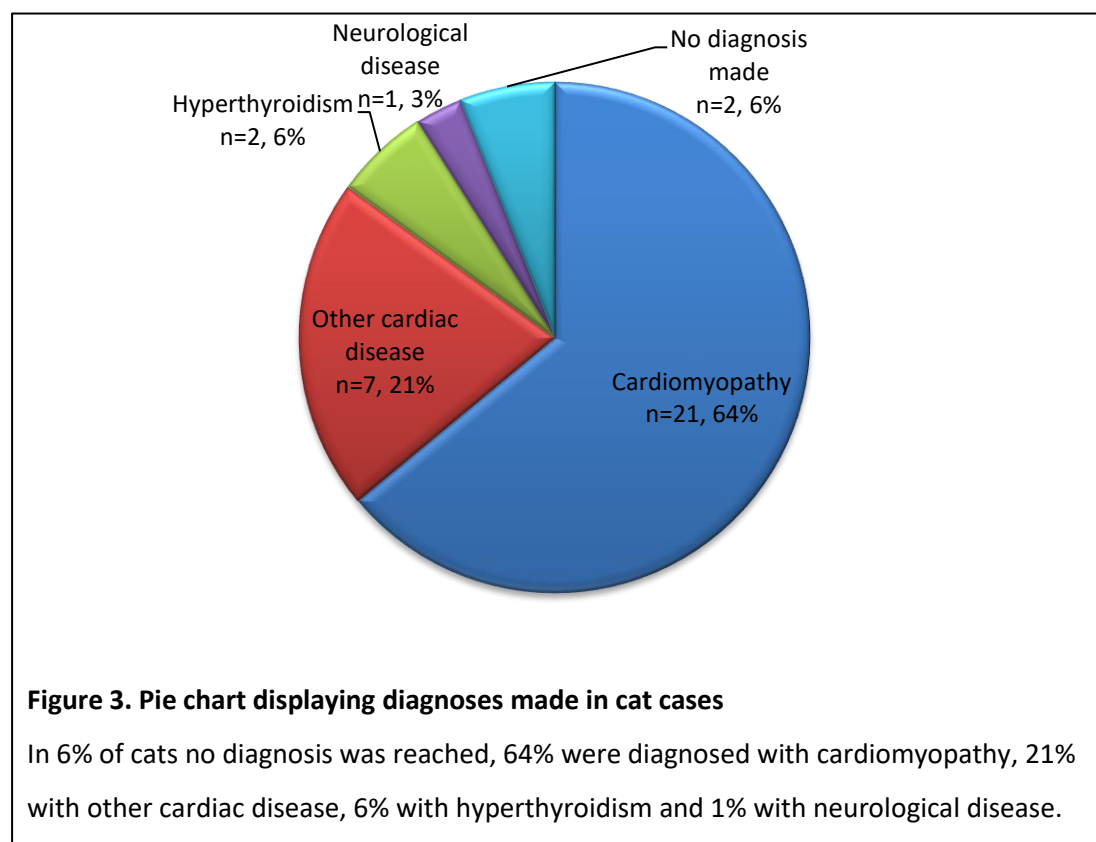
Thirty cats underwent echocardiographic examination and, of these, structural heart disease was identified in 93% of cases (n=28) (Appendix 6). Left ventricular hypertrophy (LVH) was identified in 60% of cats (n=20/30) and, in the 13 cases in which a description was recorded, it was asymmetrical in 92% (n=12/13). Two cats had increased total thyroxine levels, one of these cats did not undergo echocardiography and the other had LVH. There was one case with PE and two with pleural effusion.

Radiographic findings were available for 17 cats. Forty-one percent of cases had a lung pattern identified (n=7/17), comprising of pulmonary venous congestion (n=5) and an interstitial pattern (n=2). One case had radiographic evidence of pleural effusion. Enlargement of the cardiac silhouette was reported in eight cases (47%), all of these cats had echocardiographic diagnosis of cardiomyopathy.

#### 4.1.4 Diagnosis

A diagnosis was made in 31 cats (94%) (Figure 3). Of the cases in which a diagnosis was made, cardiac disease was the most common (n=28/31, 90%).

Cardiomyopathy was diagnosed in 64% of cases (n=21/33); and of these the most common was hypertrophic cardiomyopathy (HCM) (n=17/21, 81%), followed by restrictive cardiomyopathy (n=2/21, 10%) and unclassified cardiomyopathy (UCM) (n=2/21, 10%), and then DCM (n=1/21, 5%). Other cardiac disease consisted of three cases of dynamic right ventricular outflow tract obstruction (DRVOTO) and one case each of patent ductus arteriosus, mitral valve dysplasia (MVD) and ARVC.



Of all the cats included in the study, 58% had CUO (n=19) (Figure 4) and none had arrhythmia. In the 42% of cases where a cause for the collapse was identified (n=14), cardiac disease was the most common (n=8/14, 57%).

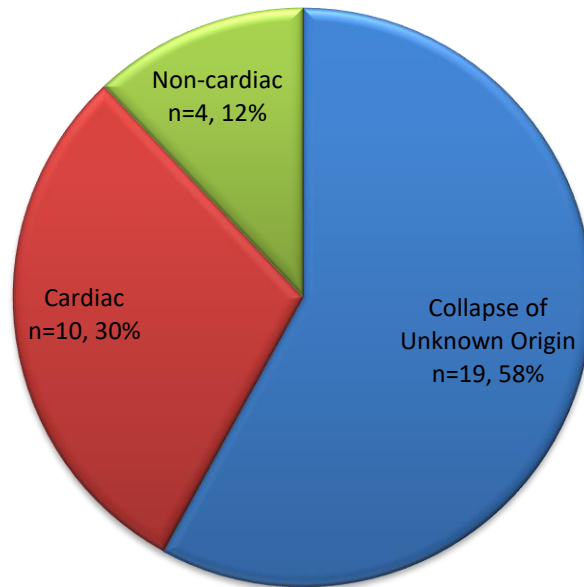


**Figure 4. Pie chart displaying the causes of collapse in cat cases**

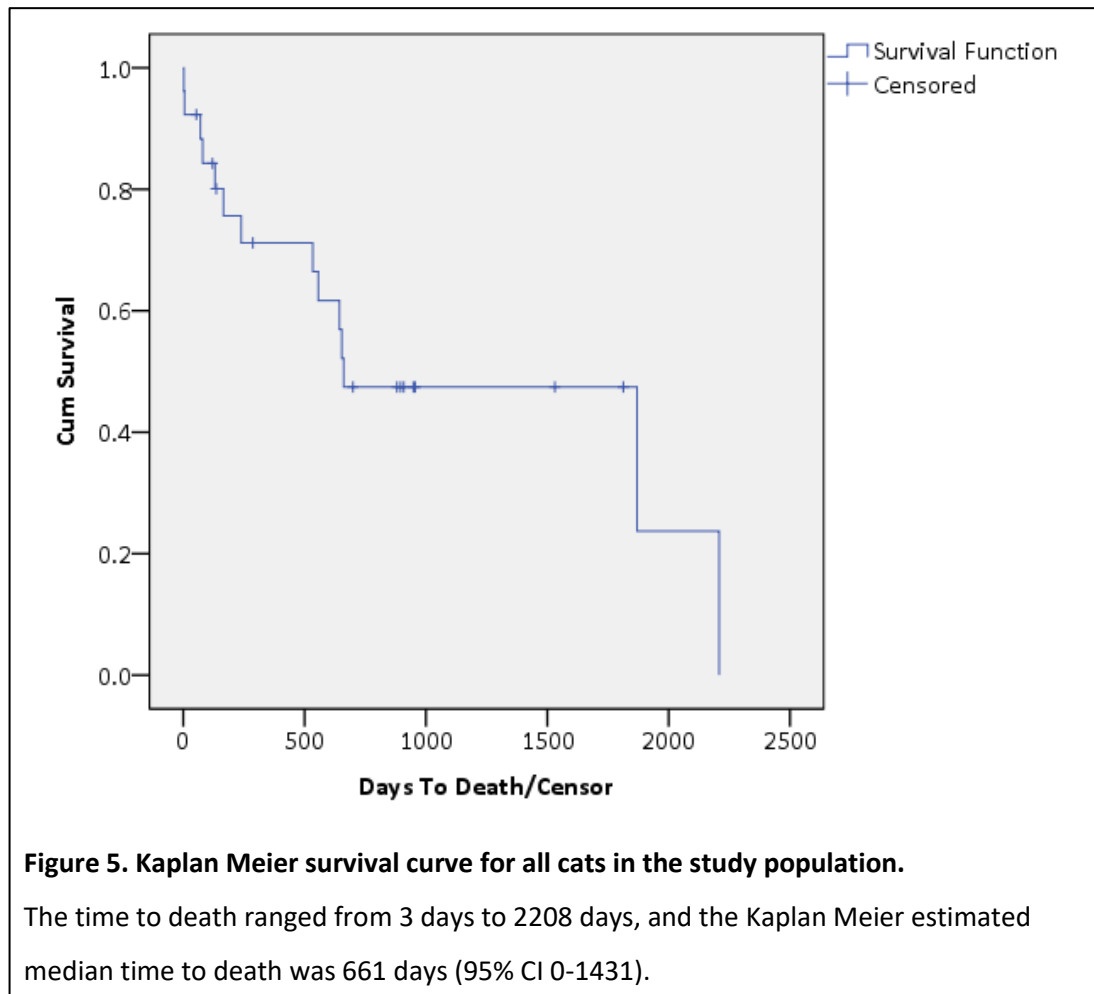
The cause of collapse was unknown in 58% of cases, cardiac disease in 30% and non-cardiac disease in 12% of cats.

#### 4.1.5 Outcome

The follow-up period ranged from zero to 2208 days. Information about ongoing collapse(s) (subsequent to the initial referral appointment) was available for 14 cats; and of these 36% (n=5) experienced continued collapse(s). For nine of the cases with at least three months follow-up, information about continued collapse was obtained; of these 56% experienced another episode of collapse (n=5/9)).

Of the 28 cats for which data was available, 57% had died (n=16) and the KM estimate of median survival time was 661 days (95% CI 0-1431) (Figure 5). The cat with the longest follow-up died 2208 days (6 years) after referral and was diagnosed with MVD.

The cause of death was recorded for seven cats; the most common reason was cardiac disease (n=5/7, 71%). One cat died from a road traffic accident (RTA) and one cat was euthanased due to deterioration in clinical signs related to upper respiratory, cardiac and gastrointestinal disease. The cause of death was the same as the diagnosis for all cats, other than the one which died from an RTA.



Seven cats were known to have died within one year of presentation for referral, and all of these were diagnosed with structural heart disease. Four were diagnosed with HCM, two with UCM and one with DCM. Seven cats lived for at least two and a half years, of these two were diagnosed with HCM, two with DRVOTO, one with MVD and one with ARVC.

## 4.2 DOGS

### 4.2.1 Case Inclusion

The database search identified 450 cases which met the inclusion criteria and review of the case files led to the exclusion of 197 dogs, leaving a total of 253 cases (Figure 6).

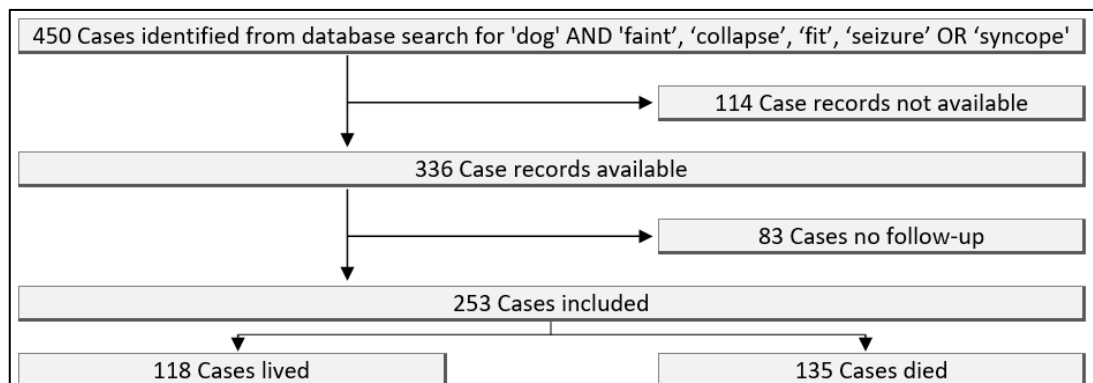


**Figure 6. Flow chart outlining case selection in dog cases.**

The initial database search identified 450 canine cases, 336 case records were available, 83 cases were excluded, leaving 253 cases included in the study; and 135 cases had died during at follow-up.

#### 4.2.2 Signalment

Fifty-four breeds were represented (Appendix 7); Boxers were the most common (36%), followed by crossbreeds (10%), Labradors (8%) and Cavalier King Charles Spaniels (5%). Age at presentation ranged from four months to 16 years 7 months, with a median age of 68 months (IQR 27 – 107 months) (Figure 7). Males and females were equally represented (51% and 49% respectively).

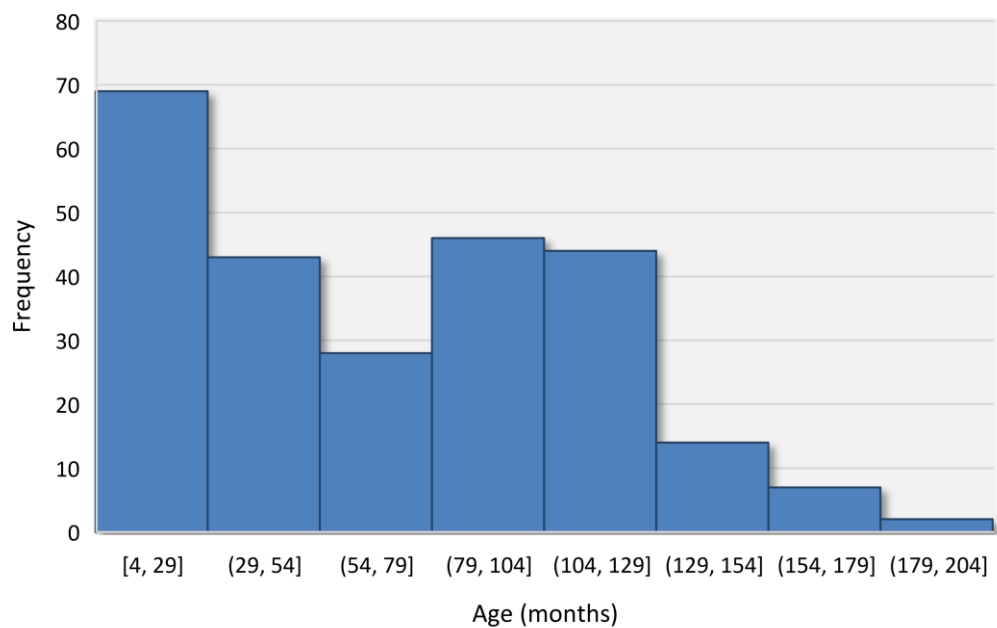
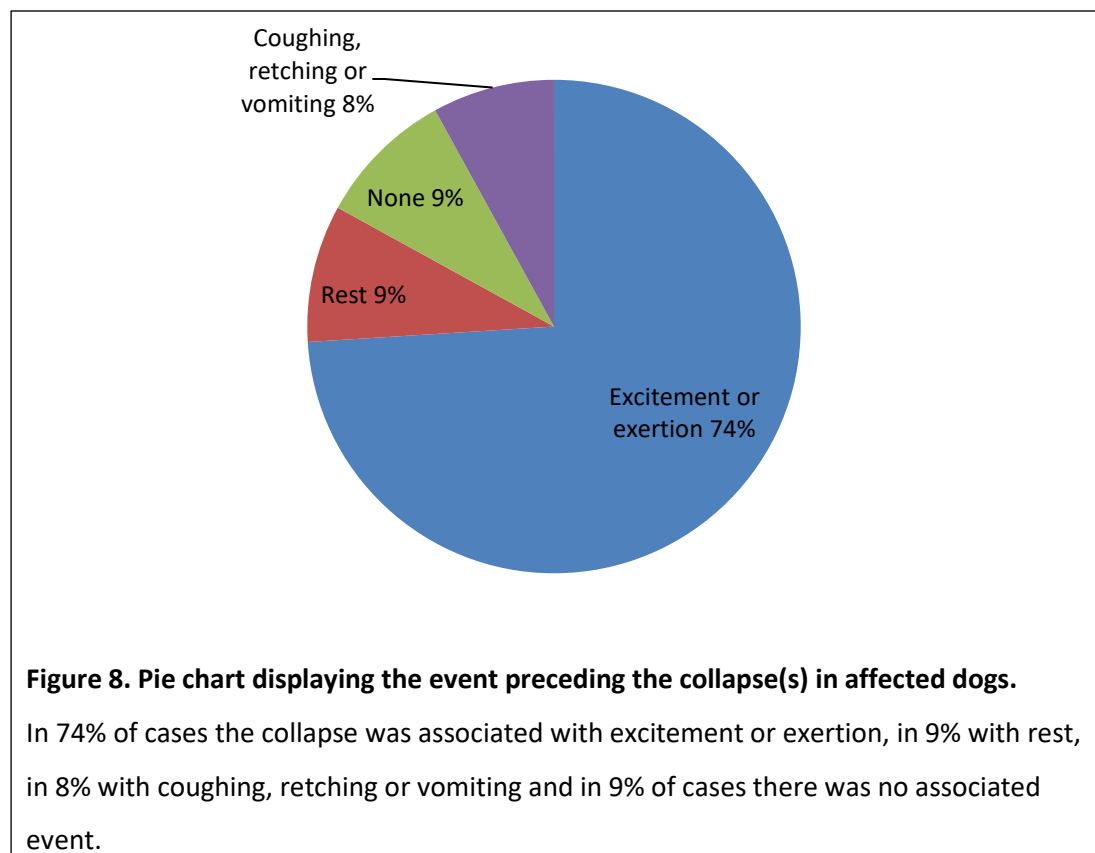


**Figure 7. Histogram displaying the ages of the dogs in the study.**

Age at presentation ranged from four months to 16 years 7 months, with a median age of 68 months (IQR 27 – 107 months).

### 4.2.3 History and Diagnostic Investigations

Data for previous health problems was available for 195 dogs (Appendix 8). A description of the collapse was obtainable for 243 dogs (Figure 8). Forty-seven percent of dogs (n=114) were unresponsive during the collapse. Ninety-one percent of collapses were associated with an event (n=221); and the most common was excitement or exertion (74%), followed by rest (9%), then coughing, retching or vomiting (8%).



Of the 253 cases included in the study, data from echocardiographic examination was available in 220 dogs (Table 2), clinical pathology in 203 dogs (Table 3), ECG in 154 dogs (Table 4), thoracic radiography in 143 dogs (Table 5) and HM in 102 dogs (Table 4).

| Finding                               | Total |    | Mild |    | Moderate |   | Severe |   |
|---------------------------------------|-------|----|------|----|----------|---|--------|---|
|                                       | n     | %  | n    | %  | n        | % | n      | % |
| Atrial enlargement                    | 13    | 6  | 6    | 3  | 4        | 2 | 3      | 1 |
| Ventricular enlargement               | 24    | 11 | 8    | 4  | 8        | 4 | 8      | 4 |
| Generalised enlargement <sup>a</sup>  | 28    | 13 |      |    |          |   |        |   |
| Mitral regurgitation                  | 64    | 29 | 41   | 18 | 15       | 7 | 8      | 4 |
| Tricuspid regurgitation               | 40    | 18 | 30   | 14 | 6        | 3 | 4      | 2 |
| Aortic stenosis                       | 30    | 14 | 20   | 9  | 3        | 1 | 7      | 3 |
| Mitral dysplasia                      | 5     | 2  |      |    |          |   |        |   |
| Tricuspid dysplasia                   | 2     | 1  |      |    |          |   |        |   |
| Pericardial effusion                  | 7     | 3  |      |    |          |   |        |   |
| Cardiac mass                          | 7     | 3  |      |    |          |   |        |   |
| FS decreased (<25%)                   | 28    | 13 |      |    |          |   |        |   |
| FS increased (>45%)                   | 5     | 2  |      |    |          |   |        |   |
| Structural heart disease <sup>b</sup> | 123   | 55 |      |    |          |   |        |   |

**Table 2. Echocardiographic findings for dog cases.**

<sup>a</sup> All four chambers enlarged.

<sup>b</sup> Any structural abnormality identified by echocardiography.

| Variable                            | n with finding | n tested | Percent |
|-------------------------------------|----------------|----------|---------|
| ALKP or ALT > ref.range             | 40             | 205      | 20      |
| Sodium < ref. range                 | 1              | 205      | 0       |
| Potassium > ref. range              | 1              | 205      | 0       |
| Urea and/or creatinine > ref. range | 30             | 205      | 15      |
| Glucose > or < ref. range           | 7              | 205      | 3       |
| White blood cells > ref. range      | 9              | 205      | 4       |
| CTnI > ref. range                   | 11             | 14       | 79      |
| Thyroxine < ref. range              | 8              | 20       | 40      |
| HCT/PCV > or < ref. range           | 9              | 205      | 4       |
| Albumin < ref. range                | 6              | 205      | 3       |
| Cholesterol > ref. range            | 9              | 205      | 4       |
| Eosinophils > ref. range            | 3              | 205      | 1       |

**Table 3. Clinical pathology data for dog cases.**

ALKP – alkaline phosphatase, ALT – alanine aminotransferase, CtnI – cardiac troponin I, HCT-haematocrit, PCV – packed cell volume, ref. range – laboratory/analyser reference range

| Finding                               | ECG |    | HM |    | Combined |    |
|---------------------------------------|-----|----|----|----|----------|----|
|                                       | n   | %  | n  | %  | n        | %  |
| Ventricular Premature Complex(s)      | 21  | 19 | 50 | 49 | 71       | 28 |
| Abnormal Rate                         | 29  | 19 | 4  | 4  | 33       | 13 |
| Supraventricular Premature Complex(s) | 4   | 3  | 14 | 14 | 18       | 7  |
| Atrioventricular Block                | 13  | 8  | 4  | 4  | 17       | 7  |
| Sinus Arrhythmia <sup>a</sup>         | 14  | 9  | 0  | 0  | 14       | 5  |
| Ventricular Tachycardia               | 4   | 3  | 9  | 9  | 13       | 5  |
| Sinus Pause <sup>b</sup>              | 3   | 2  | 1  | 1  | 4        | 2  |
| Supraventricular Tachycardia          | 3   | 2  | 5  | 5  | 8        | 3  |
| Atrial Fibrillation                   | 4   | 3  | 1  | 1  | 5        | 2  |
| Sinus Arrest                          | 1   | 1  | 1  | 1  | 2        | 1  |
| Sick Sinus Syndrome                   | 2   | 1  | 0  | 0  | 2        | 1  |
| Ventricular Fibrillation              | 0   | 0  | 1  | 1  | 1        | 0  |
| Atrial Standstill                     | 1   | 1  | 0  | 0  | 1        | 0  |
| Arrhythmia                            | 62  | 40 | 35 | 34 | 97       | 38 |
| Tachydysrhythmia                      | 45  | 29 | 39 | 29 | 84       | 33 |
| Bradydysrhythmia                      | 19  | 12 | 8  | 8  | 27       | 11 |

**Table 4. Electrocardiographic and Holter monitor recording findings for dog cases.**

ECG – electrocardiography recording, HM – holter monitor recording

<sup>a</sup> On HM only if occurred at an inappropriate time, e.g. during exercise

<sup>b</sup> On HM only if prolonged ( $\geq 8$  seconds).

| Finding                        | Number | Percent |
|--------------------------------|--------|---------|
| Cardiac silhouette enlargement | 48     | 34      |
| Hypervascular pattern          | 12     | 8       |
| Interstitial pattern           | 6      | 4       |
| Bronchial pattern              | 5      | 4       |
| Alveolar pattern               | 3      | 2       |
| Mixed lung pattern             | 1      | 1       |
| Pleural effusion               | 6      | 4       |
| Lung consolidation             | 5      | 4       |
| Mass lesion                    | 6      | 4       |

**Table 5. Thoracic radiography findings for dog cases.**

#### 4.2.4 Diagnosis

A cause for the collapse was identified in 56% of all cases (n=142/253) (Table 6) and in 64% of these 'diagnosed' dogs (n=91/142) the cause of collapse was cardiac disease (comprising 69 dogs with cardiac disease and 22 dogs with arrhythmia).

| Cause of Collapse                               | Total |                | Dead |                | Alive |                |
|-------------------------------------------------|-------|----------------|------|----------------|-------|----------------|
|                                                 | n     | % <sup>a</sup> | n    | % <sup>b</sup> | n     | % <sup>c</sup> |
| Collapse of Unknown Origin                      | 111   | 44             | 44   | 40             | 67    | 60             |
| Cardiac Disease                                 | 69    | 27             | 62   | 90             | 7     | 10             |
| Dilated cardiomyopathy                          | 16    | 6              | 14   | 88             | 2     | 13             |
| Arrhythmogenic right ventricular cardiomyopathy | 11    | 4              | 10   | 91             | 1     | 9              |
| Chronic valve disease                           | 10    | 4              | 9    | 90             | 1     | 10             |
| Aortic stenosis                                 | 8     | 3              | 7    | 88             | 1     | 13             |
| Heart base mass                                 | 8     | 3              | 8    | 100            | 0     | 0              |
| Mitral valve dysplasia                          | 3     | 1              | 2    | 67             | 1     | 33             |
| Right-to-left shunt                             | 3     | 1              | 3    | 100            | 0     | 0              |
| Myocarditis                                     | 2     | 1              | 1    | 50             | 1     | 50             |
| Tricuspid valve dysplasia                       | 2     | 1              | 2    | 100            | 0     | 0              |
| Pericardial disease                             | 2     | 1              | 2    | 100            | 0     | 0              |
| Pulmonic stenosis                               | 1     | 0              | 1    | 100            | 0     | 0              |
| Endocarditis                                    | 1     | 0              | 1    | 100            | 0     | 0              |
| Mitral stenosis & valvular aortic stenosis      | 1     | 0              | 1    | 100            | 0     | 0              |
| Pulmonic stenosis & tricuspid valve dysplasia   | 1     | 0              | 1    | 100            | 0     | 0              |
| Tricuspid valve dysplasia                       | 1     | 0              | 1    | 100            | 0     | 0              |
| Arrhythmia                                      | 22    | 9              | 12   | 55             | 10    | 45             |
| Bradyarrhythmia                                 | 20    | 8              | 10   | 50             | 10    | 50             |
| Atrioventricular block                          | 15    | 6              | 7    | 47             | 8     | 57             |
| Sinus node disease                              | 4     | 2              | 2    | 50             | 2     | 50             |
| Persistent atrial standstill                    | 1     | 0              | 1    | 0              | 0     | 0              |
| Tachyarrhythmia                                 | 2     | 1              | 2    | 100            | 0     | 0              |
| Supraventricular                                | 2     | 1              | 2    | 100            | 0     | 0              |
| Ventricular                                     | 0     | 0              | 0    | 0              | 0     | 0              |
| Non-cardiac disease                             | 51    | 20             | 17   | 33             | 34    | 67             |
| Vasovagal syncope                               | 34    | 13             | 12   | 35             | 22    | 65             |
| Exercise induced collapse                       | 11    | 4              | 0    | 0              | 11    | 100            |
| Tussive syncope                                 | 3     | 1              | 2    | 67             | 1     | 33             |
| Splenic mass (haemorrhage)                      | 2     | 1              | 2    | 100            | 0     | 0              |
| Pulmonary hypertension                          | 1     | 0              | 1    | 100            | 0     | 0              |
| Total                                           | 253   | 100            | 135  | 53             | 118   | 47             |

**Table 6. Cause of collapse for dog cases.**

<sup>a</sup> percentage of all dogs; <sup>b</sup> percentage of dogs with that cause of collapse, that had died during the follow-up period; <sup>c</sup> percentage of dogs with that cause of collapse, that were alive at the end of the follow-up period

The most common heart diseases were DCM (n=16), ARVC (n=11) and CVD (n=10). Other conditions included a heart base mass (n=8), congenital right-to-left shunt (n=3), tricuspid valve dysplasia (n=2) and PE (n=2). The three dogs with a right-to-left shunt were diagnosed with a reverse patent ductus arteriosus, a large atrial septal defect with PH and a Tetralogy of Fallot. One of the dogs diagnosed with tricuspid valve dysplasia had paroxysmal SVT, which was the mechanism of the collapse. In eight percent of cases the cause of collapse was a bradyarrhythmia (n=20), 15 of these were atrioventricular block (14 third degree and 1 second degree).

Four dogs had sinus node disease and three of these dogs had a pacemaker fitted. The cause of collapse for one dog was persistent atrial standstill. In two dogs the cause of collapse was a primary tachyarrhythmia, both were SVT.

The cause of collapse was vasovagal syncope in 13% of cases (n=34) and in two of these dogs the diagnosis was supported by HM during a collapse. In eleven dogs (4%) the cause of collapse was EIC. Of these, five were Labradors, two Border Collies and one each of Flatcoat Retriever, German Shorthaired Pointer, Golden Retriever and German Shepherd Dog. Three dogs had tussive syncope, one related to interstitial pulmonary fibrosis (IPF), one to tracheal collapse and the other to nasopharyngeal disease (which caused sneezing and coughing/retching). In one dog, the cause of collapse was severe PH (pulmonary arterial pressure 100mmHg) which was secondary to pulmonary thromboembolism.

#### **4.2.5 Outcome**

The assumption of proportional hazards, in the cox proportional hazards model, was not violated. The Schoenfeld residuals demonstrated no systematic or significant changes over time and the delta-betas showed that no data points were heavily influencing any regression coefficient (if any dog was missing from the data, all model coefficients would change by less than 5%) (Appendix 9).

The median duration of follow-up was 630 days (IQR 255-1230 days). The overall KM median estimate of survival time was 1230 days (95% CI 871-1589) (Figure 7) and the time to death ranged from 0 - 4110 days.

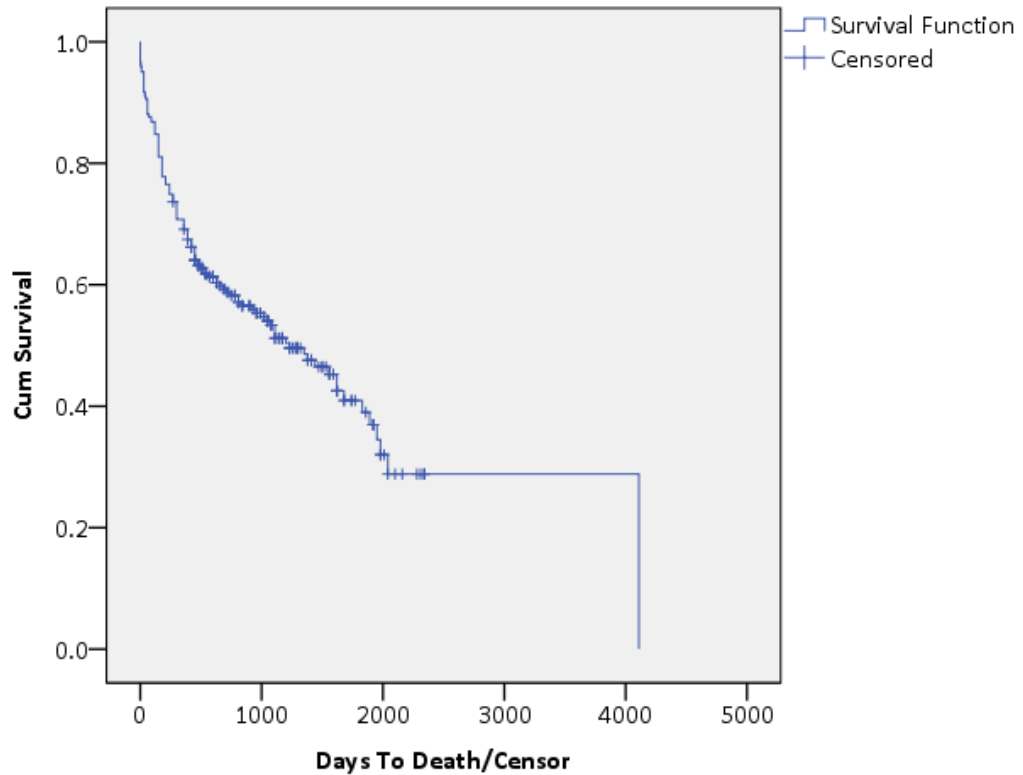


**Figure 7. Kaplan Meier survival curve for all dogs included in the study.**

The Kaplan Meier median estimate of survival time was 1230 days (95% CI 871-1589)

Forty-four percent of dogs had CUO (n=111) and the KM estimated median survival time was 1950 days (95% CI 1735-2165), compared to 36% of dogs (n=91) which were diagnosed with cardiac disease (including arrhythmia), and had a KM estimated median survival time of 270 days (95% CI 180-360) ( $p<0.01$ ) (Figure 8).

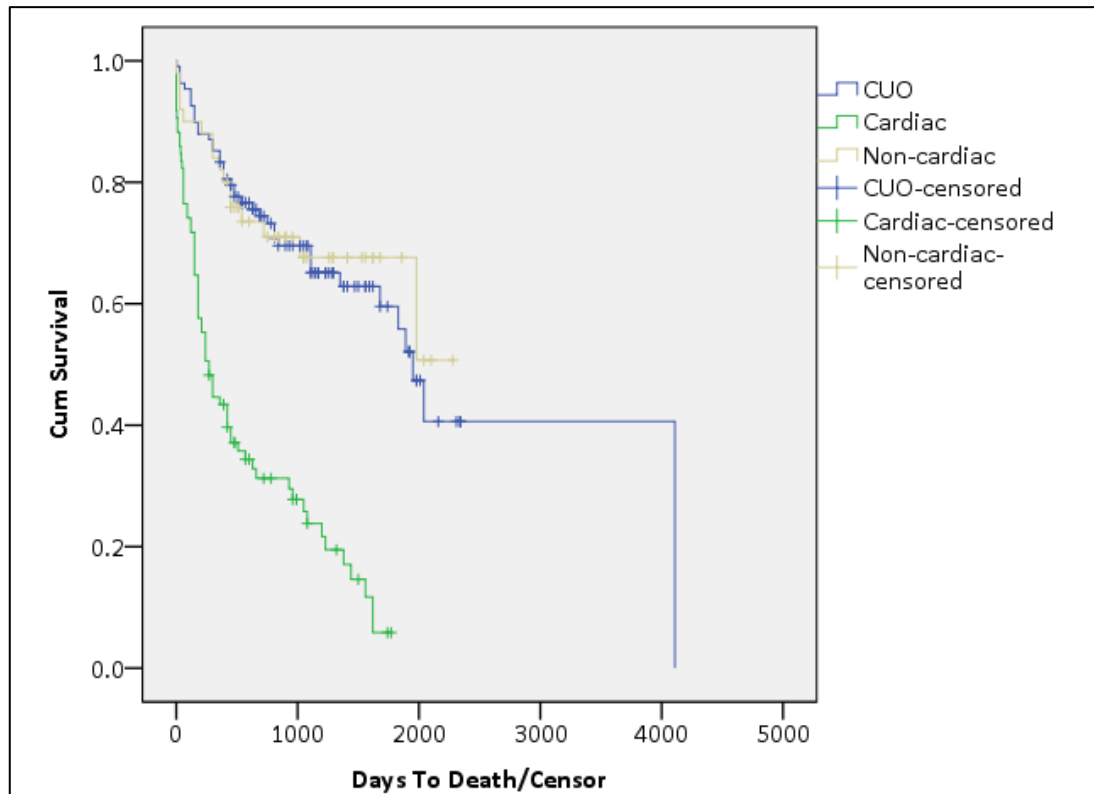


**Figure 8. Kaplan Meier survival curves for dogs in each cause of collapse category.**

Dogs with non-cardiac disease (brown line) estimated median survival time >1980 days\*, collapse of unknown origin (CUO) (blue line) estimated median survival time 1950 days (95%CI 1735-2165) and cardiac disease (green line) estimated median survival time 270 days (95%CI 180-360) ( $p<0.01$ ).

\*Kaplan Meier median estimate of survival time could not be calculated as 50% of dogs had not died within the study period.

Follow-up information relating to continued collapse(s) was available for 117 dogs. Thirty-nine percent (n=46) had another collapse(s) after their referral examination and the KM estimated median time to death was 630 days (85%CI 0-1440), compared to >1680 days for the dogs that did not collapse again (Figure 9). In five percent of dogs (n=6) the next collapse was a sudden death. Of the 133 dogs for which data was available, 53% (n=70) had developed health problems that were not present at their original referral appointment.

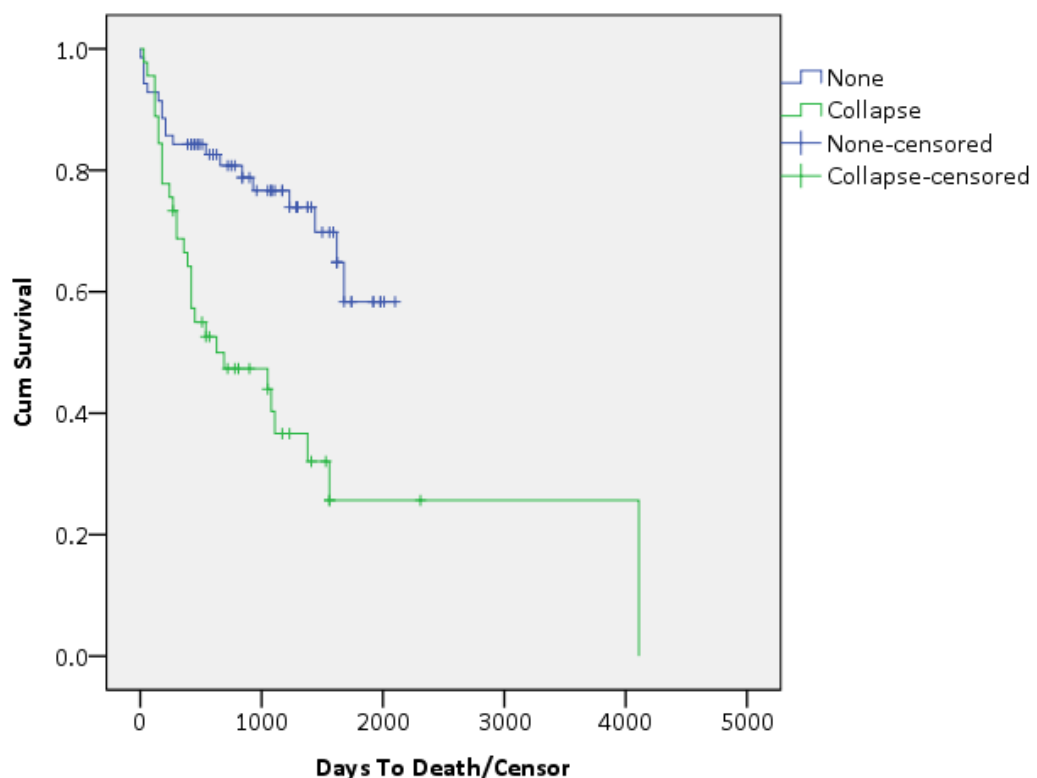


**Figure 9. Kaplan Meier survival curves for dogs with and without collapse(s) subsequent to examination.**

Dogs which had ongoing collapse (green line) had an estimated median survival time of 630 days (95%CI 0-1440); compared to dogs that did not collapse again following presentation (blue line), which had an estimated median survival time >1680 days\* (p<0.01).

\*KM median estimate of survival time could not be calculated as 50% of dogs had not died within the study period.

#### 4.2.6 Survival Analysis

Univariable analysis identified 28 variables which were significantly related to death ( $p < 0.25$ ) (Table 7). When dogs were grouped according to the inciting event of their collapse, no significant difference was found between the categories: 'associated with rest' ( $n=22$  of 243 cases,  $p=0.33$ ), 'associated with excitement or exertion' ( $n=180$  of 243 cases,  $p=0.36$ ), 'associated with coughing, retching or vomiting' ( $n=19$  of 243 cases,  $p=0.68$ ) and 'not associated with any event' ( $n=22$  of 243 cases,  $p=0.51$ ). No specific breed conferred a worse prognosis. Univariable analysis did not identify a significantly greater likelihood of death in dogs which had abnormalities in serum electrolytes ( $n=3$  of 203 cases,  $p=0.35$ ), glucose ( $n=7$  of 203 cases,  $p=0.29$ ) or cardiac troponin I (cTnI) ( $n=11$  of 14 cases,  $p=0.83$ ).

| Variable                                   | n   | p     | HR  | 95% CI |       |
|--------------------------------------------|-----|-------|-----|--------|-------|
|                                            |     |       |     | Lower  | Upper |
| Collapse with loss of responsiveness       | 114 | 0.07  | 1.4 | 1.0    | 2.0   |
| Unrelated health problem(s)                | 116 | <0.01 | 1.9 | 1.3    | 3.0   |
| Age $\geq 7$ years                         | 106 | <0.01 | 4.3 | 2.9    | 6.2   |
| Female neutered                            | 79  | 0.15  | 0.7 | 0.4    | 1.2   |
| Murmur grade $\geq IV/VI$                  | 96  | <0.01 | 3.2 | 2.0    | 5.3   |
| Clinical examination - abnormal heart rate | 25  | <0.01 | 2.0 | 1.2    | 3.3   |
| Clinical examination - arrhythmia          | 19  | <0.01 | 3.2 | 1.8    | 5.7   |
| Reduced pulse quality                      | 12  | <0.01 | 4.7 | 2.5    | 8.9   |
| Expiratory noise/dyspnoea                  | 3   | 0.04  | 4.4 | 1.1    | 17.9  |
| EKG or HM tachyarrhythmia                  | 61  | <0.01 | 3.6 | 2.4    | 5.5   |
| Echocardiography:                          |     |       |     |        |       |
| Ventricular enlargement                    | 52  | <0.01 | 4.1 | 2.8    | 6.2   |
| Mitral regurgitation                       | 64  | <0.01 | 2.1 | 1.4    | 3.1   |
| Tricuspid regurgitation                    | 40  | 0.03  | 1.7 | 1.1    | 2.7   |
| Moderate/severe aortic stenosis            | 10  | <0.01 | 3.2 | 1.6    | 6.6   |
| Abnormal fractional shortening             | 31  | <0.01 | 3.9 | 2.5    | 6.2   |
| Pericardial effusion                       | 7   | <0.01 | 4.8 | 2.1    | 11.2  |
| Cardiac mass                               | 7   | <0.01 | 8.9 | 4.0    | 19.9  |

|                                |    |       |     |     |      |
|--------------------------------|----|-------|-----|-----|------|
| Increased liver enzyme(s)      | 40 | 0.01  | 1.8 | 1.2 | 2.8  |
| Azotaemia                      | 30 | 0.05  | 1.7 | 1.0 | 2.7  |
| Hypothyroidism                 | 8  | 0.16  | 2.3 | 0.7 | 7.7  |
| Anaemia                        | 9  | <0.01 | 2.8 | 1.4 | 5.8  |
| Hypoalbuminaemia               | 6  | 0.03  | 2.8 | 1.1 | 6.8  |
| Hypercholesterolaemia          | 9  | <0.01 | 2.9 | 1.4 | 5.7  |
| Thoracic Radiography:          |    |       |     |     |      |
| Cardiac silhouette enlargement | 48 | <0.01 | 2.7 | 1.8 | 4.2  |
| Lung pattern                   | 29 | 0.01  | 1.9 | 1.1 | 3.1  |
| Pleural effusion               | 6  | 0.11  | 0.2 | 0.0 | 1.4  |
| Thoracic mass                  | 6  | <0.01 | 5.2 | 2.1 | 13.2 |
| Continued collapse(s)          | 46 | <0.01 | 2.9 | 1.6 | 5.1  |

**Table 7. Significant variables (p<0.25) identified by Univariable Cox Regression analysis in dogs.**

CI – confidence interval, HR – hazard ratio

Multivariable Cox regression analysis identified nine variables which were significantly negatively associated with survival ( $p < 0.05$ ) (Table 8). These were, dogs older than seven years of age ( $n=106$ ,  $p<0.01$ ), echocardiographic identification of ventricular enlargement ( $n=52$ ,  $p<0.01$ ), AS with a transtenotic pressure gradient  $\geq 50\text{mmHg}$  ( $n=10$ ,  $p<0.01$ ), echocardiographic identification of PE ( $n=7$ ,  $p<0.01$ ), increased serum cholesterol concentration ( $n=7$ ,  $p<0.01$ ), radiographic detection of a lung pattern ( $n=29$ ,  $p<0.01$ ), on-going collapse ( $n=46$ ,  $p<0.01$ ), identification of a tachyarrhythmia on ECG or HM ( $n=61$ ,  $p<0.01$ ) and anaemia ( $n=9$ ,  $p=0.03$ ).

| Variable                                         | n   | P       | HR  | 95% CI |       |
|--------------------------------------------------|-----|---------|-----|--------|-------|
|                                                  |     |         |     | Lower  | Upper |
| Age $\geq 7$ years – Yes                         | 106 | $<0.01$ | 2.9 | 1.9    | 4.4   |
| Echo ventricular enlargement – No                | 168 | $<0.01$ |     |        |       |
| Echo ventricular enlargement – Yes               | 52  | $<0.01$ | 2.9 | 1.8    | 4.5   |
| Aortic stenosis (PG $\geq 50\text{mmHg}$ ) - No  | 210 | $<0.01$ |     |        |       |
| Aortic stenosis (PG $\geq 50\text{mmHg}$ ) - Yes | 10  | $<0.01$ | 6.3 | 2.9    | 13.8  |
| Pericardial effusion – No                        | 213 | $<0.01$ |     |        |       |
| Pericardial effusion – Yes                       | 7   | $<0.01$ | 6.9 | 2.7    | 17.4  |
| Hypercholesterolaemia – No                       | 194 | $<0.01$ |     |        |       |
| Hypercholesterolaemia – Yes                      | 9   | $<0.01$ | 3.5 | 1.6    | 7.5   |
| Radiographic lung pattern – No                   | 114 | $<0.01$ |     |        |       |
| Radiographic lung pattern - Yes                  | 29  | $<0.01$ | 2.6 | 1.5    | 4.6   |
| Continued collapse(s) – No                       | 71  | $<0.01$ |     |        |       |
| Continued collapse(s) – Yes                      | 46  | $<0.01$ | 3.0 | 1.6    | 5.5   |
| ECG/HM tachyarrhythmia – No                      | 140 | $<0.01$ |     |        |       |
| ECG/HM tachyarrhythmia – Yes                     | 61  | $<0.01$ | 2.9 | 1.8    | 4.5   |
| Anaemia – No                                     | 194 | 0.03    |     |        |       |
| Anaemia – Yes                                    | 9   | 0.03    | 2.5 | 1.1    | 5.5   |

**Table 8. Significant variables ( $p<0.25$ ) identified by Multivariable Cox Regression analysis in dogs.**

CI – confidence interval, HR – hazard ratio, Echo – echocardiography, PG – pressure gradient, ECG – electrocardiography, HM – Holter monitor recording

## 5 DISCUSSION

### 5.1 SUMMARY

This study provides an overview of the diagnoses (definitive and presumptive) and outcome in dogs/cats which presented with collapse to referral cardiorespiratory centre(s). Additionally, in cats, the signalment, history, clinical presentation and results of diagnostic investigations are reported. All of which is information that is currently unpublished.

This study affirms the difficulty in achieving a diagnosis for the cause of the collapse, with a cause for the collapse being recorded for only 42% of cats and 56% of dogs in this study, and this from a referral caseload where animals would have had thorough and appropriate investigations, based on the case presentation. This percentage is comparable to the proportion of diagnoses made in humans with syncope (59%) (Kapoor, 1990), although this study includes presentations other than syncope alone.

Additionally, in animals in which a cause for the collapse was identified, the percentage with cardiac disease was similarly high for both cats (57%) and dogs (64%), which is likely a reflection of the study design including only cases from a cardiorespiratory referral caseload. However, whilst comparisons such as this must be made with care, this is a smaller percentage than that reported in the overall literature in cats presenting with collapse/weakness/syncope; if one combines the cats included in the scientific papers (9 case reports and 1 study which included 2 cats with syncope (Harwood, 1970; Meurs et al., 1994; Malik et al., 1998; Bright and Cali, 2000; Ferasin et al., 2002; Poncelet et al., 2003; Harvey et al., 2005; Ferasin, 2009b; Penning et al., 2009; Whitley and Stepien, 2001)), 12 out of 14 cats had cardiovascular disease (86%). The results of this study suggest that animals presenting with collapse, where the more readily diagnosed conditions have already been ruled out, have a higher prevalence of cardiac disease.

Also, in both cats and dogs, the collapse was most commonly associated with exercise/exertion, which is likely a reflection of the high proportion of animals with cardiac disease.

The time to death varied widely in both species (cats 3 - 2208 days, dogs 0 - 4110 days), which is likely a reflection of the variety of underlying aetiologies of collapse. And, in dogs, the KM estimated median survival time was significantly shorter for dogs that collapsed again after presentation (630 days (95%CI 0-1440), compared to >1680 days for those that did not); and for dogs in the cardiac disease group (270 days (95%CI 180-360), compared to 1950 days (95%CI 1735-2165) in the CUO group), which is consistent with the human literature in which it is widely reported that cardiac syncope carries a worse prognosis (D'Ascenzo et al., 2013; Rosanio et al., 2013).

Finally, the results of this study indicate that it is possible to use parameters that are routinely obtained in clinical practice to predict the outcome in dogs presenting with collapse, regardless of the underlying cause of the collapse (or whether a diagnosis is reached); although a prospective study would be needed to validate them. In this population, dogs which are older than seven years, have echocardiographic evidence of ventricular enlargement, AS with a transtenotic pressure gradient  $\geq 50$ mmHg, echocardiographic identification of PE, increased serum cholesterol concentration, radiographic detection of a lung pattern, on-going collapse, identification of a tachyarrhythmia on ECG or HM, or anaemia, are at increased risk of death. These survival predictors may not be applicable to all dogs presenting with collapse; however, it can be surmised that the prognosis is likely to be worse for a dog in which one or more of these predictors is identified (whose primary presenting complaint is collapse) and in which more readily diagnosable conditions, such as orthopaedic disease, had been ruled out.

## 5.2 LIMITATIONS

This was a retrospective study, which tends to cause more bias and confounding than prospective studies (Petrie and Sabin, 2005) (although retrospective analysis of clinical records has been validated in human medicine (Hassey et al., 2001)); and given the frequency with which animals are presented for investigation of collapse (especially cats) a prospective study would take many years to generate enough numbers to be sufficiently powered for survival analysis. Additionally, the data came from a single referral centre (dogs)/two referral centres (cats), seeing only cardiorespiratory cases, creating a population bias; which was further confounded by the dog referral centre and one of the cat referral centres only taking cardiorespiratory cases, meaning that any inter-departmental referrals may have been omitted from the dataset. This is particularly relevant in cats, whose clinical presentation of seizures is varied (Kline 1998), and for example, may present to Neurology for 'seizure' investigation which is then diagnosed as a cardiac condition following onward referral to Cardiology (such as bradyarrhythmia). Additionally, the diagnostic investigations performed were not standardised; meaning that some animals did not undergo all available diagnostic investigations. However, given that the cases were investigated at a referral centre, the diagnostic investigations carried out are likely to have been thorough and appropriate, and the percentage of animals with CUO is comparable to humans. In addition to the non-standardised work-up, the reference laboratories and analysers used for the blood tests were not standardised, which may have caused a systematic error and laboratory results need to be interpreted with caution. However, all samples were run either in-house at the referral centre(s) or at a professional external laboratory, reducing the likelihood of a systematic error. Finally, the animals may or may not have been starved prior to blood sampling; whilst both referral centres routinely advised starving for at least eight hours prior to the appointment, it was not recorded as to whether or not this advice was followed. These are the types of issues inherent in all retrospective analysis of this sort and, whilst it is important to identify and acknowledge them as potential limitations, these types of study can still provide valuable insight, particularly the identification of hypotheses which can be further tested in prospective study designs.

The results of this study should be validated by a prospective study involving many animals taken from multiple centres and disciplines, with a standardised work-up which should include quality tested laboratory analyses.

Death from all causes was selected as the primary end point for survival analysis, because collapse is a clinical sign that may occur secondary to a wide variety of diseases and can remain undiagnosed, as such it would have been impossible to be certain whether the cause of the collapse(s) had also caused death. Additionally, euthanised dogs were included in order to maintain the size of the dataset. It has been suggested by Hosgood and Scholl (2001)) that right-censoring and KM analysis should not be used in veterinary studies, due to the inclusion of euthanized animals. This is because the reason for euthanasia is multi-factorial; it is related to the underlying disease, client and clinician interaction, financial status and emotional stress. Therefore there are concerns that including euthanised animals biases the study. However, the study by Hosgood and Scholl (2001) included populations of only 32, 70 and 100 animals; whereas this study included 253 dogs. Furthermore, in clinical practice animals are euthanased (for whatever reason) so not including euthanased animals would have made the study unrealistic for clinical practice. Cox Regression analysis has limitations; primarily that it assumes that the hazard ratio is independent of time (Bewick et al., 2004).

## **5.3 CATS**

### **5.3.1 Signalment**

Cats included in this study tended to be middle-to-old aged and the most common breeds were DSH (64%) and DLH (12%). This is a reflection of the prevalence of these breeds in the general population, rather than a predilection for collapse; since these breeds make-up a similar percentage of all cats presenting to private veterinary practices (65% DSH, 16% DLH) (Lund et al., 1999). In this study, males were overrepresented (70%), which suggests males may be predisposed to collapse, since only 50% of cats presenting to veterinary practices are male (Lund et al., 1999).

It has been reported that cardiac disease is more prevalent in male cats, which may explain this finding (Wagner et al., 2010). The feline literature is variable; there are three case reports of collapse in the cat in which all were male (Meurs et al., 1994; Whitley and Stepien, 2001; Willis et al., 2003), however in Penning et al's (2009) article describing collapse in three cats due to AVB, two were female and one was male.

### **5.3.2 History**

In this study, the presenting complaint was sudden recumbency in 71% of cases and weakness in 29%; which is contrary to two reviews on collapse in cats, both of which reported that hindlimb weakness was the more common presentation (Lievesley, 1989; Gruffyd-Jones, 1991); it is possible that more cats in this study were referred to another discipline (such as neurology or orthopaedics) than those cats discussed in the Lievesley and Gruffyd-Jones review papers (1989 and 1991 respectively).

### **5.3.3 Diagnosis**

Structural heart disease and LVH were identified by echocardiography in 93% and 60% of cats respectively, which is higher than reported in apparently healthy cats with murmurs (53% heart disease (Nakamura et al., 2011) and 34% LVH (Wagner et al., 2010)). This finding suggests that structural heart disease is more prevalent in cats presenting with collapse than in apparently healthy cats.

Fifty-eight percent of cases had CUO, which is higher than reported in people presenting for the investigation of syncope (41% (Kapoor, 1990)) and in dogs presenting for the investigation of collapse (33% (Barnett et al., 2011)). It is interesting that, despite this being a cardiac referral caseload and 82% of cats being diagnosed with cardiac disease, only 24% of cats were thought to have collapsed because of their cardiac disease. Additionally, the majority of cats which had a disease diagnosed, but no cause for collapse identified, were cats diagnosed with cardiac disease which was thought to be too mild to cause collapse.

It is therefore possible that mild structural heart disease can cause collapse in cats (the mechanism of which could be transient arrhythmia or angina) or that mild structural heart disease is simply a common finding in cats presenting to a cardiorespiratory referral service. Angina is chest pain caused by reduced blood flow to the myocardium, from any mechanism, for example atherosclerosis, coronary artery spasm, or an embolus (Anderson et al., 2007). It is reported that people diagnosed with HCM suffer from angina and that includes people with HCM both with and without atherosclerosis (Kawasaki, 2014).

Additionally, myocardial ischaemia and infarction is reported in cats with HCM (Cesta et al., 2005 and Driehuys et al., 1998 respectively), as are thickened intramural coronary arteries (Fox, 2003). It is therefore possible that cats with only mild HCM collapse due to sudden chest pain; however, further studies would be needed to confirm this.

Furthermore, the description of the collapses in this study were consistent with non-neurological collapse in dogs (Berendt and Gram, 1999; Berendt et al., 2004) (most were preceded by exercise/exertion, all were unaware of an impending collapse, none showed seizure-like activity during the collapse and the majority experienced a complete and rapid recovery), which may support the theory that more of the collapses than reported were cardiac in origin. However, cats have very varied manifestation of seizures (Kline, 1998) and it is possible that more cats than reported in this study had neurological disease, especially since no confirmatory neurological tests were carried out.

#### **5.3.4 Outcome**

Fifty-six percent of cats in this study (with more than three months follow-up) continued to collapse following their referral appointment. This is more than the dogs in this study (39%) and in dogs with undiagnosed collapse (23%) (Barnett et al., 2011); more studies would be needed to investigate any potential species difference.

In this population of cats, the cause of death was consistent with the diagnosis, which is unsurprising since the cause of death is based on the owner/referring veterinarian's opinion and this will be led by their knowledge of the cats' disease.

The time to death varied greatly, from 3 days to 2208 days (6 years), which is likely a reflection of the varied outcome of the underlying diagnosis; for example, cats with HCM have been reported to survive from 2 days to 12 years (Rush et al., 2002).

### **5.3.5 Limitations**

Follow-up data for the time to death was very good (85%), however follow-up data regarding continued collapse was poor (42%); a human study recommends follow-up in at least 80% of patients (Altman, 2000). The variability in follow-up can be explained by the fact that the time to death could be ascertained from the referring veterinary practices (which were contactable in 100% of cases), whereas continued collapse relied on owner contact. Contacting owners was less successful, which may be related to the amount of time passed since the cats' examination (up to 6 years). Cats presenting with collapse may then cease to collapse, continue to collapse and/or die; however, a larger study population with more consistent follow-up data would be needed to ascertain which of these outcomes is more likely and if there are any predictors of prognosis.

This study attempted to distinguish between the diagnosis (which may or may not have been the underlying cause of the collapse) and the aetiology of the collapse, however there are no studies available on this topic and therefore this differentiation is based on the clinicians' opinions.

Consequently, the results of this study may not apply to the wider population, as different clinicians may draw alternative conclusions. In addition to these limitations, and those already outlined above, this study only included 33 cats, which is a reflection of the infrequency with which cats are presented for the investigation of collapse and meant that there was insufficient data to make any predictions regarding variables which may impact on prognosis. Further evaluation using a larger study population, including cases from general practice, would provide a better overview of this subject.

## **5.4 DOGS**

### **5.4.1 Signlamente**

There was a wide age range in the dogs included in this study, which can be explained by the wide variety of underlying aetiologies for collapse, with conditions such as vasovagal syncope and congenital disease typically being seen in young dogs (Bonagura and Lehmkuhl, 1999; Rush, 1999) and conditions such as CVD being more common in older dogs (Atkins et al., 2009). Fifty-one percent of dogs in this study were male, which is consistent with both the veterinary (Miller et al., 1999) and human literature (D'Ascenzo et al., 2013). Boxers were the most common breed represented (36%), which is consistent with other studies (Miller et al., 1999; MacKie et al., 2010; Barnett et al., 2011), and may be because Boxers show a high incidence of vasovagal syncope (Thomason, 2009), ARVC (Basso et al., 2004) and AS (Oliveira et al., 2011). Labradors were also seen commonly in this study (8%) and in others (Miller et al., 1999; Barnett et al., 2011), which may be because Labradors are the most popular registered breed in the UK (The Kennel Club, 2011) and/or because Labradors are predisposed to EIC (Minor et al., 2011) and AS (Oliveira et al., 2011).

### **5.4.2 Diagnosis**

The collapse was of unknown origin in 44% of cases, which is similar to that reported in humans with syncope (41%) (Kapoor, 1990), however is higher than reported in a previous veterinary study (33%) (Barnett et al., 2011); this disparity may be explained by differences in case selection, since the veterinary study also included dogs that presented for exercise intolerance. Additionally, the cause of collapse was not always definitively diagnosed and relied on clinician opinion, based on the available history, clinical examination and diagnostic investigation; and, whilst this is often the case in clinical practice, it is far from ideal when conducting a study due to the potential for mis-diagnosis and bias. Any results found in this study may only apply to this population of dogs.

The most common cause for collapse was cardiac disease (27%); there are no veterinary studies to compare this finding with, however it is far higher than reported in humans with syncope (3%) (Schnipper and Kapoor, 2001). This may be because the cases in this study came from a cardiac caseload, or that people with heart disease notice more subtle symptoms (such as palpitations and fatigue) before the disease causes collapse, whereas dogs are reliant on owner awareness of their clinical signs. The KM estimated median survival time was significantly shorter in the cardiac disease group (270 days, 95%CI 180-360) than in the CUO group (1950 days, 95%CI 1735-2165), which is consistent with the human literature, in which it is widely reported that cardiac syncope carries a worse prognosis (D'Ascenzo et al., 2013; Rosanio et al., 2013).

There were only two dogs for which the cause of collapse was determined to be PE, which is likely due to the fact that dogs with PE typically present with lethargy, weakness and ascites, with only 23% presenting with collapse (Stafford-Johnson et al., 2004). Only three dogs collapsed due to respiratory disease (all of which had tussive syncope); this is likely because dogs with respiratory disease are typically referred for investigation of a cough or dyspnoea, rather than collapse. Collapse is reported in severe cases of tracheal collapse (Johnson, 2000), but is not reported in dogs with IPF (Corcoran et al., 2011). It is possible the dog with IPF also had PH, which does cause collapse in dogs (Johnson et al., 1999). Tussive syncope has been reported previously in dogs (Davies et al., 2011) and people (Mattle et al., 1995). Additionally, there were only two cases diagnosed with SVT; it may be that dogs with SVT present with an alternative clinical sign, such as lethargy or congestive heart failure, and therefore they were not included in this cohort.

In dogs vasovagal syncope is ideally diagnosed based on documentation of a collapse associated with a sinus bradycardia preceded by a sinus tachycardia on HM (Johnson et al., 2007). However, HM recording during a collapse occurs in only 30% (Thomason et al., 2011) or 42% (Miller et al., 1999) of cases and as such, often a presumptive diagnosis based on an appropriate history and an absence of ECG abnormalities, has to be made (Johnson et al., 2007; Thomason, 2009; Thomason et al., 2011). As a definitive diagnosis with HM was not made in all dogs in this study, it is possible that some were misdiagnosed.

There were five non-Labrador breeds diagnosed with EIC, which has previously been reported in Labradors (Takanosu et al., 2012), Chesapeake Bay Retrievers and Curly-coat Retrievers (Patterson et al., 2008). Currently EIC is a presumptive diagnosis based on the clinical history and the lack of identification of another cause, although an associated gene mutation has been identified (Patterson et al., 2008). It is therefore possible that these dogs were misdiagnosed, or that EIC does occur in breeds other than the Labrador.

#### **5.4.3 Outcome and survival analysis**

Follow-up was achieved in a high percentage of cases (75%). The survival analysis was checked to confirm that the cox proportional hazards model was robust and that the assumption of proportionality of hazards was not violated. The Schoenfeld residuals demonstrated no systematic changes over time, which is consistent with hazards being proportional, and a global test of proportionality of hazards using the 'cox.zph()' function gave a P value of 0.08 which again indicates there was no clear evidence of a lack of proportionality of hazards in the model. The delta-betas showed that no data points were heavily influencing any regression coefficient. Although the univariable survival plots show survival lines crossing, this is not good evidence that the assumption of proportionality of hazards is violated in a multivariable model setting; the latter has hazard ratios that are 'corrected' (i.e. adjusted to account for the simultaneous effects of other variables in the model). Whilst no model can be shown to be 'absolutely correct', all diagnostics on the model used in this study provide evidence that the model was safe, that no assumptions were violated and that no data points were having undue influence on the outcome.

Thirty-nine percent of dogs in this study continued to collapse, which is more than reported by Barnett et al (2011) (23%); however, this can be explained by differences in study design, Barnett et al's study (2011) only included dogs with an unknown cause of collapse and also included dogs presenting with exercise intolerance. Dogs which continued to collapse had a shorter median survival time than those that did not collapse again (630 days (95%CI 0-1440) and >2100 days, respectively). Most studies focus on prognostic indicators from the history and clinical findings at presentation, however one human study reported an increased incidence of cardiac syncope in patients which reported ongoing syncopal episodes (Soteriades et al., 2002); and, as already stated, cardiac syncope is widely reported to carry a worse prognosis (D'Ascenzo et al., 2013; Rosanio et al., 2013).

In this study, dogs older than 7 years of age had a worse prognosis, which was not unexpected and is consistent with both the veterinary (Barnett et al., 2011) and human literature (Colivicchi et al., 2003; D'Ascenzo et al., 2013). Additionally, identification of a tachyarrhythmia, enlarged ventricle(s), PE and moderate/severe AS were all significant predictors of a worse outcome and are all associated with cardiac disease, which is extensively reported to carry a worse prognosis in both people (Colivicchi et al., 2003; D'Ascenzo et al., 2013; Rosanio et al., 2013) and dogs (Yee, 2010) presenting for investigation of collapse. Furthermore, echocardiographic identification of enlarged cardiac chamber(s) or PE has been reported in the veterinary literature as carrying a worse prognosis in association with CVD (Häggström et al., 2008). In the current study dogs with moderate/severe AS (pressure gradient >50mmHg) had a worse outcome. This is consistent with a study by Kienle et al (1994) which found that dogs which developed major complications and were subsequently euthanized/died, had a median pressure gradient of 45mmHg (range 16-105mmHg). Dogs which were anaemic had a significantly worse outcome, which has been reported in human patients with syncope (Quinn et al., 2004) and may be a reflection of chronic disease (Naigamwalla et al., 2012).

Additionally, there are many reports in the human literature of anaemia in association with heart failure, in which it is often coincident with renal disease (Ezekowitz et al., 2003; Handelman and Levin, 2008); it is likely that dogs with heart failure were included in this study, as 27% of the dogs collapsed because of cardiac disease and 14% had a lung pattern or pleural effusion identified by radiography, which may be seen with congestive heart failure (Suter and Lord, 1971). However, there is insufficient information available to confirm this.

Finding hypercholesterolemia to be a negative prognostic indicator was unexpected, and investigating this in a larger, prospective study would be needed to confirm the validity of this finding. Studies have shown that serum cholesterol levels are not affected by fasting, which suggests that the lack of records regarding fasted versus non-fasted is not a confounding factor in this population of dogs (Delkic, A. D. et al., 2018; Matsuzawa, T. and Sakazume, M. 1994). Possible biological explanations for the negative effect of hypercholesterolemia include the development of atherosclerosis and/or cardiomyocyte toxicity and a possible association with dilated cardiomyopathy.

Dogs with hypercholesterolemia have been shown to develop atherosclerosis (Mahley et al., 1977; Liu et al., 1986) and in people atherosclerosis is a major cause of death (Raal and Santos, 2012). Additionally, the severity of the atherosclerosis is proportional to the level and duration of hypercholesterolaemia (Raal and Santos, 2012). In dogs, hypercholesterolemia occurs secondary to hyperlipidaemia, which can be familial (Jeusette et al., 2006; Mori et al., 2010), secondary to other diseases such as diabetes mellitus and hyperadrenocorticism or in association with obesity (Mori et al., 2010). It is possible that the dogs in this study were suffering from one of these conditions, as body condition scoring and detailed information about prior/current diseases were not recorded. Cholesterol is an important lipid component of the plasma membrane of mammalian cells (Deng et al., 2012). Cholesterol homeostasis is important for cardiomyocyte function (Deng et al., 2012) and studies have shown that products of cholesterol oxidation are cytotoxic to cardiomyoblasts, causing apoptosis (Chiu et al., 2001; Sathishkumar et al., 2009)

and are likely to be involved in the development of cardiovascular lesions (Sathishkumar et al., 2009).

There are reports of low cholesterol being associated with a poorer outcome, however these are only in patients with severe CHF (Horwich et al., 2002; Hollander et al., 2012) and it is hypothesised that this link may be due to low cholesterol serving as a marker for poor nutritional status and reduced metabolic reserve (Hollander et al., 2012). Hypercholesterolaemia has also been found in dogs with DCM (Tidholm and Jonsson, 1997) and DCM carries a poor prognosis (the median survival in dogs is reported to be 19 weeks (Martin et al., 2009)). Finally, this may have been a randomly generated incorrect finding, as no statistical analysis model can be absolutely correct. As already discussed above, the diagnostic checks carried out to test the model found it to have been used appropriately and, therefore, the chances of this being a randomly generated error are less than five percent. This study does not have sufficient information to provide a clear explanation for why hypercholesterolaemia was associated with a worse outcome in the dogs in this study, the above are merely possible explanations. It is important to be clear that this finding requires further investigation and may not apply to other populations of dogs.

In this study, identification of a lung pattern on thoracic radiographs also conferred a worse prognosis. There are no published studies of radiographic findings in dogs with collapse, however congestive heart failure and shunting defects can cause radiographic changes and, as already discussed, cardiac causes of collapse carry a worse prognosis. The decision to include all lung patterns in one variable was made for two reasons.

Firstly, because there were insufficient dogs to analyse each lung pattern separately and, secondly, because determining which lung pattern is present is subjective and can be challenging if more than one pattern is present (Mai et al., 2008). It is possible, therefore, that a specific lung pattern carries a worse prognosis, however a larger study population would be required to evaluate this. Identification of an enlarged cardiac silhouette on thoracic radiography was

significant in the univariable analysis, however did not carry through to the multivariable analysis.

This may be explained by the fact that, statistically, echocardiographic chamber enlargement explained the most variation in outcome (as both variables are measures of heart size (Nakayama et al., 2001)); it may be that identifying an enlarged cardiac silhouette on radiographs is a useful negative prognostic indicator if echocardiography is not available; however, further analysis would be needed.

Finally, dogs that continued to collapse after their initial referral examination were at greater risk of death. There are no veterinary studies to compare this with, however in humans the incidence of cardiac syncope was increased in people who continued to collapse (Soteriades et al., 2002); and, as already discussed, cardiac syncope carries a worse prognosis in people (Colivicchi et al., 2003; D'Ascenzo et al., 2013; Rosanio et al., 2013). Additionally, dogs which were euthanized on the day of presentation, or died shortly after (and therefore potentially did not have sufficient time to collapse again) were coded as 'no on-going collapse', which suggests continued collapse may be even more important than these results imply.

In this study, no specific breed was at increased risk of death, which is contrary to a study by Barnett et al (2011), which found that Boxers were at increased risk of death; this may be explained by the differences in case selection between these studies; Barnett et al's (2011) paper examined dogs with CUO (rather than dogs presenting with collapse or any origin, as in this study) and, additionally, Barnett et al's (2011) paper included dogs presenting with exercise intolerance, which were not included in this study.

Owners of dogs presenting for collapse are routinely asked whether or not their dog lost consciousness/was unresponsive, in order to try and differentiate syncope from other causes of collapse such as neuromuscular disorders, electrolyte imbalance, endocrine disorders or hypoglycaemia (Davidow et al., 2001).

Multivariable Cox regression analysis did not identify a significant survival difference between dogs that were and were not responsive during the collapse,

suggesting that this may not be a useful piece of history to gain from the owner in terms of prognosis.

It was surprising that dogs with an increased serum cTnI concentration were not at increased risk of death, as increased cTnI is a marker of myocardial damage (Oyama and Sisson, 2004; Spratt et al., 2005). This may be because increased cTnI has been associated with heart disease (including cardiomyopathy, CVD, AS and PE) (Oyama and Sisson, 2004; Spratt et al., 2005) and statistically, detection of cardiac disease (enlarged ventricle, AS, tachyarrhythmia, PE) explained the variation in outcome. Additionally, it is interesting that different inciting events of the collapse did not confer an increased risk of death, this is likely explained by the fact that multiple diseases (with different prognoses) could have the same inciting event, for example collapse on excitement/exertion could be due to neurocardiogenic (vasovagal syncope) (Thomason, 2009), EIC (Taylor et al., 2008) or cardiac disease (Miller et al., 1999).

## **6 CONCLUSIONS**

### **6.1 CATS**

The results of this study highlight that collapse is a rare occurrence in cats and, based on this series of cats, it tends to be middle-to-old aged, male cats, with echocardiographic evidence of structural heart disease. A cause for the collapse cannot always be identified, however, cats presenting with collapse should be screened for cardiac disease. Additionally, owners can be reassured that in the majority of cases (77%), the collapse is transient and the cats experience a rapid return to 'normal', however survival time is variable.

### **6.2 DOGS**

This study found that the signalment of dogs presenting for collapse is varied and that the majority of collapse(s) are associated with a preceding event (most commonly exercise/exertion). A diagnosis cannot always be reached, but in cases where cardiac disease is identified, and in cases which continue to collapse, the survival time is less.

Additionally, the results of this study identified parameters from the history, signalment and diagnostic investigations that negatively impact on survival in dogs with collapse, irrespective of the underlying cause (and whether or not a diagnosis is reached).

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JabRef version 2.8.1 (Free software foundation) for manuscript preparation

## 9 APPENDICES

### 9.1 Appendix 1. Questionnaire for cat owners.

- 
- 1 Were the episode(s) preceded by any particular activity (e.g. eating, jumping off the bed, running upstairs)?
  - 2 Do you think (cat's name) knew he/she was about to have an episode?
  - 3 Was he/she responsive to you during the event?
  - 4 If not, how long was he/she unresponsive for?
  - 5 Did he/she violently paddle/jerk his/her legs during the episode?
  - 6 Did [animal's name] chomp his/her jaw?
  - 7 After the episode(s), did he/she immediately return completely back to "normal"?
  - 8 If not, how long did he/she remain abnormal for?
  - 9 Has (cat's name) had any episodes since being seen here (at Martin Referrals/Nantwich Vets) in (date of presentation)?
  - 10 Did he/she have any health problems at the time of presentation to Martin Referrals/Nantwich Vets?
  - 11 Is (cat's name) still living with you?
  - 12 If he/she has passed away, would you mind providing the date and circumstances of his/her death?
  - 13 We have a description of the events from the clinical records, however could you describe a typical episode in your own words?
- 

### 9.2 Appendix 2. Questionnaire for dog owners.

- 
- 1 Were the episode(s) preceded by any particular activity (e.g. exercise, urination, sleeping)?
  - 2 Do you think (dog's name) knew he/she was about to have an episode?
  - 3 Was he/she responsive to you during the event?
  - 4 If not, how long was he/she unresponsive for?
  - 5 Did he/she violently paddle/jerk his/her legs during the episode?
  - 6 Did [animal's name] chomp his/her jaw?
  - 7 After the episode(s), did he/she immediately return completely back to "normal"?
  - 8 If not, how long did he/she remain abnormal for?
  - 9 Has (dog's name) had any episodes since being seen here (at Martin Referrals) on (date of presentation)?
  - 10 Did he/she have any health problems at the time of presentation to Martin Referrals?
  - 11 Is (dog's name) still living with you?
  - 12 If he/she has passed away, would you mind providing the date and circumstances of his/her death?
  - 13 We have a description of the events from the clinical records, however could you describe a typical episode in your own words?
-

**9.3 Appendix 3. Health problems at presentation for cat cases.**

|                                              | <b>Finding</b>                                    | <b>Number</b> | <b>Percentage</b> |
|----------------------------------------------|---------------------------------------------------|---------------|-------------------|
| <b>Health Problem(s)<br/>At Presentation</b> | None                                              | 5             | 29                |
|                                              | Cardiac disease                                   | 3             | 18                |
|                                              | Endocrine disease                                 | 2             | 12                |
|                                              | Musculoskeletal disease                           | 2             | 12                |
|                                              | Gastrointestinal disease                          | 1             | 6                 |
|                                              | Anaemia                                           | 1             | 6                 |
|                                              | Neurological disease                              | 1             | 6                 |
|                                              | Cardiac & endocrine disease                       | 1             | 6                 |
|                                              | Upper respiratory & gastro-<br>Intestinal disease | 1             | 6                 |
| <b>Total</b>                                 |                                                   | <b>17</b>     |                   |

**9.4 Appendix 4. Clinical examination findings for cat cases .**

|                                    | <b>Finding</b>                                             | <b>Number</b> | <b>Percentage<sup>a</sup></b> |
|------------------------------------|------------------------------------------------------------|---------------|-------------------------------|
| <b>Heart murmur</b>                | None                                                       | 8             | 26                            |
|                                    | Grade I                                                    | 5             | 16                            |
|                                    | Grade II                                                   | 7             | 23                            |
|                                    | Grade III                                                  | 9             | 29                            |
|                                    | Grade IV                                                   | 2             | 7                             |
|                                    | Grade V                                                    | 0             | 0                             |
|                                    | Grade VI                                                   | 0             | 0                             |
| <b>Total</b>                       |                                                            | <b>31</b>     |                               |
| <b>Heart rate</b>                  | Normal                                                     | 18            | 58                            |
|                                    | > 180 beats/minute                                         | 13            | 42                            |
|                                    | < 120 beats/minute                                         | 0             | 0                             |
|                                    | <b>Total</b>                                               | <b>31</b>     |                               |
| <b>Arrhythmia</b>                  | None                                                       | 27            | 87                            |
|                                    | Irregular heart rhythm,<br>rate >180 beat/minute           | 2             | 7                             |
|                                    | Irregular heart rhythm,<br>rate >120 and <180 beats/minute | 2             | 7                             |
|                                    | <b>Total</b>                                               | <b>31</b>     |                               |
| <b>Pulse quality</b>               | Normal                                                     | 28            | 90                            |
|                                    | Bilaterally reduced strength                               | 2             | 7                             |
|                                    | Unilaterally reduced strength                              | 1             | 3                             |
|                                    | <b>Total</b>                                               | <b>31</b>     |                               |
| <b>Respiratory<br/>Abnormality</b> | None                                                       | 27            | 87                            |
|                                    | Respiratory rate >40 breaths/minute                        | 3             | 10                            |
|                                    | Mildly increased respiratory effort <sup>b</sup>           | 1             | 3                             |
|                                    | <b>Total</b>                                               | <b>31</b>     |                               |

<sup>a</sup> Some percentage totals add to 99 or 101 because of rounding up/down of decimals.

<sup>b</sup> This cat had concurrent upper respiratory disease.

## 9.5 Appendix 5. Electrocardiography and Holter monitor data for cat cases.

| Finding                           |                          | Combined |    | ECG |     | Holter |     |
|-----------------------------------|--------------------------|----------|----|-----|-----|--------|-----|
|                                   |                          | n        | %* | n   | %*  | n      | %*  |
| Rate<br>(ECG overall,<br>HM mean) | Normal                   | 23       | 79 | 17  | 77  | 6      | 86  |
|                                   | >180 (ECG) >130 (HM) BPM | 5        | 17 | 4   | 18  | 1      | 14  |
|                                   | <120 (ECG) <110 (HM) BPM | 1        | 3  | 1   | 5   | 0      | 0   |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| VPC                               | None                     | 21       | 72 | 20  | 91  | 1      | 14  |
|                                   | Present                  | 8        | 28 | 2   | 9   | 6      | 86  |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| VT                                | None                     | 27       | 93 | 22  | 100 | 5      | 71  |
|                                   | Present                  | 2        | 7  | 0   | 0   | 2      | 29  |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| SVPC                              | None                     | 27       | 93 | 21  | 96  | 6      | 86  |
|                                   | Present                  | 2        | 7  | 1   | 5   | 1      | 14  |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| SVT                               | None                     | 27       | 93 | 20  | 91  | 7      | 100 |
|                                   | Present                  | 2        | 7  | 2   | 9   | 0      | 0   |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| AF                                | None                     | 28       | 97 | 21  | 96  | 7      | 100 |
|                                   | Present                  | 1        | 3  | 1   | 5   | 0      | 0   |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| AVB                               | None                     | 28       | 97 | 21  | 96  | 7      | 100 |
|                                   | Present                  | 1        | 3  | 1   | 5   | 0      | 0   |
| Total                             |                          | 29       |    | 22  |     | 7      |     |
| AVD                               | None                     | 26       | 90 | 20  | 91  | 6      | 86  |
|                                   | Present                  | 3        | 10 | 2   | 9   | 1      | 14  |
| Total                             |                          | 29       |    | 22  |     | 7      |     |

ECG – electrocardiographic recording, HM – Holter monitor recording, BPM- beats per minute, VPC – ventricular premature complex, VT – ventricular tachycardia, SVPC – supraventricular premature complex, SVT – supraventricular tachycardia, AF – atrial fibrillation, AVB – atrioventricular block, AVD – atrioventricular dissociation.

\*Some percentage totals add to 99 or 101 because of rounding up/down of decimals.

**9.6 Appendix 6. Echocardiographic data for cat cases.**

| <b>Finding</b>           |                                   | <b>Number</b> | <b>Percentage</b> |
|--------------------------|-----------------------------------|---------------|-------------------|
| Structural Heart Disease | None                              | 2             | 7                 |
|                          | Present <sup>a</sup>              | 28            | 93                |
| Total                    |                                   | 30            | 100               |
| Chamber Dilation         | None                              | 13            | 43                |
|                          | Atrial dilation                   | 14            | 47                |
|                          | Ventricular dilation <sup>b</sup> | 3             | 10                |
| Total                    |                                   | 30            | 100               |
| LVH <sup>c</sup>         | None                              | 12            | 40                |
|                          | Mild (6-7mm)                      | 12            | 40                |
|                          | Moderate (7-8mm)                  | 3             | 10                |
|                          | Severe(>8mm)                      | 3             | 19                |
| Total                    |                                   | 30            | 100               |
| LVH Symmetry             | No hypertrophy                    | 12            | 40                |
|                          | Symmetrical                       | 1             | 3                 |
|                          | Asymmetrical                      | 12            | 40                |
|                          | Not recorded                      | 5             | 17                |
| Total                    |                                   | 30            | 100               |
| SAM                      | None                              | 21            | 70                |
|                          | Present                           | 9             | 30                |
| Total                    |                                   | 30            | 100               |
| DLVOTO                   | None                              | 19            | 63                |
|                          | Present                           | 11            | 37                |
| Total                    |                                   | 30            | 100               |
| DRVOTO                   | None                              | 24            | 80                |
|                          | Present                           | 6             | 20                |
| Total                    |                                   | 30            | 100               |
| Mitral Regurgitation     | None                              | 14            | 47                |
|                          | Mild                              | 16            | 53                |
|                          | Moderate                          | 0             | 0                 |
|                          | Severe                            | 0             | 0                 |
| Total                    |                                   | 30            | 100               |
| Tricuspid Regurgitation  | None                              | 24            | 80                |
|                          | Mild                              | 5             | 17                |
|                          | Moderate                          | 1             | 3                 |
|                          | Severe                            | 0             | 0                 |
| Total                    |                                   | 30            | 100               |
| Smoke <sup>d</sup>       | None                              | 25            | 83                |
|                          | Present                           | 5             | 17                |
| Total                    |                                   | 30            | 100               |
| Diastolic Dysfunction    | None                              | 10            | 33                |
|                          | Delayed                           | 5             | 17                |
|                          | Pseudo-normal                     | 0             | 0                 |
|                          | Restrictive                       | 3             | 10                |
|                          | Pattern not specified             | 12            | 40                |
| Total                    |                                   | 30            | 100               |
| AV Dysplasia             | None                              | 28            | 93                |
|                          | Mitral                            | 1             | 3                 |
|                          | Tricuspid                         | 1             | 3                 |
| Total                    |                                   | 30            | 100               |

LVH – left ventricular hypertrophy, SAM - systolic anterior motion of the mitral valve, DLVOTO - dynamic left ventricular outflow tract obstruction, DRVOTO - dynamic right ventricular outflow tract obstruction, AV – atrioventricular.

<sup>a</sup> includes three cats whose only echocardiographic abnormality was DRVOTO

<sup>b</sup> dilation refers to eccentric hypertrophy

<sup>c</sup> hypertrophy refers to concentric hypertrophy

<sup>d</sup> smoke refers to spontaneous echocardiographic contrast

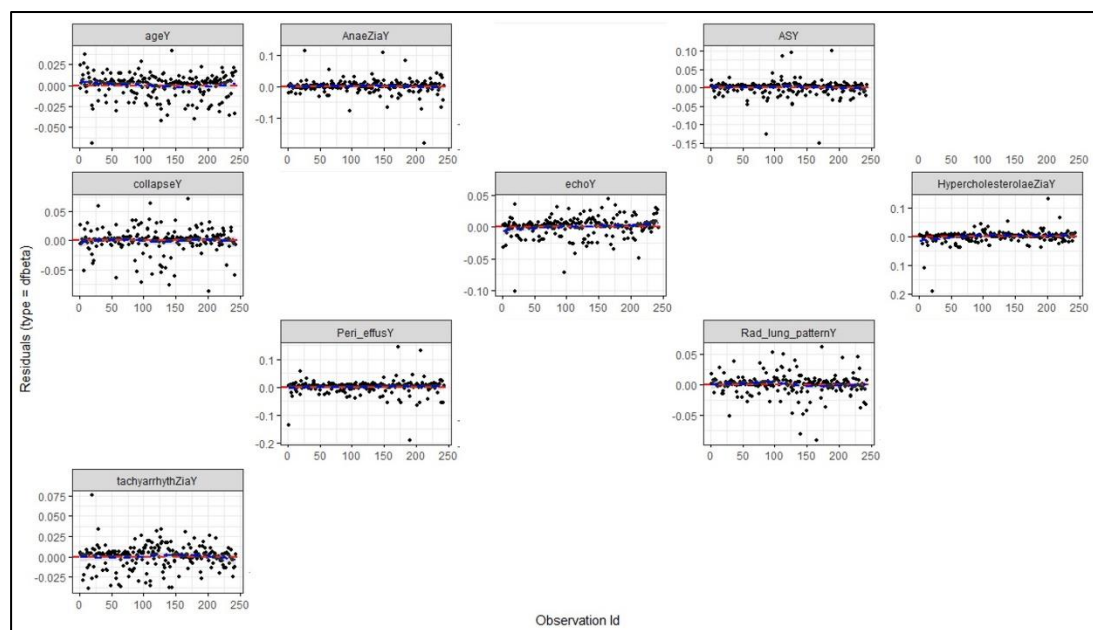
## 9.7 Appendix 7. Breed distribution of dogs cases.

| Breed                         | Number | Percent |
|-------------------------------|--------|---------|
| Boxer                         | 90     | 36      |
| Cross breed                   | 24     | 10      |
| Labrador                      | 19     | 8       |
| Cavalier King Charles Spaniel | 12     | 5       |
| Border collie                 | 9      | 4       |
| English Bull Terrier          | 6      | 2       |
| Jack Russell Terrier          | 6      | 2       |
| Springer Spaniel              | 5      | 2       |
| Cocker spaniel                | 4      | 2       |
| West Highland White Terrier   | 4      | 2       |
| German Shepherd Dog           | 4      | 2       |
| Doberman                      | 4      | 2       |
| Great Dane                    | 3      | 1       |
| Lurcher                       | 3      | 1       |
| Bull Mastiff                  | 3      | 1       |
| Shih Tsu                      | 3      | 1       |
| Golden Retriever              | 3      | 1       |
| Flat Coated Retriever         | 3      | 1       |
| Yorkshire Terrier             | 3      | 1       |
| Other                         | 45     | 18      |
| Total                         | 253    | 100     |

## 9.8 Appendix 8. Health problems at presentation for dog cases.

| Breed                                   | Number | Percent |
|-----------------------------------------|--------|---------|
| None                                    | 81     | 42      |
| Cardiac disease                         | 19     | 10      |
| Respiratory disease                     | 16     | 8       |
| Dermatological disease                  | 16     | 8       |
| Gastrointestinal disease                | 14     | 7       |
| Musculoskeletal disease                 | 10     | 5       |
| Reproductive disease                    | 9      | 5       |
| Endocrine disease                       | 8      | 4       |
| Neurological disease                    | 5      | 3       |
| Haematological abnormality              | 4      | 2       |
| Urinary disease                         | 2      | 1       |
| Disease involving $\geq 2$ body systems | 11     | 6       |
| Total                                   | 195    | 100     |

## 9.9 Appendix 9. Delta-beta residual coefficient graph.



## **CLINICAL EXPERIENCE**

### **Author's cases**

Nantwich Veterinary Hospital, Crewe Road End, Nantwich, CS5 5SF

Pride Veterinary Centre, Riverside Road, Derby, Derbyshire DE24 8HX

Rushcliffe Veterinary Centre, Collington Way, West Bridgford NG2 7LR

### **Cases seen under supervision**

Defence Animal Centre, Asfordby Rd, Melton Mowbray LE13 0HX

Dovecote Veterinary Hospital, 5 Delven Lane, Castle Donington, Derby DE74 2LJ

Ohio State University Veterinary Hospital, 601 Vernon L Tharp Street, Columbus, OH 43210, USA

Small Animal Teaching Hospital, The University of Liverpool, Leahurst, Chester High Road, Neston Cheshire CH64 7TE

School of Veterinary Medicine & Science, Sutton Bonington Campus, Sutton Bonington, Loughborough LE12 5RD

The Veterinary Cardiorespiratory Centre, Thera house, 43 Waverley Road, Kenilworth, Warwickshire CV8 1JL

### **Clinical experience**

Cardiac Catheter Lab, Glenfield Hospital, Groby Road, Leicester LE3 9QP

## CASELOG

| PRACTICE | PATIENT           | Species | BREED               | AGE    | SEX | CONDITION                                     | INTERVENTION |     |  |  |
|----------|-------------------|---------|---------------------|--------|-----|-----------------------------------------------|--------------|-----|--|--|
| NVG      | Ailsa Tourney     | Dog     | GSD                 | 1y8m   | Fe  | Arrhythmia                                    |              |     |  |  |
| NVG      | Aimee Rigby       | Dog     | Greyhound           | 9y7m   | Fe  | MMVD                                          |              |     |  |  |
| NVG      | AJ Jones          | Cat     | DSH                 | 3y8m   | Me  | HOCM                                          | CHF          |     |  |  |
| NVG      | Alaska Cartwright | Dog     | Golden Retriever    | 10y2m  | Fn  | MMVD                                          |              |     |  |  |
| NVG      | Ales Hayward      | Cat     | Ragdoll             | 11m    | Mn  | murmur                                        |              |     |  |  |
| NVG      | Alex Gilham       | Dog     | EBT                 | 7y2m   | Me  | Reduced systolic function post-GA             |              |     |  |  |
| NVG      | Alfie Bayley      | Dog     | Airdale             | 9y4m   | Me  | Abdominal effusion & tachycardia post-surgery |              |     |  |  |
| NVG      | Alfie Cameron     | Dog     | Cairn Terrier       | 1y2m   | Me  | Flow murmur                                   |              |     |  |  |
| NVG      | Alfie Coker       | Dog     | Cocker Spaniel      | 8y     | Mn  | DCM                                           |              |     |  |  |
| LVH      | Alfie Greensmith  | Dog     | Lhasa Apso          | 8y     | Mn  | MMVD                                          |              |     |  |  |
| NVG      | Alfie Machin      | Cat     | DSH                 | 12y2m  | Mn  | RCM                                           | CHF          | SVT |  |  |
| NVG      | Alfie Merry       | Cat     | DSH                 | 1y     | Mn  | Pyothorax                                     |              |     |  |  |
| NVG      | Alfie Shaw        | Cat     | DSH                 | 8y6m   | Mn  | HCM                                           | CHF          |     |  |  |
| NVG      | Alfie Spencer     | Cat     | DSH                 | 7y     | Mn  | HOCM                                          |              |     |  |  |
| PVC      | Alfie Wilkinson   | Dog     | GSD                 | 10y11m | M   | MR                                            |              |     |  |  |
| NVG      | Amy Fox           | Dog     | CKCS                | 9y     | Fn  | MMVD                                          | CHF          |     |  |  |
| NVG      | Angel Parsons     | Cat     | DSH                 | 8y3m   | Fn  | Hyperthyroidism                               | asthma       |     |  |  |
| NVG      | Anna Rathbone     | Dog     | WHWT                | 13y    | Fn  | Bradydysrhythmia                              |              |     |  |  |
| NVG      | Annie Birchall    | Dog     | CKCS                | 7y     | Fn  | MMVD                                          | Bronchitis   |     |  |  |
| NVG      | Annie Preece      | Dog     | JRT                 | 14y7m  | Fn  | MMVD                                          |              |     |  |  |
| PVC      | Archie Castelli   | Dog     | Chinese crested dog | 8y6m   | M   | MMVD (mild)                                   |              |     |  |  |
| NVG      | Archie Henshall   | Dog     | ESS                 | 10m    | Me  | Dysrhythmia                                   |              |     |  |  |
| NVG      | Archie Hill       | Cat     | DSH                 | 4y     | Mn  | Abdo scan for uroperitoneum                   |              |     |  |  |

|     |                 |     |                  |        |    |                                               |          |  |  |           |
|-----|-----------------|-----|------------------|--------|----|-----------------------------------------------|----------|--|--|-----------|
| LVH | Archie Taylor   | Dog | WHWT             | 3y     | Mn | Pulmonic stenosis                             |          |  |  |           |
| NVG | Army Dean       | Dog | Labrador         | 1y7m   | Me | PS                                            | TVD      |  |  |           |
| VCC | Army Dean       | Dog | Labrador         | 1y8m   | Me | PS                                            |          |  |  | BV        |
| NVG | Arnie Cree      | Dog | JRT              | 8y     | Me | MMVD                                          |          |  |  |           |
| NVG | Arnie Swetman   | Cat | DSH              | 16y    | Mn | Dysrhythmia                                   |          |  |  |           |
| VCC | Asterix Hewins  | Dog | GWHP             | 10y    | Mn | 3AVB                                          |          |  |  | Pacemaker |
| NVG | Axel Teare      | Dog | GSD              | 8y10m  | Me | Dysrhythmia                                   | murmur   |  |  |           |
| PVC | Badger Low      | Dog | Collie X         | 14y1m  | M  | MMVD (mild)                                   |          |  |  |           |
| PVC | Bagel Walker    | Cat | DSH              | 4y     | Fn | HCM (mild)                                    |          |  |  |           |
| NVG | Bailey Haspell  | Cat | Persian          | 12y2m  | Mn | Tachypnoea                                    |          |  |  |           |
| NVG | Bailey Ray      | Dog | Boxer            | 10y    | Me | Pre-chemotherapy scan                         |          |  |  |           |
| PVC | Barney Sams     | Cat | DSH              | 7y8m   | Mn | WNL                                           |          |  |  |           |
| NVG | Barney Swetman  | Dog | crossbreed       | 9y5m   | Me | EI                                            |          |  |  |           |
| NVG | Bart Barber     | Cat | DSH              | 8y8m   | Mn | WNL                                           |          |  |  |           |
| VCC | Baxter Beasley  | Dog | Basset Hound     | 4y11m  | Mn | Lymphoma chest and heart (interatrial septum) |          |  |  |           |
| PVC | Bear Conn       | Cat | DSH              | 11y11m | Mn | HOcm (mild)                                   |          |  |  |           |
| NVG | Bear Pallett    | Cat | DSH              | 10y    | Mn | murmur                                        |          |  |  |           |
| PVC | Beau Smith      | Cat | Russian Blue     | 1y5m   | Fe | HCM (mild)                                    |          |  |  |           |
| PVC | Beauty Lake     | Cat | DSH              | 2y     | Fn | HOcm (mild)                                   |          |  |  |           |
| NVG | Becks Street    | Dog | Boxer            | 8y5m   | Mn | PE                                            | Lymphoma |  |  |           |
| VCC | Bella Doyle     | Dog | GSD              | 3m     | Fe | PDA                                           |          |  |  | CDO       |
| VCC | Bella Gladstone | Dog | Springer spaniel | 12w    | Fe | PDA                                           |          |  |  | CDO       |
| NVG | Bella Walsgrove | Dog | SBT              | 1y7m   | Fn | Flow murmur                                   |          |  |  |           |
| VCC | Ben Carter      | Cat | DSH              | 9y3m   | Mn | RCM                                           | CHF      |  |  |           |
| NVG | Ben Manion      | Dog | Pinscher         | 6y7m   | Me | MMVD                                          |          |  |  |           |
| NVG | Ben Newsone     | Dog | YT               | 5y6m   | Me | Neck pain                                     |          |  |  |           |

|     |                     |     |                |       |    |                                            |       |             |  |     |
|-----|---------------------|-----|----------------|-------|----|--------------------------------------------|-------|-------------|--|-----|
| NVG | Ben Robinson        | Dog | CKCS           | 13y2m | Mn | MMVD                                       | CHF   |             |  |     |
| NVG | Benji Ellis         | Dog | Sheltie        | 11y   | Mn | MMVD                                       | Cough | hepatopathy |  |     |
| NVG | Benji Hassall       | Dog | Border Collie  | 12y4m | Mn | Cough                                      |       |             |  |     |
| NVG | Benji Moore         | Dog | Terrier cross  | 15y   | Mn | MMVD                                       | PAH   |             |  |     |
| NVG | Benny Buckley       | Cat | DSH            | 13y   | Mn | DCM                                        | CHF   |             |  |     |
| NVG | Benny Ginders       | Dog | Toy Poodle     | 10y7m | Mn | MMVD                                       | Cough |             |  |     |
| NVG | Benny Millns        | Cat | DSH            | 9y    | Mn | HCM                                        | CHF   |             |  |     |
| NVG | Benny Stretton      | Dog | Greyhound      | 8y2m  | Mn | Pre-chemotherapy scan                      |       |             |  |     |
| NVG | Benson Brooke       | Dog | Boxer          | 1y5m  | Mn | SAS (mild)                                 |       |             |  |     |
| PVC | Benson Cunningham   | Dog | Corgi X        | 2y6m  | M  | MR                                         | TR    |             |  |     |
| NVG | Benson Healey       | Dog | Boxer          | 1y6m  | Me | Heart test                                 |       |             |  |     |
| NVG | Bernard Irish       | Cat | DSH            | 5y7m  | Mn | HOCM                                       |       |             |  |     |
| VCC | Bertie ?            | Dog | Beagle         | 16w   | Me | Bordetella pneumonia                       |       |             |  |     |
| VCC | Bertie Williams     | Dog | Border Terrier | 4m    | Me | PDA                                        |       |             |  | CDO |
| NVG | Bess Mason          | Dog | Border Collie  | 10y3m | Fe | MMVD                                       |       |             |  |     |
| NVG | Bethanie Cherington | Dog | CKCS           | 12y3m | Fn | MMVD                                       | CHF   | Hepatopathy |  |     |
| NVG | Betsy Copper        | Dog | Labrador       | 10y   | Fn | MMVD                                       |       |             |  |     |
| NVG | Betty Goodwin       | Dog | Cairn Terrier  | 1y    | Fe | Murmur                                     |       |             |  |     |
| PVC | Betty Westacott     | Cat | DSH            | 8y1m  | Fn | DRVOTO – needs full sedation for full scan |       |             |  |     |
| NVG | billie gregory      | Dog | crossbreed     | 14y   | Fn | MMVD                                       | CHF   | PAH         |  |     |
| VCC | Billy               | Dog | Cocker Spaniel | 1y10m | Mn | PS                                         |       |             |  | BV  |
| NVG | Billy Booth         | Cat | DLH            | 7y8m  | Mn | HOCM                                       |       |             |  |     |
| LVH | Billy Coleman       | Dog | EBD            | 6y    | Me | BOAS                                       |       |             |  |     |
| NVG | Billy Davies        | Dog | Crossbreed     | 5y4m  | Mn | Bradycardia                                |       |             |  |     |
| NVG | Billy Gregory       | Dog | Crossbreed     | 14y   | Fn | MMVD                                       | CHF   |             |  |     |
| NVG | Billy Lawton        | Dog | CKCS           | 10y   | Mn | MMVD                                       | CHF   | SH          |  |     |

|     |                    |        |                  |        |    |                      |                |                     |  |                  |
|-----|--------------------|--------|------------------|--------|----|----------------------|----------------|---------------------|--|------------------|
| NVG | Billy Mirze        | Cat    | DSH              | 15y    | Mn | HOCM                 | CHF            |                     |  |                  |
| NVG | Blaze Baranciukas  | Dog    | ESS              | 4y7m   | Me | WNL (athletic heart) |                |                     |  |                  |
| VCC | Blue Beal          | Dog    | Border collie    | 10y    | Mn | 3AVB                 |                |                     |  | Pacemaker (VVIR) |
| NVG | Blue Benbow        | Dog    | Border Terrier   | 6y6m   | Me | MVD                  |                |                     |  |                  |
| VCC | Blue Miller        | Cat    | DSH              |        | Mn |                      |                |                     |  |                  |
| NVG | Bluey Bebbington   | Rabbit | Rabbit           | 8y     | Mn | CHF                  |                |                     |  |                  |
| NVG | Bob Graham         | Dog    | Border Collie    | 11y7m  | Fn | MMVD                 |                |                     |  |                  |
| PVC | Bob Prince         | Dog    | CKCS             | 6y5m   | M  | SVT                  |                |                     |  |                  |
| NVG | Bobbie Harper      | Dog    | GSD              | 4y6m   | Fe | RTA                  |                |                     |  |                  |
| NVG | bobby cooke        | Dog    | YT               | 3y8m   | Mn | PS (mild)            | Cough          |                     |  |                  |
| NVG | Bonnie Keys        | Dog    | Great Dane       | 6y10m  | Fn | EI                   |                |                     |  |                  |
| PVC | Boots Rayner       | Cat    | DSH              | 1y5m   | Mn | HCM (mild)           |                |                     |  |                  |
| PVC | Boris Gibbons      | Cat    | DSH              | 5m     | Me | Flow murmur          |                |                     |  |                  |
| NVG | Boris Hassall      | Cat    | DSH              | 16y6m  | Mn | thoracic mass        |                |                     |  |                  |
| NVG | Bosley Bridle      | Dog    | Crossbreed       | 17y    | Mn | MMVD                 | kidney failure |                     |  |                  |
| NVG | Bosun Bellian      | Dog    | SBT              | 11y7m  | Mn | DCM                  | CHF            |                     |  |                  |
| NVG | Bramble Mace       | Dog    | ESS              | 12y    | Me | DCM                  | CHF            | laryngeal paralysis |  |                  |
| PVC | Bramble Pearce     | Dog    | Dachshund        | 9y     | M  | MMVD                 | PAH (mild)     |                     |  |                  |
| NVG | Brandy Annable     | Dog    | ESS              | 11y6m  | Fe | Cough                |                |                     |  |                  |
| NVG | Brandy Gray        | Dog    | crossbreed       | 13y10m | Fn | MMVD                 | CHF            |                     |  |                  |
| NVG | Breeze Harvey      | Dog    | Golden Retriever | 2y3m   | Fe | SAS (mild)           |                |                     |  |                  |
| NVG | Brock Benbow       | Dog    | Border Terrier   | 1y9m   | Me | SSS                  |                |                     |  |                  |
| NVG | Bronte Whitfield   | Cat    | DSH              | 10y2m  | Fn | HOCM                 | CHF            |                     |  |                  |
| VCC | Brownstone Vivanco | Dog    |                  | 1y1m   | Me | PDA                  | PS             |                     |  | CDO              |
| LVH | Bruce Green        | Dog    | Bull mastiff     | 4y     | Me | Chylothorax          |                |                     |  |                  |
| NVG | Bruce Moulstone    | Dog    | Doberman         | 5y2m   | Me | DCM                  | CHF            |                     |  |                  |

|     |                     |     |                  |        |    |                                      |              |     |  |  |
|-----|---------------------|-----|------------------|--------|----|--------------------------------------|--------------|-----|--|--|
| NVG | Bruce Roberts       | Dog | Bull Mastiff     | 6y10m  | Me | Pre-chemotherapy scan                |              |     |  |  |
| NVG | Bruno Tudor         | Dog | Boxer            | 9y6m   | Mn | ARVC                                 |              |     |  |  |
| NVG | Bryn Breese         | Dog | Border Collie    | 11y11m | Mn | MMVD                                 | PAH          | CHF |  |  |
| NVG | Bubba Mayo          | Cat | DSH              | 10y    | Fn | Hyperthyroidism                      |              |     |  |  |
| NVG | Bubbles Bailey      | Dog | Miniature poodle | 12y5m  | Fn | MMVD                                 | CHF          |     |  |  |
| NVG | Buck Harte          | Dog | Labrador         | 10y7m  | Me | DCM                                  | CHF          |     |  |  |
| PVC | Buddy Sanderson     | Dog | British bulldog  | 2y6m   | M  | Valvular disease                     |              |     |  |  |
| PVC | Buddy Tobin         | Dog | CKCS             | 9y5m   | M  | MMVD (mild)                          |              |     |  |  |
| NVG | Buffy Sigley        | Dog | Boxer            | 2y4m   | Fn | Murmur                               | Collapse     |     |  |  |
| NVG | Bugga Richardson    | Cat | DSH              | 6m     | Fe | Flow murmur                          |              |     |  |  |
| NVG | Buntly Wight        | Dog | Bull Mastiff     | 4y8m   | Fe | Pleural effusion post pericardectomy | Mesothelioma |     |  |  |
| PVC | Buster Copley       | Dog | Labrador         | 10y2m  | M  | Endocarditis                         | MMVD         |     |  |  |
| NVG | Buster Potts        | Cat | DSH              | 7y4m   | Mn | lymphoma                             | ascites      |     |  |  |
| NVG | Button Machin       | Dog | CKCS             | 8y     | Fn | MMVD                                 |              |     |  |  |
| NVG | Candy Burnham       | Dog | Border Collie    | 14y10m | Fn | MMVD                                 | collapse     |     |  |  |
| NVG | Candy Green         | Dog | Poodle           | 4y7m   | Fn | Eosinophilic bronchopneumopathy      |              |     |  |  |
| NVG | Casper Crombie      | Dog | WHWT             | 7y4m   | Mn | Hyperkalaemia                        |              |     |  |  |
| VCC | Cassias Cadman      | Dog |                  |        | M  |                                      |              |     |  |  |
| NVG | Cassie Martin       | Dog | Crossbreed       | 11y11m | Fn | PE (suspect haemangiosarcoma)        |              |     |  |  |
| NVG | Cassie Tuckey       | Dog | GSD              | 8y     | Fn | PDA                                  |              |     |  |  |
| NVG | Cat Shone           | Cat | DSH              | 10y    | Mn | Hyperthyroidism                      |              |     |  |  |
| NVG | Chance Walker       | Dog | Golden Retriever | 4y6m   | Fn | Pre-chemotherapy scan                | WNL          |     |  |  |
| NVG | Charlie Bobbett     | Dog | CKCS             | 10y2m  | Mn | MMVD                                 | CHF          |     |  |  |
| NVG | Charlie Brown Lloyd | Cat | BSH              | 2y     | Mn | Dysrhythmia                          | UCM          |     |  |  |
| NVG | Charlie Downey      | Cat | DSH              | 10y    | Mn | seizures                             | Dysrhythmia  |     |  |  |
| NVG | Charlie Lake        | Cat | DSH              | 7y     | Mn | HCM                                  | CHF          |     |  |  |

|     |                               |     |                   |       |    |                            |                |  |  |                  |
|-----|-------------------------------|-----|-------------------|-------|----|----------------------------|----------------|--|--|------------------|
| NVG | Charlie Martin                | Dog | YT                | 8y    | Mn | Cough                      |                |  |  |                  |
| NVG | Charlie Peers                 | Dog | SBT               | 3y2m  | Mn | Pre-GA scan                | WNL            |  |  |                  |
| NVG | Charlie Platt                 | Cat | DSH               | 3y9m  | Mn | HOCM                       | kidney failure |  |  |                  |
| NVG | Charlie Ross                  | Dog | CKCS              | 6y    | Me | MMVD                       | CHF            |  |  |                  |
| NVG | Charlie Rutter                | Dog | Labrador          | 5y1m  | Mn | Possible collapse          |                |  |  |                  |
| VCC | Charlie Smith                 | Dog | Sheltie           | 9y8m  | Mn | 3AVB                       |                |  |  | Pacemaker (VVIR) |
| NVG | Charlie Turner                | Dog | Boxer             | 9y6m  | Fe | Pre-chemotherapy scan      |                |  |  |                  |
| NVG | Charlie Wallace               | Dog | JRT               | 13y8m | Fn | PE                         |                |  |  |                  |
| NVG | Chicken Joyner                | Cat | DSH               | 7y    | Mn | HCM                        |                |  |  |                  |
| NVG | Chilli Fox                    | Cat | DSH               | 4y6m  | Mn | Cortriatriatum dexter ?    |                |  |  |                  |
| NVG | Cleo Shaw                     | Cat | DSH               | 11y6m | Fn | Thoracic mass              |                |  |  |                  |
| NVG | Cleo Watkins                  | Cat | DSH               | 10y   | Fn | HCM                        |                |  |  |                  |
| NVG | Clover Allen                  | Cat | Ragdoll           | 10y   | Fn | HOCM                       | CHF            |  |  |                  |
| NVG | Clover Molton                 | Cat | DSH               | 10y   | Fn | HCM                        | CHF            |  |  |                  |
| NVG | Coco Aitken                   | Dog | Dalmation         | 4y8m  | Fe | ARVC                       |                |  |  |                  |
| NVG | Cooper Jones                  | Dog | Boxer             | 7m    | Me | TVD                        |                |  |  |                  |
| NVG | Cote Booth                    | Dog | Spanish Water Dog | 12y7m | Me | DCM                        | CHF            |  |  |                  |
| NVG | CPL cat                       | Cat | DSH               | 1y    | Fn | expiratory noise           |                |  |  |                  |
| NVG | Cuthbert Burns                | Cat | BSH               | 8m    | Mn | Endocardial cushion defect |                |  |  |                  |
| NVG | Daisy Cafferata's puppies x 3 | Dog | Boston Terrier    | 3y4m  | Fe | MVD                        | SAS            |  |  |                  |
| NVG | Daisy Darby                   | Cat | BSH               | 6y    | Fn | HCM                        | CHF            |  |  |                  |
| PVC | Daisy Egan                    | Dog | JRT x             | 8y3m  | F  | Chronic valve disease      |                |  |  |                  |
| NVG | Daisy Flanagan                | Cat | DSH               | 14y1m | Fn | Upper respiratory disease  |                |  |  |                  |
| VCC | Daisy Hocking                 | Dog | ESS               | 7m    | Fn | PDA                        |                |  |  | CDO              |
| NVG | Daisy Jones                   | Dog | ESS               | 1y2m  | Fe | Cough                      |                |  |  |                  |
| NVG | Daisy Price                   | Cat | DSH               | 11y6m | Fn | RCM                        |                |  |  |                  |

|     |                      |     |                       |       |    |                                               |                      |                  |  |             |
|-----|----------------------|-----|-----------------------|-------|----|-----------------------------------------------|----------------------|------------------|--|-------------|
| NVG | Daisy Williams       | Dog | Pomeranian            | 2y3m  | Fn | collapse                                      |                      |                  |  |             |
| NVG | Daisy-May Dimmelow   | Dog | Cocker Spaniel        | 12y3m | Fn | Pre-chemotherapy scan                         | WNL (athletic heart) |                  |  |             |
| NVG | Dancer Wickson       | Dog | Greyhound             | 12y   | Fn | PE                                            |                      |                  |  |             |
| NVG | Dennis Duignan       | Cat | Burmese               | 15y7m | Mn | Thoracic mass                                 |                      |                  |  |             |
| VCC | Dennis Evans         | Dog | Shi Tzu               | 2y    | Me | PS                                            |                      |                  |  | BV          |
| LVH | Dennis Townsend      | Dog | Labrador              | 11m   | Me | SVT                                           |                      |                  |  |             |
| NVG | Denzil Storey        | Cat | DSH                   | 13y5m | Mn | HCM                                           | CHF                  |                  |  |             |
| NVG | Dexter Bradbury      | Dog | Boxer                 | 2y6m  | Mn | Collapse                                      |                      |                  |  |             |
| NVG | Dexter Owen          | Cat | DSH                   | 9y    | Mn | HCM                                           | CHF                  |                  |  |             |
| PVC | Dexter Warren        | Cat | DSH                   | 3y2m  | Mn | DRVOTO                                        |                      |                  |  |             |
| NVG | Diesel Liversage     | Dog | Welsh Collie          | 4y7m  | Me | Bradycardia                                   | MMVD                 |                  |  |             |
| NVG | Digby Boulton        | Dog | Cocker Spaniel        | 11y6m | Me | DCM                                           | CHF                  |                  |  |             |
| NVG | Digger Berrisford    | Dog | Australian cattle dog | 8m    | Mn | cortriatriatum dexter                         | TVD                  | CHF              |  |             |
| VCC | Digger Berrisford    | Dog | Australian Cattle Dog | 8m    | Mn | Cortriatriatum dexter, anomalous azygous vein | TVD                  | CHF (right side) |  | Angiography |
| NVG | Digger Buckley       | Dog | Crossbreed            | 10y2m | Mn | Collapse                                      | MMVD                 | PAH              |  |             |
| PVC | Dillon Garratt-Mason | Dog | YT                    | 7y1m  | M  | Restrictive VSD                               |                      |                  |  |             |
| NVG | Dillon Short         | Cat | Persian               | 3m    | Me | DLVOTO                                        | DRVOTO               |                  |  |             |
| NVG | Diva Pickford        | Dog | Norweigan Forest Cat  | 10y9m | Fn | HOCM                                          |                      |                  |  |             |
| VCC | Dolly Ritchie        | Dog | Crossbreed            | 12m   | Fn | PDA                                           |                      |                  |  | CDO         |
| NVG | Domino Richardson    | Cat | DSH                   | 11y3m | Mn | Hyperthyroidism                               |                      |                  |  |             |
| NVG | Domino Robshaw       | Cat | persian               | 12y   | Mn | RCM                                           | CHF                  |                  |  |             |
| NVG | Donut Richards       | Dog | Labrador              | 11y5m | Fn | Tachydysrhythmia                              | CHF                  | DCM              |  |             |
| NVG | Doogie Oakes         | Dog | CKCS                  | 8y19m | Mn | MMVD                                          | CHF                  |                  |  |             |
| NVG | Dora Daniels         | Dog | Boxer                 | 1y10m | Fe | Flow murmur                                   |                      |                  |  |             |
| PVC | Dorothy Cheetham     | Cat | DSH                   | 6y1m  | Fn | WNL, except for SAM                           |                      |                  |  |             |
| NVG | Dotty James          | Cat | Syphnx                | 2y11m | Fe | HCM                                           |                      |                  |  |             |

|     |                   |        |                    |       |    |                                               |     |     |  |  |
|-----|-------------------|--------|--------------------|-------|----|-----------------------------------------------|-----|-----|--|--|
| NVG | Dougal Doherty    | Cat    | BSH                | 2y8m  | Mn | Hindlimb collapse, neuro                      |     |     |  |  |
| NVG | Dougal Smith      | Dog    | Lhasa Apso         | 14y   | Mn | MMVD                                          | CHF |     |  |  |
| NVG | Dougie Manley     | Dog    | WHWT               | 14y   | Me | IPF                                           |     |     |  |  |
| NVG | Dougie Manly      | Dog    | WHWT               | 14y   | Me | IPF                                           |     |     |  |  |
| NVG | Douglas Riddell   | Cat    | DSH                | 6y5m  | Mn | HOCM                                          |     |     |  |  |
| NVG | Duck Lowton       | Ferret | Ferret             | 5y    | F  | collapse                                      |     |     |  |  |
| NVG | Dudley Fenlon     | Dog    | CKCS               | 13y   | Mn | MMVD                                          | CHF |     |  |  |
| NVG | Dylan Cook        | Dog    | Cocker Spaniel     | 11y   | Mn | DCM                                           | CHF |     |  |  |
| PVC | Dylan Mitchell,   | Cat    | DSH                | 8y    | Mn | HCM (mild)                                    |     |     |  |  |
| PVC | Eddie Lincoln     | Cat    | DSH                | 1y5m  | Mn | LVOTO                                         |     |     |  |  |
| NVG | Edna Taylor       | Dog    | Dachshund          | 12y   | Fe | MMVD                                          |     |     |  |  |
| NVG | Edward Williams   | Dog    | EBT                | 10y   | Me | MMVD                                          | CHF |     |  |  |
| NVG | Ellie Healey      | Dog    | Boxer              | 1y6m  | Fe | Heart test                                    |     |     |  |  |
| NVG | Elmo Harrison     | Dog    | Terrier            | 3y1m  | Me | PDA                                           | CHF |     |  |  |
| PVC | Elvis Jones       | Dog    | Greyhound          | 7y6m  | M  | WNL, other than small PE and pleural effusion |     |     |  |  |
| NVG | Emma Smith        | Dog    | CKCS               | 7y11m | Fe | MMVD                                          | CHF | PAH |  |  |
| LVH | Emmy Watson       | Dog    | Bull mastiff       | 4y    | Fn | Pre-chemotherapy scan                         |     |     |  |  |
| VCC | Enzo Aimes        | Dog    |                    |       | M  |                                               |     |     |  |  |
| NVG | Erin CPL          | Cat    | DSH                | 10y   | Fn | Tachydysrhythmia                              |     |     |  |  |
| NVG | Evie Peers        | Dog    | Bloodhound         | 3y7m  | Fn | Flow murmur                                   |     |     |  |  |
| NVG | Faraday Dale      | Dog    | Bengal x           | 3y8m  | Me | DLVOTO                                        |     |     |  |  |
| NVG | Felix Wilkinson   | Cat    | DSH                | 4y4m  | Mn | HCM                                           | CHF |     |  |  |
| NVG | Figaro Bainbridge | Cat    | DSH                | 2y5m  | Mn | HOCM                                          | CHF |     |  |  |
| PVC | Figaro Mervyn     | Cat    | DSH                | 16y2m | Mn | SAM                                           |     |     |  |  |
| NVG | Finlay Morris     | Dog    | Bedlington Terrier | 1y    | Mn | Flow murmur                                   |     |     |  |  |
| NVG | Finn Birchall     | Dog    | CKCS               | 7y    | Fn | MMVD                                          |     |     |  |  |

|     |                   |        |                     |        |    |                               |        |    |  |  |
|-----|-------------------|--------|---------------------|--------|----|-------------------------------|--------|----|--|--|
| NVG | Flo Ellis         | Dog    | Lurcher             | 11y    | Fn | Pre-GA scan                   |        |    |  |  |
| PVC | Flo Spears        | Dog    | Pointer             | 6y3m   | F  | MMVD (mild)                   |        |    |  |  |
| NVG | Flossie Arnold    | Dog    | SBT                 | 7y5m   | Fe | MMVD                          |        |    |  |  |
| NVG | Flossy Katz       | Cat    | DSH                 | 12y8m  | Fn | systemic hypertension         |        |    |  |  |
| NVG | Fluffy RSPCA      | Rabbit | Rabbit              |        | F  |                               |        |    |  |  |
| PVC | Fly Beard         | Dog    | Border collie       | 10y1m  | F  | exercise intolerance/collapse |        |    |  |  |
| NVG | Flynn Oliver      | Dog    | CKCS                | 6y     | Me | MMVD                          | CHF    |    |  |  |
| NVG | Flynne Oliver     | Dog    | CKCS                | 6y5m   | Me | MMVD                          | CHF    |    |  |  |
| LVH | Frankie Jaidika   | Dog    |                     |        | F  | Pre-chemotherapy scan         |        |    |  |  |
| NVG | Frankie Parsonage | Dog    | YT                  | 10y    | Me | Cough                         |        |    |  |  |
| NVG | Fred Cooper       | Cat    | DSH                 | 7y5m   | Mn | DCM                           | CHF    |    |  |  |
| NVG | Freddie Walker    | Dog    | Miniature Schnauzer | 4y3m   | Mn | Pre-chemotherapy scan         |        |    |  |  |
| NVG | Frodo Yates       | Dog    | Golden Retriever    | 7y     | Me | PE                            |        |    |  |  |
| NVG | Fudge Kearns      | Cat    | DSH                 | 18y    | Mn | HCM                           | CHF    | AF |  |  |
| NVG | Fudge Timmis      | Dog    | ESS                 | 4y     | Mn | DLVOTO                        |        |    |  |  |
| NVG | Fudge Turnock     | Cat    | DSH                 | 2y10m  | Mn | Feline asthma                 |        |    |  |  |
| NVG | GDBA Puppy        | Dog    | Labrador            | 3m     | Me | SAS                           |        |    |  |  |
| NVG | Genie Swetman     | Dog    | Greyhound           | 13y    | Fn | Dysrhythmia                   |        |    |  |  |
| NVG | George Wilford    | Dog    | CKCS                | 8y7m   | Mn | MMVD                          | CHF    |    |  |  |
| NVG | Georgie Bell      | Dog    | Pomeranian          | 8y     | Mn | MMVD                          | CHF    |    |  |  |
| NVG | Georgie Mullock   | Dog    | Collie x            | 13y    | Fn | PE                            |        |    |  |  |
| NVG | Georgie Reddish   | Dog    | Terrier             | 7y7m   | Fe | MMVD                          |        |    |  |  |
| NVG | Geri Bradley      | Cat    | DSH                 | 12y10m | Mn | Hyperthyroidism               |        |    |  |  |
| NVG | Gibson Caesar     | Dog    | Boxer               | 6y8m   | Me | ARVC                          |        |    |  |  |
| NVG | Gismo Armstrong   | Cat    | DSH                 | 9y8m   | Me | UCM                           |        |    |  |  |
| NVG | Gizmo Barratt     | Cat    | DSH                 | 12y    | Mn | Upper respiratory disease     | murmur |    |  |  |

|     |                       |     |                     |        |    |                               |     |               |  |    |
|-----|-----------------------|-----|---------------------|--------|----|-------------------------------|-----|---------------|--|----|
| VCC | Goldie Uribe          | Dog | Belgian Shepherd    | 11m    | Fe | Sub-valvular PS               |     |               |  | BV |
| VCC | Gracie ?              | Dog | Cocker Spaniel      | 8y     | Fn | DCM                           | CHF |               |  |    |
| LVH | Gracie Cottam         | Dog | SBT                 | 1y     | Fe | EI                            |     |               |  |    |
| NVG | Gracie Kinsey         | Dog | Greyhound           | 10y4m  | Fn | VPC                           | VT  | (no collapse) |  |    |
| NVG | Gromit Smith          | Dog | Pug                 | 10y    | Me | Respiratory disease           |     |               |  |    |
| NVG | Gus Cakebread         | Dog | CKCS                | 8y2m   | Mn | MMVD                          | CHF |               |  |    |
| NVG | Hamilton Baker        | Dog | Miniature Schnauzer | 8m     | Me | Flow murmur                   |     |               |  |    |
| NVG | Hamish Lowen          | Dog | GSP                 |        | Me | WNL                           |     |               |  |    |
| NVG | Hannah Atkins         | Dog | YT                  | 13y6m  | Fn | Neuro                         |     |               |  |    |
| NVG | Harley Howes          | Cat | DSH                 | 15y10m | Mn | HCM                           |     |               |  |    |
| NVG | Harley Morgan         | Dog | Great Dane          | 3y4m   | Me | DCM (occult)                  | AF  |               |  |    |
| NVG | Harry Clewes          | Dog | Cocker Spaniel      | 7y7m   | Mn | DCM                           | CHF |               |  |    |
| LVH | Harvey Einig          | Dog | Bearded Collie      | 10y    | Mn | MMVD                          |     |               |  |    |
| NVG | Harvi Cousins         | Dog | Weimaraner          | 4y4m   | Mn | DCM (occult)                  |     |               |  |    |
| NVG | Hattie Noden          | Dog | Manchester Terrier  | 6y     | Fe | Collapse                      |     |               |  |    |
| NVG | Haughty Parsonage     | Cat | Persian             | 8y7m   | Fn | HOCM                          |     |               |  |    |
| NVG | Heather Hounsell      | Dog | WHWT                | 8y4m   | Fn | IPF                           | PAH |               |  |    |
| NVG | Hector Bushell        | Dog | Whippet             | 4y9m   | Mn | PS                            |     |               |  |    |
| NVG | Hector Lewis          | Dog | Border Terrier      | 2y7m   | Me | PS                            |     |               |  |    |
| VCC | Hector Lewis          | Dog | Border Terrier      |        | M  |                               |     |               |  | BV |
| NVG | Hedley Cliffe         | Dog | CKCS                | 10y8m  | Me | MMVD                          | CHF |               |  |    |
| NVG | Hennessey             | Cat | DSH                 |        | Mn | pleural effusion (RTA bloody) |     |               |  |    |
| NVG | Henry Fisher          | Dog | Fox Terrier         | 8m     | Me | SAS                           |     |               |  |    |
| NVG | Henry Lee Atkins      | Dog | ESS                 | 12y    | Mn | Murmur                        |     |               |  |    |
| PVC | Henry Marriott & Lane | Dog | Cocker spaniel      | 10y9m  | M  | MMVD (mild)                   |     |               |  |    |
| NVG | Henry Pearson         | Dog | CKCS                | 10y2m  | Me | MMVD                          | CHF |               |  |    |

|     |                 |     |                       |       |    |                         |                   |     |  |  |
|-----|-----------------|-----|-----------------------|-------|----|-------------------------|-------------------|-----|--|--|
| NVG | Henry Wilford   | Dog | CKCS                  | 8y7m  | Mn | MMVD                    | CHF               |     |  |  |
| NVG | Hettie Potts    | Dog | Boxer                 | 8y    | Fe | Collapse                |                   |     |  |  |
| VCC | Holi Wood       | Dog | JRT x                 | 9y1m  | Fe |                         |                   |     |  |  |
| LVH | Holly Ashton    | Dog |                       |       | F  |                         |                   |     |  |  |
| NVG | Holly Bryson    | Dog | Cocker Spaniel        | 5y    | Fe | holter monitor          |                   |     |  |  |
| NVG | Holly Shenton   | Dog | Labrador              | 8y4m  | Fn | SAS                     |                   |     |  |  |
| NVG | Honey Beresford | Cat | DSH                   | 1y    | Fn | HCM                     | CHF               |     |  |  |
| NVG | Hoops Gilmartin | Cat | DSH                   | 8y9m  | Mn | HOCM                    |                   |     |  |  |
| NVG | Hugo Sharp      | Dog | Pyrenean Mountain Dog | 11y6m | Me | collapse                |                   |     |  |  |
| NVG | Hummer Cottrell | Dog | ESS                   | 14y5m | Me | Thoracic mass           |                   |     |  |  |
| NVG | Inca Pearson    | Dog | Labrador              | 8y    | Fe | Tachydysrhythmia        |                   |     |  |  |
| NVG | Indy Woodward   | Dog | Golden Retriever      | 13y3m | Me | PE                      |                   |     |  |  |
| NVG | Izzy Golden     | Dog | CKCS                  | 3y5m  | Fn | Bradydysrhythmia        |                   |     |  |  |
| NVG | Jack Day        | Dog | Terrier cross         | 3y    | Mn | Chronic cough           | Tracheobronchitis |     |  |  |
| NVG | Jack Edwards    | Dog | CKCS                  | 9y4m  | Mn | MMVD                    | CHF               |     |  |  |
| NVG | Jack Gruszka    | Cat | DSH                   | 12y9m | Mn | DCM                     | CHF               |     |  |  |
| NVG | Jack Mirze      | Cat | DSH                   | 11y5m | Mn | HCM                     | EPI               |     |  |  |
| NVG | Jack Wedgewood  | Dog | JRT                   | 11y   | Mn | MMVD                    | CHF               | PAH |  |  |
| NVG | Jack Wedgwood   | Dog | JRT                   | 11y   | Mn | MMVD                    | CHF               | PAH |  |  |
| NVG | Jack Williams   | Dog | Lab x collie          | 11y   | Mn | Ventricular arrhythmias | collapse          |     |  |  |
| NVG | Jake Cowap      | Dog | crossbreed            | 9y    | Mn | MMVD                    | CHF               |     |  |  |
| NVG | Jake Edwards    | Dog | CKCS                  | 9y4m  | Mn | MMVD                    | CHF               |     |  |  |
| NVG | Jasper Burrows  | Cat | DSH                   | 9y9m  | Mn | Hyperthyroidism         |                   |     |  |  |
| NVG | Jasper Burwood  | Cat | DSH                   | 16y0m | Mn | HCM                     | CHF               |     |  |  |
| NVG | Jasper Fisher   | Dog | Terrier               | 10y   | Mn | MMVD                    |                   |     |  |  |
| NVG | Jasper Heath    | Cat | Siamese               | 4m    | Me | SAS                     |                   |     |  |  |

|     |                 |     |                        |       |    |                         |          |                |    |                     |
|-----|-----------------|-----|------------------------|-------|----|-------------------------|----------|----------------|----|---------------------|
| NVG | Jasper Wiggly   | Cat | DSH                    | 11y7m | Mn | HOCM                    |          |                |    |                     |
| NVG | Jasper Wigley   | Cat | DSH                    | 11y7m | Mn | HOCM                    |          |                |    |                     |
| NVG | Jay Gibson      | Dog | Boxer                  | 5y7m  | Mn | Collapse/seizure        |          |                |    |                     |
| NVG | Jazz Cope       | Cat | DSH                    | 10y1m | Fn | HCM                     |          |                |    |                     |
| NVG | Jazz Pickering  | Dog | Boxer                  | 9y    | Fn | ARVC                    | collapse |                |    |                     |
| NVG | Jess Orgill     | Cat | DSH                    | 11y9m | Fn | DCM                     | FATE     | CHF            |    |                     |
| VCC | Jess Paddon     | Dog | Labrador               | 1y6m  | Fe | PS                      |          |                |    | BV                  |
| NVG | Jet Davies      | Dog | Welsh Springer Spaniel | 4y6m  | Me | EI                      |          |                |    |                     |
| NVG | Jet Noden       | Dog | crossbreed             | 7y1m  | Mn | seizures                | collapse |                |    |                     |
| VCC | Jetta Pitman    | Dog | Labrador               | 4y    | Fe | 3AVB                    |          |                |    | Pacemaker<br>(VVIR) |
| NVG | Jim Mason       | Cat | DSH                    | 5y4m  | Mn | HCM                     | CHF      |                |    |                     |
| PVC | Jinxy Clapson   | Cat | DSH                    | 4y7m  | Fn | HOCM (mild)             | DRVOTO   |                |    |                     |
| NVG | Joe Wood        | Cat | DSH                    | 10y   | Mn | HCM                     | CHF      | Kidney disease | SH |                     |
| PVC | Jonny Cassady   | Dog | JRT                    | 7y9m  | M  | PS                      | TVD      | CHF            |    |                     |
| NVG | Josh Johnston   | Cat | DSH                    | 15y   | Mn | pleural effusion (mass) |          |                |    |                     |
| NVG | Juno Furnevall  | Dog | Doberman               | 12y   | Fn | DCM                     | CHF      |                |    |                     |
| NVG | Kaboodle Molton | Cat | DSH                    | 16y   | Fn | HCM                     | CHF      |                |    |                     |
| PVC | Kali Sutherland | Dog | GSP                    | 5y10m | F  | PPDH                    |          |                |    |                     |
| NVG | Katie Parker    | Dog | Shi Tzu                | 13y5m | Fn | MMVD                    | CHF      |                |    |                     |
| NVG | Kazik Razanska  | Cat | DSH                    | 1y    | Mn | HOCM                    | CHF      |                |    |                     |
| NVG | Kazik Rozanska  | Cat | DSH                    | 1y    | Mn | HOCM                    | CHF      |                |    |                     |
| NVG | kazik Rzanska   | Cat | DSH                    | 1y    | Mn | HOCM                    | CHF      |                |    |                     |
| NVG | Keano Langley   | Cat | DSH                    | 14y8m | Mn | DCM                     | CHF      |                |    |                     |
| NVG | Kevin Charles   | Dog | Golden Retriever       | 3y6m  | Mn | DCM                     | CHF      |                |    |                     |
| NVG | Kit Clynes      | Cat | DSH                    | 14y2m | Fn | HOCM                    | CHF      |                |    |                     |
| NVG | Kitty Foster    | Cat | DSH                    | 7y6m  | Fn | HCM                     |          |                |    |                     |

|     |                    |     |                     |       |    |                       |                       |     |     |    |
|-----|--------------------|-----|---------------------|-------|----|-----------------------|-----------------------|-----|-----|----|
| NVG | Lady Barlow        | Dog | CKCS                | 4y1m  | Fn | MMVD                  | Laryngeal paralysis   |     |     |    |
| NVG | Leah Harper        | Cat | DSH                 | 2y    | Fn | MVD                   | VSD                   | CHF |     |    |
| NVG | Leigh Cameron      | Dog | Cairn Terrier       | 4y    | Fe | DCRV                  | VSD                   | TVD | CHF |    |
| NVG | Lennie Wandsworth  | Dog | EBT                 | 3y    | Mn | MVD                   | Collapse              |     |     |    |
| NVG | Lennox Mills       | Dog | Boxer               | 9y    | Mn | Cough                 | EI                    |     |     |    |
| NVG | Lenny Slack        | Cat | Siamese             | 12y2m | Me | HOCM                  | Chronic renal failure |     |     |    |
| NVG | Leo Evans          | Dog | Great Dane          | 5y    | Me | DCM                   |                       |     |     |    |
| PVC | Lexi Stevens       | Dog | Lhasa apso          | 2y1m  | F  | WNL – flow murmur     |                       |     |     |    |
| NVG | Libby Ashurst      | Dog | Newfoundland        | 1y8m  | Fe | Heart test            |                       |     |     |    |
| NVG | Lily Burrows       | Dog | YT                  | 2y3m  | Fe | PDA                   |                       |     |     |    |
| NVG | Lily Draper        | Cat | DSH                 | 4y4m  | Fn | UCM                   |                       |     |     |    |
| PVC | Lola Hudson        | Cat | Siberian forest cat | 11m   | Fe | Flow murmur           |                       |     |     |    |
| NVG | Louie Craddock     | Cat | Persian             | 6y5m  | Mn | HCM                   |                       |     |     |    |
| NVG | Louie Gilbert      | Dog | Shi Tzu             | 7y    | Me | MMVD                  | CHF                   |     |     |    |
| PVC | Louis Dogs Trust   | Dog | Afghan Hound        | 7y1m  | M  | MMVD (mild)           |                       |     |     |    |
| NVG | Louis Johnstone    | Cat | Birman              | 4y    | Mn | HCM                   | CHF                   |     |     |    |
| NVG | Louis Stones       | Cat | persian             | 11y   | Mn | HOCM                  | CHF                   | IBD |     |    |
| NVG | Luca Whitlow       | Dog | Italian Spinone     | 12y8m | Me | Murmur                |                       |     |     |    |
| NVG | Lucy Bedford-Smith | Dog | WHWT                | 12y   | Fn | cough                 |                       |     |     |    |
| NVG | Lucy Brown         | Dog | Boxer               | 8y4m  | Fe | Dynamic SAS           |                       |     |     |    |
| NVG | Lucy Harper        | Dog | CKCS                | 9y3m  | Fn | MMVD                  | CHF                   |     |     |    |
| VCC | Lucy Thompson      | Dog | Cocker spaniel      | 6m    | Fe | PS                    |                       |     |     | BV |
| NVG | Lucy Tomkinson     | Dog | Dalmation           | 10y8m | Fn | MMVD                  |                       |     |     |    |
| PVC | Luna Thomas        | Cat | DSH                 | 4y1m  | Fn | WNL other than MR jet |                       |     |     |    |
| NVG | Lunar Rudge        | Cat | BSH                 | 5y7m  | Fn | cough                 |                       |     |     |    |
| NVG | Mac Daniels        | Dog | Boxer               | 5y5m  | Mn | SAS                   |                       |     |     |    |

|     |                       |     |                    |        |    |                        |                |                    |  |     |
|-----|-----------------------|-----|--------------------|--------|----|------------------------|----------------|--------------------|--|-----|
| NVG | Mac Hayward           | Dog | OES                | 9y2m   | Mn | DCM                    | CHF            |                    |  |     |
| NVG | Maggie Bonell         | Dog | EBD                | 8w     | Fe | PS (aberrant coronary) |                |                    |  |     |
| NVG | Maisie Povey          | Dog | Crossbreed         | 1y     | Fn | Portosystemic shunt    |                |                    |  |     |
| NVG | Maisy Donking         | Dog | Cocker Spaniel     | 10y10m | Fe | Cough                  |                |                    |  |     |
| NVG | Maisy Lee             | Dog | Cocker Spaniel     | 3m     | Fe | VSD                    | PS             |                    |  |     |
| NVG | Maisy Marsden         | Dog | Newfoundland       | 2y     | Fe | Heart test             |                |                    |  |     |
| NVG | Makari Lampier        | Dog | Bengal             | 0y11m  | Mn | Respiratory disease    |                |                    |  |     |
| LVH | Marble Higgin-Botham  | Cat | British Blue       | 10y    | Mn |                        |                |                    |  |     |
| NVG | Marks Sadler          | Cat | DSH                | 13y7m  | Mn | HCM                    | CHF            |                    |  |     |
| PVC | Marlowe Lockwood      | Dog | Collie X           | 13y1m  | M  | MMVD (mild-moderate)   |                |                    |  |     |
| NVG | Matilda Cox           | Dog | Border Terrier     | 9y4m   | Fn | Brain tumour           |                |                    |  |     |
| VCC | Maud Attwell          | Dog | Griffon Bruxellois | 1y     | Fn | PDA                    |                |                    |  | CDO |
| NVG | Max Bostock           | Dog | Boxer              | 1y6m   | Me |                        |                |                    |  |     |
| NVG | Max George            | Dog | Golden Retriever   | 12y    | Mn | Murmur                 | Hypothyroidism | Cruciate disease   |  |     |
| NVG | Max MacDonald         | Dog | Dalmation          | 8y1m   | Me | MMVD                   |                |                    |  |     |
| NVG | Max Wilcock           | Dog | Boxer              | 11y0m  | Mn | SAS (severe)           | Collapse       | Aortic body tumour |  |     |
| NVG | Max Wood              | Dog | Staffie cross      | 9m     | Me | VSD                    |                |                    |  |     |
| VCC | Maybel Inett          | Dog | Golden Retriever   | 1y2m   | Fn | sAS                    |                |                    |  |     |
| NVG | Meg Brookes           | Dog | Sheltie            | 3y7m   | Fn | Reverse PDA            | CHF            |                    |  |     |
| NVG | Megan Quigley         | Dog | Border Collie      | 12y    | Fn | Pre-chemotherapy scan  | MMVD (early)   |                    |  |     |
| NVG | Megan Williamson      | Dog | CKCS               | 10y    | Fn |                        |                |                    |  |     |
| NVG | Merlin Foxley         | Cat | DSH                | 3y     | Mn | WNL (murmur)           |                |                    |  |     |
| NVG | Merlin Newton         | Dog | YT                 | 3y     | Me | TVD MVD                | bronchitis     | tracheal collapse  |  |     |
| NVG | Merlin Willett        | Cat | DSH                | 1y     | Mn | FIP                    | PE             |                    |  |     |
| NVG | Mia Davies            | Dog | Boxer              | 1y7m   | Fn | Syncope                |                |                    |  |     |
| NVG | Mia Lyttleton-Frances | Cat | DSH                | 16y3m  | Fn | HOVM                   |                |                    |  |     |

|     |                  |     |                     |       |    |                                 |                   |     |  |           |
|-----|------------------|-----|---------------------|-------|----|---------------------------------|-------------------|-----|--|-----------|
| NVG | Mickey Dodd      | Dog | YT                  | 11y9m | Me | MMVD                            | Tracheal collapse | CHF |  |           |
| NVG | Mike Smith       | Cat | DLH                 | 11y6m | Mn | HOCM                            | CHF               |     |  |           |
| VCC | Millie Bonsall   | Dog | Miniature Schnauzer | 9y    | Fn | MMVD                            | Sinus arrest      |     |  | Pacemaker |
| NVG | Millie Coates    | Dog | Leonberger          | 10y8m | Fe | Pre-GA scan                     | WNL               |     |  |           |
| VCC | Millie Fletcher  | Dog | Chihuahua           | 8y    | Fn | MMVD                            |                   |     |  |           |
| NVG | Millie Mason     | Cat | DSH                 | 5y4m  | Fn | HCM                             | CHF               |     |  |           |
| NVG | Millie Rice      | Cat | DSH                 | 15y   | Fn | HCM                             | CHF               |     |  |           |
| NVG | Milo Bedson      | Cat | DSH                 | 2y    | Mn | HOCM                            |                   |     |  |           |
| NVG | Milo Sproston    | Cat | DLH                 | 11y   | Mn |                                 |                   |     |  |           |
| NVG | Mindy Young      | Dog | Miniature Schnauzer | 1y2m  | Fn | Flow murmur                     |                   |     |  |           |
| NVG | Minnie Knight    | Dog | St Bernard          | 1y8m  | Fe | MR                              | DLVOTO            |     |  |           |
| VCC | Missy Biggins    | Dog | Flatcoat Retriever  | 7m    | Fn | PDA                             |                   |     |  | CDO       |
| NVG | Missy Mayer      | Cat | DSH                 | 7y    | Fn | 3AVB                            |                   |     |  |           |
| NVG | Misty Lea        | Cat | DLH                 | 16y5m | Fn | HCM                             |                   |     |  |           |
| NVG | Mittens McCabe   | Cat | DSH                 | 9y11m | Fn | HCM                             | CHF               |     |  |           |
| PVC | Mitzy Draycott   | Cat | DLH                 | 13y5m | Fn | Unclassified cardiomyopathy,    |                   |     |  |           |
| PVC | Mog Mariner      | Cat | BSH                 | 6y9m  | Mn | WNL, RA prominent and mild TR   |                   |     |  |           |
| NVG | Molli Harrison   | Dog | Labrador            | 4y1m  | Fn | Collapse                        |                   |     |  |           |
| NVG | Mollie Armstrong | Dog | CKCS                | 11y7m | Fn | MMVD                            | CHF               |     |  |           |
| NVG | Mollie Bowyer    | Dog | Crossbreed          | 12y   | Fn | Dysrhythmia                     |                   |     |  |           |
| NVG | Mollie Lilley    | Dog | Golden Retriever    | 5y    | Fn | Cough                           |                   |     |  |           |
| NVG | Molly Carey      | Dog | Crossbreed          | 15y6m | Fn | MMVD                            | CHF               |     |  |           |
| NVG | Molly Hobson     | Dog | CKCS                | 8y6m  | Fe | MMVD                            | CHF               |     |  |           |
| NVG | Molly Lightfoot  | Dog | Crossbreed          | 9y    | Fn | Collapse                        |                   |     |  |           |
| NVG | Molly Poole      | Cat | Birman              | 12y3m | Fn | HOCM                            |                   |     |  |           |
| NVG | Molly Purser     | Dog | Cocker Spaniel      | 1y9m  | Fe | Eosinophilic bronchopneumopathy |                   |     |  |           |

|     |                     |     |                |        |    |                                 |          |          |  |      |
|-----|---------------------|-----|----------------|--------|----|---------------------------------|----------|----------|--|------|
| NVG | Molly Roberts       | Dog | EBT            | 4y     | Fe | Arrhythmia                      |          |          |  |      |
| PVC | Molly Sandhu        | Dog | Pug            | 1y2m   | F  | VSD                             |          |          |  |      |
| NVG | Monty Martin        | Dog | Labrador       | 6y     | Mn | Eosinophilic bronchopneumopathy |          |          |  |      |
| NVG | Monty Scales        | Dog | GSD            | 8y     | Mn | DCM                             | CHF      | AF       |  |      |
| VCC | Moogie Witkowski    | Cat | DSH            | 3y4m   | Fn | PDA                             |          |          |  | Coil |
| NVG | Moppet Griffin      | Cat | DSH            | 12y6m  | Fn | Hyperthyroidism                 | CHF      |          |  |      |
| NVG | Morgan Rothwell     | Dog | Bearded collie |        | Mn | Collapse                        |          |          |  |      |
| NVG | Morgana Chick       | Cat | DSH            | 15y    | Fe |                                 |          |          |  |      |
| PVC | Mortimer Walker     | Cat | DSH            | 7y3m   | Mn | HCM (improved)                  |          |          |  |      |
| NVG | Moss Evans          | Dog | Border Collie  | 9y     | Me |                                 |          |          |  |      |
| PVC | Mr Wiggles Osbourne | Cat | BSH            | 1y5m   | Me | Moderate HCM                    |          |          |  |      |
| NVG | Muffin Cundall      | Dog | Labrador       | 5y8m   | Fe | PE                              |          |          |  |      |
| VCC | Murphy Hetherington | Dog | Crossbreed     | 3y1m   | Mn | PDA                             |          |          |  | CDO  |
| NVG | Narla Sargeant      | Dog | EBT            | 10y9m  | Fe | MMVD                            | collapse |          |  |      |
| NVG | Nell Evans          | Dog | Boxer          | 9y5m   | Fn | Collapse                        |          |          |  |      |
| NVG | Nelly Henshaw       | Dog | JRT            | 15y5m  | Fn | MMVD                            |          |          |  |      |
| NVG | Nelson Taylor       | Dog | Crossbreed     | 16y0m  | Mn | MMVD                            |          |          |  |      |
| PVC | Norah Porter        | Dog | Rottweiler     | 3y5m   | F  | SAS (mild)                      |          |          |  |      |
| NVG | Oleander Lucas      | Cat | Siamese        | 7y9m   | Mn | Asthma                          |          |          |  |      |
| NVG | Oliver Bostock      | Dog | Sheltie        | 9y2m   | Mn | Chronic bronchitis              | MMVD     |          |  |      |
| NVG | Ollie Hatswell      | Dog | CKCS           | 4y10m  | Mn | Anaemia                         |          |          |  |      |
| NVG | Opea Wright         | Cat | DSH            | 10y2m  | Fn | HCM                             |          |          |  |      |
| NVG | Orion Penrose       | Cat | DSH            | 8y     | Mn | HOCM                            |          |          |  |      |
| NVG | Oscar Chalton       | Dog | CKCS           | 11y    | Mn | MMVD                            | CHF      | pyoderma |  |      |
| NVG | Oscar Furlong       | Cat | Ragdoll        | 2y10m  | Mn | HCM                             | CHF      |          |  |      |
| NVG | Oscar Leggett       | Cat | DSH            | 11y11m | Mn | Hyperthyroidism                 |          |          |  |      |

|     |                |     |                      |       |    |                       |                      |         |              |
|-----|----------------|-----|----------------------|-------|----|-----------------------|----------------------|---------|--------------|
| NVG | Oscar Lyons    | Dog | CKCS                 | 11y7m | Mn | kidney failure        |                      |         |              |
| PVC | Otis Hood      | Cat | DSH                  | 10y1m | Mn | HCM (mild)            |                      |         |              |
| NVG | Otto Winter    | Dog | YT                   | 9y    | Mn | MMVD                  | CHF                  |         |              |
| NVG | Ozzy Wilshaw   | Dog | Whippet              | 10y   | Mn | MMVD                  |                      |         |              |
| NVG | Panda Jones    | Dog | Norwegian Forest Cat | 176m  | Mn | VSD                   | CHF                  |         |              |
| NVG | Parsley West   | Cat | DSH                  | 11y   | Fn | HCM                   | CHF                  |         |              |
| NVG | Peeny Leese    | Dog | JRT                  | 12y   | Fn | MMVD                  |                      |         |              |
| NVG | Pele Burrows   | Dog | Chihuahua            | 10y   | Mn | MMVD                  | CHF                  |         |              |
| NVG | Pepper Hutton  | Dog | Crossbreed           | 12y   | Fn | Lymphoma              |                      |         |              |
| PVC | Pepper Lumsden | Dog | Boxer                | 7y4m  | M  | Splenic mass          |                      |         |              |
| NVG | Pepsi Yoxall   | Dog | YT                   | 1y    | Fn | PUO                   |                      |         |              |
| NVG | Percy Green    | Cat | DSH                  | 6y3m  | Mn | UCM                   |                      |         |              |
| NVG | Perdie Edwards | Dog | Mastiff              | 3y3m  | Fe | Chylothorax           |                      |         |              |
| NVG | Perdita Smith  | Cat | DSH                  | 10y8m | Fn | HOCM                  |                      |         |              |
| NVG | Pero Daniels   | Dog | Boxer                | 11y3m | Me | ARVC                  | pancreatitis         |         |              |
| NVG | Petrie Mulrey  | Dog | JRT                  | 2y9m  | Mn | Bronchitis            | Aspiration pneumonia |         |              |
| NVG | Philly Biggins | Dog | Flatcoat Retriever   | 8y6m  | Fe | Pre-chemotherapy scan |                      |         |              |
| NVG | Pip Corker     | Cat | DSH                  | 9y7m  | Fe | HOCM                  |                      |         |              |
| NVG | Pippy Longson  | Dog | CKCS                 | 5y11m | Fn | MMVD                  | CHF                  |         |              |
| PVC | Pluto Crawford | Cat | DSH                  | 1y3m  | Mn | HOCM                  |                      |         |              |
| NVG | Poppet Brough  | Dog | JRT                  | 8y6m  | Fn | MMVD                  | CHF                  | LA tear |              |
| VCC | Poppy ?        | Dog | Cocker spaniel       | 6m    | Fe | PS                    | PDA                  |         | Pre-BV check |
| PVC | Poppy Brown    | Dog | Whippet x            | 8y7m  | F  | Chronic valve disease |                      |         |              |
| NVG | Poppy Darby    | Cat | BSH                  | 7y    | Fn | HCM                   | CHF                  |         |              |
| NVG | Poppy Hartley  | Dog | Dalmation            | 10y   | Fn | Cough                 |                      |         |              |
| LVH | Poppy Mawson   | Dog | CKCS                 | 8y    | Fn | MMVD                  |                      |         |              |

|     |                  |     |                 |       |    |                                        |                       |  |  |
|-----|------------------|-----|-----------------|-------|----|----------------------------------------|-----------------------|--|--|
| LVH | Poppy Mawson     | Dog |                 |       | F  | holter monitor                         |                       |  |  |
| PVC | Poppy Melniks    | Dog | CKCS            | 2y11m | F  | MVD (mild)                             |                       |  |  |
| LVH | Poppy Rogers     | Dog | Cocker Spaniel  |       | Fn | Pulmonary hypertension, post BV for PS |                       |  |  |
| LVH | Poppy Rogers     | Dog |                 |       | F  | Recheck                                |                       |  |  |
| NVG | Posh Whittaker   | Dog | Boxer           | 7y    | Fe | Pre-GA scan                            | SAS                   |  |  |
| NVG | Potchka Russell  | Cat | DSH             | 13y   | Fn | DRVOTO                                 |                       |  |  |
| NVG | Prince Dickinson | Dog | Doberman x      | 11y   | Mn | DCM                                    | CHF                   |  |  |
| PVC | Pumpkin Jardine  | Cat | Sphynx          | 3y9m  | Fn | HOCM                                   |                       |  |  |
| NVG | Pumpkin Wilde    | Cat | DSH             | 10y4m | Fn | UCM                                    | Lymphoma              |  |  |
| NVG | Purdy Morgan     | Cat | DSH             | 12y6m | Fn | Hyperthyroidism                        | Systemic hypertension |  |  |
| NVG | Puss Gleeson     | Cat | DSH             | 1y3m  | Fn | HCM                                    | CHF                   |  |  |
| NVG | Rafa Maziere     | Dog | Boxer           | 3y6m  | Mn | SAS (mild)                             |                       |  |  |
| NVG | Raffles Harman   | Cat | DLH             | 13y9m | Mn |                                        |                       |  |  |
| NVG | Red Carter       | Dog | Irish Setter    | 5y    | Fn | EI                                     |                       |  |  |
| PVC | Red Drayton      | Cat | Persian x       | 11m   | Fn | DLVOTO                                 | TR                    |  |  |
| NVG | Reggie Hymers    | Cat | DSH             | 8y3m  | Mn | HOCM                                   |                       |  |  |
| NVG | Reggie McGeehan  | Dog | Irish Terrier   | 5y1m  | Mn | bronchitis                             |                       |  |  |
| NVG | Rigsby Latham    | Dog | JRT x           | 5y    | Mn | MMVD                                   |                       |  |  |
| NVG | Riker Foster     | Cat | DSH             | 4y1m  | Mn | HOCM                                   |                       |  |  |
| NVG | Riley Fisher     | Dog | Irish Terrier   | 11y   | Mn | DCM                                    | CHF                   |  |  |
| NVG | Rizzo Tripp      | Dog | Poodle x CKCS   | 3y6m  | Fn | MVP                                    |                       |  |  |
| NVG | Rocky Punyer     | Dog | Boxer           | 8y    | Me | SAS                                    |                       |  |  |
| NVG | Romeo Shoebridge | Dog | Labrador        | 7y2m  | Me | Gastritis & 2ndary cough/retch         |                       |  |  |
| NVG | Ronnie Williams  | Dog | Labrador        | 7y10m | Mn | DCM                                    | CHF                   |  |  |
| NVG | Rosie Chadwick   | Dog | Parsons Terrier | 9y3m  | Fn | Flow murmur                            |                       |  |  |
| NVG | Rosie Howshall   | Dog | ESS             | 4y1m  | Fn | Seizures                               |                       |  |  |

|     |                            |     |                    |       |    |                                        |                 |     |  |                  |
|-----|----------------------------|-----|--------------------|-------|----|----------------------------------------|-----------------|-----|--|------------------|
| NVG | Rosie Jameson              | Cat | DSH                | 8m    | Fe | Flow murmur                            |                 |     |  |                  |
| LVH | Rosie Williams             | Dog | Border Collie      | 10y   | Fn | Endocarditis (midsystolic click)       |                 |     |  |                  |
| PVC | Roxy Cooke                 | Dog | Greyhound          | 3y2m  | F  | Athletic heart                         |                 |     |  |                  |
| VCC | Roxy Greenfield            | Dog | Boxer              | 3y1m  | Fe | Heart test - fail                      |                 |     |  |                  |
| NVG | Roxy Mitchem               | Dog | Boxer              | 3m    | Fe | Flow murmur                            |                 |     |  |                  |
| PVC | Ruby Bassett Hound Welfare | Dog | Bassett Hound      | 7y3m  | F  | MMVD (mild)                            |                 |     |  |                  |
| VCC | Rufus Turnbull             | Dog | Lakeland Terrier   | 12w   | M  | PS                                     |                 |     |  | BV               |
| VCC | Rufus Willimough           | Dog | Springer spaniel   | 5y    | Me | 3AVB                                   |                 |     |  | Pacemaker (VVIR) |
| LVH | Rupert McDonagh            | Cat | DSH                | 1y6m  | Mn | Suspect FIP                            |                 |     |  |                  |
| NVG | rusty harley               | Dog | CKCS               | 8y6m  | Mn | MMVD                                   | PAH             |     |  |                  |
| NVG | Rusty Wheeler              | Dog | Border Terrier     | 2y8m  | Mn | ToF                                    | CHF             |     |  |                  |
| NVG | Rusty Wood                 | Dog | ESS                | 9y    | Me | cough                                  |                 |     |  |                  |
| NVG | Saffy Ashurst              | Dog | Newfoundland       | 1y6m  | Fe | Heart test                             |                 |     |  |                  |
| NVG | Salem Cooper               | Cat | DSH                | 11y8m | Mn | Systemic hypertension, ? thoracic mass | Hyperthyroidism | SVT |  |                  |
| PVC | Sally Poxton               | Dog | CKCS               | 9y9m  | F  | MMVD (mild)                            |                 |     |  |                  |
| NVG | Sally Rhodes               | Dog | Bearded collie     | 8y    | Fn | MMVD                                   |                 |     |  |                  |
| NVG | Sam Evans                  | Dog | Collie x           | 12y   | Mn | MMVD                                   |                 |     |  |                  |
| NVG | Sam Southall               | Dog | Crossbreed         | 7y8m  | Mn | Collapse                               | Dysrhythmia     |     |  |                  |
| NVG | Sam Vidler                 | Cat | DLH                | 10y4m | Mn | Dysrhythmia                            |                 |     |  |                  |
| NVG | Sammy McCaig               | Cat | DSH                | 10y   | Mn | HCM                                    | SVT             | CHF |  |                  |
| NVG | Sandy Prince               | Cat | DSH                | 11y   | Mn | Murmur                                 |                 |     |  |                  |
| VCC | Sasha Mathieson            | Dog | Golden Retriever x | 5y3m  | Fn | PE                                     |                 |     |  |                  |
| NVG | Sassi Cousins              | Dog | Weimaraner         | 8y4m  | Fn | Hypothyroidism                         |                 |     |  |                  |
| VCC | Scamp Wilson               | Dog | JRT                | 6y    | Mn | Pleural effusion (blood)               |                 |     |  |                  |
| NVG | Scampi Lunt                | Cat | DSH                | 12y6m | Mn | HCM                                    |                 |     |  |                  |
| PVC | Scampi Rosier              | Cat | DSH                | 10y1m | Mn | WNL – flow murmur                      |                 |     |  |                  |

|     |                         |     |                  |        |    |                                                 |                       |                 |     |     |
|-----|-------------------------|-----|------------------|--------|----|-------------------------------------------------|-----------------------|-----------------|-----|-----|
| NVG | Scampy Thompson         | Dog | GSDx             | 6y2m   | Mn | MMVD                                            |                       |                 |     |     |
| PVC | Scarlett Murphy         | Cat | Devon Rex        | 6y6m   | Fn | HCM (mild)                                      | DRVOTO                |                 |     |     |
| PVC | Scout Morris            | Dog | CKCS             | 5y3m   | M  | MMVD (mild-moderate)                            |                       |                 |     |     |
| PVC | Scrubber Brown          | Dog | Patterdale cross | 10y1m  | M  | Thoracic mass and seizures                      |                       |                 |     |     |
| NVG | Sean Thorpe             | Dog | Brittany Spaniel | 12y    | Me | MMVD                                            | Systemic hypertension | Cough           |     |     |
| NVG | Senna Rytel             | Dog | Northern InnuIt  | 5y0m   | Fe | Pneumonia                                       |                       |                 |     |     |
| VCC | Sharia Rooney           | Dog | GSD              | 11m    | Fn | PDA                                             |                       |                 |     | CDO |
| PVC | Simba Harrison          | Cat | DSH              | 12y11m | Mn | HOCM                                            |                       |                 |     |     |
| NVG | Simba Lyons             | Dog | CKCS             | 8y6m   | Mn | MMVD                                            | Cough                 |                 |     |     |
| NVG | Simba Taylor            | Cat | DSH              | 4y     | Mn | HCM                                             | CHF                   |                 |     |     |
| NVG | Skippy Campbell         | Dog | JRT              | 13y4m  | Mn | MMVD                                            | AF                    | CHF             | PAH |     |
| NVG | Skye Ackers             | Dog | ESS              | 5y1m   | Fn | MVD                                             | Bradydysrhythmia      |                 |     |     |
| NVG | Skye Daniels            | Dog | Boxer            | 7y6m   | Fn | ARVC                                            |                       |                 |     |     |
| NVG | Skye Parkes             | Dog | Dalamation       | 2y1m   | Fe | Collapse                                        | WNL                   |                 |     |     |
| NVG | Smartie Chapman-Smith   | Cat | DSH              | 11y    | Mn | HCM                                             | CHF                   | FATE            |     |     |
| NVG | Smartie Pope            | Cat | DSH              | 6y11m  | Mn | Systemic hypertension                           |                       |                 |     |     |
| PVC | Smudge Maylard          | Cat | DSH              | 3y     | Mn | HCM                                             |                       |                 |     |     |
| NVG | Smudge Pugh             | Cat | DSH              | 10y8m  | Fn | Pre-GA scan                                     |                       |                 |     |     |
| NVG | Snipe Wilson            | Cat | DSH              | 18y    | Mn | HCM                                             |                       |                 |     |     |
| NVG | Snowball Bone           | Cat | DSH              | 11y1m  | Mn | HCM                                             |                       |                 |     |     |
| PVC | Snuggles Blackwell      | Cat | DSH              | 3y3m   | Mn | Normal Systolic function but intermittent VPC's |                       |                 |     |     |
| NVG | Socks Bone              | Cat | DSH              | 4y4m   | Mn | HCM                                             |                       |                 |     |     |
| NVG | Sophie Dempsey          | Dog | CKCS             | 11y    | Fn | MMVD                                            | PAH                   | Increased Avmax |     |     |
| NVG | Sophie Dempsey (Lara's) | Dog | CKCS             | 11y    | Fn | MMVD                                            | PAH                   | Increased Avmax |     |     |
| LVH | Sophie Milne            | Dog | Dachshund        | 14y    | Fn | SSS                                             |                       |                 |     |     |
| NVG | Spartacus Anders        | Cat | DSH              | 11y6m  | Mn | Ascites                                         |                       |                 |     |     |

|     |                      |     |                    |       |    |                                             |                     |             |     |
|-----|----------------------|-----|--------------------|-------|----|---------------------------------------------|---------------------|-------------|-----|
| PVC | Squeaky Summerscales | Cat | Bengal x           | 1y1m  | Fn | WNL                                         |                     |             |     |
| NVG | Stan Dodd            | Dog | YT                 | 13y   | Me | MMVD                                        | Collapse            |             |     |
| NVG | Stanley Thompson     | Dog | Labrador           | 7y10m | Me | Tachypnoea                                  |                     |             |     |
| NVG | Stanley Wilson       | Dog | EBD                | 3y    | Me | PS                                          | Respiratory disease |             |     |
| NVG | Stitch Jones         | Dog | Crossbreed         | 6y9m  | Mn | Cough                                       |                     |             |     |
| NVG | Sunny Barlow         | Dog | Collie x           | 10y1m | Fe | MMVD                                        | collapse            |             |     |
| NVG | Sunny Zawistowicz    | Cat | DSH                | 13y   | Mn | HOCM                                        | CHF                 | (prev FATE) |     |
| NVG | Sweep Broomhall      | Dog | Parsons Terrier    | 9y4m  | Mn | restless/panting                            | behavioural problem |             |     |
| NVG | Sweetie Holden       | Cat | persian            | 18y   | Fn | Systemic hypertension                       |                     |             |     |
| NVG | Sylvie Regan         | Dog | Cocker Spaniel     | 5y6m  | Fe | PS                                          |                     |             |     |
| NVG | Tabby Lloyd          | Cat | DSH                | 12y   | Mn | HOCM                                        |                     |             |     |
| NVG | Taffi Green          | Dog | Border Collie      | 8y9m  | Me | MMVD                                        | CHF                 | PAH         |     |
| NVG | Tammy Reece          | Cat | DSH                | 11y8m | Fn | UCM                                         |                     |             |     |
| NVG | Tango Morris         | Dog | Boxer              | 6m    | Me | SAS                                         | ARVC                |             |     |
| NVG | Tara Hillage         | Dog | WHWT               | 2y9m  | Fn | Pre-GA scan                                 |                     |             |     |
| VCC | Tara Ramshaw         | Dog | CKCS               | 1y6m  | Fe | PDA                                         |                     |             | CDO |
| NVG | Tara Robertson       | Dog | Bloodhound         | 9y5m  | Fn | PE                                          |                     |             |     |
| VCC | Tarn Thompson        | Dog |                    |       | M  |                                             |                     |             |     |
| NVG | Tate Manion          | Dog | Boxer              | 7y8m  | Mn | Pre-chemotherapy scan                       |                     |             |     |
| NVG | Teasel Hoy           | Dog | YT                 | 3y4m  | Mn | Arrhythmia                                  | PSS                 |             |     |
| NVG | Ted King             | Dog | Labrador           | 8y9m  | Me | CHF (right side) (previous pericardiectomy) | AF                  |             |     |
| NVG | Tessie Putterill     | Dog | Miniature Pinscher | 10y0m | Fn | MMVD                                        |                     |             |     |
| NVG | Theo Thorpe          | Cat | DSH                | 5y    | Mn | Pyothorax                                   |                     |             |     |
| NVG | Tig Court            | Dog | ESS                | 11y6m | Mn | Cough                                       |                     |             |     |
| NVG | Tigger Turnock       | Dog | Bengal             | 1y10m | Mn | DRVOTO                                      |                     |             |     |
| NVG | Tiggys Cushway       | Cat | DLH                | 3y6m  | Mn | Respiratory disease                         |                     |             |     |

|     |                  |     |                     |        |    |                       |          |                   |     |     |
|-----|------------------|-----|---------------------|--------|----|-----------------------|----------|-------------------|-----|-----|
| VCC | Tilly Odelet     | Dog | Miniature Schnauzer | 1y     | Fe | PS                    |          |                   |     | BV  |
| NVG | Tilly Walker     | Cat | DLH                 | 12y    | Fn | PE                    | Anaemia  |                   |     |     |
| NVG | Tilly Wood       | Cat | DSH                 | 14y1m  | Fn | HCM                   | CHF      |                   |     |     |
| PVC | Tilly Wright     | Dog | Basset Hound        | 6y7m   | F  | MMVD (mild)           |          |                   |     |     |
| NVG | Tin Tin Metcalf  | Dog | WHWT                | 5y     | Mn | IPF                   |          |                   |     |     |
| PVC | Titania Turnbull | Cat | DLH                 | 9y2m   | Fn | HCM (mild)            |          |                   |     |     |
| PVC | Toby Ball        | Dog | Standard Schnauzer  | 12y2m  | M  | Chronic valve disease |          |                   |     |     |
| VCC | Toby Berry       | Dog | JRTxWHWT            | 3m     | Me | PDA                   |          |                   |     | CDO |
| NVG | Toby Fenlon      | Dog | CKCS                | 3y1m   | Me | Pre-GA scan           | MVD      |                   |     |     |
| PVC | Toby Horden      | Dog | yt                  | 9y8m   | M  | MMVD (mild)           |          |                   |     |     |
| NVG | Toby Hunton      | Dog | Miniature Schnauzer | 7y2m   | Me | MMVD                  | Collapse |                   |     |     |
| NVG | Toby Parker      | Dog | Labrador            | 12y    | Mn | Pneumonia             |          |                   |     |     |
| NVG | Toby Prince      | Dog | CKCS                | 11y2m  | Mn | MMVD                  |          |                   |     |     |
| NVG | Toby Richbell    | Dog | JRT                 | 3y     | Me | MVD                   |          |                   |     |     |
| LVH | Tod Morter       | Cat | DSH                 | 5y     | MN | HOCM                  | CHF      |                   |     |     |
| NVG | Toffee Simpson   | Cat | DSH                 | 16y    | Fe |                       |          |                   |     |     |
| NVG | Toffee Smith     | Cat | DSH                 | 4y9m   | Mn | HOCM                  | CHF      |                   |     |     |
| NVG | Tom Callaghan    | Cat | DSH                 | 6y5m   | Mn | HCM                   | CHF      |                   |     |     |
| NVG | Tom Shone        | Cat | DSH                 | 12y10m | Mn | HCM                   | CHF      |                   |     |     |
| PVC | Tommi Partridge  | Cat | DLH                 | 12y6m  | Mn | Pre-radioiodine scan  |          |                   |     |     |
| PVC | Tommy Bell       | Dog | WHWT                | 9y3m   | M  | DLVOTO (mild)         |          |                   |     |     |
| NVG | Trixie Maidment  | Cat | DSH                 | 4y5m   | Fn | HOCM                  |          |                   |     |     |
| NVG | Troy Heath       | Dog | Patterdale          | 3y     | Mn | Chronic cough         |          |                   |     |     |
| NVG | Tucker Mehan     | Cat | DSH                 | 15y    | Mn | Hyperthyroidism       |          |                   |     |     |
| NVG | Tyler Woods      | Dog | Bichon Frise        | 12y    | Mn | MMVD                  | CHF      | tracheal collapse | PAH |     |
| NVG | Umi Temple       | Dog | Springer Spaniel    | 3m     | Fe | PDA                   |          |                   |     |     |

|     |                  |     |                    |        |    |                                         |                  |         |  |                 |
|-----|------------------|-----|--------------------|--------|----|-----------------------------------------|------------------|---------|--|-----------------|
| VCC | Umi Temple       | Dog | Springer spaniel   | 3m     | Fe | PDA                                     |                  |         |  | CDO             |
| VCC | Unknown          | Dog | Border Terrier     | 6m     | Me | PS                                      |                  |         |  | BV              |
| VCC | Unknown          | Dog |                    |        |    | PS                                      |                  |         |  | BV              |
| VCC | Unknown          | Dog |                    |        |    | PDA                                     |                  |         |  | CDO             |
| VCC | Unknown          | Dog | WHWT               | 6y     | Fe | IPF                                     |                  |         |  |                 |
| VCC | Unknown          | Dog | CKCSx Min poodle   | 4m     | Fn | PDA                                     |                  |         |  | CDO             |
| VCC | Unknown          | Dog | Neopolitan Mastiff | 9y     | Me |                                         |                  |         |  | Pericardiectomy |
| VCC | Unknown          | Dog | GSD                | 1y2m   | Fn | PDA                                     |                  |         |  | CDO             |
| VCC | Unknown          | Dog | Labradoodle        | 6m     | Fe | PS                                      |                  |         |  | BV              |
| NVG | Valentine Large  | Dog | Cocker Spaniel     | 13y8m  | Fn | TVD                                     | PAH              | syncope |  |                 |
| NVG | Vegas Forster    | Dog | EBT                | 7y     | Me | DCM                                     | CHF              |         |  |                 |
| LVH | Vesty Roberts    | Cat | British Blue       | 9y     | Mn | HOCM                                    |                  |         |  |                 |
| NVG | Vinnie Stockton  | Cat | DSH                | 6y4m   | Mn | HCM                                     |                  |         |  |                 |
| NVG | Walnut Mirze     | Cat | DSH                | 5y6m   | Mn | HCM                                     |                  |         |  |                 |
| NVG | Whitney Cook     | Dog | Toy Poodle         | 11y8m  | Fe | MMVD                                    |                  |         |  |                 |
| VCC | Willow ?         | Dog | Crossbreed         | 3y     | Fn | ASD (Pulm vein into LA and RA), TR mild |                  |         |  | BV septum       |
| NVG | Winnie Barratt   | Dog | Crossbreed         | 11y7m  | Fn | MMVD                                    | CHF              |         |  |                 |
| NVG | Zaffie Zaggiotti | Cat | Siamese            | 12y10m | Mn | HCM                                     | Chronic rhinitis |         |  |                 |
| PVC | Zena Gilchrist   | Dog | Boxer              | 1y5m   | F  | SAS (mild)                              |                  |         |  |                 |
| NVG | Zeus Ashfield    | Dog | Neopolitan Mastiff | 10y    | Me | DCM                                     | CHF              |         |  |                 |
| NVG | Ziggy Hammond    | Dog | GSD                | 3m     | Me | Cardiac shock                           |                  |         |  |                 |
| PVC | Ziggy Johnson    | Dog | Dalmation          | 10y4m  | M  | Tachydysrhythmia                        |                  |         |  |                 |
| NVG | Zimmer Pearce    | Cat | DSH                | 4y     | Mn | HCM                                     | CHF              |         |  |                 |

## Abbreviations

Practice: LVH Liverpool Veterinary Hospital, NVG Nantwich Veterinary Group, PVC Pride Veterinary Centre, VCC Veterinary Cardiorespiratory Centre

Breed: BSH British Shorthair, CKCS Cavalier King Charles Spaniel, DLH Domestic Longhair, DSH Domestic Shorthair, EBD English Bulldog, EBT English Bull Terrier, ESS English Springer Spaniel, GSD German Shepherd Dog, GWHP Gernam Wirehaired Pointer, JRT Jack Russell Terrier, OES Old English Sheepdog, SBT Staffordshire Bull Terrier, WHWT West Highland White Terrier, YT Yorkshire Terrier

Condition: 3AVB Third degree atrioventricular block, AF Atrial fibrillation, ARVC Arrhythmogenic right ventricular cardiomyopathy, ASD Atrial septal defect, AVmax Maximal aortic outflow velocity, BOAS Brachycephalic obstructive airway syndrome, CHF Congestive heart failure, DCM Dilated cardiomyopathy, DCRV Double chambered right ventricle, DLVOTO Dynamic left ventricular outflow tract obstruction, DRVOTO Dynamic right ventricular outflow tract obstruction, EI Exercise intolerance, EPI Exocrine pancreatic insufficiency, FB Foreign body, FIP Feline infectious peritonitis, HCM Hypertrophic cardiomyopathy, HOCM Hypertrophic obstructive cardiomyopathy, IPF Interstitial pulmonary fibrosis, MR Mitral regurgitation, MMVD Myxomatous mitral valve disease, MVD Mitral valve dysplasia, PAH Pulmonary hypertension, PDA Patent ductus arteriosus, PE Pericardial effusion, PPDH Pericardioperitoneal diaphragmatic hernia, PPS Portosystemic shunt, PS Pulmonic stenosis, PUO Pyrexia of unknown origin, Pre-GA Pre-general anaesthesia, RCM Restrictive cardiomyopathy, RTA Road traffic accident, SAM Systolic anterior motion of the mitral valve, SAS Subaortic stenosis, SH Systemic hypertension, SSS Sick sinus syndrome, SVT Supraventricular tachycardia, TR Tricuspid regurgitation, ToF Tetralogy of Fallot, TVD Tricuspid valve dysplasia, UCM Unclassified cardiomyopathy, VPC Ventricular premature complex, VSD Ventricular septal defect, WNL Within normal limits

Procedure: BV Balloon valvuloplasty, CDO Canine duct occluder

## CONTINUING PROFESSIONAL DEVELOPMENT

| Date                                                | Venue                 | Activity                                                                                        |
|-----------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------|
| 7th February 2011                                   | UON                   | Speaking in public with authority and confidence                                                |
| 10 <sup>th</sup> February 2011                      | SVMS                  | Undergraduate teaching: Taking and interpreting ECGs (practical)                                |
| 18th February 2011                                  | SVMS                  | Limitations of P values: type I and type II error                                               |
| 21st February 2011                                  | UON                   | Referencing for researchers                                                                     |
| 8 <sup>th</sup> March 2011                          | SVMS                  | Cardiogroup                                                                                     |
| 8 <sup>th</sup> March 2011                          | SVMS                  | CPD provided:Supplements in heart failure – where are we now? (evening meeting)                 |
| 11th March 2011                                     | SVMS                  | Confidence intervals – when do you use them                                                     |
| 30 <sup>th</sup> March 2011                         | Birmingham            | VCS Meeting                                                                                     |
| 31 <sup>st</sup> March – 3 <sup>rd</sup> April 2011 | Birmingham            | BSAVA Congress                                                                                  |
| 5th April 2011                                      | UON                   | Introductory event to teaching for postgraduate research students and researchers               |
| 12th April 2011                                     | UON                   | Critical analysis of the scientific literature (clinical)                                       |
| 19 <sup>th</sup> April 2011                         | Cheshire              | CPD provided:Cardiac Scanning Refresher (half day course)                                       |
| 26th April 2011                                     | Gloucestershire       | Respiratory disease of the dog and cat: a comprehensive review                                  |
| 3rd May 2011                                        | UON                   | Presentation skills – practicing and reviewing                                                  |
| 1st June 2011                                       | SVMS                  | Odds ratio and relative risk                                                                    |
| 5th July 2011                                       | UON                   | Presentation skills – structure and technique                                                   |
| 6 <sup>th</sup> September 2011                      | SVMS                  | Cardiogroup                                                                                     |
| 8 <sup>th</sup> – 10 <sup>th</sup> September 2011   | Seville               | ECVIM Congress                                                                                  |
| 30th September 2011                                 | SVMS                  | Analysis of continuous data (t-test, Mann-Whitney, Wilcoxon)                                    |
| 7 <sup>th</sup> October 2011                        | SVMS                  | Research Presentation: Clinical predictors of mortality in dogs with syncope /episodic collapse |
| 12 <sup>th</sup> October 2011                       | Stoneleigh            | CPD provided:Cardiology Course (Boehringer) Day 4 (day course)                                  |
| 14 <sup>th</sup> October 2011                       | SVMS                  | CPD provided:Echocardiography Vets4Pets Course (day course)                                     |
| 11 <sup>th</sup> – 12 <sup>th</sup> November 2011   | Loughborough          | VCS Meeting                                                                                     |
| 18th November 2011                                  | SVMS                  | Analysis of ordinal data                                                                        |
| 21st November 2011                                  | SVMS                  | Minimally invasive surgery                                                                      |
| 23 <sup>rd</sup> November 2011                      | Stoneleigh            | CPD provided:Cardiology Course (Boehringer) Day 5 (day course)                                  |
| 9th December 2011                                   | SVMS                  | Correlation                                                                                     |
| 16th December 2011                                  | British Racing School | Equine auscultation and scanning                                                                |
| 19th December 2011                                  | SVMS                  | Endnote: managing your references                                                               |
| 10 <sup>th</sup> January 2012                       | SVMS                  | Undergraduate teaching: Cardiac Therapeutics (seminar)                                          |
| 24 <sup>th</sup> January 2012                       | SVMS                  | Undergraduate teaching: Cardiac Therapeutics (seminar)                                          |
| 25 <sup>th</sup> January 2012                       | Nantwich Vet Group    | CPD provided:Cattle Cardiology (evening meeting)                                                |
| 10 <sup>th</sup> February 2012                      | SVMS                  | Undergraduate teaching: Cardiac Therapeutics (seminar)                                          |
| 13 <sup>th</sup> February 2012                      | SVMS                  | Undergraduate teaching: Echocardiography (practical)                                            |

|                                                        |                       |                                                                                            |
|--------------------------------------------------------|-----------------------|--------------------------------------------------------------------------------------------|
| 16 <sup>th</sup> February 2012                         | SVMS                  | Undergraduate teaching: Clinical examination of the Cardiorespiratory System               |
| 17 <sup>th</sup> February 2012                         | School of Biosciences | Big Macs, bacteria and the arteries: New roles for Toll-like receptors in atherosclerosis? |
| 17 <sup>th</sup> February 2012                         | SVMS                  | Undergraduate teaching: Cardiac Radiography (lecture)                                      |
| 17 <sup>th</sup> February 2012                         | SVMS                  | Undergraduate teaching: Electrocardiography (practical)                                    |
| 24 <sup>th</sup> February 2012                         | SVMS                  | REML, mixed models with random effects, GLM, GLMM                                          |
| 27 <sup>th</sup> February – 5 <sup>th</sup> March 2012 | SVMS                  | Large animal residents diagnostic imaging course                                           |
| 4 <sup>th</sup> – 7 <sup>th</sup> April 2012           | Birmingham            | BSAVA Congress                                                                             |
| 11 <sup>th</sup> April 2012                            | Birmingham            | VCS Meeting                                                                                |
| 12 <sup>th</sup> – 15 <sup>th</sup> April 2012         | Birmingham            | BSAVA Congress                                                                             |
| 4 <sup>th</sup> – 7 <sup>th</sup> May 2012             | Dubai                 | International Cardiovascular Disease Symposium                                             |
| 18 <sup>th</sup> May 2012                              | SVMS                  | Undergraduate teaching: ECG interpretation (seminar)                                       |
| 23 <sup>rd</sup> May 2012                              | Newmarket             | CPD provided:BEVA Practical equine cardiology course (assisting)                           |
| 24 <sup>th</sup> May 2012                              | Newmarket             | CPD provided:BEVA Practical equine cardiac ultrasound course (assisting)                   |
| 8 <sup>th</sup> June 2012                              | SVMS                  | Undergraduate teaching: ECG interpretation (seminar)                                       |
| 25 <sup>th</sup> July 2012                             | SVMS                  | CPD provided:Echocardiography, image acquisition and interpretation (day course)           |
| 26 <sup>th</sup> July 2012                             | SVMS                  | Cardiogroup                                                                                |
| 24 <sup>th</sup> August 2012                           | SVMS                  | Undergraduate teaching: ECG interpretation (seminar)                                       |
| 12 <sup>th</sup> – 14 <sup>th</sup> September 2012     | Liverpool             | ECVIM Congress                                                                             |
| 17 <sup>th</sup> October 2012                          | SVMS                  | CPD provided:Vets4Pets Scanning Course (day course)                                        |
| 9 <sup>th</sup> – 10 <sup>th</sup> November 2012       | Loughborough          | VCS Meeting                                                                                |
| 21 <sup>st</sup> November 2012                         | Webinar               | Cardiology                                                                                 |
| 6 <sup>th</sup> December 2012                          | Webinar               | Cardiology                                                                                 |
| 7 <sup>th</sup> December 2012                          | Cambridge Vet School  | Internal Medicine Course                                                                   |
| 4 <sup>th</sup> -5 <sup>th</sup> March 2013            | SVMS                  | Large animal imaging course                                                                |
| 15 <sup>th</sup> March 2013                            | SVMS                  | Large animal imaging                                                                       |
| 23 <sup>rd</sup> March – 3 <sup>rd</sup> April 2013    | Ohio State University | Clinical experience                                                                        |
| 4 <sup>th</sup> – 7 <sup>th</sup> April 2013           | Ohio State University | Diploma exam revision course                                                               |
| 17 <sup>th</sup> April 2013                            | Pride Vet Centre      | Cardiopulmonary resuscitation training                                                     |
| 24 <sup>th</sup> April 2013                            | Pride Vet Centre      | Fentanyl                                                                                   |
| 22 <sup>nd</sup> May 2013                              | Webinar               | Congestive heart failure diagnosis                                                         |
| 29 <sup>th</sup> May 2013                              | Pride Vet Centre      | Journal Club                                                                               |
| 5 <sup>th</sup> June 2013                              | Webinar               | Congestive heart failure treatment                                                         |
| 17 <sup>th</sup> June 2013                             | Pride Vet Centre      | Journal Club                                                                               |
| 18 <sup>th</sup> June 2013                             | Newmarket             | Equine cardiology                                                                          |
| 24 <sup>th</sup> June 2013                             | SVMS                  | Echocardiography CPD Day                                                                   |
| 25 <sup>th</sup> September 2013                        | Pride Vet Centre      | Journal Club                                                                               |
| 2 <sup>nd</sup> October 2013                           | Pride Vet Centre      | Journal Club                                                                               |
| 17 <sup>th</sup> – 18 <sup>th</sup> October 2013       | SVMS                  | PG Presentation Day                                                                        |
| 30 <sup>th</sup> October 2013                          | Pride Vet Centre      | Journal Club                                                                               |

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|---------------------------------------------------|--------------------------|------------------------------------|
| 8 <sup>th</sup> – 9 <sup>th</sup> November 2013   | Loughborough             | VCS Conference                     |
| 20 <sup>th</sup> November 2013                    | Pride Vet Centre         | Journal Club                       |
| 2 <sup>nd</sup> December 2013                     | Kenilworth               | Collapse evening talk              |
| 18 <sup>th</sup> December 2013                    | Pride Vet Centre         | Journal Club                       |
| 2 <sup>nd</sup> January 2014                      | Online                   | Respiratory Physiology             |
| 8 <sup>th</sup> January 2014                      | SVMS                     | Boehringer CPD Day                 |
| 7 <sup>th</sup> – 8 <sup>th</sup> February 2014   | Kenilworth               | ASAC Conference                    |
| 17 <sup>th</sup> February 2014                    | Derby                    | Cardiology team dinner             |
| 25 <sup>th</sup> February 2014                    | Derby                    | Dine with cardiologists            |
| 27 <sup>th</sup> February 2014                    | Online                   | VIN Journal Club                   |
| 17 <sup>th</sup> March 2014                       | Maternity starts         |                                    |
| 29 <sup>th</sup> May 2014                         | Online                   | VIN Journal Club                   |
| 28 <sup>th</sup> August 2014                      | Online                   | VIN Journal Club                   |
| 14 <sup>th</sup> – 15 <sup>th</sup> November 2014 | Loughborough             | VCS                                |
| 23 <sup>rd</sup> January 2015                     | Chesford<br>Grange Hotel | ASAC Conference                    |
| 29 <sup>th</sup> January 2015                     | Online                   | VIN Journal Club                   |
| 26 <sup>th</sup> February 2015                    | Online                   | Presenting at VIN Journal Club     |
| 26 <sup>th</sup> March 2015                       | Online                   | VIN Journal Club                   |
| 11 <sup>th</sup> May 2015                         | Alfreton                 | Cardiogroup                        |
| 28 <sup>th</sup> May 2015                         | Online                   | VIN Journal Club                   |
| 16 <sup>th</sup> June 2015                        | Alfreton                 | Cardiogroup                        |
| 25 <sup>th</sup> June 2015                        | Online                   | VIN Journal Club                   |
| 7 <sup>th</sup> July 2015                         | London                   | Diploma exam                       |
| 30 <sup>th</sup> July 2015                        | Online                   | VIN Journal Club                   |
| 6 <sup>th</sup> – 7 <sup>th</sup> August 2015     | Glasgow                  | Diploma exam                       |
| 24 <sup>th</sup> August 2015                      | Maternity starts         |                                    |
| 28 <sup>th</sup> January 2016                     | Online                   | VIN Journal Club                   |
| 25 <sup>th</sup> February 2016                    | Online                   | VIN Journal Club                   |
| 27 <sup>th</sup> October 2016                     | Online                   | VIN Journal Club                   |
| 11 <sup>th</sup> – 12 <sup>th</sup> November 2016 | Loughborough             | VCS                                |
| 2 <sup>nd</sup> December 2016                     | Kennel Club,<br>London   | Cavalier Breed Scheme Training Day |
| 8 <sup>th</sup> December 2016                     | Online                   | Presenting at VIN Journal Club     |

### Abbreviations

Venue: SVMS School of Veterinary Medicine & Science (Sutton Bonington), UON University of Nottingham

Activity: ASAC Association of Small Animal Cardiology, CPD Continuing professional development, BSAVA British Small Animal Veterinary Association, VCS Veterinary Cardiovascular Society, VIN Veterinary Information Network, ECVIM European College of Veterinary Internal Medicine, ECG Electrocardiography, BEVA British Equine Veterinary Association

Self-study is not recorded.

## PUBLICATIONS/ARTICLES

- Gilmour, J. L. (2011). A case of intermittent collapse. *Companion*, March, 10 – 13
- Runner-up in CEVA European Cardiology Student Award 2011: Case Report – Syncope in a Cavalier King Charles Spaniel with chronic valve disease
- Gilmour, J.L. (2011). Making a diagnosis – a step-by-step approach. *Veterinary Practice Spotlight*, November, 6-8
- Gilmour J. (2012) Echocardiography. *In: Canine Cardiology*. Contributors: Cobb, M., Ristic J., Patteson M., Moneva-Jordan A., Gilmour J., Sargant J., Borgeat K. and Lopez-Alvarez J. *In Practice Focus*, May, 13-15
- Gilmour J. (2012) Case example: Collapse of a cavalier King Charles spaniel. *In: Canine Cardiology*. Contributors: Cobb, M., Ristic J., Patteson M., Moneva-Jordan A., Gilmour J., Sargant J., Borgeat K. and Lopez-Alvarez J. *In Practice Focus*, May, 16-17
- Gilmour J. (2012) Case example: Dilated cardiomyopathy and congestive heart failure in a doberman. *In: Canine Cardiology*. Contributors: Cobb, M., Ristic J., Patteson M., Moneva-Jordan A., Gilmour J., Sargant J., Borgeat K. and Lopez-Alvarez J. *In Practice Focus*, May, 30
- Gilmour, J.L. (2012). Updates on heart disease in dogs. *Veterinary Practice*, October, 26
- Huxley, J.L. and Dickson, D. (2014). Pulmonic Stenosis Literature Review. Presentation at ASAC, February, 7-8
- James, R., Guillot, E., Garelli-Paar, C., Grassi, V., Huxley, J. and Cobb, M. The SEISICAT study: a pilot study assessing efficacy and safety of spironolactone in cats with congestive heart failure secondary to cardiomyopathy. Submitted.