



A 3-year surveillance on causes of death or reasons for euthanasia of domesticated dogs in Taiwan



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ABSTRACT

Over the last 2 decades, there has been growing interest in research on the mortality of domesticated pets. These studies relied on an effective data-collecting system. During 2012–2014, a real-time reporting system was designed for mortality data in owned dogs and cats. The present retrospective study aimed to report on the causes of death (CODs) or reasons for euthanasia (RFEs) in domesticated dogs in Taiwan, and to investigate CODs/RFEs segregated by demographic variables. Data from 2306 domesticated dogs were acquired during the 3-year period in the present study. The median age at death of the study population was 10.2 years (median interquartile range 7.0–14.0; range 0.0–25.0). Crossbred, female, and neutered dogs showed greater ages at death than other groups. The most common COD/RFE was neoplasia, followed by multiple organ involvement (MOI) and cardiovascular diseases. Segregated by cut-off ages, the most common COD/RFE was infection among dogs younger than 3 years or 1 year, and neoplasia among dogs at or older than 3 years or 1 year of age; the most common COD/RFE was neoplasia among dogs younger than median age, and MOI among dogs at or older than median age. Segregated by geographic variables, the ranking and frequency of CODs/RFEs displayed different patterns between the capital city/non-capital areas, and among areas stratified by human population densities. The study provides various insights into age at death and CODs/RFEs in owned-dog population in Taiwan, and provides new directions for future research.

1. Introduction

In recent years, the complexity of global health issues highlights the importance of “one medicine” and “one health”; the contemporary thinking on health should concern not only humans, but also animals and even the entire ecosystem (Zinsstag et al., 2011). The attention in comparative medicine is helpful for the development of both veterinary and human medicine, and surveillance on health conditions of both humans and animals is one of the important issues in public health and preventive medicine (Moore and Lund, 2009; Pitt and Kaerberlein, 2015). Health surveillance data are useful for enhancing the knowledge of a population, devising strategies for public health improvements, and further forestalling disease epidemics (Moore and Lund, 2009; O’Neill

et al., 2014).

A significant amount of data with advanced analyses of animal mortality will facilitate the fulfillment of an epidemic prevention system, and will ultimately benefit both humans and animals. Because of the importance of zoonotic diseases and the increasing intimacy between owners and their pets, disease surveillance of companion animals is more crucial nowadays than ever before (Moore and Lund, 2009; Zinsstag et al., 2011). Public awareness of zoonotic diseases has been highlighted recently in Taiwan after a rabies outbreak in ferret badgers during 2012–2013 (Chiou et al., 2014).

The past two decades have witnessed a growing interest in the research on mortality and longevity in animals (Moore et al., 2001; Proschowsky et al., 2003; Bonnett et al., 2005; Egenvall et al., 2005;

Abbreviations: COD, cause of death; RFE, reason for euthanasia; MOI, multiple organ involvement

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Greer et al., 2007; Egenvall et al., 2009; Fleming et al., 2011; Hoffman et al., 2013; O'Neill et al., 2013a; Inoue et al., 2015a; O'Neill et al., 2015). Different systems were applied to investigate different animal populations, providing helpful clues in the comparative understanding of mortality in pets from different countries (Michell, 1999; Moore et al., 2001; Bonnett et al., 2005; Egenvall et al., 2005; Egenvall et al., 2009; Adams et al., 2010; Fleming et al., 2011; O'Neill et al., 2013a; Jones et al., 2014; O'Neill et al., 2015; Kass et al., 2016). In Asia, only few studies have been done on the longevity and mortality of pet dogs and cats (Hayashidani et al., 1988, 1989; Inoue et al., 2015a,b; Huang et al., 2017). Moreover, several veterinary life span studies utilized data from dead animals (Hayashidani et al., 1988, 1989; O'Neill et al., 2013a, 2015), and these lead to an artificial decrease of the estimated longevity due to right censored data (Urfer, 2008). Results of these studies should be treated with caution, especially when compared among studies.

We have investigated the mortality of domesticated cats in Taiwan using the real-time reporting system, which was designed to monitor mortality in domesticated dogs and cats in the previous article (Huang et al., 2017). The purpose of this current study was to describe causes of death (CODs) or reasons for euthanasia (RFEs) in domesticated dogs in Taiwan, and further investigate whether CODs/RFEs could be segregated by demographic variables.

2. Methods

2.1. Data collection

To collect CODs/RFEs of Taiwanese domesticated dogs and cats, the real-time reporting system for the program “**Investigations of CODs in Dogs and Cats**” was developed by the authors' research group, and utilized during 2012–2014. Details on the operation and functions of the system was elaborated in the previous article (Huang et al., 2017). Briefly, the web-based system was independent of any veterinary hospitals in Taiwan without any commercial consideration. Clinicians from registered veterinary hospitals logged in the website for the system and submitted the data of deceased dogs and cats. The submitted information included: animal's information (age at death, breed, sex, neuter status), owner's information (name, address and telephone number), clinical information (clinical case number, the name of the clinician in charge, case brief, clinical diagnosis, date of death, clinical diagnosis, COD/RFE, and the option for euthanasia). The column “COD/RFE” of the system was designed as a multiple-choice style column, consisting of a referenced list of COD/RFE category and an optional blank space. Clinicians chose multiple COD/RFE from the referenced list freely, and/or filled in their supplementary opinion for COD/RFE. Entries were reviewed instantly through a peer-review system (by two veterinarians at the authors' institute). If the entries were duplicate, incomplete or irrational, the submissions were rejected. Statistical analyses were performed for the purposes of annual reporting and retrospective studies by one or more of the authors.

All the data including personal identifiable information collected and enrolled in the study complied with country privacy and security law.

2.2. Data management

In this retrospective study, only the records of deceased dogs collected from the real-time reporting system between 2012 and 2014 were included. The owner's personal information (name, address, and telephone number), and the clinical case number were used to exclude duplicate or fake entries.

Demographic variables evaluated included: age at death, sex, neuter status, breed, breed size, whether the dogs were purebred, season of death, year of death, whether or not the dogs lived in the capital area, human population density of the location where the dog lived, whether

or not the dog attended capital veterinary hospitals, and the option for euthanasia (whether the dog died naturally or was euthanized).

To study the difference between crossbred and purebred dogs, the designated variable was whether the dog was purebred. The categorization was based on the column “breed” of submitted data, in which the crossbred dogs were reported as “mongrel/mixed” by clinicians. To study differences among dog sizes, all breeds (except the mixed/mongrel breed) were first classified into three size groups (small, medium and large) based on the breed information obtained from the website of American Kennel Club. All purebred dogs of study population were then classified based on the column “breed” of submitted data. Mongrel/mixed dogs were excluded from size classification and treated as an entity, as sizes of mongrel/mixed dogs were difficultly identified based on the submitted data.

To study seasonal differences in mortality, the designated variable was season of death, which was determined based on month of death in the present study. According to the information from the Center Weather Bureau of Taiwan, Spring was from March to May; Summer was from June to August; Autumn was from September to November; Winter was from December to February.

To study geographic differences, three demographic variables of interest were created: whether or not the dog lived in the capital city, human population density of the location where the dog lived, and whether or not the dog attended capital veterinary hospitals. The owners' addresses were utilized to represent the locations of dogs. Based on official records released by the Ministry of the Interior, Republic of China (Taiwan), the human population density was designated into low, medium and high groups, defined respectively as < 10,000, 10,000–20,000, > 20,000 people per square kilometer.

2.3. Determination of COD/RFE

All cases were reviewed by both the first and the corresponding author. On the basis of a comprehensive evaluation of the submitted case brief, clinical diagnosis, and provided COD(s)/RFE(s), each case was categorized into one or more of 18 attributed causes according to the following criteria (Fig. 1):

1. If infection, intoxication, neoplasia, or trauma was determined as the definite pathophysiological cause of death, the case was categorized into that group.
2. Cases that did not belong to any of the four major pathophysiological groups and those that had comorbid causes other than the pathophysiological causes were categorized on the basis of the involvement of a specific organ system.
3. For the rest of cases, they were categorized as multiple organ involvement (MOI), owner, or unclassified. For cases reported simply as “weak”, “old” or “multiple organ failure”, they were classified as MOI group. The owner group included cases that were euthanized due to the owners personal reasons. Cases with insufficient information such as nonspecific clinical signs, which were minimally linked to death, were categorized into the unclassified group.

Since many cases were reported with multiple CODs/RFEs and sometimes a primary cause could not be determined easily, we allowed multiple attributed causes for a single case first. After determination of attributed causes was finished, cases with multiple attributed causes were placed into MOI group. For each case, a single final COD/RFE was decided (Fig. 1).

2.4. Statistical analyses

After data were checked and coded in Microsoft Excel 2016, all statistical analyses were performed using SPSS Version 22 (SPSS Statistics, IBM Corp., Somers, NY). A *P* value < 0.05 was considered statistically significant. The missing data were exclusively deleted in the

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