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Summary: Outcomes of cardiopulmonary arrest and resuscitation in clinically affected dogs and cats have not been adequately studied. We examined the records from 200 dogs and 65 cats that had received cardiopulmonary resuscitation for respiratory or cardiopulmonary arrest; none of the animals had been anesthetized or intubated at the time of arrest, and all had been hospitalized in a veterinary critical care facility. Cardiopulmonary arrest was found to be more common than respiratory arrest in dogs and cats. Hospital discharge rates for animals with cardiopulmonary arrest ranged from 4.1% for dogs to 9.6% for cats, and were consistent with those reported from studies of human beings with cardiopulmonary arrest. Hospital discharge rates for dogs and cats with respiratory arrest were 28% and 38.3%, respectively.

Virtually every textbook of small animal anesthesia, internal medicine, cardiology, and surgery describes cardiopulmonary arrest (CPA) and resuscitation (CPR), but validated statistics in clinically affected dogs and cats are lacking. In a study of naturally occurring CPA, 4 (22%) of 18 cats that had been intubated prior to arrest survived to be discharged from the hospital.1 In that study, the type of arrest and the resuscitative efforts were not defined. A 9% survival to discharge has been reported from a study in dogs.2

Arrest can be classified as respiratory or cardiopulmonary. In respiratory arrest, breathing ceases, but malignant dysrhythmias (ventricular fibrillation, electromechanical dissociation, or ventricular asystole) are not found. Cardiopulmonary arrest includes cessation of breathing and malignant dysrhythmias. Respiratory arrest can proceed to CPA when not detected promptly, because the hypoxemia and respiratory acidosis of respiratory arrest may result in metabolic acidosis and catecholamine release, thus inducing malignant dysrhythmias.

The purpose of the study reported here was to examine the characteristics of CPA and the outcome of CPR in clinically affected dogs and cats.

Criteria for Selection of Cases

All dogs and cats experiencing respiratory arrest of CPA while hospitalized in the critical care unit were included in this study. During the study, 299 records of CPA were reviewed and 265 animals (65 cats and 200 dogs) were identified as having experienced 1 or more respiratory or cardiopulmonary arrests. The difference between the number of records and animals represented recurrences of CPA (rearrests). Only the records of the initial CPR events were reviewed for each animal. Records of rearrests were included if the rearrests occurred > 4 hours after the initial event, and only if unassisted respirations, a palpable pulse, and heart sounds were detected before the rearrest. Data collected included species, breed, age, sex, and body weight of the animal and the outcome of CPA. Data from the period of CPA were obtained from the CPR record.

Diagnosis and Treatment

Respiratory arrest was characterized by apnea, in conjunction with auscultable heart sounds or palpable pulses. For animals to be classified as having respiratory arrest, the initial electrocardiographic diagnosis could not be ventricular asystole, electromechanical dissociation, or ventricular fibrillation. Cardiopulmonary arrest was characterized by apnea, a malignant cardiac dysrhythmia (ventricular asystole, electromechanical dissociation, or ventricular fibrillation), and an absence of pulses and heart sounds. All episodes of CPA were in nonanesthetized, nonintubated animals.

Basic and advanced life support were provided by critical care unit faculty, small animal medicine and surgery faculty, residents, interns, or fourth-year veterinary students. Basic life support consisted of establishing an airway and ventilatory support, and use of simultaneous compression/ventilation of the thorax to provide circulatory support. Thoracic compression/ventilation was applied at a rate of 80 to 100 compressions/min for
Figure 1—Effect of age on the type of arrest for dogs and cats. Age categories: 1 = 0.51 to 2 months; 2 = 3 to 6 months; 3 = 7 to 12 months; 4 = 13 to 24 months; 5 = 25 to 48 months; 6 = 49 to 84 months; 7 = 85 to 120 months; 8 = 121 to 180 months; and 9 = > 180 months. ★ = Cardiopulmonary arrest (CPA) in dogs; ▽ = CPA in cats; * = respiratory arrest in dogs; and □ = respiratory arrest in cats.

Figure 2—Algorithm for results of resuscitation from respiratory arrest in dogs.

Respiratory Arrest
25 of 200 dogs (12.5%)

Resuscitated
20 (80%)

Died
5 (20%)

Rearrest
13 (65%)

Discharged
7 (35%)

28% of 25 dogs

animals > 7 kg of body weight and 120/min for animals < 7 kg. A comprehensive data sheet was completed during CPR.

Outcome data included successes or failures of initial CPR efforts, rearrests, and number of animals discharged from the hospital. Success was defined as return of unassisted respirations, a palpable pulse, and auscultable heart sounds. Death was defined as the inability to reestablish unassisted respiratory or circulatory function associated with malignant cardiac dysrhythmia. The duration of resuscitative efforts was not limited.

For ease of statistical evaluation, breed, age, weight, sex, and outcome were classified as nominal data. Statistical association was evaluated by use of the χ² test. With smaller sample sizes, Fisher’s exact test or Yate’s correction was used. Results were considered significant when P < 0.05.

Results

Dogs—Respiratory arrest was recorded in 25 (12.5%) of the cases; CPA, in 169 (84.5%); and undetermined arrest, in 6 (3%). Arrests occurred in 62 breeds. Of 189 dogs in which the sex was recorded, 83 were males (24 were castrated) and 106 were females (69 were spayed). Body weight ranged from 0.5 to 52.7 kg, with a mean of 18.0 (SD, 13.9) kg. Mean age of all dogs was 91 (SD, 55) months (mean age was 83 [SD, 74] months for dogs in respiratory arrest and 59 [SD, 37] months in CPA), with a range of 1 to 216 months. Aged dogs experienced CPA significantly (P = 0.04) more frequently than dogs < 49 months old (Fig 1).

Of the 25 dogs experiencing respiratory arrest, 20 (80%) were resuscitated (Fig 2). Of the 20 dogs initially resuscitated, 13 (65%) experienced a rearrest, and 7 (35%) were discharged from the hospital. Of all dogs with respiratory arrest, 28% were discharged from the hospital.

Of 169 dogs with CPA, only 22 (13.0%) were resuscitated and 15 (68.2%) of 22 experienced a second arrest (Fig 3). Of the 22 dogs, 7 (31.8%) were discharged from the hospital after their initial arrest. Of all dogs with CPA, only 4.1% were discharged from the hospital.

Cats—Respiratory arrest was recorded in 12 (18.5%) of the cases; CPA, in 52 (80.0%); and un-
determined arrest, in 1 (1.5%). Arrests occurred in 7 breeds. Of the 60 cats in which the sex was recorded, 35 were males (28 were castrated) and 25 were females (11 were spayed). Mean age of all cats was 67 (SD, 62) months with a range of 1 to 202 months; mean age was 86 (SD, 68) months in respiratory arrest and 62 (SD, 59) months in CPA. Body weight ranged from 0.35 to 7.78 kg, with a mean of 4.26 (SD, 1.70) kg.

The occurrences of arrests remained relatively constant through the various age categories in cats, as compared with those in dogs (Fig 1). This may have been a reflection of the inclusion of fewer aged cats than aged dogs, or of a lower prevalence of cardiovascular disease in aged cats, as opposed to that in the aged dogs.

Of the 65 cats in the study, 12 (18.5%) had respiratory arrest and 9 (75%) of the 12 were resuscitated (Fig 4). Of the initially resuscitated cats, 2 (22.2%) experienced rearrest and 7 (77.7%) were discharged from the hospital. Of all cats in respiratory arrest, 58.3% were discharged from the hospital.

Of 52 cats with CPA, 8 (15.4%) were resuscitated, and 3 (37.5%) of these 8 cats experienced rearrest (Fig 5). Of the 8 cats resuscitated, 5 (62.5%) were discharged from the hospital. These 5 cats represented 9.6% of all cats with CPA.

**Discussion**

Although most veterinary textbooks describe CPR techniques in small animals, information on the epidemiologic features and outcomes after resuscitation is minimal. Reports of 22% survival to hospital discharge in cats\(^1\) and of 9% in dogs\(^2\) have provided the only objective data on the effectiveness of CPR in animals with naturally occurring CPA. Anecdotal comments can be found\(^3,4\) but little information has been provided to assess the data. One investigator stated that a survival rate of 3.2%
is excellent but 10% is more realistic," but this too is not validated.

In this study, the occurrence of respiratory arrest and CPA in cats and respiratory arrest in dogs was reasonably constant throughout the age categories represented in available data. The occurrence of CPA in this population of dogs began to significantly (P = 0.04) increase at 49 to 84 months of age. Coincident with this age is the onset of cardiovascular disease in dogs, as well as that of neoplasm and metabolic diseases.

As expected, resuscitation of dogs and cats with respiratory arrest was more successful than that of those with CPA. Although 80% (20 of 25) of the dogs with respiratory arrest initially were resuscitated, 65% (13 of 20) of these experienced the shortest time for resuscitation; however, one disappointing statistic of this study was the hospital discharge rate for dogs resuscitated from respiratory arrest (35%), or 28% of all dogs with respiratory arrest. Although the cause of death was not specifically identified, the condition of the heart at the time of death was found to be a more accurate predictor of outcome in cats, the hospital discharge rate after resuscitation from respiratory arrest was more acceptable (77.7%, or 58.3% of all cats with respiratory arrest).

One of the purposes of this study was to provide veterinarians with information from our experience in using simultaneous compression/ventilation in dogs and cats with CPA. In dogs, 13% (22 of 169) were resuscitated initially, and 31.8% (7 of 22) were discharged from the hospital. The disappointment were in the overall resuscitation rate of 4.1% of 169 dogs, and in the rearrest rate of 68.2%. Cats fared somewhat better, with a resuscitation rate of 1.4% (8 of 52) and a discharge rate of 62.5% (5 of 8, or 9.6% of 52 cats). These discharge rates are consistent with those reported from most studies of hospitalized and nonhospitalized human beings with CPA. For human beings, ≤ 29% of hospitalized patients with CPA were discharged, whereas discharge rates for out-of-hospital CPA ranged from 2 to 25% for all patients and from 3 to 33% for patients with ventricular fibrillation.

Reports of drugs administered during CPR to the animals discharged from the hospital were not available for this study. We did not attempt to relate advanced life support techniques to the chance of discharge from the hospital.

The benefit of resuscitation in aged human patients is controversial. Data from our study and other veterinary studies were insufficient to allow conclusions about the benefits of CPR in aged dogs and cats, but at this time, clinical judgment and discussions with the pet owner prior to hospitalization are advised in deciding whether to resuscitate an aged animal.

References