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Changes in adherence to cardiopulmonary resuscitation guidelines in a single referral center from January 2009 to June 2013 and assessment of factors contributing to the observed changes

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Abstract

Background – This retrospective study reviewed compliance to cardiopulmonary resuscitation (CPR) teaching at a small animal referral center from January 2009 to June 2013. CPR training commenced in October 2009. This was a lecture format by European specialists in veterinary anesthesia and analgesia. Teaching was originally based on published guidelines. Changes made to the content of the lectures after publication of the Reassessment Campaign on Veterinary Resuscitation (RECOVER) guidelines in 2012 are discussed.

Key Findings – Data regarding basic life support and monitoring equipment were collected from all cases requiring CPR. A Mann–Kendall test for trend showed a significant increased use of both capnography ($P = 0.017$) and suction to aid tracheal intubation ($P = 0.017$) over the period of study. There was a significant increase in capnography use in 2011 ($P = 0.046$), 2012 ($P = 0.002$), and 2013 ($P = 0.002$) compared to 2009 (1/15).

Significance – The sequential increase in capnography use without any change to the number or availability of capnography units provides evidence that CPR teaching has altered clinical practice. The publication of the RECOVER guidelines provided an evidence base upon which to refine and improve teaching of CPR.

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Introduction

Historically, evidence-based guidelines for best practice for veterinary cardiopulmonary resuscitation (CPR) for dogs and cats were not available. Suggestions for CPR were extrapolated from human medicine and from expert veterinary opinion with no definitive recommendations.[1,2] An Internet-based study showed there to be considerable variation in CPR techniques used across general and referral practices.[3] It has been suggested that this disparity in techniques was in part due to a lack of accepted, evidence-based guidelines for CPR in cats and dogs. Recently, there has been a review of clinical literature to provide guidelines on CPR technique. The current guidelines, released in June 2012 are detailed in the Reassessment Campaign on Veterinary Resuscitation (RECOVER) initiative instigated by the American College of Veterinary Emergency and Critical Care and the Veterinary Emergency and Critical Care Society. The publication of these guidelines was motivated by improved outcomes in human CPR after publication of evidence-based guidelines and standardized training.[4]

Abbreviations

CPR	cardiopulmonary resuscitation
ECG	electrocardiogram
RECOVER	Reassessment Campaign on Veterinary Resuscitation

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The aim of this study is to evaluate the changes in CPR management from January 2009 to June 2013 at a single referral center and to assess factors contributing to observed changes. The study focused on the teaching of CPR, clinical guidelines used,[5] and monitoring[6] performed during CPR.

Materials and Methods

Data from all CPR records from January 2009 to June 2013 were included in the study. Information was taken from patients' contemporaneous clinical records, which included a standardized CPR form, or directly from clinical records. The protocol at this institution stipulates that the CPR form is to be filled out immediately following the performance of CPR. Data were entered into a commercial spreadsheet computer program[a] and transferred to a commercial statistical analysis program[b] for analysis. The collected data detailed basic life support parameters (eg, compression rate [thoracic compressions], ventilation, use of suction) and the monitoring (eg, capnography, electrocardiogram [ECG], pulse palpation, and pulse oximetry) used during the resuscitation attempt. When records were incomplete the omitted details were assumed not to have been used or performed.

At the time of the study, staff received lecture-based CPR training every 2 years. There is a small component of role play within these sessions. The training is given by European specialists in veterinary anesthesia and analgesia. The inception of training was October 2009; it took 12 months for all staff to receive this training. Training at this time was based on the 2008 review by Plunkett and McMichael that interpreted the 2005 American Heart Association guidelines for use in cats and dogs.[2,7]

After publication of the RECOVER guidelines in June 2012 the training changed slightly to emphasize the importance of commencing cardiac compressions promptly, the importance of capnography was reinforced and debriefing after CPR was initiated. Currently, any new staff undergoes CPR training within the first month of employment and refresher CPR training is every 24 months. CPR training was delivered in a similar format throughout the study period.

As this was an audit of current practice and involved no interventions or additional testing, ethical approval was not sought in line with guidance from the local ethics committee.

Results

Sixty-nine dogs received CPR over the study period. There was no significant change in the number of CPR events each year over the period of study ($P = 0.817$). A Mann–Kendall test for trend showed a statistically significant increase in both capnography ($P = 0.017$) suction ($P = 0.017$) and pulse oximetry use ($P = 0.043$) from 2009 to 2013 (Figure 1). Fisher's exact test showed a significant increase in capnography use in 2011 ($P = 0.046$), 2012 ($P = 0.002$), and 2013 ($P = 0.002$) compared to 2009 (1/15). There was no significant difference between capnography used between 2012 and 2013 ($P = 0.616$). Fisher's exact test showed a significantly greater use of suction in 2013 compared to 2009 ($P = 0.046$), comparison between other years was not statistically significant. Cardiac compressions and intermittent positive pressure ventilation were both used on most occasions. There was no significant change in the use of pulse palpation ($P = 0.083$), ECG ($P = 0.233$), cardiac compressions ($P > 0.9$), or intermittent positive pressure ventilation ($P = 0.267$) throughout the study period (Table 1). The ventilation and compression rate used during CPR was only recorded in 6 of 69 cases (<9%); therefore, analysis of these data was not possible.

Table 1: Techniques and monitoring equipment used at a small animal referral center during CPR from 2009 to 2012

	Technique					Monitoring device		
Year	CC	IPPV	Defib	PP	Suction	Cap	ECG	Pulse ox
2009	100.0	93.3	0.0	40.0	7.1	6.7	60.0	0.0
2010	92.9	100.0	14.3	71.4	14.3	21.4	50.0	14.3
2011	88.9	94.4	0.0	44.4	17.6	38.9	61.1	22.2
2012	93.8	100.0	6.3	75.0	31.3	62.5	81.3	50.0
2013	100.0	100.0	0.0	83.3	50.0	83.3	66.7	50.0

CC, cardiac compressions; IPPV, intermittent positive pressure ventilation; Defib, defibrillation; PP, pulse palpation; Cap, capnography; Pulse ox, pulse oximetry.
Number of CPR cases for each year. 2009:15, 2010:14, 2011:18, 2012:16, 2013:6. Results displayed as percentage of cases that received that technique or monitoring device. Data from 2013 is from January to June.

Discussion

The reason for the significantly increased use of capnography and suction documented in this study is likely to be multifactorial. The major change with respect to staff, equipment, and training over the study period was the inception of CPR training in October 2009. Additionally, following the publication of the RECOVER guidelines in June 2012, training emphasized the benefit of earlier commencement of cardiac compressions and promoted debriefing after CPR. An improvement in the number of cases on which capnography was used was seen by 2011, when all staff had received CPR training. This suggests that this training had a significant impact on clinical practice.

Advanced techniques used in the human field to aid learning for CPR include simulators and

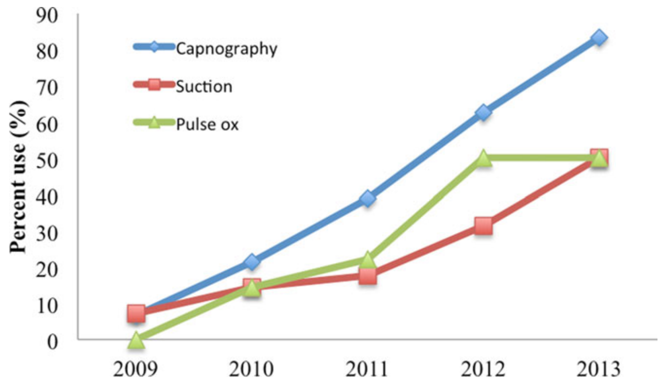

Figure 1: Use of capnography, suction to aid tracheal intubation, and pulse oximetry from 2009 to 2013. Data points are the annual percent use, the data line is extrapolated from the general trend of the data.

computer-based programs. A study regarding teaching techniques for CPR compared traditional practical exercises in a classroom environment, (similar to those used at the institute in this study) to a multimedia computer screen-based simulator. The study concluded that students trained with the multimedia screen-based program performed significantly better on a high-fidelity patient simulator.[8]

In human CPR, there is increased emphasis on the use of capnography, along with clinical assessment to confirm and continually monitor tracheal tube placement and the quality of CPR.[9] End-tidal carbon dioxide is useful for monitoring of the effectiveness of chest compressions and return of spontaneous circulation.[10] In the current study, capnography was used more frequently on each successive year of data collection, which demonstrates annual sequential improvements in compliance to what has been taught. Given that teaching was based on current clinical guidelines, the available data provide evidence of clinical compliance to the RECOVER guidelines.

No new capnography machines were purchased during the study period and location of monitoring units did not change. Unfortunately, absolute $ETCO_2$ values were rarely recorded therefore the performance of CPR could not be objectively measured.

Human studies show intubation attempts by inexperienced providers can cause unacceptable incidences of trauma and interruption of cardiac compressions.[9] Using suction may help to increase the success rate of endotracheal intubation if visualization is compromised. In this study, there were successive annual increases in use of suction to aid visualization for endotracheal intubation; this could be simply due to more cases needing suction. There was no change in the availability of suction units during the study period. The RECOVER guidelines recommend initiating ventilation early at a rate of 10 breaths/minute in intubated patients;[5] the rate that is taught in the CPR training at the clinic. The increased use of suction in this study may have allowed earlier initiation of ventilation; however, data to prove this are not available.

Pulse oximetry is beneficial in primary respiratory arrest in people, which may be comparable to acute hypoxia seen in acute airway obstruction in brachycephalic breeds. However, during CPR, the pulse oximeter may not have adequate signal to measure oxygen saturation reliably.[11] In this study, pulse oximetry was used increasingly each year however the reliability and value of this tool during CPR is debatable. Staff were not trained that pulse oximetry was a helpful tool during CPR. The increased use could reflect more CPR occurring when pulse oximetry is already being utilized or could represent a misuse or misunderstanding of the value of pulse oximetry.

RECOVER recommends that chest compressions are at a minimal rate of 100/minute, at a depth of one third to a half of chest width, allowing full recoil of the chest wall with minimal pauses in delivery of compressions.[5] These factors are impossible to assess objectively from the clinical records used in this study and rate of cardiac compression was rarely documented. The rate and depth of cardiac compressions has been studied in human CPR. A human study assessing the quality of CPR using a CPR-sensing defibrillator, which measures chest compression rate and depth, showed that real-time audio-visual feedback during CPR and debriefing after CPR can significantly improve the depth of chest compressions.[12] Debriefing after a CPR event has been implemented since the publication of the RECOVER guidelines. Audio-visual feedback of $ETCO_2$ value could be an interesting and valuable tool for further advancements in CPR.

In this study not all clinical records were complete. Omitted details were assumed not performed, which could account for inaccuracies in data collection. For example the data reveals that in 2011 over 11% of patients did not receive chest compressions after cardiopulmonary arrest, which is unlikely and more likely a result of poor record keeping. Due to the small number of patients in this study an improvement in documentation of events may account for some of the trends seen in this study. To further assess compliance to current guidelines, there would need to be more detailed clinical records of future CPR attempts to provide information regarding rate and depth of cardiac compressions, ventilation rate, and timing of employment of ECG and pulse palpation.

The changes implemented at this referral institute in response to the findings in this study are likely to include but not be limited to; more practical training with simulation, improved bedside documentation, and more rigorous implementation of repetition of training. The standard form used to document CPR is likely to be changed to include the rate of thoracic compression, ventilation rate, and $ETCO_2$ values.

Footnotes

[a] Microsoft Office Excel 2010.
[b] Addinsoft XLSTAT.

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