Title

Further comments regarding CPR techniques in dogs

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Authors

Burkitt-Creedon, Jamie M

Fletcher, Daniel J

Boller, Manuel

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Chest compression techniques in dogs and cats requiring cardiopulmonary resuscitation

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Dear Dr. Chan –

We read with interest Mr. Rottenberg's letter regarding various strategies to optimize coronary perfusion in animals undergoing CPR. We appreciate and share the author's interest in and dedication to improving patient outcomes following cardiopulmonary arrest (CPA). We write to highlight areas ripe for future study in clinically applicable ways in the target species.

Mr. Rottenberg recommends hand placement over the left ventricular inflow tract when the rescuer is performing compressions over the heart. Considering the wide variety of thoracic shapes and sizes particularly in dogs, and the small thoracic size in domestic cats compared with the average rescuer's palm, we think it would be challenging to identify and target the specific location of the left ventricular inflow tract reliably in clinical patients. It would be interesting and could be valuable to study whether there are reliable external anatomic marker(s) on dogs and cats that could guide optimal rescuer hand placement. Studies regarding the clinical impact of such specific hand placement could then be evaluated. Until more evidence is available, it seems reasonable to continue to recommend hand placement caudal to the elbow with the animal in lateral recumbency when the goal is to compress the heart directly, as recommended in the 2012 RECOVER CPR Guidelines.[1]

High impulse CPR involves chest compressions in which the compression phase is shortened and the decompression phase is prolonged; rather than a 50:50 duty cycle, compressions are delivered at 20:80 to 40:60 time cycles of compression:decompression.[2] A recent pilot study in 16 adults with out-of-hospital cardiac arrest showed significantly higher $ETCO_2$ of 27 ± 11 mmHg when using a high impulse, palm lift chest compression technique compared to 18 ± 9 mmHg (P = 0.037) with standard high quality chest compressions.[3] While 1 experimental study showed benefit to stroke volume and coronary perfusion using high impulse manual chest compression technique in dogs weighing 25 – 35 kg,[4] a study by Kern and others found no benefit of high impulse chest compressions when compared to standard manual chest compressions on the critical outcomes of 24-hour survival and favorable neurologic outcome in dogs weighing 20 – 32 kg.[5] Finally, it is unclear how high impulse chest compressions may affect cats and smaller dogs that could experience more thoracic trauma from this approach than larger dogs and adult people. The routine use of high impulse chest compression technique cannot be recommended in small animals at this time, and the RECOVER Executive Committee currently recommends standard manual chest compression techniques with a 50:50 duty cycle during CPR in dogs and cats.

Mr. Rottenberg's letter states that the thoracic pump mechanism, whereby forward blood flow is generated primarily by changes in intrathoracic pressure during chest compressions, "can never be a dominant mechanism" of cardiac output during CPR. A recent literature search found 3 studies demonstrating that alterations in intrathoracic pressure produce cardiac output during CPR.[6-8] One canine model of sternal chest compressions showed that intracardiac and intravascular pressures reflect changes in intrathoracic pressure and are not due to direct compression of the heart.[6] A study of manual CPR in dogs positioned in dorsal recumbency

demonstrated that the thoracic pump mechanism prevails in this scenario (rather than direct compression of the heart), and that blood flow is generated in response to intrathoracic pressure changes.[7] Finally, another experimental study in dogs showed that intrathoracic pressure changes can lead to mitral valve closure.[8] This evidence suggests that a thoracic pump mechanism can lead to meaningful cardiac output during CPR. In medium- to large-sized, round-chested dogs, there is concern that hand placement over the heart may not create sufficient thoracic compression to create a cardiac pump mechanism of flow. Therefore, hand placement over the widest part of the chest may be preferable in these dogs. Finally, all three of us have achieved good $ETCO_2$ values and ROSC in many large breed dogs by performing chest compressions over the widest part of the thorax, which supports the idea that this method is acceptable in certain cases. We believe that clinical studies in dogs of various sizes and chest conformations are warranted to determine ideal hand placement based on critical outcomes such as ROSC and survival to discharge with acceptable neurologic function.

Lastly, in his letter Mr. Rottenberg recommends consideration of abdominal compression-only CPR in large breed, round-chested dogs. Considering the differences in size and thoracic conformation of various dog breeds, and the fact that most of them naturally lie in lateral rather than dorsal recumbency, we agree that additional experimental studies would be needed to assess the technique in this species. Such studies would need to evaluate the impact of abdominal compression-only CPR in dogs on critical outcomes such as ROSC and survival with favorable neurologic outcome. Also, considering all authors have experienced cases of iatrogenic liver fractures following application of abdominal counter-compressions during standard CPR, the safety of abdominal compression-only CPR applied in a clinically-relevant way (eg, manually by veterinary professionals in a clinical setting) would need to be assessed. Finally, many large breed, round-chested dogs that experience cardiopulmonary arrest have meaningful intra-abdominal disease that may prohibit safe compression of the abdominal cavity. Thus, the RECOVER Executive Committee believes that performing compressions over the thorax is preferable in large breed, round-chested dogs, and that hand placement in each specific case should be decided based on which location yields the highest $ETCO_2$ value when such monitoring is possible.

We are grateful to Mr. Rottenberg for opening this discussion, and we hope to see experimental and clinical studies of these techniques in the future. Until more data are available, we believe that the best approach for dogs and cats that experience CPA in a clinical setting is to follow the evidence-based recommendations in the RECOVER guidelines regarding chest compression approach and, as recommended in the guidelines, to alter that approach when the $ETCO_2$ is inadequate (ie, < 18 mmHg as recommended in the RECOVER 2.0 guidelines).[9] We eagerly await additional experimental and clinical evidence to inform new approaches to chest compressions, and hope that conversations such as these spur more of our colleagues to develop studies investigating these critical questions in veterinary CPR.

Jamie M. Burkitt-Creedon, DVM, DACVECC
Co-Chair, Executive Committee of the Reassessment Campaign on Veterinary Resuscitation
Associate Professor of Clinical Small Animal Emergency and Critical Care

Dept. of Veterinary Surgical and Radiological Sciences
University of California, Davis

Daniel J. Fletcher, PhD, DVM, DACVECC
Co-Chair, Executive Committee of the Reassessment Campaign on Veterinary Resuscitation
Associate Professor of Emergency and Critical Care
Cornell University College of Veterinary Medicine

Manuel Boller, Dr. med. vet., MTR, DACVECC
Co-Chair, Executive Committee of the Reassessment Campaign on Veterinary Resuscitation
Specialist in Veterinary Critical Care, VCA Canada Central Victoria Veterinary Hospital, British Columbia, Canada
Adjunct Associate Professor Veterinary Emergency and Critical Care, University of Calgary, Alberta, Canada

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Commented [JB1]: Depending on timing, this may disappear or may replace citation #1.