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The authors respond

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LETTER TO THE EDITOR

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The authors respond

Dear Editor,

We would like to thank Mr. Rottenberg for his comments on our case report[1] and CPR practices previously published in the Journal.

The described dog was successfully resuscitated by following recommendations outlined in the 2012 Reassessment Campaign on Veterinary Resuscitation (RECOVER) clinical guidelines.[2] These guidelines were developed after an extensive systematic literature review and evaluation, and their CPR algorithm groups CPR interventions into basic and advanced life support.[2,3] While basic life support interventions are recommended for all cardiopulmonary arrest patients, advanced life support drug and electrical therapies are informed by cardiac arrest rhythm diagnoses during patient reevaluations.[2] For animals with a documented nonshockable cardiac arrest rhythm, such as asystole in the described case, the administration of epinephrine 0.01 mg/kg IV every 4 minutes is currently recommended.[2] The patient outcome benefits of adhering to CPR guideline recommendations are well established in human resuscitative sciences.[4,5] Given recent similar evidence that demonstrates benefits of a RECOVER-based approach to CPR in dogs, the adherence to RECOVER guideline recommendations during clinical CPR efforts is standard practice at the reporting institution.[6]

Veterinary CPR guidelines are not alone in recommending the administration of epinephrine to patients with nonshockable cardiac arrest rhythms. In 2019, the International Liaison Committee on Resuscitation conducted a systematic reassessment of epinephrine use during CPR. Review of the available literature culminated in the recommendation to administer epinephrine to patients with nonshockable cardiac arrest rhythms as soon as feasible during CPR; a recommendation that has since been maintained in guideline updates.[7,8] This recommendation is largely informed by 2 randomized controlled trials that found increased rates of return of spontaneous circulation (ROSC) and survival to hospital discharge in out-of-hospital cardiac arrest patients that were administered epinephrine versus saline placebo.[9,10]

Although less strongly supported by the literature than epinephrine administration, atropine administration might be beneficial if increased parasympathetic tone or asphyxiation could have contributed to cardiopulmonary arrest.[2,11] Considering the case referral for uncontrolled and prolonged status epilepticus, a concern for intracranial hypertension, brain herniation, and increased parasympathetic tone was shared in the described patient.

The authors agree with Mr. Rottenberg that high-quality basic life support measures represent the most important aspects of CPR, without which advanced life support measures would likely be of limited benefit. As such, we read with interest the summary of evidence pertaining to the optimization of chest compression techniques and ancillary interventions that could be considered during CPR.

In the specific circumstances described in the case report, the exact location of the patient's left ventricular in-flow tract in relation to the applied chest compressions remained unknown and equipment for the continuous measurement of intrathoracic pressures was not readily available. Similarly, the number of rescuers was unfortunately too limited to consider the addition of abdominal counterpressure CPR. Because advanced imaging or invasive monitoring techniques might not frequently be feasible during clinical CPR efforts, our team followed recommendations to monitor end tidal carbon dioxide ($E_{T}CO_2$) as a surrogate marker of cardiac output and coronary perfusion pressure achieved during chest compressions.[2,12–14] In dogs, an $E_{T}CO_2$ of >15–18 mm Hg during CPR has been associated with increased rates of ROSC and should be targeted.[15,16] If an unsatisfactory $E_{T}CO_2$ is observed, capnometry can guide the adjustment of chest compression techniques such as compression point, rate, and depth to help optimize cardiac output in a noninvasive way.[2,14]

Although the use of extracorporeal membrane oxygenation (ECMO) has only been mentioned in conjunction with using abdominal compression-only CPR by Mr. Rottenberg, we believe this technique is certainly compelling and worthy of comment. Unfortunately, despite the availability of extracorporeal platforms compatible with this technique in many veterinary institutions, its use may be limited by the availability of ECMO filters and the associated high costs. When associated with a state of cardiopulmonary arrest, ECMO would require central double arteriovenous catheterization with large-diameter catheters and the use of high doses of systemic or regional anticoagulants while basic life support efforts are ongoing.[17] Lastly, given the small size of the described patient, this technique could only have been implemented with pediatric devices, which nonetheless would have required a potentially detrimental circuit priming volume and extracorporeal blood flow rate.[18]

In the absence of high-quality evidence suggesting harm of low-dose epinephrine and atropine administration, the information outlined above remains the best justification for our institution's routine incorporation of epinephrine in the treatment of cardiopulmonary arrest patients with nonshockable cardiac arrest rhythms and of atropine administration in those with suspected increases in parasympathetic tone.

Respectfully,

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REFERENCES

1. Iannucci C, Hoehne SN, Murthy VD, Dutil G, Maiolini A. Successful resuscitation and neurological monitoring of a dog with out-of-hospital cardiopulmonary arrest due to pentobarbital overdose. *J Vet Emerg Crit Care*. 2023;33(3):393-400.
2. Fletcher DJ, Boller M, Brainard BM, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 7: clinical guidelines. *J Vet Emerg Crit Care*. 2012;22(s1):S102-S131.
3. Boller M, Fletcher DJ. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 1: evidence analysis and consensus process: collaborative path toward small animal CPR guidelines. *J Vet Emerg Crit Care*. 2012;22(s1):S4-S12.
4. Holmberg MJ, Granfeldt A, Girotra S, Donnino MW, Andersen LW. Trends in survival and introduction of the 2010 and 2015 guidelines for adult in-hospital cardiac arrest. *Resuscitation*. 2020;157:112-120.
5. Nas J, te Grotenhuis R, Bonnes JL, et al. Meta-analysis comparing cardiac arrest outcomes before and after resuscitation guideline updates. *Am J Cardiol*. 2020;125(4):618-629.
6. Kawase K, Ujiie H, Takaki M, Yamashita K. Clinical outcome of canine cardiopulmonary resuscitation following the RECOVER clinical guidelines at a Japanese nighttime animal hospital. *J Vet Med Sci*. 2018;80(3):518-525.
7. Wyckoff MH, Greif R, Morley PT, et al. 2022 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations: summary from the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. *Circulation*. 2022;146(25):e483-e557.
8. Soar J, Maconochie I, Wyckoff MH, et al. 2019 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations: summary from the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. *Circulation*. 2019;140(24):e826-e880.
9. Perkins GD, Ji C, Deakin CD, et al. A randomized trial of epinephrine in out-of-hospital cardiac arrest. *N Engl J Med*. 2018;379(8):711-721.
10. Jacobs IG, Finn JC, Jelinek GA, Oxer HF, Oxer HF. Effect of adrenaline on survival in out-of-hospital cardiac arrest: a randomised double-blind placebo-controlled trial. *Resuscitation*. 2011;82(9):1138-1143.
11. Blecic S, Chaskis C, Vincent JL. Atropine administration in experimental electromechanical dissociation. *Am J Emerg Med*. 1992;10(6):515-518.
12. Lepilin MG, Vasilyev AV, Bildinov OA, Rostovtseva NA. End-tidal carbon dioxide as a noninvasive monitor of circulatory status during cardiopulmonary resuscitation: a preliminary clinical study. *Crit Care Med*. 1987;15(10):958-959.
13. Sanders AB, Atlas M, Ewy GA, Kern KB, Bragg S. Expired PCO2 as an index of coronary perfusion pressure. *Am J Emerg Med*. 1985;3(2):147-149.
14. Brainard BM, Boller M, Fletcher DJ. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 5: monitoring. *J Vet Emerg Crit Care*. 2012;22(s1):S65-S84.
15. Hofmeister EH, Brainard BM, Egger CM, Kang S. Prognostic indicators for dogs and cats with cardiopulmonary arrest treated by cardiopulmonary cerebral resuscitation at a university teaching hospital. *J Am Vet Med Assoc*. 2009;235(1):50-57.
16. Hogen T, Cole SG, Drobatz KJ. Evaluation of end-tidal carbon dioxide as a predictor of return of spontaneous circulation in dogs and cats undergoing cardiopulmonary resuscitation. *J Vet Emerg Crit Care*. 2018;28(5):398-407.
17. Hamdi T, Palmer BF. Review of extracorporeal membrane oxygenation and dialysis-based liver support devices for the use of nephrologists. *Am J Nephrol*. 2017;46(2):139-149.
18. Agasthya N, Froehlich CD, Golecki M, et al. Single-center experience using the Cardiohelp system for neonatal and pediatric extracorporeal membrane oxygenation. *Pediatr Crit Care Med*. 2023;24(4):e190-e195.