WORKSHEET for Evidence-Based Review of Science for Veterinary CPCR

1. Basic Demographics

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[redacted]	[redacted]

2. Clinical question:

For dogs and cats in cardiac arrest (P), does the use of feedback regarding the mechanics of CPR quality (e.g. rate and depth of compressions and/or ventilations) (I) compared with no feedback (C), improve any outcomes (eg. ROSC, survival) (O)?

3. Conflict of interest specific to this question:

None

4. Search strategy (including electronic databases searched):

The following search was conducted, date of search, list of references and relevant references are listed below.

4a-Pubmed Database

Done on July 12th and 13th , 2011:

Key words	References	Relevant reference(s)
Cardiopulmonary – dog – monitoring	19	0
Cardiopulmonary – resuscitation - canine – monitoring	32	1
Cardiopulmonary resuscitation – feline – monitoring	1	0
Cardiopulmonary – feline – monitoring	2	0
"CPR – dog" – "CPR cat" – "CPR – feline" – "CPR - canine – monitoring" – "CPR - monitoring and selected only "Review""	348	4
Compression outcome cardiopulmonary canine	19	0
Compression outcome cardiopulmonary resuscitation	323	8

4b-VIN Journal abstract

Done on July 13th, 2011:

Key words	References	Relevant reference(s)
Monitoring-cardiopulmonary-resuscitation	48	1
ventilation cardiopulmonary resuscitation feedback	30	2

4c-Review papers and 2005 and 2010 AHA guidelines

The following review and consensus guidelines articles were reviewed and reference list was scrutinized for relevant primary literature:

1. Improving cardiopulmonary resuscitation quality to ensure survival. Steen PA, Kramer-Johansen J. Curr Opin Crit Care. 2008 Jun;14(3):299-304. 3 relevant
2. Part 4: CPR overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Travers AH, Rea TD, Bobrow BJ, Edelson DP, Berg RA, Sayre MR, Berg MD, Chameides L, O'Connor RE, Swor RA. Circulation. 2010 Nov 2;122(18 Suppl 3):S676-84. 0 relevant
3. Part 5: Adult basic life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Sayre MR, Koster RW, Botha M, Cave DM, Cudnik MT, Handley AJ, Hatanaka T, Hazinski MF, Jacobs I, Monsieurs K, Morley PT, Nolan JP, Travers AH; Adult Basic Life Support Chapter Collaborators. Circulation. 2010 Oct 19;122(16 Suppl 2):S298-324. No abstract available. 7 relevant
4. Part 7: CPR techniques and devices: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Cave DM, Gazmuri RJ, Otto CW, Nadkarni VM, Cheng A, Brooks SC, Daya M, Sutton RM, Branson R, Hazinski MF. Circulation. 2010 Nov 2;122(18 Suppl 3):S720-8. Review. 0 relevant
5. Part 8: Advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Morrison LJ, Deakin CD, Morley PT, Callaway CW, Kerber RE, Kronick SL, Lavonas EJ, Link MS, Neumar RW, Otto CW, Parr M, Shuster M, Sunde K, Peberdy MA, Tang W, Hoek TL, Böttiger BW, Drajer S, Lim SH, Nolan JP; Advanced Life Support Chapter Collaborators. Circulation. 2010 Oct 19;122(16 Suppl 2):S345-421.– 1 relevant
6. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 7.4: Monitoring and Medications. *Circulation*. 2005;112:IV-78-IV-83 – 1 relevant

4d-. State inclusion and exclusion criteria for choosing studies and list number of studies excluded per criterion

Twenty-eight (28) abstracts were reviewed. Twenty-three (24) were excluded (see below for criteria). Five (4) papers (see below) were included in the recommendations.

Inclusion criteria:

Prospective studies

Veterinary or Human data

Peer reviewed journals

Related to use of real-time feedback on cardiopulmonary resuscitation (CPR) mechanics

Exclusion criteria

Human pediatric population: 1

Impact of feedback on outcome data was not studied: 9

No physiologic real-time feedback was studied: 10

Study in duplicate: 3

Case report: 1

<u>4d-. Number of articles meeting criteria for further review: 4</u>

One human, out-of-hospital, prospective, controlled, cluster randomized trial – 1586 patients (1)
One human, out-of-hospital, prospective, controlled, non randomized trial -284 patients (2)
One human, in-hospital, prospective, controlled, non randomized trial – 156 patients (3)
One human, out-of-hospital, prospective, 2 arms, randomized trial – 300 patients (4)

1. Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial. Hostler D, Everson-Stewart S, Rea TD, Stiell IG, Callaway CW, Kudenchuk PJ, Sears GK, Emerson SS, Nichol G; Resuscitation Outcomes Consortium Investigators. BMJ 2011; 342:d51*2.*
2. Quality of out-of-hospital cardiopulmonary resuscitation with real time automated feedback: a prospective interventional study. Kramer-Johansen J, Myklebust H, Wik L, Fellows B, Svensson L, Sørebø H, Steen PA. Resuscitation. 2006 Dec;71(3):283-92.
3. CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system. Abella BS, Edelson DP, Kim S, Retzer E, Myklebust H, Barry AM, O'Hearn N, Hoek TL, Becker LB Resuscitation. 2007 Apr;73(1):54-61.
4. The addition of voice prompts to audiovisual feedback and debriefing does not modify CPR quality or outcomes in out of hospital cardiac arrest--a prospective, randomized trial. Bohn A, Weber TP, Wecker S, Harding U, Osada N, Van Aken H, Lukas RP. Resuscitation. 2011 Mar;82(3):257-62.

5. Summary of evidence

Evidence Supporting Clinical Question

Good						
Fair						
Poor						
	1	**2**	**3**	**4**	**5**	**6**
			Level of evidence (P)			

Evidence Neutral to Clinical question

Good						
Fair						*Hostler et al.* BMJ *2011: A-C-E*
Poor						*Bohn et al.. Resuscitation. 2011: A-C-E* *Kramer-Johansen et al. Resuscitation. 2006: B-E* *Abella et al. Resuscitation. 2007: A-C-E*
	1	**2**	**3**	**4**	**5**	**6**
			Level of evidence (P)			

A = Return of spontaneous circulation
C = Survival to hospital discharge
E = Other endpoint
B = Survival of event
D = Intact neurological survival
Italics = Non-target species

Evidence Opposing Clinical Question

Good						
Fair						
Poor						
	1	**2**	**3**	**4**	**5**	**6**
Level of evidence (P)						

6. REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

Mechanics of CPR include compression technique (rate, depth, etc) and ventilation technique (rate, pressure, etc). In humans, newer defibrillators have been used to record compression and ventilation data. Ventilation data comes from changes in chest impedance secondary to changes in the volume of air in the lungs and chest compressions data come from their induction of ECG artifacts or via sternal movements measured by accelerometers or indicated by force transducers. Real-time feedback usually consists of verbal messages and/or prompts displayed on defibrillator monitors. The four (4) studies reviewed used audiovisual real time feedback technology for human cardiac arrest. No veterinary study on real-time feedback was identified. Some human manikin studies were identified but not included.

The most powered study (*Hostler D, Everson-Stewart S, Rea TD, et al BMJ 2011; 342:d512*) was not able to identify a positive effect on outcome, for either ROSC or hospital discharge. Study design was prospective, controlled and cluster randomized on 1586 patients. While there was no effect on overall outcome, quality of CPR (e.g. number and depth of chest compression) was improved. Translation to clinical veterinary medicine may be difficult, especially as the study population was out-of-hospital CPR, performed by health professionals, but without the ancillary support available during in-hospital cardiac arrest. Looking at the primary outcome measurements, there were no differences in pre-hospital ROSC (45% control vs 44% feedback) or survival to discharge (12% control vs 11% feedback). However, post-hoc analysis showed that for the first 2 randomization periods (beginning of the study), the control group had better outcome than the real-time feedback group, but the tendency switched for subsequent randomization periods with post-hoc analysis showing a positive effect on outcome of the use of real time feedback, (13% survival vs 10% for control, cluster adjusted average difference of 1.6 (-3.1 to 6.4)). The authors discussed distraction from the prompts at the beginning of the study or a training effect as possible causes for such a difference over time.

A 2006 prospective study (*Kramer-Johansen J, Myklebust H, Wik L, at al. Resuscitation. 2006 Dec;71(3):283-92*) investigating out-of-hospital arrest showed a trend toward a benefit for the use of real-time feedback (Hospital discharge 2.9% for control vs 4.3% with feedback). The study was prospective and controlled, but not randomized. 284 patients (176 control vs 108 feedback) were studied. Some CPR variables (compression depth and percentage of compressions with adequate depth) improved with feedback; however, that study was underpowered for outcome and did not reach statistical significance (P=0.2).

The only in-hospital study (Abella BS, Edelson DP, Kim S, et al. Resuscitation. 2007 Apr;73(1):54-61) did not show any differences between control and intervention in term of ROSC (40% vs 44.6% respectively) or hospital discharge (9.1% vs 8.9% respectively) but was underpowered for outcome with only 156 patients for both arms of the study. The study was prospective and controlled but not randomized. They show a "trend toward improvement of CPR variables".

A recent study (Bohn A, et al. Resuscitation. 2011) studying real-time audiovisual feedback compared limited vs extended feedback for out-of-hospital cardiac arrest. There was no effect in CPR quality or outcome (ROSC 43.9% control vs 47.8% with feedback P=0.49). The study was prospective and randomized trial, but compared limited (139 patients) vs extended (161 patients) feedback without a "control" group (no feedback). Details for randomization were not provided. That study was probably underpowered for detecting changes in outcome and the study groups were probably too closed to detect even changes in CPR quality showed in earlier studies Post hoc analysis showed that mean compression depth of 5-6 cm improves ROSC.

The American Heart Association guidelines provide no other specific input. The 2010 consensus guidelines states that "*real-time CPR prompting and feedback technology such as visual and auditory prompting devices can improve the quality of CPR*" and the 2005 consensus guidelines states that "*there is little other technology [other that end-tidal CO2] available to provide real-time feedback on the effectiveness of CPR*". The 2005 consensus guidelines recommend against the use of palpation of arterial pulses or visualization of carotid pulsations during chest compressions to assess the effectiveness of compressions.

One interesting paper, not including in the paper reviewed (Reference 21 in the excluded paper list - *Kern KB, et al. Arch Intern Med. 1992 Jan;152(1):145-9*) used metronomic technology to ensure appropriate rate of compression. This is a feasible way to have "real-time" feedback in veterinary medicine. That study was excluded because it compared two different rates of compressions (80 vs 120 bpm) and CPR guidelines were from the 1986 AHA consensus guidelines, without information on outcome measures.

7. Conclusion

Consensus on Science:

There is no evidence that feedback about the mechanics of CPR quality affect outcome in dogs and cats, or that current methodology is applicable to veterinary species. Studies in humans (LOE 6) do not show a clear benefit of the use of real-time feedback defibrillator/monitoring in terms of outcome improvement. Randomized prospective studies using metronomic guidance are feasible in veterinary medicine and merit investigation.

Treatment Recommendations:
None.

8. Acknowledgement

None

9. Citation list

Articles reviewed:

1. The addition of voice prompts to audiovisual feedback and debriefing does not modify CPR quality or outcomes in out of hospital cardiac arrest--a prospective, randomized trial. Bohn A, Weber TP, Wecker S, Harding U, Osada N, Van Aken H, Lukas RP. Resuscitation. 2011 Mar;82(3):257-62.
2. Quality of out-of-hospital cardiopulmonary resuscitation with real time automated feedback: a prospective interventional study. Kramer-Johansen J, Myklebust H, Wik L, Fellows B, Svensson L, Sørebø H, Steen PA. Resuscitation. 2006 Dec;71(3):283-92.
3. CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system. Abella BS, Edelson DP, Kim S, Retzer E, Myklebust H, Barry AM, O'Hearn N, Hoek TL, Becker LB Resuscitation. 2007 Apr;73(1):54-61
4. Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial. Hostler D, Everson-Stewart S, Rea TD, Stiell IG, Callaway CW, Kudenchuk PJ, Sears GK, Emerson SS, Nichol G; Resuscitation Outcomes Consortium Investigators. BMJ 2011; 342:d512
5. A study of chest compression rates during cardiopulmonary resuscitation in humans. The importance of rate-directed chest compressions. Kern KB, Sanders AB, Raife J, Milander MM, Otto CW, Ewy GA. Arch Intern Med. 1992 Jan;152(1):145-9.

Articles excluded (and reasons for exclusion):

1. Better adherence to the guidelines during cardiopulmonary resuscitation through the provision of audio-prompts. Chiang WC, Chen WJ, Chen SY, Ko PC, Lin CH, Tsai MS, Chang WT, Chen SC, Tsan CY, Ma MH. Resuscitation. 2005 Mar;64(3):297-301. NO OUTCOME
2. Efficacy of audio-prompted rate guidance in improving resuscitator performance of cardiopulmonary resuscitation on children. Berg RA, Sanders AB, Milander M, Tellez D, Liu P, Beyda D. Acad Emerg Med. 1994 Jan-Feb;1(1):35-40. Children-outcome is ETCO2
3. Rescuer fatigue during actual in-hospital cardiopulmonary resuscitation with audiovisual feedback: a prospective multicenter study. Sugerman NT, Edelson DP, Leary M, Weidman EK, Herzberg DL, Vanden Hoek TL, Becker LB, Abella BS. Resuscitation. 2009 Sep;80(9):981-4. Epub 2009 Jul 5. NO OUTCOIME
4. Leaning is common during in-hospital pediatric CPR, and decreased with automated corrective feedback. Niles D, Nysaether J, Sutton R, Nishisaki A, Abella BS, Arbogast K, Maltese MR, Berg RA, Helfaer M, Nadkarni V. Resuscitation. 2009 May;80(5):553-7. Epub 2009 Mar 18. NO OUTCOME
5. Ann Emerg Med. 1994 Dec;24(6):1176-9. Femoral venous pulsations during open-chest cardiac massage. Connick M, Berg RA. NO OUTCOME – CASE REPORT
6. Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Edelson DP, Abella BS, Kramer-Johansen J, Wik L, Myklebust H, Barry AM, Merchant RM, Hoek TL, Steen PA, Becker LB. Resuscitation. 2006 Nov;71(2):137-45. Epub 2006 Sep 18 - NO FEEDBACK mechanisms – Prospective, multi centric observatyional study in-hospital and out-of-hispital CPR. 60 patients. Primary outcome is first shock success
7. Quality assessment of defribrillation and advanced life support using data from the medical control module of the defibrillator. Sunde K, Eftestøl T, Askenberg C, Steen PA. Resuscitation. 1999 Aug;41(3):237-47. NO OUTCOME
8. Advanced cardiac life support before and after tracheal intubation--direct measurements of quality. Kramer-Johansen J, Wik L, Steen PA. Resuscitation. 2006 Jan;68(1):61-9. Epub 2005 Dec 1.NO OUTCOME
9. J Am Vet Med Assoc. 2009 Jul 1;235(1):50-7. Prognostic indicators for dogs and cats with cardiopulmonary arrest treated by cardiopulmonary cerebral resuscitation at a university teaching hospital. Hofmeister EH, Brainard BM, Egger CM, Kang S. No Feedback

10. J Am Vet Med Assoc. 1992 Jun 15;200(12):1993-6. Respiratory and cardiopulmonary arrest in dogs and cats: 265 cases (1986-1991). Wingfield WE, Van Pelt DR. No feedback
11. Relationship of blood pressure and flow during CPR to chest compression amplitude: evidence for an effective compression threshold. Babbs CF, Voorhees WD, Fitzgerald KR, Holmes HR, Geddes LA. Ann Emerg Med. 1983 Sep;12(9):527-32. NO FEEDBACK
12. Am J Vet Res. 1987 Nov;48(11):1603-6. Effects of body position and ventilation/compression ratios during cardiopulmonary resuscitation in cats. Henik RA, Wingfield WE, Angleton GM, Porter RE. NO FEEDBACK
13. Circulation. 1984 Jul;70(1):86-101. The physiology of external cardiac massage: high-impulse cardiopulmonary resuscitation. Maier GW, Tyson GS Jr, Olsen CO, Kernstein KH, Davis JW, Conn EH, Sabiston DC Jr, Rankin JS. . NO FEEDBACK
14. A higher chest compression rate may be necessary for metronome-guided cardiopulmonary resuscitation. Chung TN, Kim SW, You JS, Cho YS, Chung SP, Park I. Am J Emerg Med. 2011 Jan 3. NO SURVIVAL OUTCOME
15. Quality of chest compressions during continuous CPR; comparison between chest compression-only CPR and conventional CPR. Nishiyama C, Iwami T, Kawamura T, Ando M, Yonemoto N, Hiraide A, Nonogi H. Resuscitation. 2010 Sep;81(9):1152-5. NO SURVIVAL OUTCOME
16. Quality of closed chest compression on a manikin in ambulance vehicles and flying helicopters with a real time automated feedback. Havel C, Schreiber W, Trimmel H, Malzer R, Haugk M, Richling N, Riedmüller E, Sterz F, Herkner H. Resuscitation. 2010 Jan;81(1):59-64. NO SURVIVAL OUTCOME
17. Effect of caregiver gender, age, and feedback prompts on chest compression rate and depth. Peberdy MA, Silver A, Ornato JP. Resuscitation. 2009 Oct;80(10):1169-74. NO SURVIVAL OUTCOME
18. Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. Abella BS, Alvarado JP, Myklebust H, Edelson DP, Barry A, O'Hearn N, Vanden Hoek TL, Becker LB. JAMA. 2005 Jan 19;293(3):305-10. NO FEEDBACK
19. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. Wik L, Kramer-Johansen J, Myklebust H, Sørebø H, Svensson L, Fellows B, Steen PA. JAMA. 2005 Jan 19;293(3):299-304. NO FEEDBACK
20. Arch Intern Med. 2008 May 26;168(10):1063-9. Improving in-hospital cardiac arrest process and outcomes with performance debriefing. Edelson DP, Litzinger B, Arora V, Walsh D, Kim S, Lauderdale DS, Vanden Hoek TL, Becker LB, Abella BS. NO FEEDBACK
21. A study of chest compression rates during cardiopulmonary resuscitation in humans. The importance of rate-directed chest compressions. Kern KB, Sanders AB, Raife J, Milander MM, Otto CW, Ewy GA. Arch Intern Med. 1992 Jan;152(1):145-9. A prospective, cross over trial, in-hospital cardiac arrest, 80 vs 120 bpm 23 patients total $EtCO_2$ 17.9 vs 10.4 $p<0.1$. So basically compared HR 80 vs 120 and not the use of the metronomic therapy