WORKSHEET for Evidence-Based Review of Science for Veterinary CPCR

1. Basic Demographics

Worksheet author(s)

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[redacted]

2. Clinical question:

In dogs and cats with cardiac arrest (P), does optimizing chest wall recoil (I) compared with standard care (C), improve outcome (e.g. ROSC, survival) (O)?

3. Conflict of interest specific to this question:

No

4. Search strategy (including electronic databases searched):

4a. Databases

-MEDLINE via PUBMED (performed on May 1st 2011)
1. chest wall recoil
2. chest wall decompression
3. leaning
4. incomplete release
5. active compression-decompression
6. cardiopulmonary resuscitation (CPR)

1 and 6: **5** relevant hits out of 12 total hits (Zuercher CCM 2010, Udassi Resuscitation 2009, Aufderheide Resuscitation 2006, Yannopoulos Resuscitation 2005, Aufderheide Resuscitation 2005)
2 and 6: **4** additional relevant hits out of 19 total hits (Kern Am Heart J 1996, Chang Chest 1994, Lurie Resuscitation 1994, Tucker Resuscitation 1994)
3 and 6**: 3** additional relevant hits out of 8 total hits (Fried Resuscitation 2011, Niles Resuscitation 2009, Gunderson Resuscitation 2009)
4 and 6: **2** additional relevant hits out of 10 total hits (Hostler BMJ 2011, Wu AM J Emerg Med 2009)
5 and 6: 0 additional relevant hits out of a total of 142 hits (all not "includable" as they are about ACD, not lean vs. no lean)

-CAB Abstracts via OVID (1973 to 2011 Week 20) (performed on May 1st 2011)
1 and 6: 0 total hits
2 and 6: 0 total hits
3 and 6: 0 total hits
4 and 6: 0 relevant hits out of 1 total hit
5 and 6: 0 relevant hits out of 2 total hits

CSA Illumina (Natural Sciences area) (performed on May 20th 2011) – all of these references were already retrieved from PubMED search
1 and 6: 4 relevant hits out of 7 total hits (Yannopoulos Resuscitation 2005, Aufderheide Resuscitation 2006, Aufderheide Resuscitation 2005)
2 and 6: no additional relevant hits out of 3 total hits (all found in 1 and 6 search)
3 and 6: 1 additional relevant hit out of 15 total hits (Gunderson Resuscitation 2009)
4 and 6: no additional relevant hits out of 5 total hits
5 and 6: 0 additional relevant hits out of 43 total hits

References identified from databases:
1. Zuercher CCM 2010 - included
2. Udassi Resuscitation 2009 – excluded manikins only, excluded active compression-decompression (ACD)
3. Aufderheide Resuscitation 2006 – excluded manikins only
4. Yannopoulos Resuscitation 2005 – included
5. Aufderheide Resuscitation 2005 - included
6. Kern Am Heart J 1996 – excluded ACD
7. Chang Chest 1994 – excluded ACD
8. Lurie Resuscitation 1994 – excluded ACD
9. Tucker Resuscitation 1994 – excluded ACD
10. Fried Resuscitation 2011 – excluded as only documented the prevalence of lean and did not correlate with outcome

11. Niles Resuscitation 2009 – excluded as it only documented that leaning is common in pediatric CPR, and reduced with automated audiovisual feedback, but did not correlate leaning with outcome
12. Gunderson Resuscitation 2009 – excluded since it didn't assess the effects of lean in isolation
13. Hostler BMJ 2011 – excluded. Study showed that real time feedback reduced lean, but the effects of lean were not assessed in isolation
14. Wu AM J Emerg Med 2009 - excluded as multiple variables assessed concurrently (i.e. effects of lean were not assessed in isolation)

4b. Other sources

-GOOGLE SCHOLAR (including "cited by" option) (performed on May 1st 2011)
1 and 6: 0 additional relevant hits (i.e. additional to hits found above) out of 910 total hits
2 and 6: additional relevant hit out of 1650 total hits
3 and 6: no additional relevant hits
4 and 6: no additional relevant hits
5 and 6: no additional relevant hits

-In addition all references of identified articles were checked for additional relevant articles:
Tomlinson et al. Resuscitation 2007;72(3):364-370. – OHCA study. Excluded for multiple reasons. Observational. Residual force during decompression was assessed but was not correlated with outcome

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

Inclusion criteria - Use of devices or techniques that alter chest wall recoil / decompression or studies assessing the effect of leaning in CPR
Exclusion criteria:
Studies assessing the effect of a combination of multiple variations in CPR technique (a CPR bundle) such that the effect of altering chest wall recoil could not be differentiated from other effects of the 'bundle'. N=7
Studies using manikins only. N = 2
Studies using computer simulations only.
Studies not in English.
Abstracts only.
Editorials.

4d. Number of articles/sources meeting criteria for further review: 3

-Two randomized controlled trials were identified, however were in porcine models (1 adult pigs, 1 piglets).
-One relevant human study was identified (Aufderheide 2005)

5. Summary of evidence

Evidence Supporting Clinical Question

Good						*Zuercher 2010; E = CPP, CI, MBF*
Fair						*Yannopoulos 2005; E = RAP, AoP, calculated CPP and CePP*
Poor						
	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 studies*
CPP = coronary perfusion pressure, CePP = cerebral perfusion pressure, CI = cardiac index, MBF = myocardial blood flow

Evidence Neutral to Clinical question

Good						
Fair						
Poor						*Aufderheide 2005; E = airway pressure*
	1	**2**	**3**	**4**	**5**	**6**
Level of evidence (P)						

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

Evidence Opposing Clinical Question

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

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

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

Allowing complete chest wall (i.e. avoiding leaning) recoil between chest compressions during CPR is recommended in the current American Heart Association's Guidelines for Emergency Cardiovascular Care and Cardiopulmonary Resuscitation (CPR). Evidence in support of this recommendation is primarily theoretical and derived from limited data in VF porcine models demonstrating improved hemodynamics, rather than a difference in ROSC or survival to discharge. There is no supporting evidence for allowing complete chest wall recoil in human clinical trials or in dogs (experimental or naturally occurring CPA). Unfortunately many studies address improvements in chest wall recoil in combination with other interventions, such as active decompression, such that the effects of allowing complete chest wall recall alone cannot be assessed.

7. Conclusion

DISCLAIMER: Potential possible wording for a Consensus on Science Statement. Final wording will differ due to other input and discussion.
CONSENSUS ON SCIENCE: Two prospective, sequential, controlled experimental studies in non-target species (LOE 6)(Zuercher 2010; Yannopoulos 2005) reported improved coronary and cerebral perfusion pressures when complete chest recoil occurred during the decompression phase of CPR when compared to lean. While the effects of avoiding leaning have not been correlated with ROSC or other late-stage outcome measures, and have not been evaluated in isolation in a clinical setting in human or veterinary medicine, it seems acceptable that allowing full chest wall expansion / recoil should be emphasized in CPR training. Additionally frequent (every 2 minute) personnel rotations may reduce lean.

8. Acknowledgement None

9. Citation list

Aufderheide TP, Pirrallo RG, Yannopoulos D, et al. Incomplete chest wall decompression: a clinical evaluation of CPR performance by EMS personnel and assessment of alternative manual chest compression-decompression techniques. *Resuscitation*. 2005; 64(3): 353-362
Summary: This was a 2 part study. Phase 1 was an observational case series to evaluate the quality of chest wall recall performed by EMS personnel on people with OHCA. Observations were performed by trained research personnel. Phase II involved manikins (not live animals) and thus was not evaluated for our purposes here. 13 consecutive patients were enrolled in phase 1; arrest rhythms included VF (3), PEA (5) and asystole (5). Phase 1 identified that leaning, resulting in incomplete chest recoil was common (demonstrated by 6/13 EMS personnel/CPR efforts at some stage during CPR). Observers commented that "lean" appeared to be associated with rescuer fatigue. Airway pressures were consistently positive (>0mmHg) during the decompression phase when leaning was occurring. While positive airway pressures are undesirable during decompression, lean is not the only potential cause for this. Other contributors may have included prolonged PPVs, intrinsic PEEP, increased airway resistance or a combination of such factors. This study was the first to report that incomplete chest wall recoil occurs during CPR performed by EMS providers.
LOE: Level 6
Quality: Poor (not even sure if I should consider this study)
Evidence: Neutral (not adequate outcome measures)
Funding: NIH SBIR number 2-R44-HL65851-02 and 3-R44-HL65851-02-S1 to Advanced Circulatory Systems Inc., Eden Prairie, MN; Keith Lurie, MD, PI.

Yannopoulos D, McKnite S, et al. (2005). "Effects of incomplete chest wall decompression during cardiopulmonary resuscitation on coronary and cerebral perfusion pressures in a porcine model of cardiac arrest." Resuscitation 64(2005):363-372.
Summary: This study used an adult pig VF model of CPA. Compressions were delivered with an automated compression/decompression device. CPR without lean was provided by a pneumatic piston device that compressed the chest wall 25% of the AP diameter, and then allowed 100% decompression. Residual lean was added by reducing the decompression distance to 75% of its full exertion in the decompression phase. All pigs had untreated VF for 3 mins, then 3 minute of CPR with full decompression, 1 minute with "lean" and another 1 minute with full decompression. Incomplete chest wall recoil during the decompression phase of CPR in this model was found to increase endotracheal pressure and RA pressure, while decreasing systolic, diastolic and mean aortic, coronary (CPP) and cerebral perfusion (CePP) pressures. CPP recovered mildly, while CePP almost totally recovered, after returning to complete decompression for the third phase of compressions in this study. ET, RA, Ao and IC pressures were measured. Coronary and cerebral perfusion pressures were estimated (not ideal). While these results are promising you cannot rule out that the hemodynamic differences between groups were due to 25% decreased stroke length during "lean". Another limitation of the study was that 1 minute of "lean" may be insufficient to fully assess its hemodynamic effects. The authors conclude that "Based on this study, more emphasis should be placed during CPR training on the importance of full chest wall expansion. Frequent personnel rotations are essential to prevent fatigue and incomplete decompression during CPR."
LOE: Level 6
Quality: Fair (same treatment order?)
Evidence: Supporting
Funding: None stated

Zuercher M, Hilwig R, et al. (2010). "Leaning during chest compressions impairs cardiac output and left ventricular myocardial blood flow in piglet cardiac arrest". Crit Care Med 38(4):1141-1146.
Summary: This study was a prospective controlled VF cardiac arrest model in piglets assessing the effect of no lean, 10% and 20% lean. Lean was achieved by adding weights to the chest – however I'm not sure if this accurately simulates lean. Compressions were delivered manually using a device connected to monitoring equipment. Each piglet received each treatment (no lean, 10% and 20% lean) twice; a total of 6 x 3 minute cycles of compressions were performed. The order in which treatments are applied was somewhat randomized (although no lean always the first and last 3 minutes. The outcomes assessed in this study were right atrial diastolic pressure, coronary perfusion pressure (CPP), left ventricular myocardial blood flow (MBF) and microsphere determined cardiac index (CI). They used a linear mixed-effect model to control for changes in CPR hemodynamics over time. Leaning resulted in decreased RABP, decreased CPP, decreased MBF and decreased CI ($p<0.05$), with progressive decreases between the groups (20% < 10%< no lean) ($P<0.05$).
LOE: Level 6
Quality: Good
Evidence: supporting
Funding: Laerdal Medical. NIH RO1 HL71694-01.