WORKSHEET for Evidence-Based Review of Science for Veterinary CPCR

1. Basic Demographics

Worksheet author(s)

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2. Clinical question:

In dogs and cats with cardiac arrest (P) does the use of a pre-stocked arrest station with checklists/charts/aids (I) compared with not using these methods (C), improve outcome in basic life support (O) (eg. ROSC, discharge alive)?

3. Conflict of interest specific to this question:

I do not have any conflict of interest disclosures relevant to this worksheet.

4. Search strategy (including electronic databases searched):

4a. Databases

-MEDLINE via PUBMED (any date to present = 2011) (performed April 6, 2011)
1. CPR checklists (52 hits)- 4 articles selected
2. CPR outcome and cart (4 hits)- no articles selected
3. crash cart (33 hits)- 3 articles selected
4. arrest station and CPR (10 hits)- no articles selected
5. arrest station and cardiac arrest (54 hits)- no articles selected
6. resuscitation trolley (43 hits)- 2 articles selected
7. resuscitation cart outcome (8 hits)- no articles selected
8. resuscitation cart (74 hits)- no articles selected
9. CPR aids (99 hits)- 1 article selected
10. CPR charts (97 hits)- 1 article selected
11. CPR preparation (106 hits)- no articles selected
12. code cart (11 hits)- no articles selected
13. cardiac arrest dogs and outcome (190 hits)- no articles selected
14. cardiac arrest cats and outcome (21 hits)- no articles selected
15. cardiac arrest dogs and ROSC (29 hits)no articles selected
16. cardiac arrest and charts and outcome (59 hits)- no articles selected
17. cardiac arrest and checklists and outcome (10 hits)- no articles selected
18. cardiac arrest and cart and outcome (4 hits)- no articles selected

-CAB (1910 to present = 2011) (performed on April 6, 2011)- no additional relevant articles selected
1. crash cart (3 hits)
2. CPR charts, CPR checklists, CPR outcome and cart, arrest station and CPR, arrest station and cardiac arrest, resuscitation trolley, resuscitation cart outcome, cardiac arrest and charts and outcome, cardiac arrest and checklists and outcome, cardiac arrest and cart and outcome (all 0 hits)
3. CPR aids (3 hits)
4. resuscitation cart (2 hits)
5. CPR preparation (7 hits)
6. code cart (1 hit)
7. cardiac arrest dogs and outcome (10 hits)
8. cardiac arrest cats and outcome (7 hits)
9. cardiac arrest dogs and ROSC (2 hits)

4b. Other sources

-GOOGLE SCHOLAR (performed on April 6, 2011)
1. crash cart (13 hits)- no articles selected

2.. code cart (5 hits)- no articles selected
3. resuscitation trolley (23 hits)- 1 article selected
4. resuscitation cart (22 hits)no articles selected
5. cardiac arrest dogs outcome (53 hits)- no articles selected

-In addition all references of identified articles and in particular the references of the following relevant review articles were checked (2 additional articles were obtained from the references of these and the selected articles above):
(Plunkett, SJ et al. JVIM 2008), (Hackett, TB Vet Clin North Am Small Anim Pract 2001), (Rieser, TM Clin Tech Small Anim Pract 2000), (Robella, CD Vet Clin North Am Small Anim Pract 1989), Crowe, DJ Jr. Semin Vet Med Surg (Small Anim) 1988 – parts 1 and 2), (Safar, P. Ann Emerg Med 1984), (Yarbrough, BE Va Med 1984), (Redding, JS Clin Anesth 1969)

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

Inclusion criteria

Human studies, veterinary studies, in-hospital arrest

Exclusion criteria

Articles in foreign languages, bystander/out-of-hospital arrests, advanced life support, abstract only, editorials

4d. Number of articles/sources meeting criteria for further review: 14

-Two randomized human trials were identified: (Bould MD et al., 2009) and (Ward P et al, 1997)

-Eleven relevant human studies were identified: (Seethala et al., 2010), (Rosenberg, M, 2010), (Shetty P et al., 2009), (Smith A et al., 2009), (Hand H and Banks A, 2004), (DeVita MA, 2004), (Dyson E and Smith G, 2002), (Burke DP and Bowden DF, 1993), (Telesca K, 1992), (Royse A, 1989), (Williams J, 1986)

-One relevant animal study was identified: (Boller M et al., 2010)

5. Summary of evidence

Evidence Supporting Clinical Question

Good						*(Ward P et al, 1997)E, (Dyson E and Smith G, 2002) E*
Fair			(Boller, M et al, 2010) E			*(Royse A, 1989) E,, (DeVita MA, 2004) E, (Burke DP and Bowden DF,1993) E,(Schade J 1983) E, (King D et al., 1994) E*
Poor						*(Williams J, 1986) E, (Telesca K, 1992) E*
	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 Neutral to Clinical question

Good						*(Bould MD et al., 2009) E, (Shetty P et al., 2009) E*
Fair						*(Seethala et al., 2010) E, (Hand H and Banks A, 2004) E*
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

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:

The use of a pre-stocked, organized and functional arrest station with appropriate checklists is a key element in the efficient operation of CPCR. A recent internet survey in veterinary medicine (Boller et al., 2010) found that of the CPCR preparedness measures evaluated, 80% of generalists and 98% of specialists have a regularly maintained crash cart consistently available to them for use in an emergency setting. In addition, 75% of generalists and 90% of specialists have a drug dosing chart displayed for use in CPCR. Checklists and crash carts have also been the subject of multiple human studies in an effort to improve the outcome associated with cardiopulmonary arrest. Concerns for the arrest station center around lack of standardization and systematic layout which affect team organization during a crisis event (Royse, 1989). Most problematic is deficient equipment due to lack of return to the cart or incomplete stocking of appropriate materials, inability to identify or locate needed medications, and failure to have drugs and syringes in a quick, usable form (Schade, 1983). Deficiencies and defects in resuscitation equipment include basic device failure (intrinsic design faults, manufacturing errors, or component failures), external factors (electric power or gas supply failure), and human error (which is the most common reason for failure and includes inadequate knowledge, training or supervision and lack of experience with the use of the equipment – Dyson et al., 2002). Inadequate preventative maintenance and checklists lead to inappropriate equipment components, device wear and tear, defects and incorrect assembly of equipment (Dyson et al., 2002). In fact, in a retrospective study evaluating cardiac arrest in a district hospital, delays in cardiopulmonary resuscitation was found to be related to equipment failure in 18% of the cases (King et al., 1994). This study also found that 9% of the carts had significant deficiencies which included such problems as unacceptable cart location for immediate use and infrequent assessment of cart content. Solutions for these problems center on detail planning and teaching. Emphasis should be placed on having identical equipment for every response to minimize the need to re-learn what equipment is present, where it is located and how to operate it (Devita, 2004). The code carts should have standardization of contents and location, determination of medications and supplies needed for stocking, sealing of the carts to ensure that supplies are present when needed, regular maintenance checks and restocking of used materials and providing a method for personnel to familiarize themselves with the cart and have appropriate training on its contents (Schade, 1983, Royse, 1989 and Hand et al., 2004). Williams in 1986 devised a mobile educational crash cart, fully stocked with equipment, supplies, and educational tools that was identical to those used in the hospital setting for procedural training on the CPCR equipment and materials.

The use of checklists and cognitive aids are often inconsistently used in CPCR settings and reasons for poor reference to these materials included lack of clarity and specifics, time pressure, unfamiliarity, difficult to use in the middle of a scenario, disagreement with the content, or not having a need for it (Bould et al., 2009). Other studies have found an association between formal training in the use of cognitive aids and whether the aids were used in an arrest situation (Mills, 2004). Two additional studies have evaluated cardiopulmonary resuscitation skills performance and the use of checklists, one evaluating a short or long version of a checklist for success in simulated CPCR (Ward, 1997) and the other evaluating outcome based on adherence to an established protocol (Shetty, 2009). The former study found that a long and more detailed checklist improved outcome over no checklist or a shortened version and the latter study found that outcome was affected by the number of critical tasks that the CPCR team performed but unaffected by the sequence of activities recommended in the protocol. There does, however, seem to be support for having a resuscitation chart for drug dosing and calculations readily available (Burke, 1993) and based on the veterinary survey mentioned, the majority of practitioners have these charts available for use. Further studies are needed prospectively in human and veterinary medicine to evaluate if checklists and cognitive aids contribute to improved CPCR outcome.

Poor outcome in CPCR is multifactorial and has largely been linked to technical and human errors (Seethala, 2010). In particular, inefficient organization and delegation of responsibility as well as poorly designed and organized equipment systems have been implicated in lack of structure during an arrest, affecting overall CPCR performance and outcome (Telesca, 1992).

Treatment Recommendation

Recommendations should include standardizing the location, storage and content of resuscitation equipment, providing standard and local display of cardiac arrest algorithms, having checklists to optimize information, and regular audit of resuscitation equipment.

7. Conclusion

CONSENSUS ON SCIENCE: One veterinary internet survey (LOE 3) identified the crash cart and drug dosing chart as two measures important in CPCR preparedness for both general practitioners as well as specialists. Seven human studies including one experimental study (LOE 6, Devita et al., 2004), one retrospective study (LOE 6, King et al., 1994), and five clinical studies (LOE 6 for all – Dyson et al., 2002, Royse, 1989, Schade, 1983, Telesca, 1992, Williams, 1986) support crash cart standardization, detailed planning, improved equipment maintenance and personnel training to minimize disorganization and delay in resuscitation that is associated with poor outcome in CPCR. Seethala et al. in 2010 (LOE 6) and Hand et al. in 2004 (LOE 6) were clinical studies mostly neutral to this position but the former did point out that equipment errors delay CPCR, with human errors contributing most and the latter recommended standardized equipment in the entire hospital setting to aid in familiarity with its use. Two prospective experimental studies (LOE 6, Bould et al., 2009, Shetty et al., 2009) were neutral in regard to use of checklists in CPCR as they did not find a direct relationship with their use and improved team performance and CPCR outcome. However, it was noted that the aids were not utilized as often or as efficiently as they were designed and they concluded that performance of critical tasks in CPCR is important to outcome with training of responders on the use of cognitive aids to help improve the performance and outcome in CPCR. A final study (LOE 6, Ward et al., 1997) was a randomized controlled prospective study in good support of the question in that the use of a detailed checklist was associated with improved cardiopulmonary resuscitation skill retention and outcome for their simulated patients.

8. Acknowledgement

None

9. Citation list

Boller, M., L Kellett-Gregory, et al. (2010). "The clinical practice of CPCR in small animals: an internet-based survey." J Vet Emerg Crit Care 20(6): 558-570.

This was an internet based survey whose questionnaire evaluated various aspects of CPCR and assessed differences among general and specialty clinical expertise. CPCR is performed widely different in the veterinary profession but in terms of CPCR preparedness, a crash cart was found to be the most important measure with 80% of general practitioners (98% of boarded specialists) having a regularly maintained cart consistently available to them. As well, 75% of general practitioners (90% of boarded specialists) had a drug dosing chart available during CPCR. In terms of CPR equipment, 83% had an EKG and 92% had a pulse oximeter available to them. 33% of general practitioners had emergency drug doses calculated for high risk cardiopulmonary arrest patients (in comparison to 55% of boarded specialists).

LOE = 3, fair supportive of the question. Funding – none.

Bould, MD., MA Hayter, et al. (2009). "Cognitive aid for neonatal resuscitation: a prospective single-blinded randomized controlled trial." British Journal of Anaesthesia 103(4): 570-575.

A prospective evaluation of the effect of a cognitive aid on the performance of simulated neonatal resuscitation was studied. The intervention group had a detailed cardiopulmonary arrest algorithm for the team to reference whereas the control group did not. No significant difference was found in the performance of simulated neonatal resuscitation by anaesthesia residents with or without the use of a cognitive aid. However, only 26.7% of the intervention group used the aid frequently and none used it extensively. Both teams demonstrated poor retention of knowledge and skills regarding life-saving techniques in newborn life support emphasizing the need for a cognitive aid as a means for a more successful outcome. Other studies have also found inconsistent use of cognitive aids in a CPCR setting (Harrison et al., 2006 and Burden et al., 2008). Reasons for poor reference of the aid included lack of clarity, did not need it, lack of specifics, time pressure, unfamiliarity, worried of unblinding the study, difficult to start using in the middle of a scenario, and disagreement with the content. There was found to be an association between formal training in the use of cognitive aids and whether the aids were used in a code situation (Mills, 2004). There is a lack of studies, however, on the effect of teaching that promotes cognitive aid use and performance in CPCR.
LOE = 6; good neutral to the question because lack of use of the cognitive aid may have contributed to the non-significant difference between the intervention and control groups. CPCR training that incorporates cognitive aids is suggested with emphasis on the quality of information, in order to improve communication and situation awareness within teams.
Funding – Department of Anesthesia, University of Toronto, St. Michael's Hospital.
(Harrison, TK., T Manser, et al. (2006). "Use of cognitive aids in a simulated anesthetic crisis." Anesth Analg 103: 551-556.; Burden, A., Z Carr et al. (2008). "Observed failure to use cognitive aids in a simulated obstetric crisis." Anesthesiology 109: A410.; Mills, PD., JM DeRosier et al. (2004). "A cognitive aid for cardiac arrest: you can't use it if you don't know about it." Jt Comm J Qual Saf 30: 488-496.)

Burke, DP., DF Bowden, (1993). "Modified paediatric resuscitation chart." BMJ 306: 1096-1098.

This is a randomized prospective study to compare two paediatric resuscitation charts on improvement of speed and accuracy of drug dose calculations in simulated paediatric cardiopulmonary arrests, one chart modified and one standard. The modified chart was found to have a statistically significant increase in the accuracy of the calculations, the speed of correct calculations and the number of calculations completed compared to the standard chart. It was concluded that this modified chart should supersede the existing one. The study does emphasize the importance of having a reference chart for the purposes of drug dose calculations in paediatric patients.
LOE = 6, fair supportive of the question. Funding – none.

Devita, MA., J Schaefer, et al. (2004). "Improving medical crisis team performance." Crit Care Med 32(2 Suppl) S61-S65.

This is an experimental study evaluating a method to improve medical crisis team performance by establishing a training course to minimize the chaos associated with the event (Crisis Team Training Course). Trainees were selected and coached through the course using lecture presentation, didactic sessions, video-recorded simulations and a facilitator-moderated debriefing. There was improved task completion and simulated survival rate during successive CPCR scenarios as well as improved team organization. To organize the crisis team, emphasis was placed on detail planning and teaching. Importance was placed on identifying responders,

having available equipment at the location of the crisis, and task organization in terms of jobs to be done, sequence of events and individuals in charge of them. Emphasis was placed on having identical equipment for every response to minimize the need to re-learn what equipment is present, where it is located and how to operate it.
LOE = 6, fair supportive to the question. Funding – none.

Dyson, E., GB Smith. (2002). "Common faults in resuscitation equipment – guidelines for checking equipment and drugs using in adult cardiopulmonary resuscitation." Resuscitation 55: 137-149.

Deficiencies and defects in resuscitation equipment include basic device failure, external factors, and human error. This paper identifies the common generic faults leading to malfunctioning equipment and recommends equipment essential for resuscitation. It also makes suggestions regarding equipment and drug checks, using an easy and structured checklist. Recommendations include standardizing the location and storage of resuscitation equipment, providing standard and local display of cardiac arrest algorithms, having checklists to optimize information, and regular audit of resuscitation equipment. The checklist can ensure immediate availability of appropriate equipment. As well, preventative maintenance of equipment as recommended by the manufacturers is also suggested.
LOE = 6, good support of the question. Funding – none.

Hand, H., A Banks, (2004). "The contents of the resuscitation trolley." Nursing Standard 18(44) 43-52.

This article is an overview of the standardized resuscitation trolley in the context of basic and advanced life support. The CPR Guidance for Clinical Practice and Training in Hospitals states that there has been no attempt to standardize equipment for resuscitation. The guidance suggests standardized equipment for use in the entire hospital setting to aid in familiarity with its use. Sealing the trolleys is recommended until use in an emergency to ensure that the unit is complete.
LOE = 6, fair neutral to the question. Funding – none.

King, D., KN Davies, et al. (1994). "Survey of cardiac arrests and cardiac arrest trolleys in a district general hospital."

This is a retrospective study evaluating 137 cardiac arrests in a district hospital. Delays in cardiopulmonary resuscitation were found to be related to equipment failure in 18% of the cases. Of 32 arrest trolleys, 65% were in acceptable locations to the areas they were needed and 9% had significant deficiencies, which included being situated in the patient waiting rooms and being infrequently checked for content.
LOE = 6, fair supportive of the question. Funding – none.

Royse, AG. (1989). "New resuscitation trolley: Stages in development." Aust. Clin. Rev. 9: 107-114.

This is a clinical trial defining the main principles of resuscitation trolley development as a way to improve the standardization and completeness of the contents and provide a systematic layout to promote efficient resuscitation. This study highlights that most resuscitation trolleys are inadequate and represent a major weakness in CPCR. These weaknesses include: lack of standardization of the units, incomplete or insufficient quantities of equipment (including drugs, intubation and suction equipment), and failure to have a functional layout of the contents. Current concerns include drugs or syringes in their packaging delaying time for resuscitation efforts, time wasted in drug location due to inconsistent and inefficient layouts, equipment easily falling from the unit during movement, and cost of trolley repair and upkeep depending on the design. Suggestions for resuscitation trolleys include a complete complement of equipment and drugs without need for

electricity or main oxygen or suction supplies, should be mobile, standardized within a hospital, location should be centralized, equipment in first use should be displayed easily, no packaged drugs or syringes, equipment should be removable with one hand, easily closable for movement without content disruption, and strategic placement of equipment on the trolley for convenience of use. Improve incomplete restocking by routine checks during the day and replacement of used materials after use.
LOE = 6, fair supportive of the question. Funding – none.

Schade J. (1983). "An evaluation framework for code 99." Quality Review Bulletin 9(10): 306-309.

The code cart standardization is key to team organization during an arrest. Concerns for these carts include deficient equipment due to lack of return to the cart or incomplete stocking in the first place to provide the appropriate materials needed for prolonged arrest events. Code problems identified included having to use multiple carts due to lack of supplies on one for a prolonged arrest, too many staff members in a room, not clear who was the leader in CPR, reusable equipment was not returned to the cart, medications were not easy to identify or locate, items requested were not on the crash cart, delays in response to the code, defective equipment, and confusion about charge roles. Recommendations for the code carts include standardization of the contents and location of the carts, determination of medications and supplies needed for stocking, sealing of the cart to ensure supplies are present when needed and providing a method for personnel to familiarize themselves with the cart and have appropriate training on its contents. Establishment of a task force appointed to evaluate the effectiveness of the code procedure and cart equipment was suggested.
LOE = 6, fair supportive of the question. Funding – none.

Seethala, RR., EC Esposito, et al. (2010). "Approaches to improving cardiac arrest resuscitation performance." Current Opinion in Critical Care 16: 196-202.

This is an overview of the current literature assessing the various methods to improve delivery of resuscitation care. Outcome of resuscitation is largely related to technical and human factors. In a study by Marsch et. al in 2004, 10/16 healthcare teams in an ICU setting failed to adhere to established arrest guidelines during a simulated CPCR event. The six teams with the best compliance to these standards had improved leadership and task distribution. They also report resuscitation equipment errors accounting for 18% of delays in CPCR. Human error contributes to these equipment errors secondary to lack of knowledge, inexperience and inadequate training, and lack of equipment maintenance.
LOE = 6, fair neutral to the question. Funding – author Abella, BS received research funding and honoraria from Philips Healthcare, a manufacturer of CPR-sensing technology. No other author conflicts of interest.
(Marsch, SC., C Mueller, et al. (2004). "Human factors affect the quality of cardiopulmonary resuscitation in simulated cardiac arrests." Resuscitation 60:51-56.)

Shetty, P., T Cohen, et al. (2009). "The cognitive basis of effective team performance: features of failure and success in simulated cardiac resuscitation." AMIA 599-603.

A prospective experimental study was designed to assess team adherence to an Advanced Cardiac Life Support (ACLS) protocol during simulated critical events in cardiac resuscitation that affected their performance. A checklist was developed to evaluate accuracy of the procedure performed, timeliness of activities in accordance to the protocol, and orderliness of activity sequence. Results of the study indicated that outcome was affected by the number of critical tasks that the teams performed but unaffected by the sequence of activities recommended in the ACLS protocol. The successful team deviated more from the recommended ACLS sequence of events than the unsuccessful team but they had improved adaptation to situational changes and performance of critical tasks which was postulated as contributing to their positive outcome.

LOE = 6, good neutral to the question. Funding – award from the James S McDonnell Foundation.

Telesca, K. (1992). "A simplistic approach to restocking crash carts." Hosp Pharm 27: 1068-1072.

This is a clinical study evaluating the need for redesigning and standardizing crash carts in a hospital setting. Drugs and supplies should be readily available for use in an emergency and inefficient organization and delegation of responsibility as well as poorly designed and organized equipment systems have been implicated in lack of structure during an arrest. In this study, the pharmacy was responsible for the restocking of crash carts in the hospital in a standardized fashion such that all carts were identical and fully equipped for emergency use.
LOE = 6, poor supportive of the question. Funding – none.

Ward, P., LA Johnson, et al. (1997). "Improving cardiopulmonary resuscitation skills retention: effect of two checklists designed to prompt correct performance." Resuscitation 34: 221-225.

A randomized controlled prospective study evaluating the effects of two checklists designed to improve CPCR performance was designed. Retention of CPCR steps is often difficult for some and thus, checklists were evaluated to determine if it could guide behaviors of participants in CPCR. The study evaluated 169 undergraduates enrolled in a basic life support course. Participants were randomly assigned into control or one of two experimental groups, the first evaluating a wallet sized short checklist with diagrams and the other a longer and more detailed checklist without diagrams. The students were tested 2 months following training to assess retention skills. The effect of group was statistically significant in this study, indicating that the long check list lead to superior performance compared to the short checklist or participants who did not use a checklist (controls). Important findings from this study included: 1. the group using the long and detailed checklist was more effective at performing correct CPCR techniques and the individual variables of the procedure were equal to or more effective than either of the other groups; 2. the detailed checklist was not difficult for students in the study to use.
LOE = 6; good supportive to the question. Funding – grants from the Asmund S. Laerdal Foundation and the Laerdal Medical Corporation.

Williams, J. (1986). "The mobile educational crash cart: self-directed learning supplement that meets staff needs." Journal of Continuing Education in Nursing 17(2): 59-61.

This is a clinical study evaluating the use of an educational crash cart in human medicine for procedural training on the CPCR equipment and materials. It contains learning materials, handouts and audio/visual aids to promote familiarity with the crash carts used in this particular hospital setting as it was an exact replica. It is utilized for training, restocked and then utilized again, having the mobility for transport throughout the hospital units. It is a cost-efficient way to provide structured and self-instructional training on the cart and the task of CPCR before an emergency occurs.
LOE = 6, poor supportive to the question. Funding – none.