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Utstein-style guidelines on uniform reporting of in-hospital cardiopulmonary resuscitation in dogs and cats. A RECOVER statement

Manuel Boller, Dr med vet, MTR, DACVECC; Dan J. Fletcher, DVM, PhD, DACVECC; Benjamin M. Brainard, VMD, DACVECC, DACVAA; Steve Haskins†, DVM, DACVAA, DACVECC; Kate Hopper, BVSc, PhD, DACVECC; Vinay M. Nadkarni, MD, MS, FCCM; Peter T. Morley, MBBS, FRACP, FANZCA, FCICM, FERC; Maureen McMichael, DVM, DACVECC; Ryohei Nishimura, DVM, PhD; Joris H. Robben, DVM, PhD, DECVECC; Elizabeth Rozanski, DVM, DACVECC, DACVIM; Elke Rudloff, DVM, DACVECC; John Rush, DVM, MS, DACVIM, DACVECC; Andre Shih, DVM, DACVAA, DACVECC; Sean Smarick, VMD, DACVECC and Luis H. Tello, MV, MS, DVM

Abstract

Objective – To provide recommendations for reviewing and reporting clinical in-hospital cardiopulmonary resuscitation (CPR) events in dogs and cats and to establish nonambiguous operational definitions for CPR terminology.
Design – Consensus guidelines.
Setting – International, academia, referral practice, general practice, and human medicine.
Methods – An international veterinary Utstein task force was convened in April 2013 in San Francisco to determine the scope of the project, the variables to be reported, their definitions, and a reporting template. Factors that were essential for meaningful data reporting and were amenable to accurate collection (ie, core variables) and additional variables useful for research projects and hypothesis generation (ie, supplemental variables) were defined. Consensus on each item was either achieved during that meeting or during the subsequent online modified Delphi process and dialogue between task force members.
Results – Variables were defined and categorized as hospital, animal, event (arrest), and outcome variables. This report recommends a template for standardized reporting of veterinary in-hospital CPR studies involving dogs or cats. Core elements include the suspected cause(s) and location of arrest, first rhythm identified, the occurrence of return of spontaneous circulation (ROSC) of more than 30 seconds (any ROSC) or more than 20 minutes (sustained ROSC), survival to discharge, and functional capacity at discharge. If CPR is discontinued or the patient is euthanized by owner request, a reason is reported. The task force suggests a case report form to be used for individual resuscitation events.
Conclusions – The availability of these veterinary small animal CPR reporting guidelines will encourage and facilitate high-quality veterinary CPR research, improve data comparison between studies and across study sites, and serve as the foundation for veterinary CPR registries.

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From the Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Werribee, VIC, Australia (Boller); Department of Clinical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY (Fletcher); Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA (Brainard); Department of Veterinary Surgical and Radiological Sciences, School of Veterinary Medicine, University of California at Davis, Davis, CA (Haskins, Hopper); The Children's Hospital of Philadelphia, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA (Nadkarni); The Royal Melbourne Hospital Clinical School, University of Melbourne, Parkville, VIC, Australia (Morley); College of Veterinary Medicine, University of Illinois, Urbana, IL (McMichael); Graduate School of Agricultural and Life Sciences, The University of Tokyo, Tokyo, Japan (Nishimura); Faculty of Veterinary Medicine, Utrecht University, Utrecht, the Netherlands (Robben); Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA (Rozanski, Rush); Lakeshore Veterinary Specialists, Glendale, WI (Rudloff); College of Veterinary Medicine, University of Florida, Gainesville, FL (Shih); AVETS, Monroeville, PA (Smarick); Banfield Pet Hospital, Portland, OR (Tello).

†Deceased.

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Address correspondence and reprints request to
Dr. Manuel Boller, UVet Veterinary Hospital, University of Melbourne, 250 Princes Highway, Werribee, VIC 3030, Australia.
E-mail: manuel.boller@unimelb.edu.au
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Abbreviations

ALS	advanced life support
APPLE	Acute Patient Physiologic and Laboratory Evaluation
BLS	basic life support
C	core variable
CPA	cardiopulmonary arrest
CPR	cardiopulmonary resuscitation
CRF	case report form
DOA	dead on arrival
$ETCO_2$	end tidal CO_2
IHCA	in-hospital cardiac arrest
OHCA	out-of-hospital cardiac arrest
PCA	post-cardiac arrest
PEA	pulseless electrical activity
RECOVER	Reassessment Campaign on Veterinary Resuscitation
ROSC	return of spontaneous circulation
S	supplemental variable
VF	ventricular fibrillation
VT	pulseless ventricular tachycardia

Introduction

Cardiopulmonary resuscitation (CPR) is widely employed in small animal veterinary medicine, as cardiopulmonary arrest (CPA) occurs in all clinical settings.[1] The authors of the Reassessment Campaign on Veterinary Resuscitation (RECOVER) conducted a systematic literature review to develop evidence-based treatment recommendations for CPA and to identify important knowledge gaps.[2,3] The resulting RECOVER CPR guidelines have been widely disseminated and translated into several languages.[a] Early evidence from a recent Japanese retrospective report suggests that the implementation of a training program based on the RECOVER guidelines may improve rates for the return of spontaneous circulation (ROSC) and survival to discharge in dogs resuscitated after in-hospital CPA, in some hospital settings.[b] This is the first report in veterinary resuscitation science that suggests that changes in CPR practice may improve outcomes. At the same time, the study suffers from design limitations inherent in veterinary clinical resuscitation research, which consists predominantly of observational studies of small populations from single veterinary institutions.[4–9] These limitations compromise the reliability of study findings. To the knowledge of the authors, only one prospective interventional CPR study has been published to date.[10]

There are many hurdles and pitfalls that prevent execution of effective clinical veterinary CPR research, including difficulties with subject enrollment due to the unpredictable and relatively low occurrence of CPA and problems with the acquisition of informed consent from pet owners prior to the study intervention. In addition, the paucity of animals that survive to discharge from hospital and the associated need for large study populations to draw conclusions on survival, with a general lack of funding to support clinical trials present obstacles to research in veterinary CPR. Moreover, variability in definitions of and criteria for collection of CPR data elements can complicate multicenter efforts. Some of these issues are difficult to solve as they constitute a system-wide challenge to veterinary clinical research (eg, lack of funding) or are an intrinsic feature of resuscitation science (eg, urgency for enrollment and informed consent).[10–12] These concerns must be addressed on an individual project basis. In contrast, uniform reporting of CPR events including a consistent set of clearly defined data elements can be achieved and will benefit the entire veterinary resuscitation science community. Consistent reporting of CPR will facilitate comparison of findings across studies and locales and is of fundamental importance to multicenter clinical studies and registries.

Terminology surrounding veterinary in-hospital cardiac arrest (IHCA) resuscitation events is currently not clearly defined. A common, standard terminology is of fundamental importance for unambiguous communication and collaborative efforts. Clear operational definitions for terminology used in CPR registries are a necessity for the validity of data captured.

An international task force composed of veterinary emergency and critical care experts and representatives of veterinary critical care organizations and the International Liaison Committee on Resuscitation (ILCOR) was formed by the RECOVER initiative to develop consensus Utstein-style guidelines to define nomenclature and to generate a template for reporting veterinary resuscitation data. The "Utstein-style" has become the exemplar of consensus reporting guidelines in the field of resuscitation. The term originated from an informal meeting that was held at Utstein Abbey on the island of Mosteroy in Norway in 1990, which brought together resuscitation experts in human medicine from around the world.[13] At that meeting it was decided that guidelines for uniform reporting of CPR event data were needed, and the first CPR reporting template on out-of-hospital cardiac arrest (OHCA) in people was produced.[13] All subsequent CPR reporting standards and templates are referred to as Utstein-style, even if they were developed elsewhere. After OHCA, guidelines for reporting of pediatric resuscitation, IHCA, trauma, laboratory CPR research, and postcardiac arrest (PCA) care, among others, have been published over the course of the past 25 years and have been widely adopted by the research community.[14–19]

The availability of guidelines on uniform reporting of in-hospital CPR events in dogs and cats will close an important gap in the armamentarium of veterinary and translational researchers. Specifically, these guidelines provide a glossary of unified small animal CPR terminology and also provide recommendations for data elements that should be collected in clinical veterinary CPR studies and included in research reports.

Methods

The veterinary Utstein task force included RECOVER chairs and domain chairs, representatives from the European Veterinary Emergency and Critical Care Society (Robben), Latin American Veterinary Emergency and Critical Care Society (Tello), the Japanese Association of Veterinary Anesthesia and Surgery (Nishimura), the Veterinary Emergency and Critical Care Society (Rudloff), and ILCOR (Nadkarni and Morley) and met in a face to face meeting in San Francisco from April 13 to 15, 2013. In preparation for that meeting, draft documents including a CPR glossary, a list of reportable CPR event variables, a reporting template containing the most important CPR event variables, and a bed-side case report form (CRF) containing these variables were distributed to all members for commentary.

At the meeting, consensus was established on the overall scope of the project including the limitation to dogs and cats. Furthermore, the task force deliberately decided to limit the guidelines to reporting of CPR events executed within the hospital. This could include animals with IHCA but also cases of OHCA, if CPA was still present at the time of presentation to the hospital. The reason for not considering out-of-hospital resuscitation (eg, by bystanders) at this time was concern over data quality in these scenarios. The meeting focused on achieving consensus on specific data elements to collect during veterinary CPR research or for a veterinary small animal CPR registry, on the operational definitions of these data elements, on a reporting template for CPR research, and on a CRF for collection of the data elements.

Categorization of CPR variables

The variables reported for a CPR event are of key importance for meaningful resuscitation data collection, and the task force dedicated significant energy to selecting the variables, creating their operational definitions, and ranking them according to set criteria. Data elements with a known impact on outcome and without which the dataset would be severely compromised were denoted as *core* (C). An example of a core variable is the species of the resuscitated animal. Key outcome variables, such as whether the animal survived to hospital discharge or not, are also core variables. Core variables must be collected for every case and are considered compulsory in the context of registries and clinical reports. Therefore, a secondary requirement for core datasets was the feasibility of data collection, both in regards to effort and reliability. *Supplemental* variables (S) are those variables that were considered to be of uncertain importance for outcome, were more difficult to collect, or were thought to be inconsistently available. The collection of supplemental data is nonetheless important, as these factors could stimulate further research or hypothesis generation. Examples of supplemental data are the time interval until successful endotracheal intubation or peak $ETCO_2$ achieved during CPR. Supplemental data were not included in the veterinary Utstein in-hospital CPR reporting template and are not required to be reported. However, a more detailed dataset that would be considered supplemental and noncompulsory in a registry may be of core importance in an interventional trial. In this manuscript, each data element is followed by (C) or (S) to indicate the respective variable category.

In addition to the division into core and supplemental variables, data elements were categorized according to their origin. This approach involved classification of each metric as either hospital (eg, hospital case load), animal (eg, species, age, preexisting diseases), arrest (eg, first identified rhythm, drugs administered, time of arrest witnessed, time of initiation of CPR etc), or outcome (eg, occurrence of any or sustained ROSC, survival to hospital discharge, functional capacity at discharge) variables. Terminology was also tested for consistency with the 2012 RECOVER CPR guidelines.[3]

Consensus process

The process was initiated by one of the investigators (MB) proposing a list of key content items prior to the consensus meeting in San Francisco. During that meeting consensus among the task force members was attempted by intense discussion and was achieved for the vast majority of variables. Consensus for the purpose of this work was defined as agreement between all task force members to the extent that all could at least "live with" the proposed decision item. This approach was chosen a priori, as it was considered impractical to reach absolutely undisputed agreement on all items of debate. For variables and issues that could not be resolved during the single 3-day face-to-face meeting, a modified Delphi process was utilized to reach consensus, wherein the veterinary Utstein task force members were chartered to write and rewrite debated items in several survey rounds, ultimately transforming expert opinion into group consensus.[20] One task force member (MB) served as facilitator in the process. Internet-based surveys were sent to task force members asking

for agreement on whether variables should be included and whether respondents agreed with proposed definitions, and if not, how wording should be altered. Once all task force members responded, the collated answers were distributed to the participants in a blinded fashion, so as to avoid biased influence by specific individual respondents. If a decision item was contested by no more than two respondents, constituting an agreement rate of at least 85%, the facilitator attempted to settle the dispute directly with the respondents not yet in agreement. If agreement could not be achieved, the decision item was slightly adjusted by the facilitator according to comments received and redistributed to all task force members, along with all the other unsolved items. A total of two survey rounds were necessary to arrive at consensus on all decision items that were not solved at the initial face-to-face meeting. The results of this process were collated in a manuscript draft by the lead authors (MB, DF) and subsequently circulated to all task force members for final consensus for a duration of 2 weeks.

Results

Listed below are definitions of key CPR terms on which consensus was achieved and which the tasks force recommends be reported when conducting CPR research. A summary of data elements, their definitions, and priority, along with instruction for their collection in a CPR registry or study is provided in Table 1 and an overview on reportable CPR variables and their priority are listed in Figure 1.

Hospital variables

The environment in which CPR occurs may have an influence on all aspects of CPR. This includes the number and severity of illness of animals treated, the mechanisms in place to respond to a CPA, personnel, facilities, and technology available during resuscitation and throughout PCA care. It is therefore important that veterinary CPR research data be reported alongside a clear description of the environment in which the resuscitation occurred, especially for comparison of outcome data between centers in multicenter registries. The task force recommends the reporting of the following hospital descriptors.

The setting of the veterinary facility is expressed in the practice category, and denotes whether the hospital is a referral (ie, secondary or tertiary care) or primary care facility (C), captures the hospital's ability to care for patients overnight (C), and notes the availability of an all-hours emergency service (C). In addition, the presence of a dedicated ICU is documented (C), as well as the infrastructure of the resuscitation environment (C), including the availability of drugs, and whether the facility resources allow execution of current CPR guidelines (eg, presence of defibrillator, monitoring devices, certain drugs [eg, vasopressin]). The educational strategy for resuscitation personnel (C) in the reporting facility is also described including the type (ie, basic life support [BLS], advanced life support [ALS]), the mode (ie, didactic, simulation), and the frequency of training. Lastly, the task force recommends that metrics reflecting hospital size are reported, including annual small animal case load (C), the annual number of small animal cases admitted to the hospital (C), the annual number of small animal emergency consultations (S), the annual number of anesthetics (S), and the annual number of CPR attempts (S).

Animal variables

Date of birth and age (C)

The age of the animal may affect outcome from CPR, although such evidence is currently lacking in pets. If the patient's date of birth is known this should be recorded in a format that allows unambiguous identification of day, month, and year (eg, DD, MM, YYYY or YYYY, MM, DD). If this information is not available, the age should be estimated and expressed in months for animals considered to be less than 1 year old, and in full years of completed lifetime thereafter.

Gender (C)

The influence of gender on risk and outcome is less well defined in dogs and cats with CPA compared to humans, where evidence suggests that survival may be more favorable in women compared to men.[21–23] Experimental evidence suggests an independent protective effect of estrogen and progesterone.[24,25] With that background and the high prevalence of neutered or desexed dogs and cats, the influence of gender on outcome is of particular interest. Gender should be reported as male intact, male neutered, female intact, female spayed (ie, surgical control of reproduction), or female contraceptive (ie, reversible control of reproduction).

Species and breed (C)

The species is required and is reported as either cat (feline) or dog (canine). More detailed information on breeds should be provided, as anatomic features such as upper airway or chest conformations are variable between breeds. If the animal is registered in the medical record as a pure-bred dog, the respective breed should be reported. It is recommended to follow accepted canine and feline breed definitions (eg, *Fédération Cynologique Internationale* [FCI], American Kennel Club [AKC], Cat

Table 1: Recording of small animal in-hospital CPR events: glossary of data elements

Data element	Definition	Priority	Instructions and comments
Hospital variables			
Hospital ID	Unique identifier of the hospital in which the reported CPA occurred.	Core	Report the hospital name, for example, preformatted from drop-down menu in registry. This variable must be removed during deidentification process.
Hospital category	Classification of hospital organization and infrastructure.	Core	Specify whether facility is (1) primary care, (2) referral speciality, (3) referral (without specialists), (4) referral specialty (University), (5) after hours emergency hospital.
Small animal overall case load	Number of small animal (dog and cat) consultations performed by the reporting hospital during a calendar year, including both inpatients and outpatients.	Core	Report the total number of small animal visits during the most recent calendar year via billing codes for consults.
Number of admitted cases	Number of dogs and cats admitted to the hospital (inpatients) during the preceding calendar year. Admitted cases may be identified as visits with a hospitalization charge.	Core	Report the total number of small animals admitted during the most recent calendar year via billing codes for hospitalization.
Number of small animal emergencies	This is the combined number of dogs and cats that presented to the hospital as emergencies during the preceding calendar year.	Supplemental	Report the total number of small animal emergency consults performed during the most recent calendar year via billing codes.
Number of small animal general anesthetic procedures	This is the number of small animal general anesthetic procedures performed in the reporting hospital during the preceding calendar year.	Supplemental	Report the total number of small animal general anesthetic procedures performed during the most recent calendar year via billing codes.
Number of small animal CPR cases	Approximate annual number of small animals (dogs and cats) in which CPR is initiated. Note that this does NOT refer to the number of small animals that experience cardiopulmonary arrest.	Supplemental	Provide the number of CPR events during the most recent calendar year.
Presence of an intensive care unit	Refers to whether an ICU is present on the premises of the reporting hospital. An ICU is defined as a facility to provide advanced 24-hour care (eg, ability for long-term mechanical ventilation, invasive hemodynamic monitoring, immediate access to blood gas and electrolyte analysis, ICU-dedicated nursing staff at all times) for critically ill patients.	Core	State the presence or absence of an intensive care unit.
Presence of 24-hour emergency service	Refers to whether the hospital functions as or contains a 24-hour emergency practice.	Core	State the presence or absence of a 24-hour emergency service.
Infrastructure of resuscitation environment	Infrastructural elements relevant to CPR that are in immediate reach at the location where CPR is conducted.	Core	List items recommended to follow RECOVER CPR guidelines, including crash cart, defibrillator (monophasic or biphasic), capnograph, ECG, laryngoscopes, various size endotracheal tubes, suction unit, CPR dosing chart displayed, and CPR algorithm displayed.
Drugs available for use during CPR	Drugs relevant to CPR that are in immediate reach at the location where CPR is conducted.	Core	List drugs readily available during resuscitation, including epinephrine, vasopressin, atropine, amiodarone, lidocaine, procainamide, sodium bicarbonate, naloxone, alpha-2 adrenoceptor antagonist, benzodiazepine antagonist, dextrose, calcium gluconate/chloride, magnesium sulfate.
Educational strategy for resuscitation personnel	Classification of programmed CPR training delivered to veterinary professional personnel providing clinical services at the reporting hospital.	Core	State whether training consists of lectures or simulation or both, the frequency of training, and whether BLS or ALS, or both are included.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Animal variables			
Record ID*	Unique database record identification number automatically generated by the electronic database or manually during data entry.	N/A	This is typically populated automatically when a new research database or registry record is generated by data entry personnel. No action needed. The record ID will serve as animal identifier in deidentified datasets.
Medical record number (MRN)*	Unique medical record identifier assigned by the hospital for each case.	N/A	To help tracking ancillary data of event contained in medical record. This variable must be removed during deidentification process.
Date of admission	The date the animal was admitted to the hospital in which the reported event occurred.	Core	Record as dd/mm/yyyy.
Owner name*	Self-explanatory.	N/A	Owner's surname. This variable must be removed during deidentification process.
Pet name*	Self-explanatory.	N/A	Record name. This variable must be removed during deidentification process.
Date of birth and age	Self-explanatory.	Core	Record as dd/mm/yyyy. If exact date is unknown, enter 01/01/yyyy for animal older than 1 (one) year, and the best estimate for animals younger than 1 (one) year to arrive at the animals age in months.
Gender	Self-explanatory.	Core	Record as male, male castrated, female, female spayed, or female contraceptive.
Species	Self-explanatory.	Core	Record as either dog or cat.
Breed	Self-explanatory.	Core	Record canine breed for purebred animals, and mixed breed for all others (including crossbreeds). Do not report parent breeds in crossbreeds or mixed breeds. Report feline breeds as domestic long hair, domestic short hair, or purebred, and if the latter, specify the breed.
Chest conformation	This refers to the overall shape of the chest of dogs, expressed as the relationship between the chest width and height.	Core	Report as either round (chest as wide as high), keel shaped (chest markedly higher than wide), or flat (chest wider than high). Not reportable in cats.
Body weight	Self-explanatory.	Core	Record body weight in clearly defined units (kilograms or pounds). If the weight is not available at the time of the event, the best possible estimate should be obtained (eg, weight on last visit, data from referring veterinarian).
Disease category at admission	Category of illness that was the reason for admission to the hospital in which the event occurred. This is NOT necessarily the illness responsible for CPA.	Supplemental	Record summary disease category as medical cardiac, medical noncardiac, surgical elective, surgical emergency, trauma, DOA, or unknown/not reported. Several categories can be chosen for a given animal.
Comorbidities at the time of the event	Major medical or surgical conditions known to be present at the time of CPA, but NOT necessarily the cause of CPA.	Supplemental	Report in summary categories as: arrhythmia, congestive heart failure (prior to this admission), congestive heart failure (this admission), pericardial effusion/tamponade, hypotension./hypoperfusion, respiratory insufficiency, pneumonia, renal insufficiency, hepatic insufficiency, CNS disease, SIRS, sepsis, infectious disease, diabetes mellitus, metabolic or electrolyte abnormality, malignancy, major trauma, envenomation, postoperative, none, or unknown/not reported. Several categories can be selected for a given animal.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
CPR measures in place at the time of CPA	Self-explanatory.	Core	Report the presence of endotracheal intubation, venous access (peripheral), venous access (central), ECG monitoring, or arterial catheterization at the time of CPA.
General anesthesia at time of CPA	CPA occurred while the patient was receiving inhalant or injectable anesthetics for the purpose of anesthesia and analgesia, muscle relaxation, and absence of reflex activity. Endotracheal intubation is a requirement for general anesthesia. Patients sedated only or recovering from anesthesia are not considered to be under general anesthesia.	Core	Note whether patient was under general anesthesia at the time of arrest.
Procedural sedation at time of CPA	Procedural sedation refers to the administration of any level of sedation for the purpose of facilitating a procedure (eg, radiographs, catheterization, suture placement, etc.) and that does not fulfill the criteria of general anesthesia. Sedated animals are not intubated.	Core	Report whether the animal was receiving sedation for a procedure at the time of arrest.
Induction of general anesthesia at the time of CPA	The CPA occurred during the administration of drugs with the purpose of induction of general anesthesia.	Supplemental	Report whether the animal arrested during induction of general anesthesia.
Recovery from general anesthesia at the time of CPA	This is defined as anesthesia-related CPA, whereas CPA occurred within 24 hours after termination of general anesthesia.	Supplemental	Report whether the CPA occurred during recovery from general anesthesia.
Prearrest severity of illness	Overall morbidity of the patient prior to CPA as determined by the $APPLE_{fast}$ score. Variables required for calculating the score are glucose, lactate, albumin, platelet count, and a mentation score in dogs and lactate, PCV, mean arterial pressure, rectal temperature, and a mentation score in cats.	Supplemental	The $APPLE_{fast}$ score should be reported. Information to determine this variable may not be available in all cases. The following conditions apply for selection of measurements to calculate the score: -All variables must be collected within 24 hours PRIOR to the CPA. -Where multiple measurements for a specific variable are eligible, the one closest to the CPA should be selected. When indicating the variable values, ensure the correct indication of the units (SI or US) used.
Glucose	Point measurement of blood glucose from either plasma or whole blood. This is required to calculate $APPLE_{fast}$ score in dogs.	Supplemental	See above, regarding conditions for inclusion of values.
Albumin	Point measurement of plasma albumin. This is required to calculate $APPLE_{fast}$ score in dogs.	Supplemental	See above, regarding conditions for inclusion of values.
Lactate	Point measurement of blood lactate. This is required to calculate $APPLE_{fast}$ score in dogs and cats.	Supplemental	See above, regarding conditions for inclusion of values.
Platelet count	Point measurement of blood platelets. This is required to calculate $APPLE_{fast}$ score in dogs.	Supplemental	See above, regarding conditions for inclusion of values.
Packed cell volume	Point measurement of PCV in percent. This is required to calculate $APPLE_{fast}$ score in cats.	Supplemental	See above, regarding conditions for inclusion of values.
Mentation score	Determination of mentation score to be used to calculate $APPLE_{fast}$ score in dogs and cats. *This should be determined without sedatives.*	Supplemental	See above, regarding conditions for inclusion of values.
MAP	Point measurement of MAP by direct or oscillometric technique. This is required to calculate $APPLE_{fast}$ score in dogs and cats.	Supplemental	See above, regarding conditions for inclusion of values.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Temperature	Point measurement of rectal temperature. This is required to calculate $APPLE_{fast}$ score in cats.	Supplemental	See above, regarding conditions for inclusion of values.
Prearrest functional capacity	Functional capacity before CPA can be either retrieved from medical record data or by owner interview. Either MGCS, NDS, OPC, or the modified Karnovsky performance score can be used.	Supplemental	See above, regarding conditions for inclusion of values.
Previous CPA	This refers to a previously survived CPR event, defined as an event that is separated by the index event by at least 20 minutes of continuous ROSC (sustained ROSC).	Core	Indicate whether this was the case, and if yes, record the number or previous CPR events.
Arrest variables			
Cardiopulmonary compromise requiring resuscitation	This term describes the condition of animals that experience either *respiratory arrest only*, or CPA and require life support measures accordingly (ie, ventilation only or CPR).	Core	Confirm that the reported event is cardiopulmonary compromise requiring life support measures.
Resuscitated for all cardiopulmonary compromise	This term describes an animal that experienced *respiratory arrest only* or CPA, and resuscitation was attempted.	Core	Indicate if resuscitation was attempted.
Resuscitation not attempted	This indicates that resuscitation for the reported cardiopulmonary compromise was not initiated.	Core	Indicate if resuscitation was not attempted and provide one of three reasons: (1) DNAR if advanced directive present prior to CPA; (2) futile, if a meaningful outcome is considered extremely unlikely; (3) false arrest, if the presumed arrest was rapidly identified as no arrest.
Respiratory arrest only	This is present in a patient that is unconscious, not breathing, or exhibiting occasional agonal breath, but shows signs of effective circulation.	Core	Indicate whether the animal was ventilated only (suggesting the presence of a *respiratory arrest only*). These cases need not further to be reported in detail in a CPR study or registry.
Cardiopulmonary arrest	CPA is present in a patient that is unconscious, not breathing, or exhibiting occasional agonal breath, and shows no signs of effective circulation.	Core	Indicate whether the animal was ventilated and concurrently received chest compressions (suggesting CPA). ONLY cases in which chest compressions were administered need to be reported further in detail.
Witnessed event	Indicates whether the arrest was identified by either lay person (owner) or veterinary professional.	Core	Indicate whether the event was witnessed or not.
Suspected cause of CPA	Immediate cause/trigger for the indexed event.	Core	Report as life-threatening arrhythmia, respiratory failure, heart failure, trauma, hemorrhage, hypovolemia (nonhemorrhagic, nonseptic), brain disease, severe sepsis/septic shock, MODS, metabolic/electrolyte, toxicity/overdose. The immediately triggering cause may be unknown.
Location of CPA	Area of hospital in which CPA occurred.	Core	Record the location as: out-of-hospital in case of DOA; emergency room; intensive care unit; wards; anesthesia department; consult room; diagnostic procedure area; waiting room; other.
Open-chest CPR	Refers to direct manual compression of the heart through either transthoracic or transdiaphragmatic access.	Core	Indicate whether open-chest CPR was administered, and at what time interval since initiation of chest compressions it was started.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Route of ventilation	Describes the routes by which ventilation was administered during CPR.	Core	Report as (1) intubation, defined as endotracheal intubation, (2) tracheostomy tube, (3) mouth to snout, (4) face mask, or (5) supraglottic airway device. More than one choice can be selected, if several modes were used.
Mode of ventilation	Describes the methods with which breaths are delivered.	Supplemental	Report as (1) manual (eg, by resuscitator bag or anesthesia rebreathing bag), or (2) mechanical (ie, by means of a ventilator).
Drugs given during CPR	Medications administered during the resuscitation effort, from onset of chest compressions until CPR stopped, and for epinephrine, vasopressin, and atropine, the routes and number of doses of over the course of CPR.	Core	Indicate what drugs were given, including epinephrine (adrenaline), vasopressin, atropine, and further: lidocaine, amiodarone, procainamide, sodium bicarbonate, dextrose bolus, calcium chloride or gluconate, magnesium sulfate, alpha-2 adrenoceptor antagonist, benzodiazepine antagonist, opioid antagonist, or select other. For epinephrine, vasopressin, and atropine, also indicate the routes by which these drugs were administered, and the number of doses given over the course of CPR.
Vascular access type	Defines the routes by which drugs were administered during CPR.	Core	Indicate whether drugs were given via intravenous-peripheral, intravenous-central, intraosseus, or endotracheal routes.
Use of $ETCO_2$ and/or ECG	Denotes whether $ETCO_2$ and/or ECG were monitored during CPR.	Core	Indicate whether $ETCO_2$ and/or ECG were monitored during CPR.
Highest $ETCO_2$ during CPR	Highest $ETCO_2$ value achieved during CPR, but prior to ROSC.	Supplemental	Record the highest $ETCO_2$ value observed.
First documented rhythm	Initially identified rhythm when ECG was analyzed for the first time during CPA.	Core	Indicate as (1) asystole, (2) PEA, (3) VF, (4) VT, or (5) severe bradycardia.
Severe bradycardia as an arrest rhythm	For recording severe bradycardia as an arrest rhythm in a registry or research project, it is defined as a slow heart rate $<$30–40 bpm with loss of consciousness and respiratory arrest or agonal breathing, a palpable pulse and chest compressions delivered for $>$1 minute.	N/A	Record as arrest rhythm when definition is met.
PEA	For recording PEA as an arrest rhythm in a registry or research project, it is defined as a slow heart rate with loss of consciousness and respiratory arrest or agonal breathing, no palpable pulse and chest compressions delivered for $>$1 minute.	N/A	Record as arrest rhythm when definition is met.
Method of time/interval measurement	Time intervals between CPR elements are measured in mm:ss. This can be directly accomplished using either a clearly visible stopwatch, started at the beginning of chest compressions, or by recording the time in hh:mm:ss on a 24-hour clock, followed by calculation of the intervals after the event.	Core	Record either 24-hour clock time (hh:mm:ss) or time intervals (mm:ss) during the event.
Time/date of arrest identified	Time at which the CPA was witnessed by either lay person (owner) or veterinary professional, or time when CPA was first identified in a nonwitnessed cardiac arrest.	Core	Report point of time of identification of CPA as either hh:mm:ss on 24-hour clock or as baseline of time interval measurements (00:00 [mm:ss]) on stopwatch. Record date as dd/mm/yyyy.
Time/date CPR started	Time at which chest compressions were initiated.	Core	Report initiation of CPR as hh:mm:ss on 24-hour clock. A stopwatch should be started at this time to facilitate accurate recording of subsequent time intervals. Report time interval as mm:ss. Record date as dd/mm/yyyy.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Time/date intubation achieved	Time at which endotracheal intubation was accomplished defined as the time when the first breath was delivered by that route.	Supplemental	Report time when endotracheal intubation was successful completed as either hh:mm:ss on 24-hour clock or as time interval (mm:ss) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date of first IV/IO drug	Time at which the first drug was administered IV or IO.	Supplemental	Report time of first drug administration as time interval (mm) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date of first endotracheal drug	Time at which the first drug was administered endotracheally.	Supplemental	Report time of first endotracheal drug administration as time interval (mm) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date when first VF/VT identified	Time when first occurrence of VF/pulseless VT was noted during CPR.	Supplemental	Report time of first identification of VF/VT as either hh:mm:ss on 24-hour clock or as time interval (mm:ss) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date when first defibrillation administered	Time when first shock was administered.	Supplemental	Report time of first defibrillation as either hh:mm:ss on 24-hour clock or as time interval (mm:ss) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date open-chest CPR initiated	Time at which direct cardiac compression was begun, thus this excludes the time required for accessing the thoracic cavity.	Core	Report time of initiation of open-chest CPR as either hh:mm:ss on 24-hour clock or as time interval (mm:ss) after chest compressions are started on stopwatch. Record date as dd/mm/yyyy.
Time/date CPR stopped	Time at which a CPR event was concluded, representing either death or beginning of sustained ROSC.	Core	Report time at which CPR is discontinued as either hh:mm:ss on a 24-hour clock or as time interval (mm:ss) after chest compressions are started on a stopwatch. Record date as dd/mm/yyyy.
Outcome variables			
Any ROSC	Any ROSC refers to clinical signs of reinstituted effective circulation such as a palpable pulse, a systolic blood pressure measurement of $>$60 mm Hg in the presence of a direct arterial blood pressure measurement waveform or a marked increase in $ETCO_2$ for the duration of at least 30 seconds.	Core	Indicate whether any ROSC was achieved during the reported CPR event.
Number of any ROSC	The number of any ROSC occurrences during the reported CPR effort. If the duration of ROSC is equal or more than 20 minutes, the resuscitation event is considered a survived event. If rearrest occurs after that time, and chest compressions are reinitiated, it is considered a new event, and a new case report form needs to be completed. On that case report form, the current (reported) event will then be included as a "previous CPA" event in the *animal variables* part of the report form.	Core	Report the number of any ROSC episodes observed during the resuscitation event.
Cause for no ROSC	If any ROSC was not achieved a reason must be provided.	Core	Indicate whether clinician choice (futile), owner choice, or unresponsive to ALS (single selection).

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Owner decision to stop CPR prior to any ROSC	Indication of the cause for the owner's choice to discontinue CPR prior to any ROSC. If the owner mentioned concerns about the cost of veterinary care at the time of this episode of hospitalization, the criterion for economic considerations for euthanasia is fulfilled. If the owner expressed that cost does not play a role, economic considerations should not be selected. If the decision was significantly influenced by the prognosis of the animal, this should be indicated. Economic consideration and poor prognosis can both be selected, if contributing to similar parts.	Core	Indicate whether poor prognosis, economic considerations or both to similar parts made the owners decide to discontinue CPR.
Sustained ROSC achieved	In animals that achieved any ROSC during CPR, this indicates whether or not, sustained ROSC, defined as ROSC of at least 20 minutes, occurred.	Core	Report as yes, no, or unknown/not recorded.
Duration of sustained ROSC	Duration of sustained ROSC.	Core	Indicate duration of ROSC in two categories: sustained ROSC (20 minutes to 24 hours) or ROSC for more than 24 hours.
Cause for no sustained ROSC	If sustained ROSC was not achieved a reason should be provided.	Core	Indicate whether (1) rearrest and unresponsive to ALS, (2) rearrest and CPR stopped by clinician choice (futile), (3) rearrest and CPR stopped by owner choice, or (4) euthanasia. If episodes of ROSC followed by rearrest within 20 minutes (unsustained ROSC) occurred, "unresponsive to ALS" should be selected.
Owner decision to discontinue CPR or euthanize prior to sustained ROSC	Reports the perceived predominant reason for why the resuscitation code was asked to be discontinued by the pet owner. If the owner mentioned worries about the cost of veterinary care at the time of this episode of hospitalization, the criterion for economic considerations for euthanasia is fulfilled. If the owner expressed that cost does not play a role, economic considerations should not be selected. If the decision was significantly influenced by the prognosis of the animal, this should be indicated. Economic consideration and poor prognosis can both be selected, if contributing to similar parts.	Core	Report as either economic considerations or poor prognosis, or both.
CPR stopped			
In-hospital death	In-hospital death for any cause after event was survived (sustained ROSC [>20 minutes of ROSC]).	Core	Report date as dd/mm/yyyy and time as hh:mm. This will permit calculation of survival time. Not applicable to animals that survive to hospital discharge.
Hospital discharge	Discharge alive refers to transition of the animal either to owner or to outpatient veterinary care, and not directly to in-hospital care in other veterinary facility. If the latter occurs, information on the discharge date and time from that facility needs to be obtained.	Core	Report date as dd/mm/yyyy and time as hh:mm. This will allow to calculate the percent survival from arrest to discharge.
Mode of death before discharge	This refers to summary category of mode of death of animals that survived the CPA event but experienced an in-hospital death before hospital discharge to owner or to out-patient veterinary care occurred.	Core	Report whether the mode of death was rearrest without resuscitation attempt, rearrest with resuscitation attempt but no sustained ROSC, or euthanasia.

(*Continued*)

Table 1: Continued

Data element	Definition	Priority	Instructions and comments
Cause of euthanasia	Euthanasia is the cause of death in a large proportion of dogs and cats that survive a CPR event. The cause may or may not be related to the animal's likelihood to survive to hospital discharge. Severity of illness refers to an acute to subacute state of severe illness that poses a significant burden on the animals wellbeing and is expected to be associated with suffering until recovery is complete, however full recovery is possible. Terminal illness refers to a condition of irreversible organ injury, often chronic, wherein full recovery is extremely unlikely, and therefore an acceptable quality of life is not expected even if the animal survives to hospital discharge. Economic considerations refer to the owners expressed inability to finance the quoted cost associated with the animal's medical care.	Core	Report the cause of euthanasia as (1) severity of illness, (2) terminal disease, or (3) economic consideration, whereby more than one choice can be selected.
Date/time of extubation	Removal of the endotracheal tube (ie, extubation) can serve as indication for the animal having regained capability of spontaneous ventilation and laryngeal reflexes. This information is only required for animals that survived the event (ROSC >20 minutes).	Supplemental	Report date as dd/mm/yyyy and time as hh:mm.
Postarrest functional capacity	Functional capacity assessed in predefined intervals after a survived event. Either MGCS, NDS, OPC, or the modified Karnovsky performance score can be used.	Core	Report the functional status of the patient 1 and 24 hours after ROSC and again before discharge or death. As with all neurological assessments, the influence of impaired circulation and drugs should be considered and the drugs used noted.
30-day survival	Reports whether a patient is still alive 30 days after the reported CPA event.	Supplemental	This requires a follow-up call to the animal owner to determine reliably. Report as: yes, no, or unknown.
Date of death after discharge	In patients that were alive at the time of discharge but died within 30 days after discharge.	Supplemental	Record as known date of death (record as dd/mm/yyyy), unknown, alive. This requires follow-up with pet owner or primary care veterinary facility.
Cause of death after discharge	This refers to the summary category of cause of death in patients that survived to hospital discharge.	Supplemental	Report summary category as (1) related to an underlying cause of previous CPA, (2) related to a consequence of CPA, (3) unrelated, or (4) unknown.

* Data element denotes a variable for study or registry administration purposes only; RECOVER, Reassessment Campaign on Veterinary Resuscitation; BLS, basic life support; ALS, advanced life support; N/A, not applicable; CPA, cardiopulmonary arrest; DOA, dead on arrival; SIRS, systemic inflammatory response syndrome; APPLE, Acute Patient Physiologic and Laboratory Evaluation; MGCS, modified Glasgow Coma Scale; NDS, neurological deficit score; OPC, overall performance category; ROSC, return of spontaneous circulation; DNAR, do not attempt resuscitation; MODS, multiple organ dysfunction syndrome; $ETCO_2$, end tidal carbon dioxide; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, pulseless ventricular tachycardia; IO, intraosseus.

Fanciers' Association [CFA]) when reporting breeds to allow comparison between reporting sites. If the animal is registered as a mixed breed dog or cat, further breed characterization should not be provided as this is often based on conjecture and may be difficult to verify retrospectively. Instead, these animals should be reported as mixed breeds. The overall size and chest shape of a mixed breed dog should be captured by reporting weight and chest conformation.

Chest conformation (C)

Efficacy of chest compressions to produce blood flow may be impacted by chest shape and size.[26] The chest conformation also influences the recommended chest

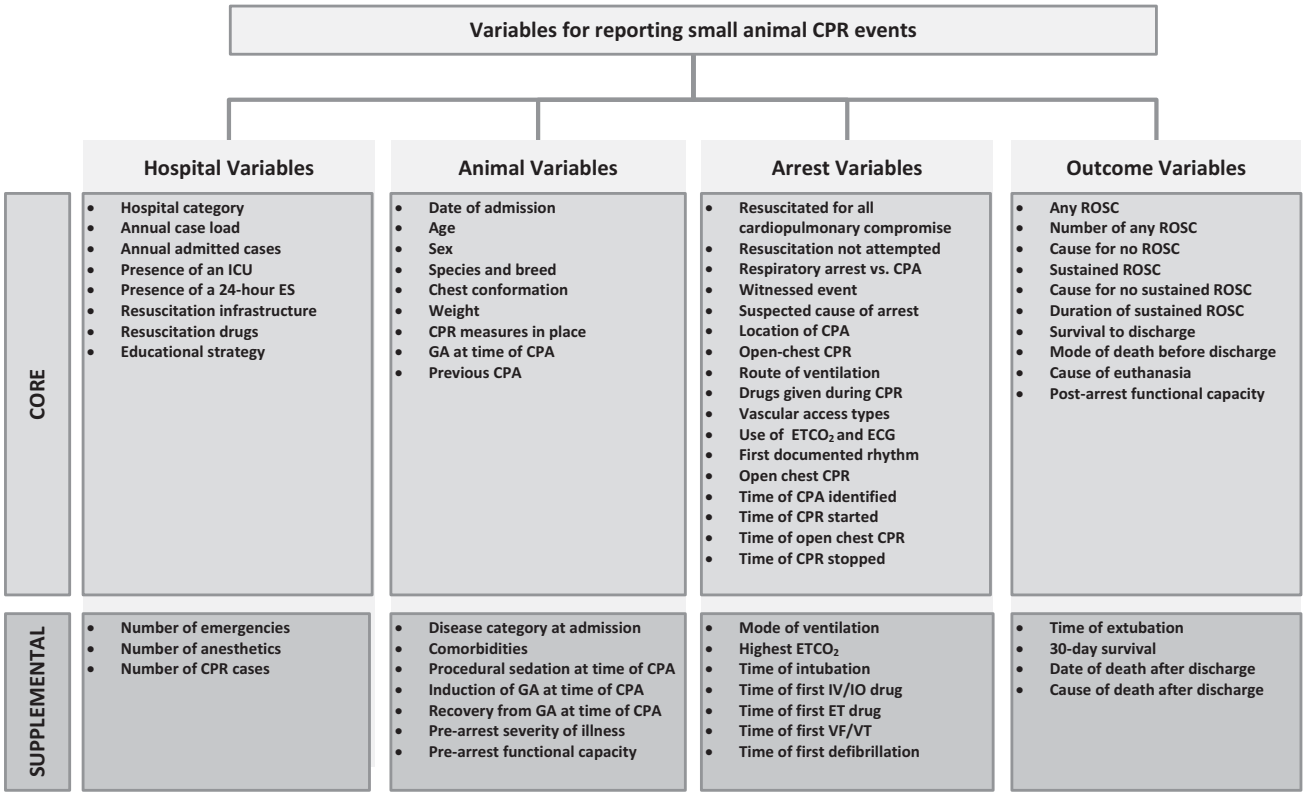


Figure 1: Recommended core and supplemental variables for reporting veterinary small animal CPR events. ES = emergency service; GA = general anesthesia; CPA = cardiopulmonary arrest; $ETCO_2$ = end tidal carbon dioxide; ROSC = return of spontaneous circulation; ET = endotracheal; IO = intraosseous; VF = ventricular fibrillation; VT = pulseless ventricular tachycardia.

compression technique.[3] In dogs, chest conformation characteristics should be reported as keel, round, or flat chested. A keel-shaped chest is markedly smaller in lateral extension compared to its ventro-dorsal extension (eg, Greyhounds, Standard Poodle). A round-chested dog has a chest that is almost as wide as it is high (eg, Labrador Retriever), while a flat or barrel-shaped chest is as wide as or wider than it is high (eg, English Bulldog). The task force acknowledges that these categories are subjective with case-specific categorization being difficult at the boundaries between chest conformations. A quantitative measure of lateral extension and dorsoventral extension would be desirable, but complicates the data collection and is absent in retrospective datasets. No chest conformation specification needs to be reported for cats.

Body weight (C)

The animal's weight should be reported, as it is a marker of animal size and may influence the effectiveness of chest compressions. If the weight is not available for the captured event, the best possible estimate should be obtained (eg, weight on last visit, data from referring veterinarian).

Disease category at admission (S)

Given the heterogeneity of patients with IHCA, an important aim of systematic CPR reporting is to characterize study populations in meaningful categories of comparable illness. To that end, the disease category at admission (Table 2), a list of comorbidities, and an estimate of the severity of illness at the time of CPA (see below) should be reported.

Comorbidities at the time of the event (S)

Comorbid conditions are major medical or surgical conditions present at the time of CPA. It is reasonable to expect that comorbid conditions affect outcome after IHCA in dogs and cats, even though studies examining this association are lacking. The significantly better survival to discharge rates in anesthetized dogs and cats compared to other causes of arrest may be interpreted as an expression of the confounding impact of comorbid conditions on outcome.[7] Comorbid conditions may influence the pet owner's decision to withdraw life support or further medical care and opt for euthanasia even after successful resuscitation. Comorbid conditions will be retrievable from medical records in the majority of in-hospital CPA

Table 2: Operational definitions of disease categories at presentation to the emergency room or admission to hospital

Disease category	Operational definition
Medical cardiac	Any medical cause relating to a cardiac disease, including congestive heart failure, pericardial effusion, arrhythmias and other.
Medical noncardiac	Any medical cause of admission with the exception of cardiac etiologies. This includes nonsurgical gastrointestinal, respiratory, oncologic, neurologic, ophthalmologic, and dermatologic problems.
Surgical elective	Admission of the animal for an elective orthopedic or soft tissue surgical procedure.
Surgical emergency	Admission of the animal for an emergency orthopedic or soft tissue surgical procedure of nontraumatic origin, such as a hemoperitoneum, septic peritonitis, or other.
Trauma	Admission of the animal after trauma, independent of severity.
DOA	The animal at presentation fulfills the criteria for CPA.
Unknown/not reported	A reason for admission of the animal cannot be obtained.

DOA, dead on arrival; CPA, cardiopulmonary arrest.

Table 3: Operational definitions of comorbid conditions at the time of the reported CPA event

Comorbidity	Operational definition
Arrhythmia	An arrhythmia has been diagnosed for which the animal was receiving treatment.
Congestive heart failure (prior to this admission)	A clinical diagnosis of congestive heart failure was established prior to this admission and the animal was receiving treatment for it.
Congestive heart failure (this admission)	A clinical diagnosis of congestive heart failure was established during the admission in which the CPA occurred.
Pericardial effusion/tamponade	A diagnosis of pericardial effusion or tamponade was established by cardiac ultrasound.
Hypotension/hypoperfusion	A clinical diagnosis of hypotension or hypoperfusion is established requiring treatment.
Respiratory insufficiency	A functional abnormality in the respiratory tract is present that leads to changes in the animal's respiratory pattern commensurate with increased respiratory effort and arterial hypoxemia (SpO_2, SaO_2, PaO_2) or hypercarbia ($PaCO_2$; $PvCO_2$) or the requirement for interventions such as oxygen supplementation or mechanical ventilation.
Pneumonia	Documented, clinical diagnosis of pneumonia.
Renal insufficiency	The presence of clinically apparent AKI or CRD (IRIS stage III-IV).[27]
Hepatic insufficiency	Established diagnosis of hepatic insufficiency or failure with documented liver dysfunction.
CNS disease	The presence of structural or functional brain or spinal cord disease, such as idiopathic epilepsy, inflammatory or neoplastic brain or spinal cord disease, ischemic processes, traumatic brain injury, and other.
SIRS	A clinical diagnosis of SIRS present at the time of CPA.
Sepsis	A clinical diagnosis of SIRS due to infection present at the time of CPA.
Infectious disease	A clinical diagnosis of a disease process elicited by a specific pathogen.
Diabetes mellitus	A diagnosis of diabetes mellitus with ongoing treatment at the time of CPA.
Metabolic or electrolyte abnormality	Significant metabolic or electrolyte abnormalities that require therapeutic consideration and in most cases will require treatment. Examples are moderate to severe acid-base abnormalities, severe hypoglycemia, hypoaldesteronism, congenital processes such as pyruvate kinase or cobalamin deficiency/malabsorption, and deviations of electrolytes (eg, sodium, potassium, calcium, magnesium, chloride) from normal.
Malignancy	Confirmed presence of a malignant neoplasm.
Major trauma	Trauma leading to systemic illness requiring hospitalization. A definition on what major entails is not commonly accepted for the veterinary medicine; however, based on previous studies, an animal trauma triage (ATT) score of 6 or higher is commensurate with major trauma.
Envenomation	The circumstance where an animal shows clinical abnormalities as a consequence of exposure to venom due to bite by or ingestion of a venomous animal.
Postoperative	The first 6 hours after conclusion of a surgical procedure.
None	The patient's overall medical condition prior to CPA is known and no comorbidities are present.
Unknown/not reported	The patient's overall medical condition prior to CPA is not known and therefore the presence or absence of comorbidities cannot be determined.

CPA, cardiopulmonary arrest; AKI, acute kidney injury; CRD, chronic renal disease; IRIS, International Renal Interest Society; SIRS, systemic inflammatory response syndrome; ATT, animal trauma triage.

cases. The suspected cause of CPA (see arrest variables) is not necessarily one of the comorbid conditions noted. Comorbid conditions are listed in Table 3.

CPR measures in place at the time of CPA (C)

These include primarily ALS measures, such as vascular access and monitoring, but also endotracheal intubation,

all of which may shorten the time interval to administration of first drug and effective ventilation, minimize pauses in chest compressions, and could positively influence survival. A recent veterinary report revealed a significant association between the presence of an IV catheter at the time of CPA and sustained ROSC.[6] In humans, monitored IHCA, even if not witnessed, is associated with improved survival.[28]

General anesthesia at the time of CPA (C)

General anesthesia at the time of CPA is associated with a marked survival benefit in dogs and cats compared to the remaining IHCA population.[6,7] It is therefore essential to include in a CPR study report the percentage of CPA cases that occurred during general anesthesia. General anesthesia at the time of CPA is defined as CPA that occurs while the patient is receiving inhalant or injectable medications for the purpose of anesthesia and analgesia, muscle relaxation, and absence of reflex activity. Endotracheal intubation is a requirement for general anesthesia. Patients that are only sedated or recovering from anesthesia are not considered to be under general anesthesia. However, these can be reported separately as arrest during procedural sedation (S), induction (S), or recovery (S) from general anesthesia (Table 1).

Prearrest severity of illness estimates in patients in ICU (S)

In addition to comorbid conditions, severity of illness may be associated with outcome of dogs and cats experiencing CPA as in humans, although it will unlikely be useful in predicting futility of CPR in individual cases.[29] Unfortunately there is no scale to describe severity of illness that has been validated for veterinary patients with CPA. The "fast" version of the Acute Patient Physiologic and Laboratory Evaluation (APPLE) score is a validated scale for reporting prearrest severity of illness in dogs and cats in veterinary ICUs, and is a feasible tool to assess the prearrest illness severity in animals that have experienced CPA.[6,30,31] All variables required to determine the $APPLE_{fast}$ score must be collected within 24 hours prior to the CPA. Where multiple measurements for a specific variable are eligible, the one closest to the CPA should be selected. As the APPLE score was validated in feline and canine patients in the emergency room or ICU, data collection should be restricted to patients that are present in these settings. Moreover, the mentation score component of $APPLE_{fast}$ is influenced by sedation and opioid analgesics and should be determined in the absence of these drugs, if possible. A recently published study showed that prearrest $APPLE_{fast}$ scores could be obtained only for a small percentage of the overall CPA population and its usefulness needs to be further explored.[6]

Prearrest functional capacity (S)

An assessment of the functional status of the patient prior to CPA is of importance to gauge the effect of CPA and CPR on the patient's postarrest neurological function. The same variables used to quantify neurological outcome after ROSC must be employed for prearrest assessment. Of the previously used tools, the task force proposes to consider either modified Glasgow Coma Scale (MGCS), neurological deficit score (NDS), or overall performance category (OPC).[10,32,33] Other scores, such as the modified Karnovsky performance score, have been described in veterinary medicine, but have not been validated.[9] The task force emphasized the need for a practical, validated tool that yields reliable data, but no consensus was reached on recommending a single currently available score. It is expected that much of the data required for these scores (especially the NDS) may not be available after the arrest, depending on the quality of medical records. Development of a score that is practical to obtain and focused on relevant functional outcomes for pets, such as consciousness, vision, and mobility is a priority.

Arrest variables

Cardiopulmonary and respiratory arrest: Cardiopulmonary compromise requiring life support measures (C)

Cardiopulmonary compromise requiring resuscitation includes *respiratory arrest only* and CPA. In dogs and cats, the diagnosis of CPA is made if the animal is unconscious, lacks signs of effective circulation, and is not spontaneously breathing, or only shows occasional, gasping breaths. Respiratory arrest only is defined as a patient that is unconscious and not breathing or exhibiting occasional gasping breaths, but with signs of effective circulation.

It may be difficult to differentiate respiratory arrest only and CPA clearly and we recommend the following approach. Animals that experienced cardiopulmonary compromise treated with assisted ventilation and chest compressions should be categorized as CPA cases (C). In addition, animals with cardiopulmonary compromise in which no life support measures are attempted and death ensues should also be classified as having experienced CPA. Animals that experienced cardiopulmonary compromise treated with assisted ventilation only should be referred to as respiratory arrest only cases (C). The clear demarcation of CPA from respiratory arrest only is essential, as the latter is associated with a markedly better outcome in both humans and small animals.[5,34]

Resuscitated for all cardiopulmonary compromise (C)

All animals in which resuscitation was attempted, whether to treat respiratory arrest or CPA, must be

reported. Resuscitation from CPA occurs when chest compressions are delivered. The task force agreed that it will be difficult in most veterinary hospitals to reliably capture all cases with cardiopulmonary compromise that are not resuscitated or those who only experience respiratory arrest, as these often do not trigger a central emergency response and remain unnoticed as no active reporting system is in place for these circumstances. It is therefore recommended to limit full reporting of CPA case details to those animals that receive chest compressions, as this will automatically trigger a medical record entry and sets forth an event recording process. However, the number of animals identified with cardiopulmonary compromise requiring resuscitation, of animals resuscitated, and of animals with respiratory arrest only should be reported where this is feasible.

Resuscitation not attempted (C)

If CPA is recognized but resuscitation not attempted, a reason should be provided. The task force recommends indicating whether an advanced directive (ie, do not attempt resuscitation [DNAR]), an assessment of futility of resuscitation (eg, in animals with end stage, irreversible chronic diseases or clear signs of death [eg, rigor mortis]), or false arrest was the cause for not attempting resuscitation.

Witnessed event (C)

A witnessed event is a cardiopulmonary or respiratory arrest event that is directly observed by a veterinary professional or a lay person such as the pet's owner or guardian. People with witnessed IHCA had significantly better odds of neurologically intact survival than those patients in whom the CPA was unwitnessed.[28]

Suspected cause of CPA (C)

The cause of CPA describes the immediate factor(s) that triggered the event (Table 4). More than one category can be selected for each CPA case. While several of these variables are similar to the comorbidities present at the time of CPA, the immediate cause(s) of CPA is that which leads to physiologic derangements severe enough to permit a plausible causative relationship. The purpose of reporting the suspected cause of CPA in a summative format is to allow comparison of study populations, and to identify causes that are preventable or actionable (ie, distinct therapeutic intervention available).[6,35] Additional, more nuanced case detail on the immediate cause of CPA may need to be collected for specific clinical studies.

Location of arrest (C)

While no such data are yet available for veterinary resuscitation, the location of IHCA within the hospital has been found to be associated with outcome in human medicine.[36,37] The location of arrest refers to the specific location within the hospital premises where the CPA occurred.

It is categorized as OHCA, if CPA occurred outside the reporting veterinary care facility, such as in an animal that was found to be dead on arrival (DOA). This describes the condition of an animal that is brought to a veterinary facility from outside of the hospital and in which initial triage reveals CPA. The term DOA applies irrespective of whether the animal received any form of out-of-hospital resuscitation or not. While the term DOA is commonly used in veterinary jargon, it may be misleading, as CPA is not equivalent with death.

If the arrest occurred within the premises of a veterinary facility (IHCA) the specific location should be noted as emergency room, treatment (consulting) room, intensive care unit, wards, anesthesia induction room, operating room, diagnostic procedure area, or other.

Open-chest CPR (C)

Open-chest CPR is CPR that includes direct manual cardiac compression via an intercostal, sternal, or transdiaphragmatic approach with the objective of generating blood flow to the heart and brain and ultimately to restore spontaneous circulation.[38]

Route (C) and mode (S) of assisted ventilation

Assisted ventilation is the inflation of the lungs by a rescuer. The route of ventilation describes the methodology by which ventilation is administered during rescue breathing and includes endotracheal intubation, tracheostomy tube, mouth-to-snout, face mask, or a supraglottic airway device (eg, laryngeal mask). The mode of ventilation describes whether breaths were delivered manually (eg, with a resuscitator bag or the rebreathing bag of an anesthesia machine), or mechanically (eg, the mechanical ventilator of an anesthesia machine).

First documented rhythm (C)

The cardiac rhythm that is first identified upon recognition of CPA is the first documented rhythm, which may be distinctly different from the rhythm present at the time that CPA occurred (ie, arrest rhythm). However, if the first documented cardiac arrest rhythm was observed at the instant of arrest, it will be synonymous with the arrest rhythm. The rhythms to be differentiated are asystole, pulseless electrical activity (PEA), ventricular fibrillation (VF), pulseless ventricular tachycardia (VT), or severe bradycardia. Severe bradycardia is defined as an arrest rhythm when there is loss of consciousness and respiratory arrest or agonal breathing with a slow heart rate <30–40 bpm. Animals with severe bradycardia have

Table 4: Operational definitions of suspected immediate causes of cardiopulmonary arrest

Suspected cause of CPA	Operational definition
Life-threatening arrhythmia	An arrhythmia that is the primary initiator of the CPA event, such as VF, pulseless VT, or severe bradycardia requiring chest compressions. In cases in which arrhythmias occur secondary to extracardiac abnormalities, such as with hyperkalemia or intoxication, the respective categories (ie, metabolic/electrolyte; toxicity/overdose) should be selected instead.
Respiratory failure	A functional abnormality in the respiratory tract, including airways and/or pulmonary parenchyma, was present that led to severe arterial hypoxemia as identified by mucous membrane color, SpO_2, SaO_2, or PaO_2 measurement and resulted in asphyxial CPA.
Heart failure	A clinical diagnosis of severe heart failure was made and considered the cause of CPA. This includes cardiac tamponade.
Trauma	Trauma and its sequelae were the trigger for CPA.
Hemorrhage	Hemorrhage severe enough to lead to CPA.
Hypovolemia (nonhemorrhagic, nonseptic)	Hypovolemia, in the absence of hemorrhage or sepsis, severe enough to lead to CPA.
Brain disease	Brain disease as trigger of CPA, likely induced by diminished brain stem function.
Severe sepsis/septic shock	The presence of uncontrolled severe sepsis/septic shock leading to critical tissue hypoperfusion and CPA.[39,40]
MODS	The presence of severe sepsis with two or more organ dysfunctions.[52]
Metabolic/electrolyte	Derangements in metabolite or electrolyte homeostasis to an extent that is commensurate with the occurrence of CPA.
Toxicity/overdose	Administration to or ingestion by an animal of a toxin or toxic dose of a pharmaceutical compound with CPA as a consequence. In the scenario where CPA occurs during general anesthesia, overdose is the trigger in most cases and should be selected accordingly.
Unknown/not reported	The suspected immediate cause of CPA is not known.

CPA, cardiopulmonary arrest; VF, ventricular fibrillation; VT, pulseless ventricular tachycardia; MODS, multiple organ failure syndrome.

palpable pulses, and chest compressions should be delivered for at least 1 minute for clear categorization of severe bradycardia as an arrest rhythm. This is identical to the definition of PEA, with the exception that a pulse is not palpable with PEA. In dogs and cats in which CPR is initiated within the hospital, approximately 75–90% of first identified rhythms are asystole and PEA, followed by VF, VT, and less commonly severe bradycardia.[6] The difficulties that exist in correctly identifying the presence or absence of a pulse, however, give rise to persisting concern regarding the accurate differentiation of severe bradycardia and PEA.[41]

Times and intervals

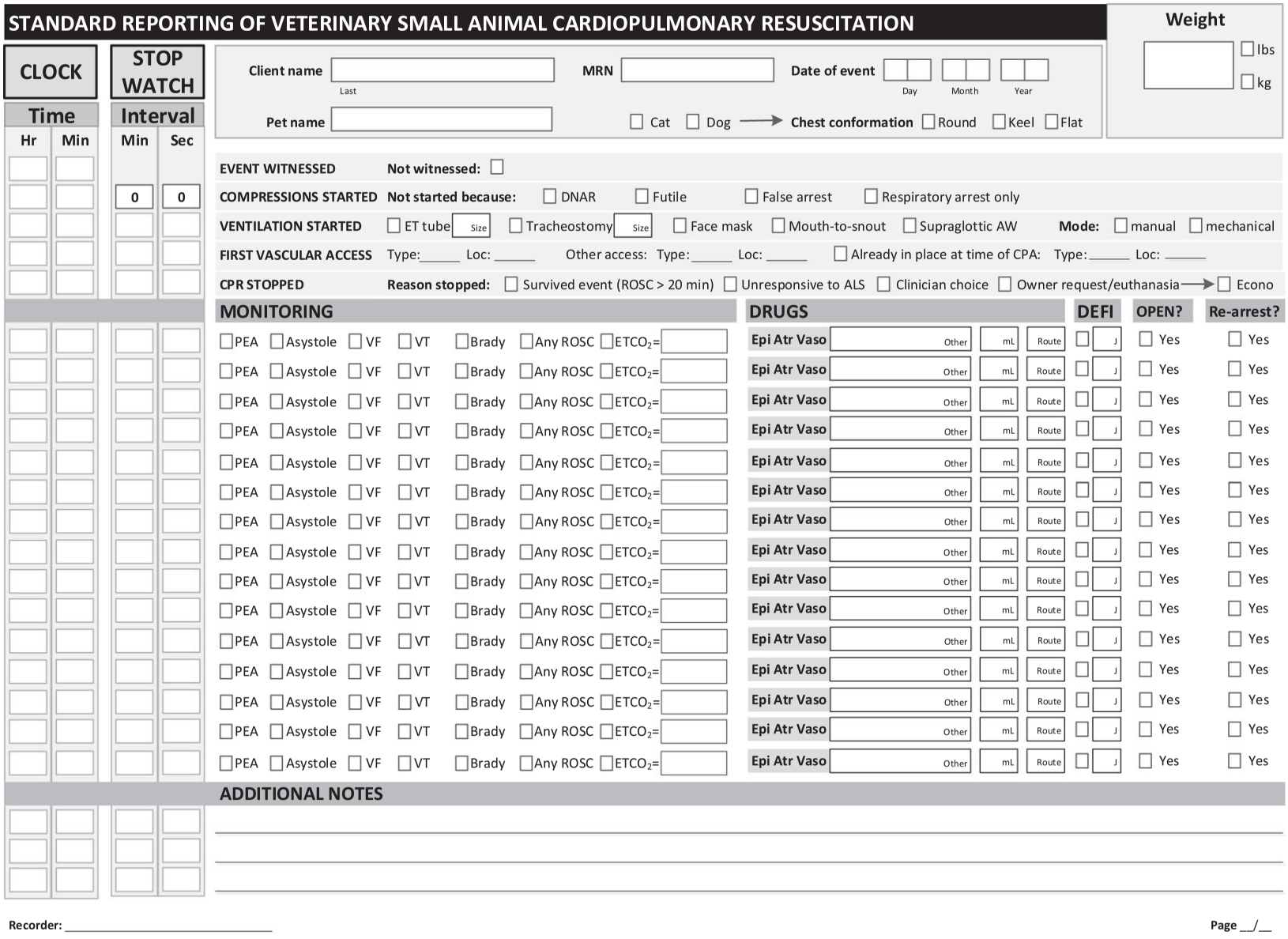
The duration of event intervals (eg, the time from CPA to initiation of chest compressions) is inversely correlated with survival (ie, any and sustained ROSC) in small animals with IHCA and in people with OHCA and IHCA.[6,29,42,43] Major event times and intervals should therefore be recorded, even though the task force recognizes that accurate capture poses a challenge. To facilitate the process and in an attempt to increase data quality, the task force developed a preformatted CRF (Figure 2). It allows recording of all important event times and intervals during CPR along with other recommended data elements. Additionally, information important for medical record documentation, such as drug doses administered, is included to facilitate the use of a single form during resuscitation.

To accurately record times and intervals, a person dedicated to recording data in real time is necessary. It is recommended that a single, clearly visible clock is used to record all times. Additionally, a stop watch can be started when first chest compressions are initiated (time zero), which will facilitate interval determination and allows cross-referencing with the clock. Due to the difficulty of consistently and accurately recording times and intervals, such event data are supplemental with the exception of four key time variables (Figure 1). These are the time at which CPA was identified (C), the time when CPR was started (C), defined as the point in time at which chest compressions were initiated, the time when open-chest CPR was started (C), and the time when CPR was stopped (C) as a consequence of sustained ROSC or death. Other time variables that must be recorded are the time and date of in-hospital death (C) in animals that initially survived the event and time and date of hospital discharge (C).

Outcome variables

Return of spontaneous circulation

Any ROSC (C) refers to clinical signs of restored effective circulation of >30 seconds of ROSC, such as a palpable pulse, systolic blood pressure measurement of >60 mm Hg in the presence of a direct arterial blood pressure measurement waveform, or a marked increase in $ETCO_2$. *Sustained ROSC* (C) is present when ROSC continues for at least 20 minutes. When sustained ROSC



STANDARD REPORTING OF VETERINARY SMALL ANIMAL CARDIOPULMONARY RESUSCITATION

CLOCK Time: Hr | Min

STOP WATCH Interval: Min | Sec (0 | 0)

Client name (Last) | MRN | Date of event (Day / Month / Year)

Pet name | ☐ Cat ☐ Dog → Chest conformation ☐ Round ☐ Keel ☐ Flat

Weight: ☐ lbs ☐ kg

EVENT WITNESSED — Not witnessed: ☐

COMPRESSIONS STARTED — Not started because: ☐ DNAR ☐ Futile ☐ False arrest ☐ Respiratory arrest only

VENTILATION STARTED — ☐ ET tube [Size] ☐ Tracheostomy [Size] ☐ Face mask ☐ Mouth-to-snout ☐ Supraglottic AW — Mode: ☐ manual ☐ mechanical

FIRST VASCULAR ACCESS — Type:_____ Loc: _____ Other access: Type:_____ Loc: _____ ☐ Already in place at time of CPA: Type:_____ Loc: _____

CPR STOPPED — Reason stopped: ☐ Survived event (ROSC > 20 min) ☐ Unresponsive to ALS ☐ Clinician choice ☐ Owner request/euthanasia → ☐ Econo

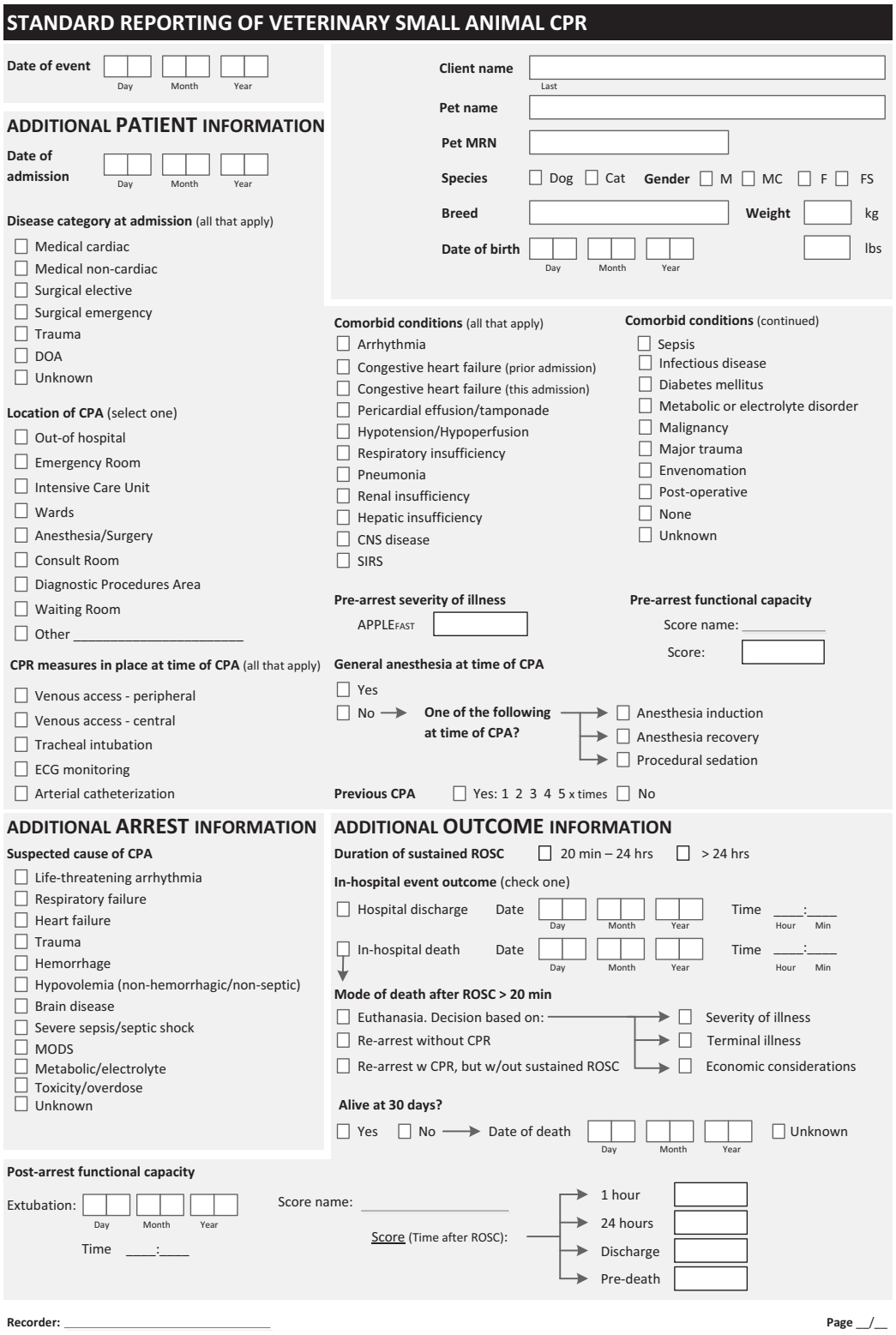
MONITORING	DRUGS	DEFI	OPEN?	Re-arrest?
☐PEA ☐Asystole ☐VF ☐VT ☐Brady ☐Any ROSC ☐$ETCO_2$=	Epi Atr Vaso [Other] [mL] [Route]	☐ [J]	☐ Yes	☐ Yes

(repeated for each row)

ADDITIONAL NOTES

Recorder: _____ Page __/__

Figure 2: Continued



STANDARD REPORTING OF VETERINARY SMALL ANIMAL CPR

Date of event ☐☐ Day ☐☐ Month ☐☐ Year

Client name ____ Last

Pet name ____

Pet MRN ____

Species ☐ Dog ☐ Cat Gender ☐ M ☐ MC ☐ F ☐ FS

Breed ____ Weight ☐☐ kg ☐☐ lbs

Date of birth ☐☐ Day ☐☐ Month ☐☐ Year

ADDITIONAL PATIENT INFORMATION

Date of admission ☐☐ Day ☐☐ Month ☐☐ Year

Disease category at admission (all that apply)
- ☐ Medical cardiac
- ☐ Medical non-cardiac
- ☐ Surgical elective
- ☐ Surgical emergency
- ☐ Trauma
- ☐ DOA
- ☐ Unknown

Location of CPA (select one)
- ☐ Out-of hospital
- ☐ Emergency Room
- ☐ Intensive Care Unit
- ☐ Wards
- ☐ Anesthesia/Surgery
- ☐ Consult Room
- ☐ Diagnostic Procedures Area
- ☐ Waiting Room
- ☐ Other _____

CPR measures in place at time of CPA (all that apply)
- ☐ Venous access - peripheral
- ☐ Venous access - central
- ☐ Tracheal intubation
- ☐ ECG monitoring
- ☐ Arterial catheterization

Comorbid conditions (all that apply)
- ☐ Arrhythmia
- ☐ Congestive heart failure (prior admission)
- ☐ Congestive heart failure (this admission)
- ☐ Pericardial effusion/tamponade
- ☐ Hypotension/Hypoperfusion
- ☐ Respiratory insufficiency
- ☐ Pneumonia
- ☐ Renal insufficiency
- ☐ Hepatic insufficiency
- ☐ CNS disease
- ☐ SIRS

Comorbid conditions (continued)
- ☐ Sepsis
- ☐ Infectious disease
- ☐ Diabetes mellitus
- ☐ Metabolic or electrolyte disorder
- ☐ Malignancy
- ☐ Major trauma
- ☐ Envenomation
- ☐ Post-operative
- ☐ None
- ☐ Unknown

Pre-arrest severity of illness
APPLE$_{FAST}$ ☐☐

Pre-arrest functional capacity
Score name: _____
Score: ☐☐

General anesthesia at time of CPA
- ☐ Yes
- ☐ No → One of the following at time of CPA?
  - ☐ Anesthesia induction
  - ☐ Anesthesia recovery
  - ☐ Procedural sedation

Previous CPA ☐ Yes: 1 2 3 4 5 x times ☐ No

ADDITIONAL ARREST INFORMATION

Suspected cause of CPA
- ☐ Life-threatening arrhythmia
- ☐ Respiratory failure
- ☐ Heart failure
- ☐ Trauma
- ☐ Hemorrhage
- ☐ Hypovolemia (non-hemorrhagic/non-septic)
- ☐ Brain disease
- ☐ Severe sepsis/septic shock
- ☐ MODS
- ☐ Metabolic/electrolyte
- ☐ Toxicity/overdose
- ☐ Unknown

ADDITIONAL OUTCOME INFORMATION

Duration of sustained ROSC ☐ 20 min – 24 hrs ☐ > 24 hrs

In-hospital event outcome (check one)
- ☐ Hospital discharge Date ☐☐ Day ☐☐ Month ☐☐ Year Time ____:____ Hour Min
- ☐ In-hospital death Date ☐☐ Day ☐☐ Month ☐☐ Year Time ____:____ Hour Min

Mode of death after ROSC > 20 min
- ☐ Euthanasia. Decision based on:
  - ☐ Severity of illness
  - ☐ Terminal illness
  - ☐ Economic considerations
- ☐ Re-arrest without CPR
- ☐ Re-arrest w CPR, but w/out sustained ROSC

Alive at 30 days?
☐ Yes ☐ No → Date of death ☐☐ Day ☐☐ Month ☐☐ Year ☐ Unknown

Post-arrest functional capacity
Extubation: ☐☐ Day ☐☐ Month ☐☐ Year
Time ____:____

Score name: _____
Score (Time after ROSC):
- 1 hour ☐☐
- 24 hours ☐☐
- Discharge ☐☐
- Pre-death ☐☐

Recorder: _____ Page __/__

Figure 2: Standard case report form for veterinary small animal in-hospital CPR events. MRN = medical record number; ET = endotracheal; AW = airway; Loc = location; CPA = cardiopulmonary arrest; ROSC = return of spontaneous circulation; ALS = advanced life support; Econo = economic; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = pulseless ventricular tachycardia; Brady = severe bradycardia; $ETCO_2$ = end tidal carbon dioxide; Epi = epinephrine or adrenaline; Atr = atropine; Vaso = vasopressin; DEFI = defibrillation; J = joules; OPEN? = was open-chest CPR administered?

occurs, resuscitation is considered successful and the CPR event is survived. Accordingly, the end of a CPR event is either marked by discontinuation of BLS and ALS with death ensuing or by sustained ROSC. All occurrences of any ROSC and sustained ROSC should be recorded. If any ROSC is not achieved, the cause for it (ie, cause for no ROSC, [C]) should be captured as either unresponsive to ALS (ie, despite maximum effort, any ROSC was not achieved), discontinued by a clinician's choice due to perceived futility (ie, severe critical illness or terminal disease as precipitating diseases or comorbidities), or discontinued due to owner's choice. Similarly, if sustained ROSC is not achieved, the cause for it (ie, cause for no sustained ROSC, [C]) should be indicated as rearrest and unresponsive to ALS, rearrest and CPR stopped by clinician choice, rearrest and CPR stopped by owner's choice, or euthanasia shortly after any ROSC. For the latter two arguments, it should be declared whether the decision was made primarily on economic grounds or in response to a poor prognosis. The task force regards reporting economic motivation for discontinuation of CPR or euthanasia after ROSC as fundamentally important, because this decision is not based on the animal's true outcome potential (ie, as if CPR was continued until declared unsuccessful). Euthanasia is the primary mechanism of death in dogs and cats that achieved ROSC, with euthanasia rates reported as 60% and 65%, respectively.[6]

Survival to discharge (C) and 30-day survival (S)

Long-term outcome should be reported as *survival to hospital discharge* and *survival to 30 days* following the CPA event. Hospital discharge refers to discharge home with or without outpatient veterinary care and should be reported. If discharge occurs to another veterinary facility for continued in-hospital care, the final discharge from that hospital must be obtained. If a dog or cat with sustained ROSC does not survive to hospital discharge, the time and date of death (C) and the mode of death (rearrest without resuscitation attempt; rearrest with resuscitation attempt but no sustained ROSC, or euthanasia; [C]) should be recorded, and the cause of euthanasia (C) must be characterized with regards to economic consideration. Since 30-day survival may be difficult to obtain in all cases, this variable is supplemental only. If the animal was discharged alive but did not survive to 30 days after ROSC, the date of death should be recorded (S) and whether death was related to a consequence of CPA, the cause of the CPA, or unrelated to either (S).

Functional outcome

A simple, validated tool should be used to report the animal's postarrest functional capacity (C) 1 and 24 hours after ROSC and at the time of hospital discharge. As no tools are available that have been validated specifically for clinical PCA neurological function testing in dogs or cats, feasible tools that have been previously used in clinical or experimental canine studies, such as MGCS, NDS, OPC, or the modified Kamovsky performance score may be employed. The same tool should be used as for prearrest functional capacity. No consensus was achieved regarding the exclusive recommendation of a specific functional assessment tool, and the task force recognizes the urgent need to validate either an available or novel, simple functional score for the use of clinical CPR research and registries. It is the consensus opinion that most animals display minimal neurological impairment at the time of discharge, likely due to the possibility of euthanasia in cases of more severe levels of neurological dysfunction.

Veterinary Utstein CPR reporting template

The Utstein template serves as a succinct guideline for reporting the most important and feasible core event variables for population description in clinical trials, observational studies, or registry reports (Figure 3). The feasibility is important for collection of accurate data. The task force therefore believes that the recommended dataset will return robust, reliable data. The template is species specific, in that dogs and cats should be reported separately.

Not all animals with cardiopulmonary compromise requiring resuscitation will be easily identified for retrospective observational studies or registries and thus the case number may be inaccurate and reporting this value is of limited benefit. However, in most prospective research studies, the number of animals requiring resuscitation can be determined and will be important to report. Prospective study designs would also require a summary report on why these animals were not resuscitated in order to permit assessment of the risk of selection bias.

In most clinical CPR studies, patients with respiratory arrests only are not reported in any further detail besides enumeration of the proportional contribution to the entire resuscitated population, unless specifics of the research objectives require additional information. If that is the case, outcomes of animals with respiratory arrest only must be reported separately.

The animals that should be further followed in CPR studies and registries are those in which cardiopulmonary compromise was identified and that were treated with chest compressions. The number of these animals is represented in the "Cardiopulmonary Arrest" box. For this population, summary statistics on the suspected causes and the location of arrest should be tabulated. The only other arrest variable to be reported is the first identified rhythm.

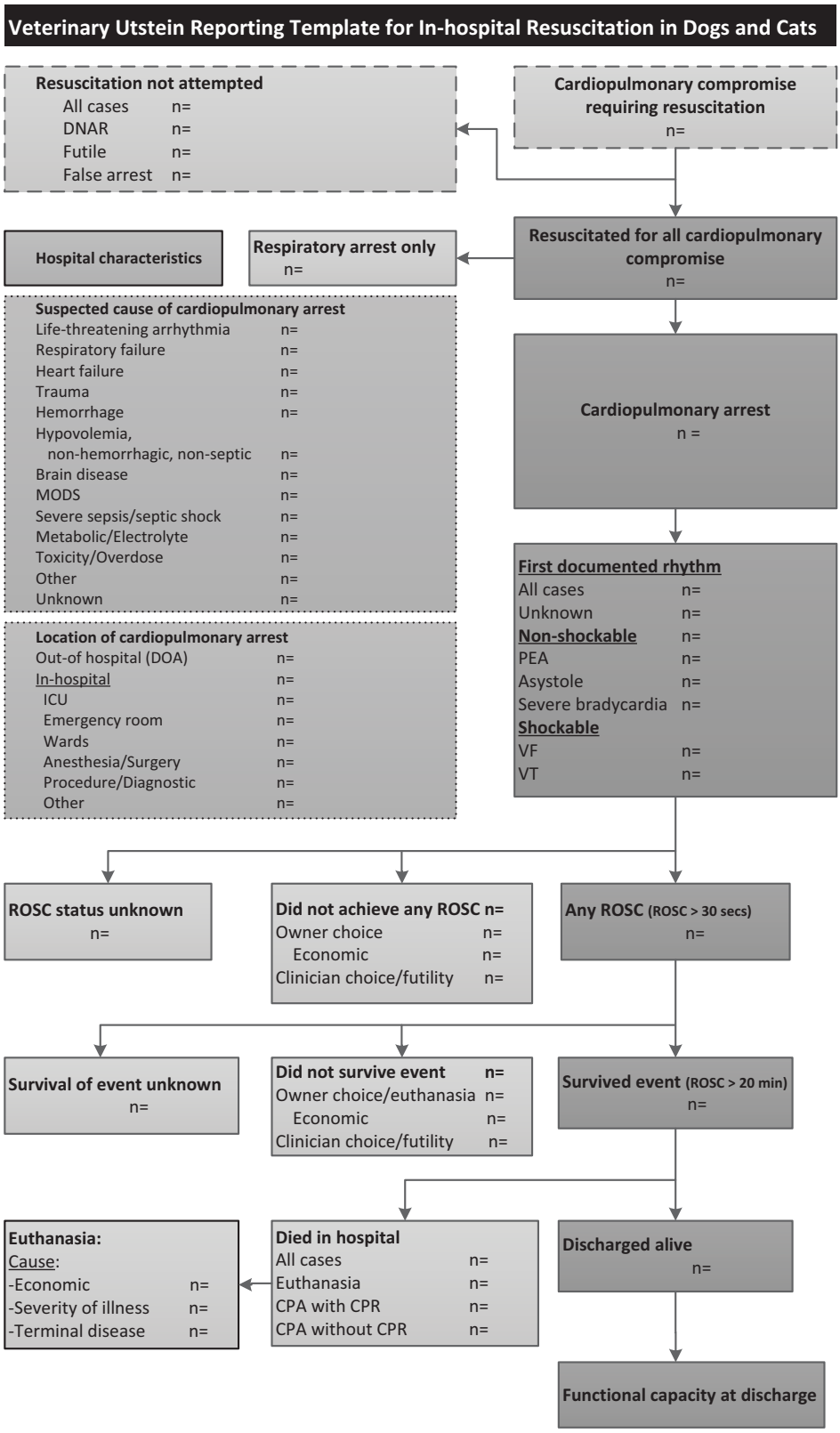


Figure 3: Utstein-style template for veterinary small animal in-hospital CPR. DNAR = do not attempt resuscitation; MODS = multiple organ dysfunction syndrome; DOA = dead on arrival; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = pulseless ventricular tachycardia; ROSC = return of spontaneous circulation; CPA = cardiopulmonary arrest.

The remaining data elements concern outcome, specifically any ROSC, sustained ROSC (survived event), survival to hospital discharge, and neurological function at hospital discharge. As euthanasia was reported to be a common mode of death in animals with ROSC in the United States, it fundamentally influences survival to hospital discharge rates.[6,7] A reason for why euthanasia occurred is therefore of critical importance to interpret survival to hospital discharge and must be provided. Similarly, if owner's choice was the reason the animal did not achieve any ROSC or sustained ROSC, a significant economic component to this decision making must be reported.

Veterinary Utstein CPR CRF

One of the greatest hurdles for effective resuscitation science is the unpredictable and instant need for case enrollment and case information gathering. This creates logistic challenges in particular for interventional clinical trials but generally jeopardizes the control over data collection. Most, if not all, veterinary centers depend on manual recording of event data on a paper CRF. This form is primarily designed as a part of the medical record and combines the need for adequately describing patient condition and interventions and for provision of a basis for billing.

In order to facilitate data collection that fulfills the requirements of the Utstein veterinary CPR reporting guidelines and of hospital-centered case management, the task force constructed a CRF template (Figure 2). Other than patient identification and a limited set of patient variables, all data to be recorded on the first page consist of arrest variables to be recorded while the resuscitation is progressing. The second page, most conveniently copied on the back of the same sheet of paper, includes additional patient, arrest, and outcome variables that can be recorded after conclusion of the resuscitation event. The form is designed to report only one resuscitation event. Thus, if a CPR event is survived (ie, ROSC of more than 20 minutes) and the animal rearrests thereafter, a new CRF will be required for this second resuscitation event.

Upon completion of the CRF, all data elements required for Utstein-style reporting of veterinary CPR will have been obtained. Thus, this form may serve as a template to construct a CRF for clinical studies or registries. All data elements follow the terminology and definitions provided in this manuscript, so that little if any ambiguity should persist regarding the data requested.

Limitations and future directions

These Utstein-style veterinary small animal CPR reporting guidelines are expected to have a positive impact on the quality and quantity of veterinary resuscitation research, but they may not be sufficient for every project. The task force went to great lengths to find a balance between simplicity and comprehensiveness. We believe that the data requested are feasible to collect accurately in many veterinary practice settings. On the other hand, not all potentially important CPR variables are requested because of likely impracticability and the associated risk of acquired data being unreliable. For that reason, metrics of CPR quality (eg, compression rate, ventilation rate, no-compression fraction, compression depth) were not included, even though CPR quality is well accepted to influence outcome and the RECOVER guidelines very specifically address these issues.[44] However, to record CPR quality elements reliably, new technology would be necessary to capture compression rates, depth, and pauses for later analysis. Modern defibrillators have sensors included that allow such data acquisition[45]; however, these are not suitable for use in animals due to differences in chest conformation and other variation. The availability of such technology would be essential to accurately assess CPR quality, as evidence suggests that even team leaders supported by feedback devices are not able to recall major CPR quality deficits within 24 hours of event conclusion.[46] It is the opinion of the task force that the integrity of data is more important than the quantity. Investigators equipped to accurately capture CPR quality metrics however, are strongly encouraged to add these data to the Utstein-style report.

While these guidelines will likely improve the consistency of reported data, they will not prevent some other issues that arise with design and execution of research studies and registries. For example, missed cases in registries are commonly reported and can severely jeopardize data integrity if the missed cases have unifying characteristics (eg, cases with high comorbidities preferentially missed).[47] These Utstein-style guidelines will therefore not replace the need for meticulous study planning and registry organization.

Lastly, the task force recognizes that a strategy to effectively reduce the number of deaths due to IHCA includes measures beyond BLS and ALS, and a report on procedural elements of all links of this chain of survival of veterinary CPR would be necessary to assess the quality of the entire system.[48] Foremost, a large proportion of patients that initially survived the CPA event will continue to die during the PCA phase.[6,7] PCA care guidelines have been developed for human and veterinary medicine and PCA care was demonstrated to improve survival in people with OHCA and IHCA.[49–52] PCA care elements are only indirectly included in these recommendations as the hospital characterization describes the presence of an intensive care unit and specialists. However, case details, such as the use of mild therapeutic hypothermia,

permissive hypothermia, targeted oxygenation, ventilation, and variables of hemodynamic optimization are not included, primarily because the concern that these data are not reliably reported. However, PCA care reporting guidelines may be included in the future.

Conclusion

In-hospital small animal CPR constitutes a highly complex sequence of processes and involves a heterogeneous population of animals. Furthermore, the unpredictable occurrence of CPA and overall low survival to discharge create a challenging research environment, where it is difficult to associate specific interventions or processes with outcome. Recommendations for standardized reporting of veterinary CPR are provided in this document. It is the hope of the task force that by clarifying veterinary CPR terminology and by suggesting a prioritized list of data elements to be reported, high-quality veterinary CPR research will occur and comparison between reported data from different studies and across study sites will be facilitated. Moreover, this document may serve as a foundation for registries in veterinary CPR. The task force, however, anticipates that these reporting guidelines may require updating in the future as new information and experience accumulates that demonstrates the importance of individual data elements and the feasibility to collect them reliably.

Acknowledgments

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Footnotes

[a] Veterinary Emergency and Critical Care Society. RECOVER – Spanish [Internet]. USA: VECCS; 2015 [cited 2015 Nov 1]. Available from: http://www.veccs.org/index.php?option=com_content&view=article&id=167&Itemid=321.

[b] Kawase KU, Takaki M, Teranishi A, Yamashita K. Outcome of cardiopulmonary resuscitation in dogs at a nighttime emergency animal hospital in Japan (2012–2015). J Vet Emerg Crit Care 2015; 25(S1):S13.

References

1. Boller M, Kellett-Gregory L, Shofer FS, et al. The clinical practice of CPCR in small animals: an internet-based survey. J Vet Emerg Crit Care 2010; 20(6):558–570.
2. 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(Suppl):S4–S12.
3. 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 (Suppl):S102–S131.
4. Kass PH, Haskins SC. Survival following cardiopulmonary resuscitation in dogs and cats. J Vet Emerg Crit Care 1992; 2(2):57–65.
5. Wingfield WE, Van Pelt DR. Respiratory and cardiopulmonary arrest in dogs and cats: 265 cases (1986–1991). J Am Vet Med Assoc 1992; 200(12):1993–1996.
6. McIntyre RL, Hopper K, Epstein SE. Assessment of cardiopulmonary resuscitation in 121 dogs and 30 cats at a university teaching hospital (2009–2012). J Vet Emerg Crit Care 2014; 24(6):693–704.
7. Hofmeister EH, Brainard BM, Egger CM, et al. 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.
8. Hopper K, Borchers A, Epstein SE. Acid base, electrolyte, glucose, and lactate values during cardiopulmonary resuscitation in dogs and cats. J Vet Emerg Crit Care 2014; 24(2):208–214.
9. Waldrop JE, Rozanski EA, Swanke ED, et al. Causes of cardiopulmonary arrest, resuscitation management, and functional outcome in dogs and cats surviving cardiopulmonary arrest. J Vet Emerg Crit Care 2004; 14(1):22–29.
10. Buckley GJ, Rozanski EA, Rush JE. Randomized, blinded comparison of epinephrine and vasopressin for treatment of naturally occurring cardiopulmonary arrest in dogs. J Vet Intern Med 2011; 25(6):1334–1340.
11. Hsieh M, Dailey MW, Callaway CW. Surrogate consent by family members for out-of-hospital cardiac arrest research. Acad Emerg Med 2001; 8(8):851–853.
12. Schmidt TA, Salo D, Hughes JA, et al. Confronting the ethical challenges to informed consent in emergency medicine research. Acad Emerg Med 2004; 11(10):1082–1089.
13. Cummins RO, Chamberlain DA, Abramson NS, et al. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein style. Circulation 1991; 84(2):960–975.
14. Idris AH, Becker LB, Ornato JP, et al. Utstein-style guidelines for uniform reporting of laboratory CPR research. Circulation 1996; 94(9):2324–2336.
15. Cummins RO, Chamberlain D, Hazinski MF, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital "Utstein style." Circulation 1997; 95(8):2213–2239.
16. Dick WF, Baskett PJF. Recommendations for uniform reporting of data following major trauma—the Utstein style: a report of a working party of the International Trauma Anaesthesia and Critical Care Society (ITACCS). Resuscitation 1999; 42(2):81–100.
17. Zaritsky A, Nadkarni V, Hazinski MF, et al. Recommended guidelines for uniform reporting of pediatric advanced life support: the pediatric Utstein style. A statement for healthcare professionals from a task force of the American Academy of Pediatrics, the American Heart Association, and the European resuscitation council writing group. Circulation 1995; 92(7):2006–2020.
18. Langhelle A, Nolan J, Herlitz J, et al. Recommended guidelines for reviewing, reporting, and conducting research on post-resuscitation care: the Utstein style. Resuscitation 2005; 66(3):271–283.
19. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein resuscitation registry templates for out-of-hospital cardiac arrest. Circulation 2015; 132(13):1286–1300.
20. Boulkedid R, Abdoul H, Loustau M, et al. Using and reporting the Delphi method for selecting healthcare quality indicators: a systematic review. PLoS One 2011; 6(6):e20476.
21. Akahane M, Ogawa T, Koike S, et al. The effects of sex on out-of-hospital cardiac arrest outcomes. Am J Med 2011; 124(4):325–333.
22. Topjian AA, Localio AR, Berg RA, et al. Women of child-bearing age have better inhospital cardiac arrest survival outcomes than do equal-aged men. Crit Care Med 2010; 38(5):1254–1260.
23. Bougouin W, Mustafic H, Marijon E, et al. Gender and survival after sudden cardiac arrest: a systematic review and meta-analysis. Resuscitation 2015; 94:55–60.
24. Noppens RR, Kofler J, Grafe MR, et al. Estradiol after cardiac arrest and cardiopulmonary resuscitation is neuroprotective and mediated through estrogen receptor-β. J Cereb Blood Flow Metab 2009; 29(2):277–286.

25. Deschamps AM, Murphy E, Sun J. Estrogen receptor activation and cardioprotection in ischemia reperfusion injury. Trends Cardiovasc Med 2010; 20(3):73–78.
26. Babbs CF, Voorhees WD, Fitzgerald KR, et al. Relationship of blood pressure and flow during CPR to chest compression amplitude: evidence for an effective compression threshold. Ann Emerg Med 1983; 12(9):527–532.
27. Boyd LM, Langston C, Thompson K, et al. Survival in cats with naturally occurring chronic kidney disease (2000–2002). J Vet Intern Med 2008; 22(5):1111–1117.
28. Brady WJ, Gurka KK, Mehring B, et al. In-hospital cardiac arrest: impact of monitoring and witnessed event on patient survival and neurologic status at hospital discharge. Resuscitation 2011; 82(7):845–852.
29. Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. Intensive Care Med 2007; 33(2):237–245.
30. Hayes G, Mathews K, Doig G, et al. The Feline Acute Patient Physiologic and Laboratory Evaluation (Feline APPLE) Score: a severity of illness stratification system for hospitalized cats. J Vet Intern Med 2011; 25(1):26–38.
31. Hayes G, Mathews K, Doig G, et al. The Acute Patient Physiologic and Laboratory Evaluation (APPLE) Score: a severity of illness stratification system for hospitalized dogs. J Vet Intern Med 2010; 24(5):1034–1047.
32. Platt SR, Radaelli ST, McDonnell JJ. The prognostic value of the modified Glasgow Coma Scale in head trauma in dogs. J Vet Intern Med 2001; 15(6):581–584.
33. Safar P, Xiao F, Radovsky A, et al. Improved cerebral resuscitation from cardiac arrest in dogs with mild hypothermia plus blood flow promotion. Stroke 1996; 27(1):105–113.
34. Brindley PG, Markland DM, Mayers I, Kutsogiannis DJ. Predictors of survival following in-hospital adult cardiopulmonary resuscitation. CMAJ 2002; 167(4):343–348.
35. Meaney PA, Nadkarni VM, Kern KB, et al. Rhythms and outcomes of adult in-hospital cardiac arrest. Crit Care Med 2010; 38(1):101–108.
36. Skrifvars MB, Castren M, Nurmi J, et al. Do patient characteristics or factors at resuscitation influence long-term outcome in patients surviving to be discharged following in-hospital cardiac arrest? J Intern Med 2007; 262.
37. Wallmuller C, Meron G, Kurkciyan I, et al. Causes of in-hospital cardiac arrest and influence on outcome. Resuscitation 2012; 83(10):1206–1211.
38. Rozanski EA, Rush JE, Buckley GJ, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 4: advanced life support. J Vet Emerg Crit Care 2012; 22(Suppl 1):S44–64.
39. Hauptman JG, Walshaw R, Olivier NB. Evaluation of the sensitivity and specificity of diagnostic criteria for sepsis in dogs. Vet Surg 1997; 26(5):393–397.
40. Kenney EM, Rozanski EA, Rush JE, et al. Association between outcome and organ system dysfunction in dogs with sepsis: 114 cases (2003–2007). J Am Vet Med Assoc 2010; 236(1):83–87.
41. Brainard BM, Boller M, Fletcher DJ, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 5: monitoring. J Vet Emerg Crit Care 2012; 22(Suppl 1):S65–S84.
42. Donnino MW, Salciccioli JD, Howell MD, et al. Time to administration of epinephrine and outcome after in-hospital cardiac arrest with non-shockable rhythms: retrospective analysis of large in-hospital data registry. BMJ 2014; 348:g3028.
43. Hara M, Hayashi K, Hikoso S, et al. Different impacts of time from collapse to first cardiopulmonary resuscitation on outcomes after witnessed out-of-hospital cardiac arrest in adults. Circ Cardiovasc Qual Outcomes 2015; 8(3):277–284.
44. Yannopoulos D, Aufderheide TP, Abella BS, et al. Quality of CPR: an important effect modifier in cardiac arrest clinical outcomes and intervention effectiveness trials. Resuscitation 2015; 94: 106–113.
45. Sutton RM, Niles D, French B, et al. First quantitative analysis of cardiopulmonary resuscitation quality during in-hospital cardiac arrests of young children. Resuscitation 2014; 85(1):70–74.
46. McInnes AD, Sutton RM, Nishisaki A, et al. Ability of code leaders to recall CPR quality errors during the resuscitation of older children and adolescents. Resuscitation 2012; 83(12):1462–1466.
47. Krumholz HM. Registries and selection bias the need for accountability. Circ Cardiovasc Qual Outcomes 2009; 2(6):517–518.
48. Boller M, Boller EM, Oodegard S, Otto CM. Small animal cardiopulmonary resuscitation requires a continuum of care: proposal for a chain of survival for veterinary patients. J Am Vet Med Assoc 2012; 240(5):540–554.
49. Smarick SD, Haskins SC, Boller M, et al. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 6: post-cardiac arrest care. J Vet Emerg Crit Care 2012; 22(Suppl 1):S85–S101.
50. Stub D, Schmicker RH, Anderson ML, et al. Association between hospital post-resuscitative performance and clinical outcomes after out-of-hospital cardiac arrest. Resuscitation 2015; 92:45–52.
51. Girotra S, Nallamothu BK, Spertus JA, et al. Trends in survival after in-hospital cardiac arrest. N Engl J Med 2012; 367(20):1912–1920.
52. Callaway CW, Donnino MW, Fink EL, et al. Part 8: post–cardiac arrest care: 2015 American Heart Association Guidelines Update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2015; 132(18 Suppl 2):S465–S482.