CPR and the RECOVER initiative

Justine A. Lee, DVM, DACVECC, DABT
CEO, VETgirl
justine@vetgirlontherun.com

Garret Pachtinger, VMD, DACVECC
COO, VETgirl
garret@vetgirlontherun.com

Introduction

Justine A. Lee, DVM,
DACVECC, DABT
CEO, VETgirl

Conflict of Interest Disclosure
Introduction

Garret Pachtinger, VMD, DACVECC
COO, VETgirl
Associate, VSEC

• The tech-savvy way to get CE credit!
• A subscription-based podcast & webinar service offering veterinary RACE-approved, online CE

VETgirl…On-The-Run

• VETgirl Standard: 50-60 podcasts/year
  • $99/year
  • 4 hours of RACE-CE

• VETgirl ELITE: 50-60 podcasts/year plus 20 hours of webinars!
  • $199/year
  • 20+ hours of RACE-CE

Subscription Plans
Members: iTunes Download!

Find us on social media and our blog!

Logistics: CE Certificates
- No need to raise your hand!
- Type in questions
- Emailed to you 48 hours after the webinar
- Active participation = no quiz
- Watching video later, must complete quiz
  - ELITE members only
- Email / contact with ANY questions
  - garret@vetgirlontherun.com
  - justine@vetgirlontherun.com
Call in from Smart Phone!

How To Join The Webinar
Wed, Jun 18, 2014 7:00 PM - 8:00 PM EDT

1. Click the link to join the webinar at the specified time and date:
   https://attendee.gotowebinar.com/l/359256560

2. Choose one of the following audio options:
   TO USE YOUR COMPUTER'S MICROPHONE:
   When the webinar begins, you will be connected to audio using your computer's microphone and
   speakers/telephone. A headset is recommended.
   TO USE YOUR TELEPHONE:
   When you click the join button, you must select "Use telephone" after joining the webinar and call in
   United States
   Tel.: +1 (646) 516-1512
   Audio: +1 (781) 756-6742
   Audio PIN: Please check after joining the webinar
   Webinar ID: 114-AGI-9E7

Goals

- Getting a code
  - survival
- Definition of CPA
- Patient assessment
- ABCs of CPR
  - Airway
  - Breathing
  - Circulation
    - arrhythmias
    - compressions
- Advanced life support
  - Class of drugs
  - Defibrillation
  - Chemical support
- Prolonged life support

CPR in veterinary medicine

- Overall studies:
  - Dogs: 25% survival
  - Cats: 22%
- Haskins and Kass 1992:
  - 1 week survival rates < 4% (both dogs and cats)
- Wingfield 1992:
  - 4.1% dogs, 9.6% cats
- Human medicine:
  - 21 and 29% survival
Cardiopulmonary arrest (CPA)

- CPA: the abrupt, unexpected cessation of spontaneous and effective ventilation and circulation

- CPCR/CRP: cardiopulmonary cerebral resuscitation: the provision of artificial ventilation and perfusion until advanced life support can be provided
  - Basic life support
  - Advanced life support
  - Prolonged life support

How do I get a 100% return with CPCR?

Prevent, prevent, prevent!
ABC’s of Basic Life Support

• A = airway
• B = breathing
• C = circulation

• Or is it?

Reassessment Campaign on Veterinary Resuscitation (RECOVER)

1. Preventative measures and Preparedness
2. Basic Life Support
3. Advanced life support
4. Monitoring
5. Post-cardiac arrest care
CPR = Poor Prognosis

- Overall poor prognosis
- 4.1% survival rate for dogs
- 9.6% survival rate for cats
  - Humans > veterinary
  - Etiology important
  - Anesthesia related > other
  - Respiratory > full CPA
- Until now guidelines were derived from humans

Pearl 1: They’re already dead…

Pearl 2: Get a code
WHAT TO SAY TO THE OWNER

• Red code/DNR
• Yellow code (e.g., closed chest CPR)
  • full resuscitation that stops short of internal cardiac massage
  • $
• Green code (e.g., open chest CPR)
  • full resuscitation with internal cardiac massage, ventilator support
  • $$$

Pearl 3:
Preparation not perspiration….

• Essential for efficient CPR
• Problems:
  • Missing equipment
  • Unable to identify/find drugs
  • Equipment failure
  • Most often human error
• Solutions:
  • Educate, train, plan
  • Standardize crash carts
  • Regularly stock crash carts

PRE-STOCKED ARREST STATION

Monitoring equipment
  • Defibrillator
  • Endotracheal tubes/laryngoscope
  • Suction and other catheters etc
  • Prepared crash drugs
  • Other drugs
Other Ways to Improve CPR Efforts

• CPR Workshops / Lectures in practice
• Post-CPR debriefing
• Standardized training programs
• Use of manikins / devices

Pearl 4: Better CPR Candidates?

• Anesthetic events
• Neonates
• Arrests in hospital > presents DOA
• Trauma > SEPSIS / SIRS / MODS

Pearl 5:
It’s a good thing you’re here…
Reassessment Campaign on Veterinary Resuscitation (RECOVER)

1. Preventative measures and Preparedness
2. Basic Life Support
3. Advanced life support
4. Monitoring
5. Post-cardiac arrest care

Why do our patients arrest?

• Most common arrest rhythm = pulseless electrical activity
• Asystole
• Ventricular fibrillation
• Sinus bradycardia

Patient assessment
### Diagnosis of arrest:
- Absence of a palpable pulse (< 60 mmHg)
- Absence of heart sounds (< 50 mmHg)
- Dilation of pupils
- Agonal breathing

### Warning signs of CPA
- Weak, irregular pulses
- Bradycardia or severe tachycardia
- Changes in respiratory rate, effort, or pattern
- Cyanosis
- Hypothermia
- Hypotension

### Basic Life Support (BLS)
- Proper technique and timing essential
- Any delay leads to a worse prognosis
- Successful outcome when well prepared
- Quick assessment, recognition and intervention
Disco Saves Lives
“Stayin’ Alive”

Basic Life Support: Airway

• ABC’s
• Do not delay chest compressions in order to intubate! Recommended to intubate in lateral recumbency
• Maybe difficult to intubate
  ▪ Laryngoscope, stylet
  ▪ Suction if necessary
  ▪ Direct palpation if necessary

Basic Life Support: Airway

• Inflate the cuff and secure the tube
• Check placement
  ▪ Visualize, palpate, auscult, chest wall movement
  ▪ End-tidal CO₂ always higher in trachea vs. esophagus
• Problems (can’t hear lungs/chest not moving)
  ▪ Severe pleural space/parenchymal disease
Basic Life Support: Breathing

- Manually ventilate with 100% oxygen
- Ambu-bag, anesthesia machine *(be sure to flush system if inhalant gas on)*
- 10 bpm
- Inspiratory time of 1 sec and a tidal volume of 10 ml/kg
- Avoid excessive ventilation!!

Excessive ventilation rates

- Increased intrathoracic pressure
  - Decreased coronary perfusion
  - Decreased cerebral perfusion
  - Decreased survival
### Basic Life Support: Ventilation

- Mouth to snout
- No studies, just a case report
- May effectively oxygenate and ventilate
- Hold patients mouth tightly closed, place mouth over nares making a tight seal, and give some breaths
- Suggested CV ratio is 30:2

### Basic Life Support: Circulation

- Best external compressions can only generate 25% of normal cardiac output
- Perform GOOD CHEST COMPRESSIONS!
- Two theories
  - Cardiac pump model for small animals
  - Thoracic pump model for large animals

### Circulation Closed chest CPR (CC CPR)

- Cardiac pump theory
  - For cats (one hand)
  - For dogs < 15 kgs (right lateral)
  - Artificial “systole” via chest compression compresses the V>A resulting in closure of the AV value
Cardiac pump theory

- Artificial “systole” via chest compression compresses the V>A resulting in closure of the AV value
- Causes ejection of blood into the systemic arteries
- During chest relaxation or “diastole,” intracardiac pressure falls and V<A pressure, resulting in opening of AV valves and ventricular filling

Thoracic pump theory

- For dogs > 15 kgs
- Right lateral
  - Widest part of the chest
- No direct heart compression

Thoracic pump theory

- No direct heart compression
- Theory: blood flow generated by external thoracic compression is the result of an increase in intrathoracic pressure
Thoracic pump theory

• The majority of blood flow results from an increase in intrathoracic pressure and not directly from cardiac compression!
  • Compress over the widest part of the chest
  • 60-100 bpm
  • Increase amount of compression force and displacement

Basic Life Support: Circulation

• For cats and small dogs
  • Perform chest compressions directly over the heart

Basic Life Support: Circulation

• For large dogs
  • Compress over the widest part of the thorax
  • Stack hands, compress with the palms
Basic Life Support: Circulation

- Barrel-chested breeds
- Dorsal recumbency
- Hands directly over the heart

Compression rate should be AT LEAST 100-120 per minute, if not higher
- Deep compressions important
  - Compress the width of the chest by 1/3-1/2
- Allow for full recoil! Blood needs to flow back
- Don’t lean
- Stand behind the animal (spine towards you) and from above (use a stool if necessary)

Don’t ask - just change compressors every 2 mins – avoid fatigue
- Minimize interruptions of chest compressions to less than 10 secs every 2 mins
- Evaluate the ECG no more frequently than every 2 mins
Basic Life Support: Circulation
• Interposed Abdominal Compression
  • Abdomen is compressed during
    relaxation phase of chest compression

Reassessment Campaign on Veterinary Resuscitation (RECOVER)
1. Preventative measures and Preparedness
2. Basic Life Support
3. Advanced life support
4. Monitoring
5. Post-cardiac arrest care

Advanced: ResQPOD
• Selectively impedes inspiratory gases during the release phase of CPR, resulting in:
  • Increased negative pressure in the chest
  • Greater venous return to the heart
  • Increased coronary perfusion
  • Increased blood flow during the next compression
Open Chest CPR

- Can achieve 100% cardiac output
- Allows for cross clamping of aorta
- Indications:
  - Significant pleural space disease
  - Chest wall disease
  - Pericardial effusion
  - Intra-operative arrests
  - Hemoabdomen
  - Large dogs
  - Unsuccessful closed chest CPR (after 5 mins)

Open Chest CPR

- Disadvantages
  - Need experienced team
  - Need surgical back-up
  - Financial responsibility
  - Risk of infection

Open Chest CPR - Technique

- 5th or 6th ICS on left or right side
- Left side preferred
- Clip strip of hair over incision site
- Quick prep with antiseptic solution - remove hair and dirt
- Incise with scalpel - avoid intercostal vessels
- Extend with scissors - avoid internal thoracic artery
- Spread ribs
- Remove heart from pericardium - avoid vagus/phrenic nerves
- Compress heart with flat of fingers & palm
- Keep heart in natural position during compressions
- Can cross clamp aorta
  - < 10 minutes, release slowly
Open Chest CPR

Components of CPR
- Advanced Life Support
  - Electrocardiogram
  - Drug therapy
  - Defibrillation
- Post-Resuscitation Care

Establishing Access for Drugs
- Venous access
  - Central > peripheral
  - If peripheral, place in forelimbs > hindlimbs
  - Lots of flush!
  - Immediate surgical cutdown often necessary
Establishing Access for Drugs

- Intraosseous access (IO) if unable to obtain venous access
  - Femur, humerus, tibia
  - Hypodermic, spinal, or intraosseus needle
  - Contraindicated in fractured bone

Intraosseous Catheter Placement
Establishing Access for Drugs

- Intratracheal administration (IT)
  - Double dose (at least), dilute to 2-5 ml, red rubber, no NaHCO3 or calcium
  - Intracardiac administration not recommended!

ABC..Drugs - route

- Route
  - Intra-cardiac?

Vasopressors (Epinephrine, Vasopressin)

  Increase vascular resistance

  Increase aortic blood pressure

  Increase myocardial and cerebral perfusion pressures

  Increase blood flow to heart and brain

Myocardial Perfusion Pressure = Aortic diastolic pressure – Right atrial pressure
Cerebral Perfusion Pressure = Mean arterial (aortic) pressure – Intracranial pressure
EPINEPHRINE

- Potent α and β catecholamine receptor agonist
  - α adrenergic effects important
  - β adrenergic effects detrimental
- Doses:
  - Low dose – 0.01-0.02 mg/kg
  - High dose – 0.1-0.2 mg/kg
- High dose associated with worse neurological outcomes and survival

EPINEPHRINE

- Low dose recommended early q. 3-5 mins but high dose can be tried if no success
- Alternate with vasopressin and give every other cycle of BLS

Advanced Cardiac Life support: Vasopressors

- Vasopressin
  - Potent vasoconstrictor via direct V₁ receptors in vascular smooth muscle
  - Unlike catecholamines, this response is not blunted in the face of acidosis
  - Doesn’t increase myocardial oxygen demand
  - 0.8 u/kg IV
Advanced Cardiac Life support: Vagolytics

- **Atropine**
  - Due to potential parasympathetic contribution to PEA or asystole, use a vagolytic!
  - 0.04 mg/kg
  - Once you give it, you can't take it away!
  - Treatment for vagal
  - 1 cc: 20 lbs

Advanced Cardiac Life Support

- **Sodium Bicarbonate**: debated!
  - Pros: Corrects the metabolic acidosis
  - Cons:
    - respiratory acidosis
    - hyperosmolality
    - transient hypotension
    - hypernatremia
    - hypokalemia
    - hypocalcemia
    - leftward shift in oxyhemoglobin curve
    - paradoxical CNS acidosis
    - Decreased in-hospital resuscitation rates

Advanced Cardiac Life

- **Sodium Bicarbonate**: debated!
  - Recommended in certain cases:
    - Severe hyperkalemia
    - CPR > 10 minutes
    - Severe pre-existing metabolic acidosis
    - Dose: 1 mEq/kg = 1 ml/kg
Glucose

- When in doubt, don’t use it!
- Worsens head trauma
- Ischemic brain tissue -> glucose metabolism to lactic acid -> increased ischemic cellular damage
- Only use in the face of documented hypoglycemia

Advanced Cardiac Life: IVF

- No longer the mainstay therapy!
  - Increases carotid blood flow, BP
- Aortic diastolic pressure – RA diastolic pressure = coronary perfusion pressure
- To increase coronary perfusion pressure, the gradient btw the two diastolic pressures must increase
- B/C IVF increases RA pressure, it decreases coronary and cerebral circulation.

Intravenous Fluids

- Only indicated in hypovolemia to restore blood volume
- Increases central venous pressure (right atrial pressure) in the euvolemic or hypovolemic patient – opposing coronary perfusion
- Myocardial perfusion pressure = Aortic diastolic pressure – right atrial pressure (RAP)
Defibrillation

- Only effective method for conversion of Vfib & pulseless Vtach
- Delivery of an electrical shock that depolarizes all myocardial cells
- Time between onset & defibrillation inversely associated with survival
- Monophasic & biphasic defibrillators, biphasic preferred

DEFIBRILLATION

- Ideally lateral recumbency for safety
- Be aware of metal
- Use enough contact gel
- Confirm ventricular fibrillation
- Confirm current
- Halt ongoing CPR

DEFIBRILLATION

- Call ‘Clear’
- Confirm that all personnel are clear
- Deliver current
- Immediate follow with 2 mins of BLS
- Do not stop to re-evaluate ECG for 2 mins
Defibrillation

• Initial shock
  - **Monophasic**: 4-6 J/kg externally, 0.4-0.6 J/kg internally
  - **Biphasic**: 2-4 J/kg externally, 0.2-0.4 J/kg internally
  - **BLS before defibrillation?**
    - If < 4 mins, immediately shock
    - If > 4 mins, give one cycle of BLS then shock

• Consecutive shocks not recommended

• Follow with immediate chest compressions and ventilation for 2 mins

• If the initial shock is not successful, increase the energy by 50%

Anesthesia-Related Arrests

• Not common

• Better prognosis

• Turn off inhalant and flush system

• **REVERSAL AGENTS**
  - Naloxone – reverse opioids, 0.01-0.04 mg/kg
  - Flumazenil – reverse benzodiazepines, 0.01-0.04 mg/kg
  - Yohimbine/atipamezole – reverse alpha2 agonists, give same dose slowly IV

• Open chest CPR should be performed if thoracotomy or celiotomy occurring
Reassessment Campaign on Veterinary Resuscitation (RECOVER)

1. Preventative measures and Preparedness

2. Basic Life Support

3. Advanced life support

4. Monitoring

5. Post cardiac arrest care

Monitoring CPR Efforts

• ECG

• Palpate pulses
  - May be misleading (venous pulses, pulse pressure)
  - Remember to not interrupt BLS

• End-tidal CO2
  - Excellent monitoring tool for CPR

  - Higher ETCO2 correlates with improved blood flow to lungs (and improved cardiac output)

  - Marked increase in ETCO2 during CPR often indicates ROSC

  - Valuable for verifying ET tube placement but use other skills
Capnogram

- **I = Inspiratory baseline**
  - Fresh gas containing no CO₂ passing through analyze
- **II = Expiratory upstroke**
  - Begin of exhalation
  - Dead space elimination from respiratory tract
  - CO₂ concentration is increasing as alveolar air is reaching analyze
- **III = Expiratory plateau**
  - Exhalation of pure alveolar gas
- **O = Inspiratory downstroke**
  - Start of inhalation
  - Fresh gas “washing away” CO₂ of gases from previous exhalation

---

Capnography Summary

- Normal ETCO₂
  - 35 – 45 mmHg
- High ETCO₂ (>55mmHg)
  - Hypoventilation
- Low ETCO₂
  - Low, abnormally high / normal PaCO₂

---

Capnography Summary

- Normal capnogram is a "square wave"
- Sudden changes in ETCO₂ and in the waveform may be due to problems with
  - Patient
  - ETT
  - Breathing circuit
  - Sampling system
Reassessment Campaign on Veterinary Resuscitation (RECOVER)

1. Preventative measures and Preparedness
2. Basic Life Support
3. Advanced Life Support
4. Monitoring
5. Post Cardiac Arrest Care

Prolonged Life Support

- Recurrence of arrest within 4 hours
- Cerebral resuscitation
  - Low flow states during CPR → ischemia and hypoxia → cerebral edema
- Treat as a head trauma
- Reperfusion injury

Prolonged Life Support

- Reperfusion injury
- Cerebral ischemia → calcium shifts → brain tissue lactic acidosis → increases in:
  - Brain free acids
  - Osmolality
  - Extracellular excitatory amino acids
- Reoxygenation injury
Post-resuscitation cerebral injury

- Perfusion failure
  - inadequate oxygen delivery

- Reoxygenation chemical cascades to cerebral necrosis

- Extracerebral derangements
  - intoxication from postanoxia viscera

- Blood derangements due to stasis
Post-Resuscitation Care

- Optimize hemodynamic status
  - Ensure adequate oxygen delivery using fluids, pressors, and pRBCs as needed
  - Monitor BP, ECG/HR
  - Early goal directed therapy

- Control of respiratory function
  - Maintain normocapnia and normoxemia
  - Cerebrovascular reactivity to CO₂ maintained
  - Hypocapnia $\downarrow$ PaCO₂ – cerebral hypoxia
  - Hypercapnia $\uparrow$ PaCO₂ – increased ICP
  - Hypoxemia $\downarrow$ PaO₂
  - Hyperoxemia $\uparrow$ PaO₂ – reactive oxygen species
  - O2 therapy: PaO₂ < 80, SPO₂ < 94%
  - PPV: PaO₂ < 80 with FIO₂ > 0.6 or PaCO₂ > 60 despite tx, or severe fatigue

Prolonged Life Support

- Oxygen therapy (mask, nasal canula, PPV)
  - 15-30° head tilt
  - No jugular pressure (ICP)
Prolonged Life Support

• Inotropic support (dobutamine/dopamine)

• Anti-arrhythmic drugs (lidocaine)

• cECG monitoring, pulse oximetry, blood pressure

Prolonged Life Support

• Treatment for cerebral edema
  • Mannitol
  • Lasix

• Monitoring UOP (1-2 ml/kg/hour)

• Fluid therapy

• Antibiotic therapy
  • Bacterial translocation gut
  • No big guns!

Post-Resuscitation Care

• Mild hypothermia
  • For those who remain comatose only if PPV & advanced critical care available

• No steroids!

• Hyperosmotic therapy (mannitol, hypertonic saline)
  • For those with signs associated with cerebral edema (eg, comatose, abnormal mentation, etc)

• Referral of critically ill for PCA care to specialty hospital is recommended
Questions?

@VetGirlOnTheRun
VetGirlOnTheRun
Garret@vetgirlontherun.com
Justine@vetgirlontherun.com

2015 VETgirl Webinar Topics
Check out some of our 2015 RACE Approved VETgirl webinars. Please visit our website for a complete list! www.vetgirlontherun.com

- Seizure diagnosis and treatment
- Common feline orthopedic conditions
- What's new in veterinary wound healing
- Common emergency room procedures
- Arrested development: The RECOVER initiative and CPR updates
- To cut or not to cut: Approach to the abdominal radiograph
- Emergency management and treatment of rattlesnake envenomations
- Misconceptions of emergency and critical care
- Summer toxins affecting small animals
- Feline pediatrics: Treating the small and the sick
Check out our 2015 upcoming VETgirl appearances!

Dr. Justine Lee
• International Veterinary Seminars (IVS), Kiawah Island, April 2015
• Merck, NYC, April 2015
• IVS, Vancouver, June 2015
• IVS, Amelia Island, July 2015

Dr. Garret Pachtinger
• CVC Washington D.C, April 2015
• Hills Global Symposium, Miami, April 2015