CPR Update
RECOVER

• Explained the scientific evidence relevant to small animal CPR
• Composed consensus-based clinical CPR guidelines for dogs and cats

ABOUT "RECOVER" – Materials & Methods

Domain 1 - PREPAREDNESS AND PREVENTION

Domain 2 - BASIC LIFE SUPPORT (BLS)

Domain 3 - ADVANCED LIFE SUPPORT (ALS)

Domain 4 - MONITORING

Domain 5 - POST ARREST CARE

CPR GUIDELINES – All 5 domains

Pre-Stocked Arrest Areas
Crash Carts

• Use of both pre-stocked arrest stations and cognitive aids improves compliance with CPR protocols
• Most problematic are:
  – Missing equipment, lack of return to the cart
  – Incomplete stocking
  – Inability to identify or locate needed medications
  – Failure to have drugs and syringes in a quick, usable form
  – Deficiencies and defects in resuscitation equipment
  – Result - 18% delay in CPR in human medicine

Pre-Stocked Arrest Areas
Crash Carts

• SOLUTIONS:
  – Checklists and dated log sheet for restocking
  – Regular re-training of staff
  – Cognitive aids improve outcome
    • Flow charts
    • Check lists
    • Dose charts or calculators
Arrest Etiology & Outcome

- Anesthesia-related CPAs and drug reactions have increased survival
  - Survival rate of dogs and cats for CPA is between 4 and 9.6%
  - Survival rate in human hospitals for CPA is 10-20%
- Human error plays a role in 91% of anesthesia deaths in people
  - Post CPR debriefing identifies and corrects human error
- Veterinary studies
  - 36-55% of CPAs occurring under anesthesia survive to discharge
  - 0-3% of other CPAs survive to discharge
  - Survival to discharge is much more important than successful resuscitation

CPR Team Leadership

- Presence of physician at human CPR does not improve outcome
- Survival rates not affected by experience of the first responder
- CPR Leadership Training improves outcome of human CPR
- CPR Leaders are more effective if they do not participate in the resuscitation
- CPA simulation is the ideal tool for teaching CPR Leadership

Basic Life Support

- Establish airway
- Ventilation (breathing)
- Chest compressions (circulation)

Preparedness & Prevention

CPR Training

- CPR skills begin to decay within weeks of training, no matter the learning method used
- By 1-2 years after training, skills return to re-training level
- Annual CPR training is crucial
- Semi-annual CPR training is even better.
Basic Life Support Training

CPR Team = Leader + 3
1. One person is the CPR Leader & record keeper
2. One person does chest compressions unless directed to stop by the Leader
3. One person establishes the airway and ventilates unless directed to stop by the leader
4. One person begins ALS, attaches monitors and carries out other tasks as instructed by the CPR Leader
5. The rest clear the room but the door is open to summon others standing by in case needed

Basic Life Support ABC

Rapid recognition of CPA
1. Patient is unresponsive, pupils unresponsive
2. Absence of breathing (agonal does not count)
3. Absence of heart beat – next slide
4. If in doubt, do chest compressions
   • <2% adverse effects when done when not in CPA
   • Rib fracture, tracheal bleeding, soreness
5. ECG checks confirm lack of effective circulation (q 2 min)
6. ETCO₂ falls to near zero

Basic Life Support ABC

Pulse Palpation to Detect CPA
• Femoral pulse is preferred
• Need corroborating evidence
  – Lack of apical beat
  – lack of an auscultable heartbeat
  – No Doppler activity on pulse points or cornea (takes time)
• Presence of dorsal pedal pulse (metatarsus) confirms MAP >80mmHg

Basic Life Support ABC

Parks Doppler

Jorvet Doppler

Basic Life Support ABC

How to Assess Breathing
• Watch for chest excursions for at least 1 minute if respiratory rest only
• One hand lightly on the costochondral junction
• Fingers of the other hand in front of the nose at the same time
• There should be clocks on the walls in all areas that are high risk for CPA
  – Surgery prep
  – OR and areas for other anesthetic procedures
  – Anesthesia Recovery
  – ICU
  – Clock on the crash cart is good, smart phones work

Basic Life Support ABC

Confirmation of Endotracheal Intubation
• direct visualization of the ETT between the arytenoid cartilages is important
• Palpate tube in the trachea
• auscultation of air movement in both hemithoraces rules out bronchial intubation
• observation of chest wall motion, or ETT condensation are supportive evidence
• high ETCO₂ immediately following intubation means endotracheal intubation is likely, due to the low amount of CO₂ in the stomach and esophagus
• low ETCO₂ isn’t helpful
**Basic Life Support Training**

**Ventilation**
- Establishing oxygenation may prevent respiratory arrest from progressing to cardiac arrest
- When intubation is not available, rescue breathing 30:2 compression: Ventilation ratio
  - Mouth to snout
  - AmbuBag and snug fitting anesthetic mask
  - Or anesthetic mask attached to oxygen tank
  - **MAKE SURE VAPORIZER IS OFF**
  - Watch for gastric distension and relieve with manual pressure
- 8-10 breaths per minute if intubated
  - Take the manometer to 20 cm H₂O

**Ventilation Monitoring During CPR**
- High ventilation rates (>10–12 breaths/min) should be avoided
- Increased time of positive intrathoracic pressure has negative effect on hemodynamics
- Excessive ventilation during CPR commonly occurs, even with trained personnel
- For respiratory arrest only, breathe 2x per minute
Basic Life Support Training

Ventilation – Choosing Reservoir Bag Size (6xTV)

<table>
<thead>
<tr>
<th>Weight of animal</th>
<th>Bag size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5 kg</td>
<td>0.5 liter bag</td>
</tr>
<tr>
<td>5 - 10 kg</td>
<td>1.0 liter bag</td>
</tr>
<tr>
<td>10 - 20 kg</td>
<td>2.0 liter bag</td>
</tr>
<tr>
<td>20 - 30 kg</td>
<td>3.0 liter bag</td>
</tr>
<tr>
<td>30 - 50 kg</td>
<td>5.0 liter bag</td>
</tr>
<tr>
<td>&gt; 500 kg</td>
<td>15 liter bag</td>
</tr>
<tr>
<td>&gt; 500 kg</td>
<td>30 liter bag</td>
</tr>
</tbody>
</table>

Basic Life Support Training

Ventilation – Choosing ET Tube Size (handout)

<table>
<thead>
<tr>
<th>DOGS</th>
<th>CATS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 kg</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>3.5 kg</td>
<td>5.5 mm</td>
</tr>
<tr>
<td>4.5 kg</td>
<td>6.0 mm</td>
</tr>
<tr>
<td>6 kg</td>
<td>6.5 mm</td>
</tr>
<tr>
<td>8 kg</td>
<td>7.0 mm</td>
</tr>
<tr>
<td>12 kg</td>
<td>8.0 mm</td>
</tr>
<tr>
<td>14 kg</td>
<td>8.5 mm</td>
</tr>
<tr>
<td>16 kg</td>
<td>9.0 mm</td>
</tr>
<tr>
<td>18 kg</td>
<td>9.5 mm</td>
</tr>
<tr>
<td>20 kg</td>
<td>10.0 mm</td>
</tr>
<tr>
<td>25 kg</td>
<td>11.0 mm</td>
</tr>
<tr>
<td>30 kg</td>
<td>12.0 mm</td>
</tr>
<tr>
<td>40-60 kg</td>
<td>14 - 16 mm</td>
</tr>
</tbody>
</table>

Remember to base the weight guidelines on lean body weight, obese cats and dogs don’t have longer tracheas. There will also be some variation by breed, brachycephalic dogs and cats tend to have narrower trachea than a mesocephalic breed of similar weight.

Basic Life Support Training

Ventilation – Tips for endotracheal intubation

- Trinity Trach Tube Ties – http://trachtubeties.com

- Fiberoptic Laryngoscopes are much superior to bulb laryngoscopes (Miller blades preferred)
- Green plastic base on blade, green stripe on handle
- Different size attachment than standard laryngoscopes

Basic Life Support Training

Chest Compressions

- Achieve cardiac output of 25-30% normal
- If they generate a pulse, technique is good
- 100-120/min has better outcome than 60/minute
- Release to allow full recoil between compressions
  - Fast then release
- If extra person, interposed abdominal compressions improve circulation
- Interruptions no more than every 2 minutes for ECG
- 1/3 to ½ the width of the chest
- Minimize interruptions (no more than 1 every 2 minutes)

Basic Life Support Training

Placement of Hands for Chest Compressions

- Hands directly over the heart
  - Often over the widest portion of the chest
- Either left or right lateral recumbency are acceptable
Placement of Hands for Chest Compressions

- for barrel chested dogs like English Bulldogs, consider doing sternal compressions directly over the heart
- patient in dorsal recumbency

Placement of Hands for Chest Compressions

- for cats and small dogs (<10 kg) with compliant chests, a 1-handed technique for circumferential chest compressions
- hand wrapped around the sternum directly over the heart

CPR Flow Sheet Form

Nonin 9874V
Pulse Oximeter with pCO₂
And respiration indicator
$1300

Domain 3
ALS – Advanced Life Support

- Defibrillation
- IV fluid therapy
- Drug therapy, including anesthetic reversal drugs
- Open chest CPR
Advanced Life Support

ALS Steps
1. IV fluid bolus 10 ml/lb over 10-15 minutes
   - Contraindicated for congestive heart failure or oliguria/anuria
   - Reassess and repeat as necessary
   - Add colloids or hypertonic fluids PRN
2. Collect blood samples for Quick Assessment Tests
   - Glucose, BUN, creat, PCV/TS
3. Run CBC, panel, electrolytes later life can be prolonged
4. Respond to abnormalities, reassess and respond again

Advanced Life Support

Drugs

Epinephrine – (0.01 mg/kg IV or IT)
- 1:1000 – 0.1cc per 20 lbs
- Raise blood pressure (pressor)
- Improve myocardial perfusion
- Increase tissue perfusion
- Increase cardiac output (increase SV, increase HR)
- This dose is preferred to higher doses

Is Vasopressin preferred to epinephrine?
- Dose – 0.8 U/kg IV or IT
- 20 U/ml - 0.1cc per 5 lbs.
- Vasopressin causes no additional harm
- No studies in dogs and cats to show that vasopressin is better than epinephrine

Atropine 1:20 (0.54 mg/ml)
- Dose – 0.4 mg/kg IV or IT – 1cc per 30 lbs.
- Reasonable to use when bradycardia or brief asystole occurs due to increased vagal tone
- Unclear role for prolonged asystole
- Take care giving atropine when alpha agonists are on board (xylazine, dexdomitor)
  - Pulmonary hypertension and pulmonary edema
- Atropine is not indicated for tachyarrhythmias:
  - Ventricular fibrillation
  - Ventricular tachycardia

Antiarrhythmics
- No compelling evidence for routine use
- Use only if arrhythmia of increased automaticity is present
  - Ventricular tachycardia
  - Ventricular fibrillation – after defibrillation fails
  - Pulseless vtach – after defibrillation fails
- Contraindicated for lack of electrical activity
  - Asystole
  - bradyarrhythmias
### Antiarrhythmics

- **Amioderone** might be the most effective antiarrhythmic for shock resistant VFib and pulseless VTach in dogs
  - Anaphylaxis has been reported
- **Lidocaine** is the next best choice
- Bretylium and magnesium play no role in treating these shock resistant arrhythmias
- Amioderone has not been evaluated in cats

### Lidocaine Cheat Sheet (Lidocaine 2% - 20 mg/ml)

1. **3 IV boluses over 10 minutes**
   - 2 mg/kg (1cc/10 lbs.) IV over 1 minute x 2
   - 4 mg/kg (2cc/10 lbs.) IV over 1 minute
2. If not effective or if effectiveness is only brief, then start IV CRI (40-80 ug/kg/min)

---

### Lidocaine CRI Recipe (40-80 ug/kg/min IV)

- If using an IV pump (36-72 ug/kg/min IV)
  1. Add 50cc 2% lidocaine to 1L fluids to make a 1 mg/ml solution
  2. Set IV pump at Body Weight in pounds per hour for low end
  3. Double fluid rate for upper end of dose range
- If using drip rate (40-80 ug/kg/min IV)
  1. Mix as above if >30 lbs. in body weight
  2. Make stronger solution if <30 lbs.
    - If <5 lbs. - 20cc 2% lidocaine in 100c fluid in the Buretrol (4 mg/ml)
    - If 5-30 lbs. - 10cc 2% lidocaine in 100c fluid in the Buretrol (2 mg/ml)
  3. Use 60 drop/ml IV set (use 15-20 drops/ml for 15-30 lb pets)
  4. Count seconds per drop if <30 lbs.
  5. Count drops/sec if >30 lbs.

### Corticosteroids

- No evidence that it helps, unless indicated for underlying process
  - Septic shock
  - Anaphylaxis
  - Addisonian crisis
- No evidence that it causes harm
- Not currently recommended

### Reversal agents

- **Naloxone** (0.04 mg/kg IV)
  - Reverses opiates on board
  - Positive inotrope, antiarrhythmic
- **Flumazenil** (0.01 mg/kg IV)
  - Reverses benzodiazepines on board
- **Atipamezole** (0.1 mg/kg IV)
  - Reverses dexdomitor or amitraz on board
- **Yohimbine** (0.125 mg/kg IV)
  - Reverses xylazine or amitraz on board
- Reversing other sedatives exacerbates ketamine dysphoria
**Lipid therapy**
- If CPA during anesthesia is resuscitated, lipid therapy to clear lipophilic anesthetic drugs faster should be considered.
- Lipophilic drugs:
  - Propofol, diazepam, ketamine, opioids
  - Beta blockers, calcium channel blockers
  - Parasiticides, herbicides
  - Psychotropic agents
- Intralipid® (Baxter) 20% lipid emulsion:
  - 1.5 mL/kg over 5–15 min then 0.25 mL/kg/min over 1–2 hrs
  - Repeated in several hours if clinical signs of toxicity return, and there is no lipemia.
  - Use aseptic technique.

**Buffers - bicarbonate**
- Preponderance of evidence recommends against routine use of bicarbonate without confirming severe acidosis.
- Could be considered in prolonged CPA.
- Fewer harmful effects in dogs as compared to other species.
- Indicated for confirmed metabolic acidosis.

**Calcium**
- Routine use is not warranted or recommended.
- Indicated for:
  - Hypocalcemia
  - Calcium channel blocker overdose
  - Severe hyperkalemia.

**Correcting Electrolyte/Metabolic Disturbances**
- Hyperkalemia — see Case Study “Torn”.
- Hypokalemia ([Potassium Supplementation Handout](#)).
- Hypocalcemia:
  - Calcium gluconate 10% 1.5–2.5cc IV slowly
  - Recheck calcium in 15 minutes, re-dose PRN.
- Hypoglycemia:
  - Dilute 1–3cc 50% Dextrose, qs to 10cc
  - Administer IV over 1–3 minutes
  - Serial reassessment of blood glucose and re-treat PRN.
  - Can use glucagon for insulin overdose.

**IV vs. IT drug administration**
- Atropine, epinephrine, vasopressin.
- Use high dose (10x) for IT epinephrine ([Drug Dose Chart](#)).
- 1:1000 – 1cc per 20 lbs.
- Technique:
  1. Draw dose and dilute qs to 3–10cc with sterile water or saline.
  2. Attach dose to 5–8F polypropylene catheter.
  3. Disconnect endotracheal tube from ventilation (oxygen tank or ambu bag).
  4. Pass catheter to resistance, inject drug.
  5. Detach syringe, fill with air, and inject again to clear drug.
  6. Resume ventilation.

**Defibrillation**
- Electrical defibrillation is the most effective therapy for sudden VF.
- Defibrillation should pre-empt CPR as soon as VFib is identified, if VFib has been present for less than 4 minutes.
- If VFib more than 4 minutes, do 30 compressions and ventilate prior to defibrillation.
- To avoid interruption of compressions, single shock every 2 minutes is preferable to several in immediate succession.
- **USE ECG cream rather than alcohol for lead contacts**.
- An escalating protocol could be considered for both types defibrillators (increase by 50% each time) ([Drug Chart](#)).
**Advanced Life Support Defibrillation**

- Coarse VF is more likely to respond with ROSC following defibrillation than fine VF.
- Asystole is unlikely to respond to defibrillation, despite this being commonly portrayed in medical dramas.
- On the other hand, little is lost by attempting to defibrillate prolonged asystole.

**Internal Cardiac Compressions**

- Open-chest CPR is more effective than closed-chest CPR in restoring ROSC and promoting a good outcome in canine models of VFib (can visualize efficacy).
- Open-chest CPR requires significant resources, is a procedure that requires a skillful veterinary team, and demands advanced post-cardiac arrest supportive care.
- In cases of significant intrathoracic disease it may be advisable to promptly perform open-chest CPR and defibrillation.
  - Tension pneumothorax
  - Pericardial effusion

**Monitoring**

- ECG to Detect CPA
  - Pulseless electrical activity (PEA) can give a false negative for CPA.
  - Relatively normal ECG must be corroborated by other evidence of spontaneous circulation.
  - ECG does reliably identify arrhythmias:
    - Vfib – defibrillate
    - VTach making pulses – drugs
    - Pulseless VTach – defibrillation then drugs
  - ECG can confirm bradyarrhythmia and asystole – atropine for both (defib not indicated for asystole).
  - ALL CPA victims get epinephrine.

**Advanced Life Support Defibrillation**

- DRE Lifepack AK9 (brochure) $1100
Monitoring ECG Monitoring During CPR
- Primary VFib remains a rare cause of CPA in veterinary patients
- Most animals have initial arrest rhythm of PEA or asystole that may convert to VFib during CPR
- ECG monitoring should be weighed against the risk of interrupting chest compressions for ECG rhythm check
- Resume chest compressions as soon as possible after defibrillation and rhythm check

Monitoring ETCO₂ to Detect CPA and monitor
- At constant ventilation, a rapid decline in ETCO₂ value is expected during the evolution of CPA
- In nonintubated patients, asphyxial CPA may elevate ETCO₂ immediately prior to CPA and fall to zero
  - Asphyxia without CPA might show improvement in ETCO₂ after intubation and oxygenation
- ETCO₂ cannot be used alone to diagnose CPA
- Rising ETCO₂ during resuscitation may indicate ROSC
- Continued low ETCO₂ predicts nonsurvival
  - ETCO₂ less than 10 mm Hg over several minutes during CPR is a poor prognostic indicator for ROSC

Monitoring ETCO₂ to Detect CPA and monitor
- Use caution when interpreting a rise in ETCO₂ after using either sodium bicarbonate or epinephrine during CPR
- Increase in ETCO₂ from <10 to >14 mm Hg should prompt evaluation for return of a heartbeat

Monitoring Blood Gas and Electrolyte Assay During CPR
- Venous blood gas values have better predictive value for ROSC than arterial blood gas values
  - Directly related to cardiac output and tissue perfusion
- When cause of CPA is due to electrolyte abnormalities, electrolyte assay may allow directed therapy
- Ionized hypocalcemia may be prognostic for ROSC
- Identifying and correcting abnormalities may promote ROSC

Monitoring Monitoring after ROSC
- To prevent re-arrest
  - Treat precipitating disease
  - Treat short term sequelae of CPA
- Treat longer term sequelae of CPA
  - Brain hypoxia and ischemia
  - Cardiac ischemia and dysfunction
  - Reperfusion injury
- Two phases of post ROSC monitoring
  - Intensive continuous monitoring
  - Intermittent monitoring

Monitoring Monitoring after ROSC
- Parameters monitored
  - ECG - Myocardial hypoxia can result in post-resuscitation arrhythmia
  - BP - Episodes of hypotension following ROSC are associated with a worse outcome
  - Temperature - thermoregulation is a good prognostic indicator
  - sPO₂, zETCO₂ - Hypoxic injury to the lungs can result in refractory pulmonary edema (ARDS)
  - Glucose - Severity of post ROSC hyperglycemia is correlated with worse outcome
- Post ROSC seizures worsen prognosis
Domain 5
Post-Arrest Care

Post-Arrest Care

• survival to discharge rates for dogs and cats range from 2-10%, despite initial ROSC of 35–45%
• these patients succumb to post-cardiac arrest (PCA) syndrome
  – multiorgan failure
  – cardiogenic shock
  – anoxic brain injury
  – Sequellae of pre-existing diseases
  – Transfer to ICU for monitoring for unstable patients can improve outcome

CPR Guidelines (handout)