

A large red square with a white border, centered on a white background. Inside the square, the text "Veterinary CPR" is written in white, bold, sans-serif font.

Veterinary CPR

What is CPR?

Cardiopulmonary Resuscitation

Some facts:

- When CPA results from a long-term/chronic disease, CPR is less successful
- When CPA is due to an acute condition, more likely to get a successful outcome
- CPA from or during anesthesia also has a better prognosis
- Successful ROSC rates: 35-45%
- Survival to discharge rates: 2-10%

CPA = cardiopulmonary arrest

ROSC = return of spontaneous circulation

5 Domains

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

Prevention and Preparedness

1. Prevention and Preparedness



- Standardized and Regularly Stocked Crash Cart
 - Cognitive Aids and CPR Algorithms Available
 - Continuing Education of Staff
 - Assigning Code Status to Every Patient
-

AAVEC Crash Cart

- In main Treatment Room
- Contains all emergency supplies and drugs
- Mobile - can be wheeled to any location
- Checked daily (and after each use) and restocked by assistants*

*ANYONE can and should take a free moment and check/stock the Crash Cart





Crash Cart

- ECG machine and leads with defibrillator
- Suction machine with tubing and red rubber catheters
- Squeeze bag for fluids
- ET tube gauze ties
- Prepared IVC set up
- Alcohol, Hydrogen Peroxide, and Ultrasound Gel
- Cognitive Aids and Algorithms Reference Sheets

Crash Cart

- Endotracheal (ET) tubes
- Laryngoscopes and blades
- Syringes, Needles
- Flushes
- Blades
- IV catheters, IVC supplies
- Emergency Drugs
 - Atropine
 - Epinephrine
 - Sodium Bicarbonate
 - Dextrose 50%



Crash Cart



- Butterfly catheters
- Blood tubes
- Bandage material
- Sterile and non-sterile lube
- ECG pads
- Red rubber catheters, connectors
- Fluid bag
- Bulb syringe
- Hypertonic NaCl
- EMMA - capnograph

Crash Cart

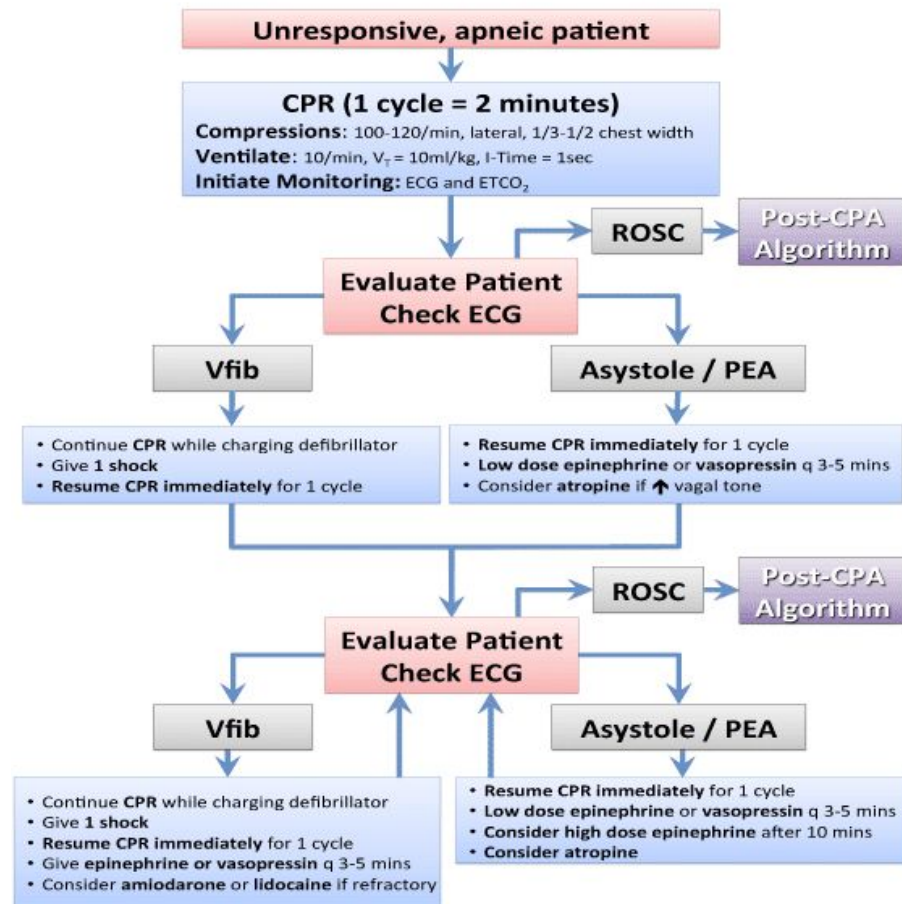


- Bag valve mask (Ambu bag)
- Extra tubing
- Large syringes
- Chest tap kits
- Hetastarch bag
- Extra hypertonic NaCl
- Reserve stock of other items

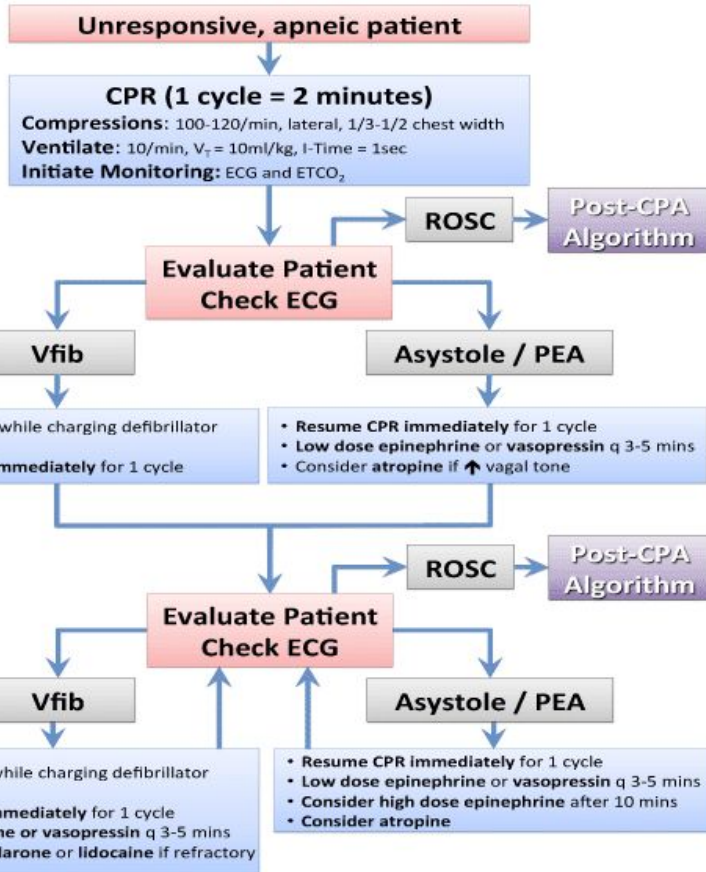
Cognitive Aids & CPR Algorithms

- Laminated Sheets
- Kept on Crash Cart for easy access
- Quick reference “cheat sheets”

CPR Algorithm



CPR Algorithm



CPR Algorithm

- Step-by-step instructions
- Provides easy checklist during emergency event

Emergency Drug Doses

CPR Emergency Drugs and Doses

		Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
		Weight (lb)	5	10	20	30	40	50	60	70	80	90	100
	DRUG	DOSE	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml
Arrest	Epi Low (1:1000)	0.01 mg/kg	0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	Epi High (1:1000)	0.1 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Vasopressin (20 U/ml)	0.8 U/kg	0.1	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
	Atropine (0.54 mg/ml)	0.05 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhyth	Amiodarone (50 mg/ml)	5 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Lidocaine (20 mg/ml)	2-8 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reversal	Naloxone (0.4 mg/ml)	0.04 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Flumazenil (0.1 mg/ml)	0.01 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Atipamezole (5 mg/ml)	50 ug/kg	0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Defib Monophasic	External Defib (J)	2-10 J/kg	20	30	50	100	200	200	200	300	300	300	360
	Internal Defib (J)	0.2-1 J/kg	2	3	5	10	20	20	20	30	30	30	50
Defib Biphasic	External Defib (J)	2-4 J/kg	6	15	30	50	75	75	100	150	150	150	150
	Internal Defib (J)	0.2-0.4 J/kg	1	2	3	5	6	8	9	10	15	15	15

Reprinted with permission from the Veterinary Emergency & Critical Care Society (veccs.org)
RECOVER Initiative CPR Emergency Drugs and Doses chart.

- Gives high and low dose for various weights
- Categorizes drugs by function
- Also includes defibrillation protocols

Continuing Education

- RECOVER Initiative
 - Evidence-based formulation of protocols and CPR training
 - REassessment
 - Campaign
 - On
 - VEterinary
 - REsuscitation



Patient Code Status

- Assigned at Triage/Intake
- Can be altered during patient's stay in hospital
- **DNR** = Do Not Resuscitate
- **BLS** = Basic Life Support
- **ALS** = Advanced Life Support



Basic Life Support

2. Basic Life Support



- Recognize CPA (cardiopulmonary arrest)
 - Chest Compressions
 - Airway Management
 - Ventilation/Breathing
-

Recognizing CPA

- CPA = Cardiopulmonary Arrest
- Assess unresponsive patients
 - This should be **10-15s** maximum
 - Auscult heart, don't spend time searching for pulses at this point
- If CPA is confirmed, immediately begin resuscitation measures
 - Circulation
 - Airway
 - Breathing



Chest Compressions

- Patient in lateral recumbency
 - Barrel-chested dogs = dorsal recumbency
- 100-120 compressions per minute (cat and dog)
 - “Stayin’ Alive”
 - “Another One Bites the Dust”
- Compressions should be $\frac{1}{3}$ to $\frac{1}{2}$ the width of the chest
 - This is TRAUMATIC
 - Can cause broken ribs, pulmonary edema
- Allow full chest expansion/recoil between compressions
- Uninterrupted 2-minute cycles



Chest Compressions

Hand placement variations

- Larger dogs
 - Compressions over widest portion of thorax
- Smaller dogs/keel-chested dogs/cats
 - Compressions directly over heart
- Cats and small animals
 - +/- Circumferential compressions



Staff posture

- Superimposed palms
- Locked elbows
- Shoulders directly **above** patient
- Bending should be at the **waist**
- 2-minute limit before switching out



Airway Management

- Intubation should occur in lateral recumbency
- Chest compressions should not be stopped to achieve intubation
- Laryngoscope should be used to visualize trachea
- Cuff of ET tube should be inflated
- Confirmation of placement should be made by:
 - Thoracic auscultation
 - Visualization
 - Palpation
 - ETCO₂ monitoring



Ventilation (Breathing)

- Intubate as soon as possible without disrupting chest compressions
- Give 1 breath every 6 seconds
- Tidal volume should be 10ml/kg
- Inspiratory time should be 1 second
- Do not exceed 20 cm H₂O on the manometer
- If intubation is not an option, 2 breaths after every 30 compressions can be given mouth-to-snout



Advanced Life Support

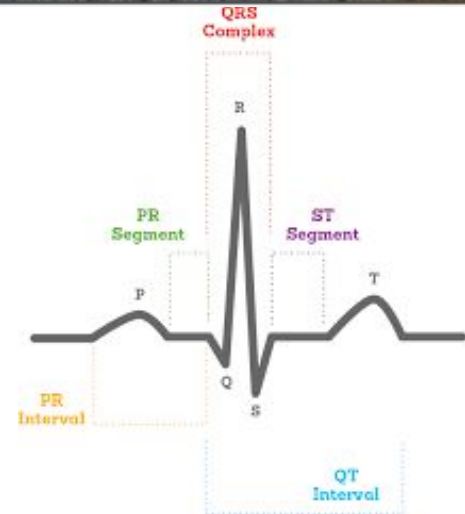
3. Advanced Life Support



- ECG to Characterize Arrhythmias
- ETCO₂ Measured
- IV Access Obtained
 - IO, IT as alternatives
- Drugs or Defibrillation

ECG Obtained

- Attachment placement
 - **White** - Right front
 - **Black** - Left front
 - **Red** - Left rear
 - **Green*** - Right rear
 - Not typically included
 - Mnemonics* to remember location
- Prefer to use ultrasound gel, NOT alcohol (in case of defibrillation)
- Evaluate during cycle rotation
 - Artifact from motion of compressions
 - Asystole?
 - PEA?
 - Ventricular fibrillation?



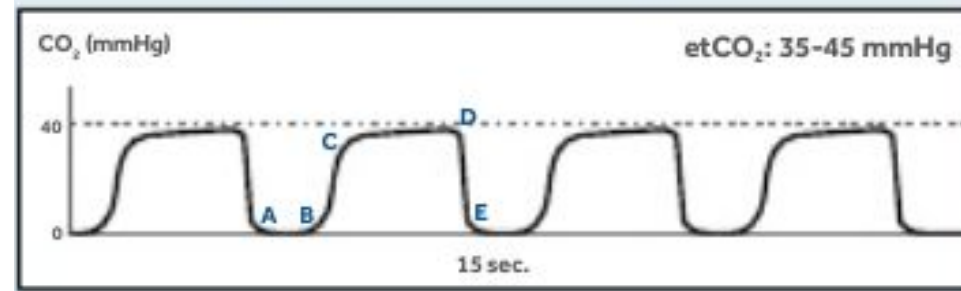
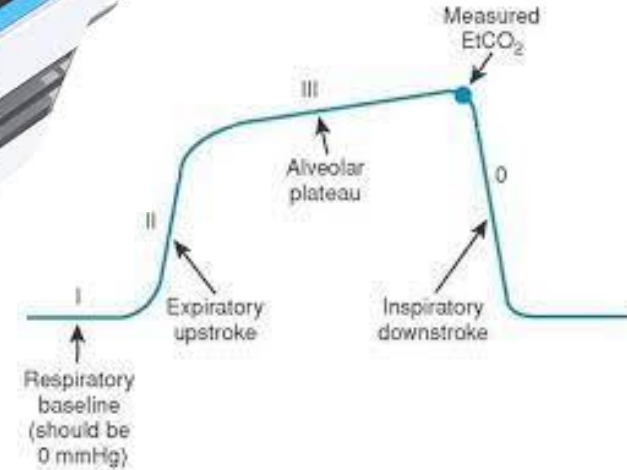
ETCO₂ Measured

- Capnography = measurement of end-tidal CO₂

- Partial pressure/amount of CO₂ released at the end of expiration
- Indicator of cardiac output
- Can confirm appropriate ET tube placement
- Normal is 35-45 mmHg
- A “now” vital sign, no lag

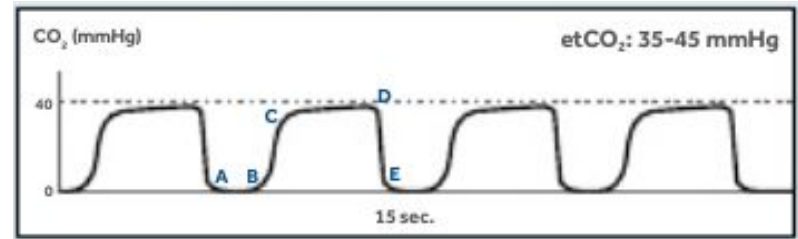
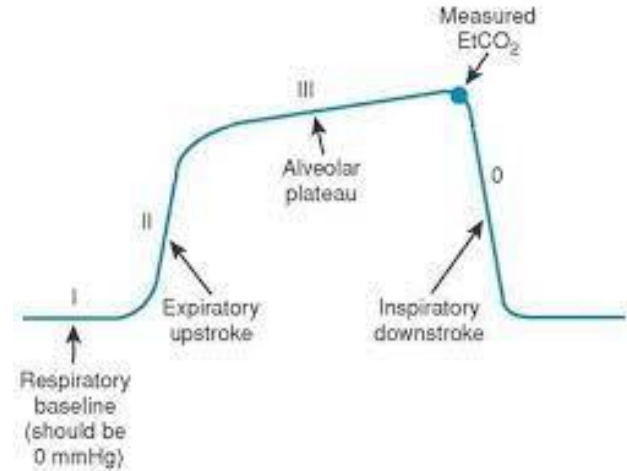
- **Waveform**

- **A-B** - inhalation
- **B-C** - start of exhalation
- **C-D** - exhalation
- **D** - where ETCO₂ value is recorded
- **D-E** - beginning of inhalation



ETCO₂ Measured

- How does this help with CPR?
 - Remember, this is a “now” vital sign
 - If high - patient is breathing out more CO₂
 - We think we want to speed ventilation
 - Actually, should continue normal ventilation unless it continues climbing
 - If it spikes (drastic increase of >20mmHg, or reaches >45mmHg) = ROSC
 - If low - patient is not breathing out enough CO₂
 - We think we want to slow ventilation
 - Actually sign of shock - ETCO₂ relies on perfusion (thus is not accurate)
 - If <10-12, compressions are not adequate



IV Access Obtained

- Without stopping any of the other resuscitation efforts, we want IV access
- Place peripheral IV catheter
 - Sometimes more than one person is trying simultaneously
 - May require venous cut-down by DVM
- Alternative drug access routes:
 - **IT** - intratracheal
 - Epinephrine
 - **IO** - intraosseous
 - Catheter placement



Drugs Administered

- IV fluids based on case
 - Can help with perfusion in hypovolemia
 - Possibility for overload due to poor contractions
- If patient arrested under anesthesia, use reversal agents
 - Naloxone - for opioids
 - Butorphanol
 - Hydromorphone
 - Buprenorphine
 - Fentanyl
 - Morphine
 - Methadone
 - Antisedan
 - Dexmedetomidine
 - Flumazenil - for benzodiazepines
 - Diazepam
 - Midazolam



Drugs Administered

- Epinephrine
 - Primary drug to reverse cardiac arrest
 - Vasopressor - increases arterial blood pressure and coronary blood perfusion during CPR
 - Good bioavailability in IT administration
 - Low dose vs. high dose*
- Atropine
 - Used to increase heart rate (especially in patients with increased vagal tone and asystole/PEA)
 - Adverse reactions at high doses
 - Not much conclusive evidence for benefits
- Sodium Bicarbonate (NaHCO_3^-)
 - Treats respiratory acidosis (CO_2 retention)
 - Used more commonly in extended CPR



** Flushing Meds - use larger volume of flush to get meds into body!

Defibrillation

- Used for ventricular fibrillation
 - Abnormal heart rhythm
 - Disorganized heart signals that causes ventricles to twitch but not pump blood.
 - Shock heart to try and re-establish normal electrical impulses
- After at least two 2-minute BLS cycles
- **CAUTION!**
 - Do **NOT** touch the patient (all “CLEAR”)
 - Do **NOT** use alcohol (flammable)
 - Do **NOT** have free-flowing O₂ (flammable)
 - Do **NOT** be on a conductive surface (metal)
 - Do **NOT** have patient wet/in water (conduction)



Open-Chest CPR Video

www.atdove.org/video/open-chest-cpr

Open-Chest CPR - Review

- Usually >10 minutes of CPR efforts
- Fast scrub/skin preparation
- Lateral incision made into side with scalpel blade, then Mayo scissors
 - Dorsal aspect of chest to sternum
 - Approximately at rib space 5
- Enter the pleura (membranes covering lungs and lining the chest cavity)
 - Be careful of lungs
- Reach in and find heart to begin internal massage/compressions
 - May need rib spreaders
 - May need to exteriorize heart from pericardial sac
- Compressions should start at apex (bottom) and squeeze cranially to base of heart (top)
 - Depending on patient size, may need both hands
- If successful resuscitation, treat as lateral thoracotomy post-CPR
 - Cavity lavage, place chest tube, achieve suction, then additional post-arrest care

Special Cases

Patients with CHF (congestive heart failure) often have pulmonary edema (fluid build-up in the lungs).

This may obstruct ventilation.

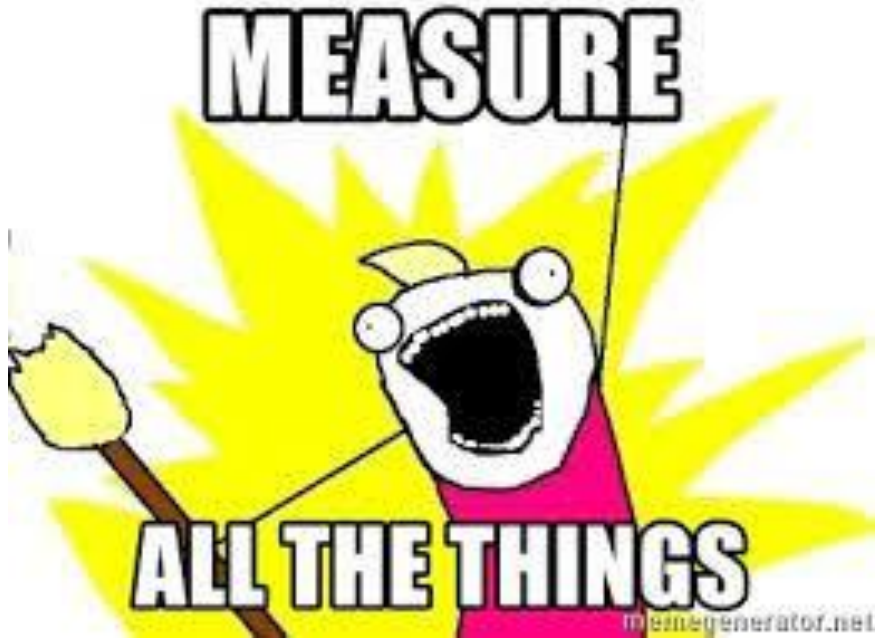
Ways to clear fluid:

- Suction of ET tube
- “Dumping” patient
 - Detach from oxygen and invert patient
 - In head-down position, fluid may freely flow out of ET tube



Monitoring

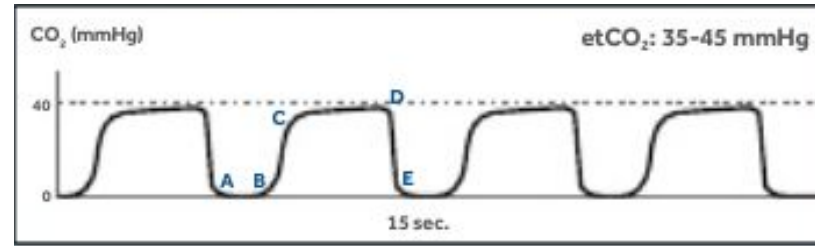
4. Monitoring



- ECG
 - ETCO₂
 - Oxygenation Levels
 - Vitals/Temperature
 - Blood Pressure
-

ECG, ETCO₂, Oxygenation

- ECG
 - Continue monitoring heart rhythm and rate
 - Observe for recurrence of CPA
- ETCO₂
 - Continue monitoring CO₂ levels as long as patient is intubated
- Oxygenation
 - Use pulse oximeter (“pulse ox”) as long as patient tolerates it
 - Ideal oxygen saturation is above 95%
 - Supplement O₂ as needed
 - May require Oxygen Cage
 - May require nasal cannula(s)



Vitals, Blood Pressure

- Monitor vitals as you would any critical patient
 - More frequent intervals as determined by doctor
 - Want to pay close attention to changes in status that may indicate decline
 - Use pressors as needed for hypotension

Vitals	Canine	Feline
Temperature	99.0-102.5	99.0-102.5
Heart Rate	80-140, size of dog	180-200
Respiratory Rate	16-40	16-40
Mucous Membranes	Pink	Light pink - Pink
Capillary Refill Time	1-2 seconds	1-2 seconds
SPO2	95-100%	95-100%
Systolic Blood Pressure	100-150 mmHg	100-150 mmHg

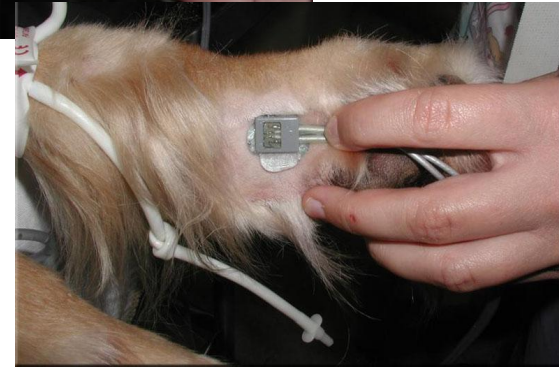
Blood Pressure - Equipment

- Doppler machine
 - Ultrasonic detection of arterial blood flow
 - Obtains systolic pressure
- Sphygmomanometer
 - “Squeezy thing”
 - Used to inflate cuff and occlude vessel
 - Contains dial to read measurement
- Ultrasound gel
 - Used as medium for ultrasound waves
- Blood pressure cuff
 - Numerous sizes
 - What side you put against the skin and its alignment *does* matter
 - Always check for leaks



Blood Pressure - Using the Doppler

- Choosing the correct size cuff
 - Width should be ~40% of the circumference of the appendage for dogs
 - ~30% of the circumference for cats
 - Follow sizing guidelines on interior of cuff to ensure appropriate size
 - Line up indicator **ARROW** with artery
 - Cuff should be **proximal** to probe location
- Clip fur of the desired location
 - Posterior aspect of metacarpal area
 - Posterior aspect of metatarsal area
 - Ventral aspect of tail
- Apply ultrasound gel to probe (be generous)
 - Ensure the correct side is against the patient
 - Orient the probe **parallel** to the blood flow



Blood Pressure - Using the Doppler

- Connect the cuff to the sphygmomanometer
 - That's the “squeezy thing”
- Confirm placement by listening for pulses
 - Consistent “whoosh whoosh” sounds
 - Can confirm beat/rhythm by palpating heart
 - Adjust probe as needed to hear pulses
- Inflate the cuff until you no longer hear pulses
 - Then, slowly deflate the cuff while watching the sphygmomanometer
 - Note the reading when you first hear the pulse return
 - This is your systolic pressure

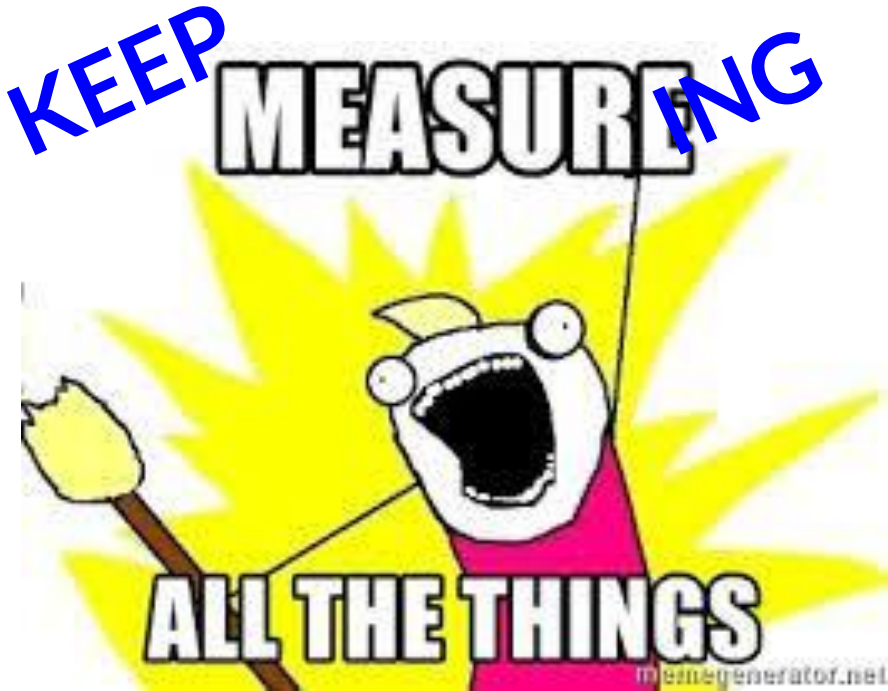


Blood Pressure - Using the Doppler

- Get several consecutive measurements
 - Obtain at least three readings
 - Average results and record systolic pressure
- Be consistent!
 - Use the same cuff size for subsequent BPs
 - Use the same limb for subsequent readings
 - Exceptions:
 - New IVC placed in limb being used
 - Incorrectly measured cuff initially
- Patient position matters
 - Ideal positioning is lateral recumbency, with cuff on the “top” limb at the level of the heart
 - Restraint can stress patients and elevate their BP
 - Find a comfortable, relaxed position for the patient if they will not tolerate being lateral



5. Post-Cardiac Arrest Care



Continue monitoring all the things!

- ECG
- ETCO₂
- Oxygenation Levels
- Vitals/Temperature
- Blood Pressure

AND

- Bloodwork
 - Neurologic Support
-

Bloodwork

- **Lactate**
 - Levels can rise dramatically in shock and cardiopulmonary arrest
 - Usually resolve with appropriate treatment
- **Glucose Levels**
 - Hyperglycemia following trauma increases mortality
 - Hyperglycemia may indicate poor neurological outcome
- **Blood Gases**
 - Can measure effects of inadequate blood supply during CPA



Neurologic Support

- Anoxic Brain Injury
 - Time-sensitive
 - Injury occurs after 4 minutes without oxygen
- Cerebral Edema
 - May occur from hypoxia followed by the inflammatory response during reperfusion
 - Osmotic agents can reduce edema
 - Hypertonic NaCl
- Seizures
 - May occur in anytime, but most likely in first three days after arrest
 - Prophylactic control



The CPR Team

The CPR Team

Role	Who?	Tasks
CPR Leader	DVM or Technician	Organize CPR
Compressions	Anyone	Perform chest compressions, rotating 2-minute cycles
Intubator	DVM*	Intubate patient
Ventilation	Anyone	Manage O ₂ machine Ventilate patient
Crash Cart, Supplies	Anyone	Plug in equipment (ECG, Suction) Attach ECG leads Set up IVC, get stool for CPR
Venous Access	Technician	Place IVC Administer drugs per DVM
Record Keeper	Anyone	Document events, Record times, drugs, drugs doses and routes, time of ROSC or death

Circle of Communication

- Good communication during CPR is vital to success
- Be clear and specific
 - Give commands and use names
 - “Jennifer, start chest compressions.”
 - “Michael, give 2ml Epi IV.”
 - “Courtney, get me another 20g IVC.”
 - If you are responding, confirm and repeat out loud the command/task that you are performing
 - Jennifer: “I’m starting chest compressions. I need a stool.”
 - Michael: “Drawing up 2ml Epinephrine.” and then “Giving 2ml Epinephrine IV.”
 - Courtney: “I’m getting the 20g IVC for Sara.” and then “Here is the 20g IVC.”
 - This ensures that
 - The proper instructions were heard and followed
 - The record keeper can keep track of what is happening
 - Try to reduce extraneous chatter - there is a LOT going on!

Outcomes and Debriefing

- Try not to take it personally if CPR efforts fail
- Debriefing afterwards and discussing what went right and wrong can help improve future CPR efforts
- Remember, you can't really make the patient *more* dead



Thanks!