Stayin' Alive
CPR / RECOVER 2.0

Katie Carignan, DVM, DACVECC

January 7th, 2025
Cape Cod Vet Specialists

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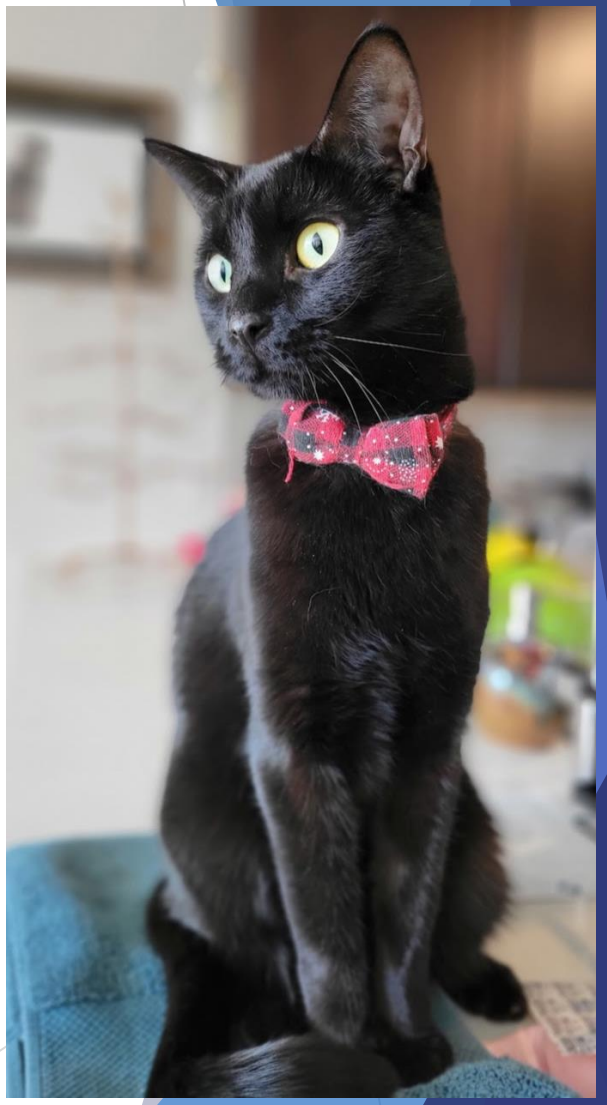
Who am I?

- Born and raised in Georgia
- Grew up doing dog sports (agility and frisbee)
- Currently share my life with 4 cats, 1 dog, and a wife
- Parents were both in human emergency medicine



Education

- Berry College
  - Bachelors of Science – 2015

- University of Georgia, College of Veterinary Medicine
  - Doctor of Veterinary Medicine - 2019

College of
Veterinary Medicine
UNIVERSITY OF GEORGIA

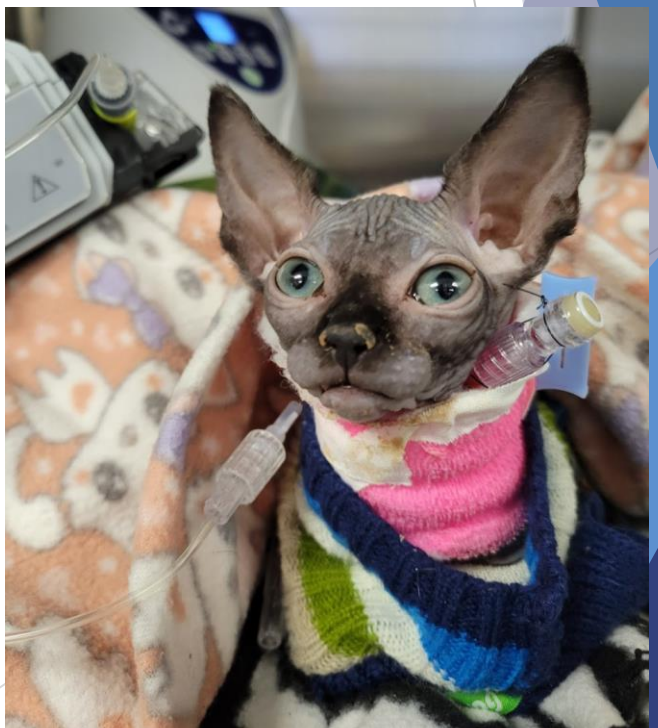
Specialty Training

- The Animal Medical Center
  - Rotating Internship - 2019-2020

- University of Georgia, College of Veterinary Medicine
  - Emergency and Critical Care Residency - 2020-2023
  - DACVECC - October 2023

Employment

- Cape Cod Veterinary Specialists
  - Criticalist – October 2023 – Present
  - Special interests:
    - Feline critical care
    - Trauma
    - Sepsis
    - Patient well-being in the ICU



Outline

- RECOVER history
- Recognition of cardiopulmonary arrest (CPA)
- Basic Life Support
- Advanced Life Support
- Post-resuscitation care
- Application

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RECOVER History

- Cardiopulmonary arrest (CPA) is deadly
  - 5-7% survival to discharge
- Standardized cardiopulmonary resuscitation (CPR) guidelines in human medicine led to remarkable improvement in survival rates
  - 13.7% (2000) → 22.3% (2009)
- Led to the RECOVER initiative
  - Reassessment Campaign of Veterinary Resuscitation

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RECOVER History

- The first RECOVER guidelines were published in 2012
  - Two overarching goals:
    - 1) Devise clinical guidelines on how to best treat CPA in dogs and cats
    - 2) Identify important knowledge gaps in veterinary CPR that needed to be filled in order to improve the quality of recommendations and patient care in the future

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RECOVER History

- A group of over 80 veterinarians participated in the initial research that allowed for writing the original guidelines
- 5 topics were assessed
  - Preparedness & Prevention
  - Basic Life Support (BLS)
  - Advanced Life Support (ALS)
  - Monitoring
  - Post-Cardiac Arrest Care

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RECOVER History

- In 2024, the RECOVER guidelines were updated
  - Over 200 veterinary professionals were involved in this update
  - New domains were added including:
    - Newborn Resuscitation
    - First Aid
    - Large Animal CPR
- In this presentation, we'll focus on the updates most relevant to small animal medicine

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Recognition of CPA

- CPA should be highly suspected in any apneic, non-responsive patient
  - Assessment should be brief → no more than 10-15 seconds
- CPR should be started as soon as CPA is suspected
  - Pulse palpation is insensitive and should not be relied on as the decision point for starting CPR
  - Even short delays in starting CPR reduces survival rates
  - Starting CPR on a patient not in CPA carries minimal risks

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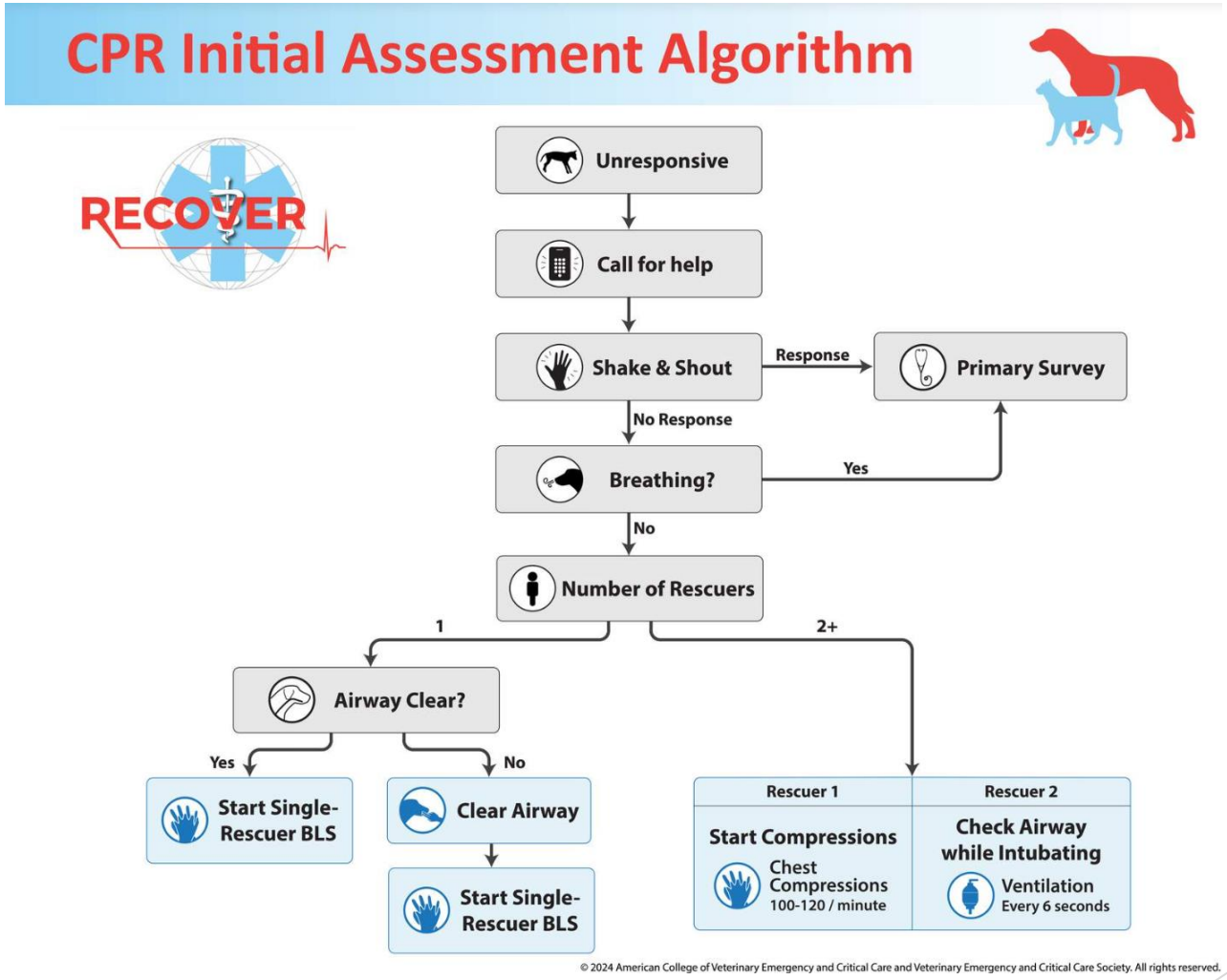
Recognition of CPA



https://doi.org/10.1111/vec.13391

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Basic Life Support

- Basic Life Support (BLS) consists of two major components
  - Chest compressions
  - Ventilation and oxygenation

- BLS is CRUCIAL
  - Without well-executed, high-quality BLS, no amount of Advanced Life Support (ALS) will matter

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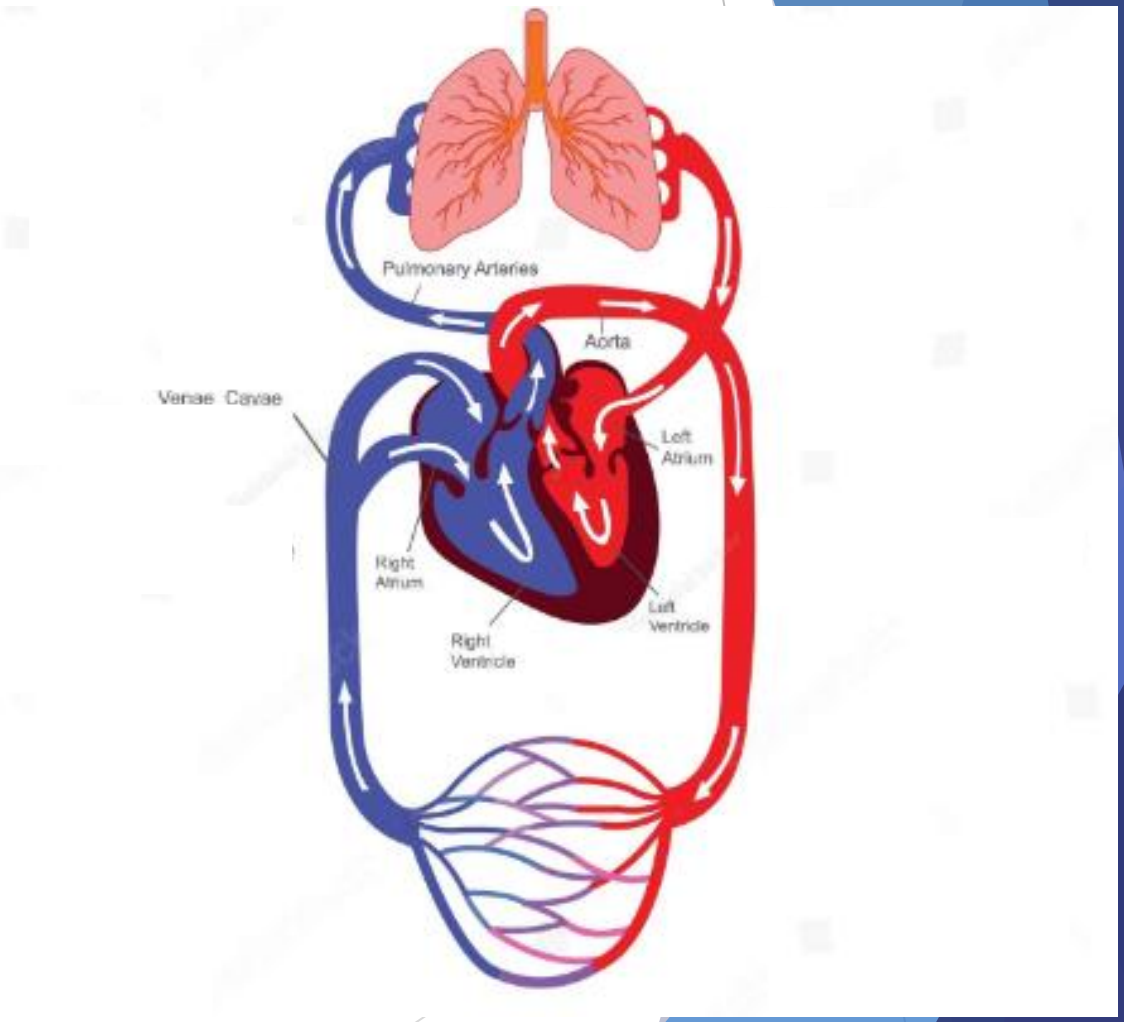
Basic Life Support

- Chest compressions
  - Two main goals:
    - 1) Restore pulmonary blood flow → allows for elimination of CO_2 and uptake of O_2
    - 2) Deliver O_2 to tissues to allow for energy production
- Even high-quality chest compressions only produce about 30% of normal cardiac output



https://www.shutterstock.com/image-vector/blood-circulation-system-stylized-heart-anatomy-2225383989

Basic Life Support

- Chest compressions
  - Two theories as to how chest compressions produce forward blood flow
    - 1) Cardiac pump method
    - 2) Thoracic pump method

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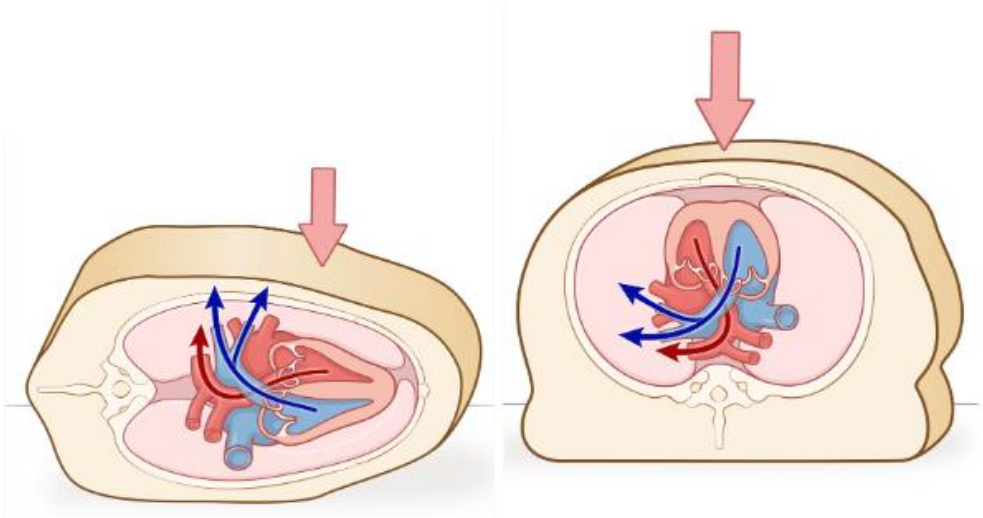
Basic Life Support

- Cardiac pump method
  - Right and left ventricles are compressed directly between ribs (lateral recumbency) or between sternum and spine (dorsal recumbency)



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Basic Life Support

- Cardiac pump method
  - Compression increases pressure in ventricles
  - Closes mitral / tricuspid valves
  - Opens pulmonic / aortic valves
  - Provides blood flow to lungs / tissue
  - Recoil of heart during relaxation creates negative pressure
  - Ventricles fill before the next compression

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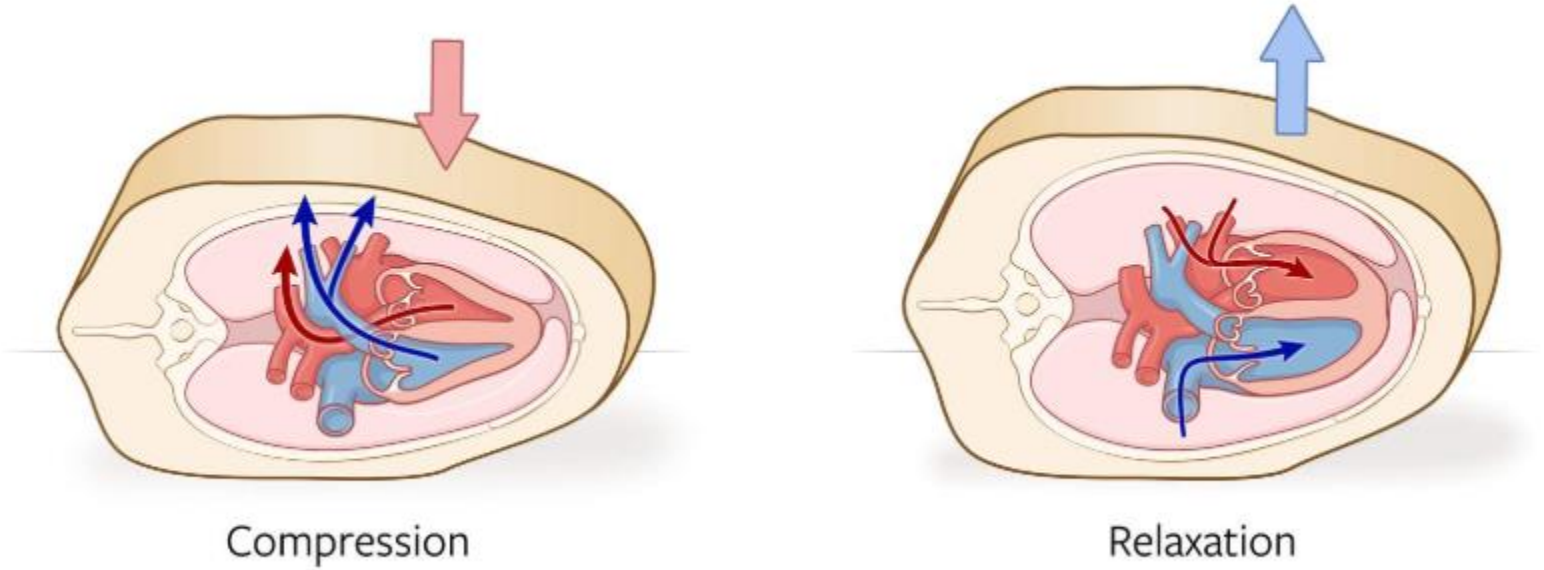
Basic Life Support

- Cardiac pump method



Basic Life Support

- Thoracic pump method
  - Relies on changes in overall intrathoracic pressure vs. just pressure within the ventricles
  - Heart acts as a passive conduit for blood flow

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Basic Life Support

- Thoracic pump method
  - During compression:
    - Increases in intrathoracic pressure move blood from the lungs into the left ventricle
    - Aortic compression pushes blood into extra-thoracic tissues
  - During relaxation:
    - Elastic recoil of the chest causes the lungs to expand which pulls blood through the vena cavae and into the right side of the heart
  - In this theory, all valves remain open through compression and relaxation

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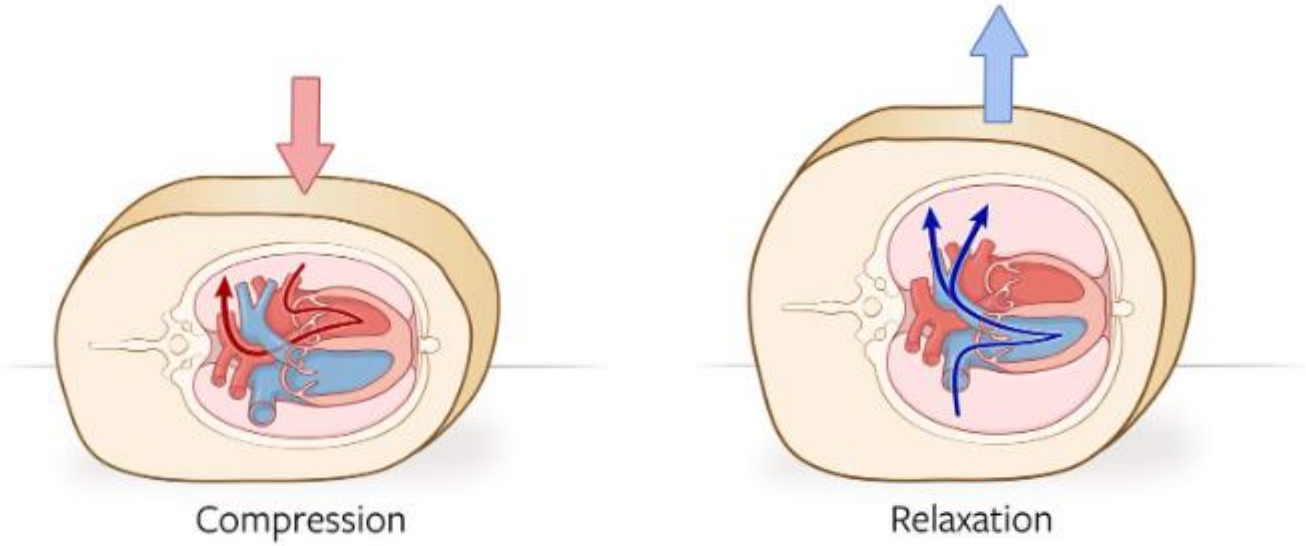
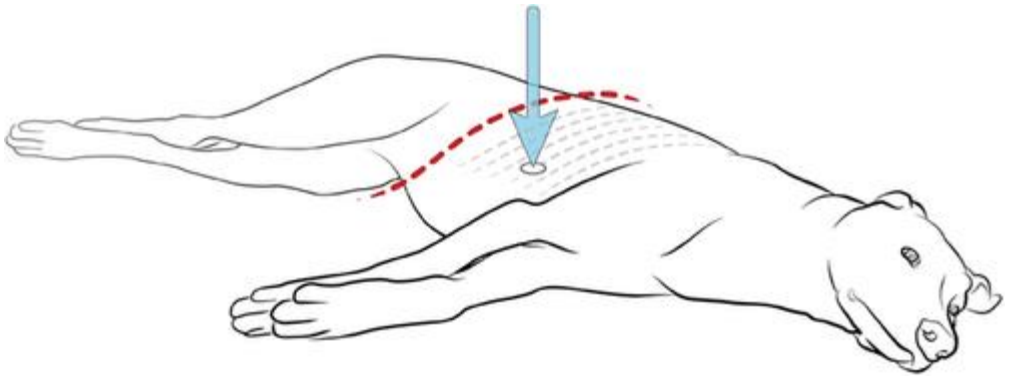
Basic Life Support

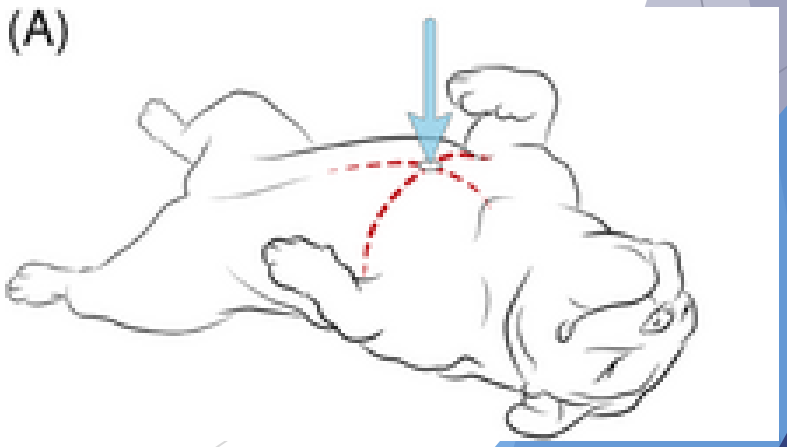
- Thoracic pump method



Basic Life Support

- Which patients benefit the most from each theory?
  - Cardiac pump method
    - Keel-chested dogs
    - Wide chested dogs in dorsal recumbency



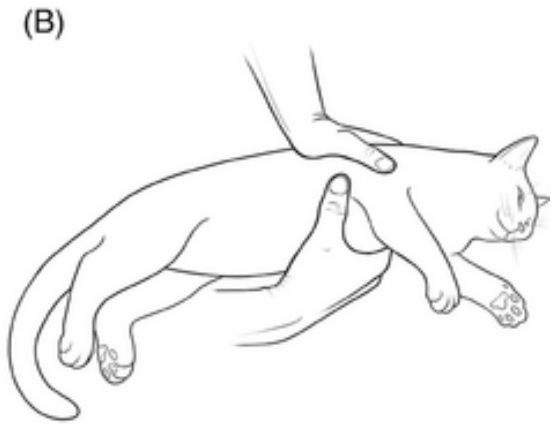


https://doi.org/10.1111/vec.13391

Basic Life Support

Basic Life Support

- Which patients benefit the most from each theory?
  - Cardiac pump method
    - Cats and small dogs
      - A) Circumferential, 2-thumb technique
      - B) 1-handed technique
      - C) 1-handed heel technique



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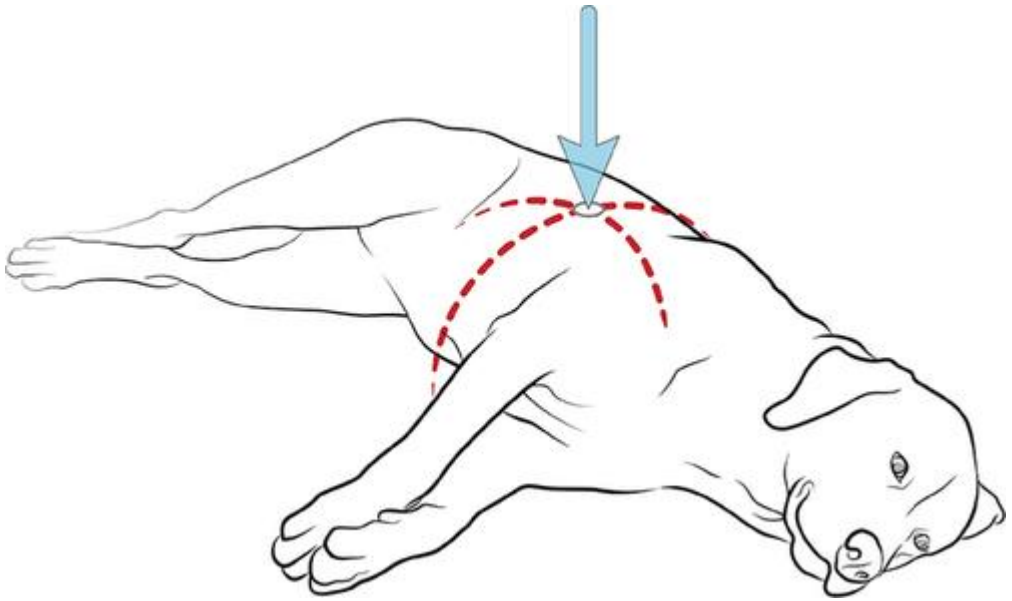
Basic Life Support

- Which patients benefit the most from each theory?
  - Thoracic pump method
    - Round chested dogs



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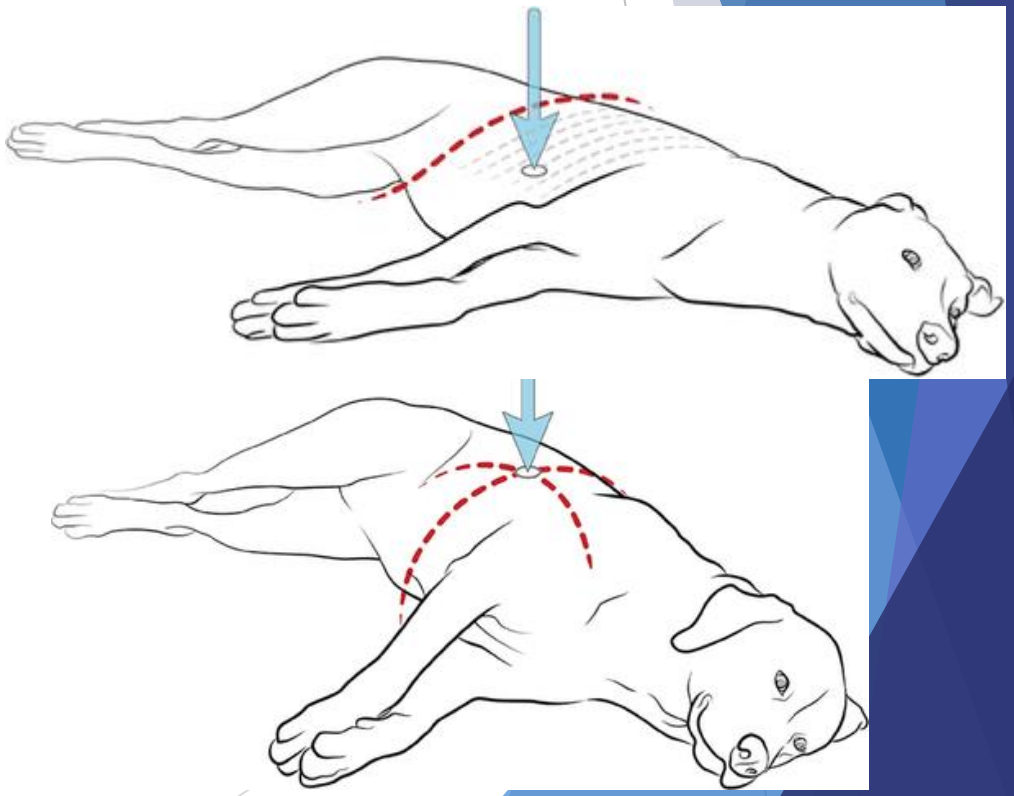
Basic Life Support

- Hand positioning



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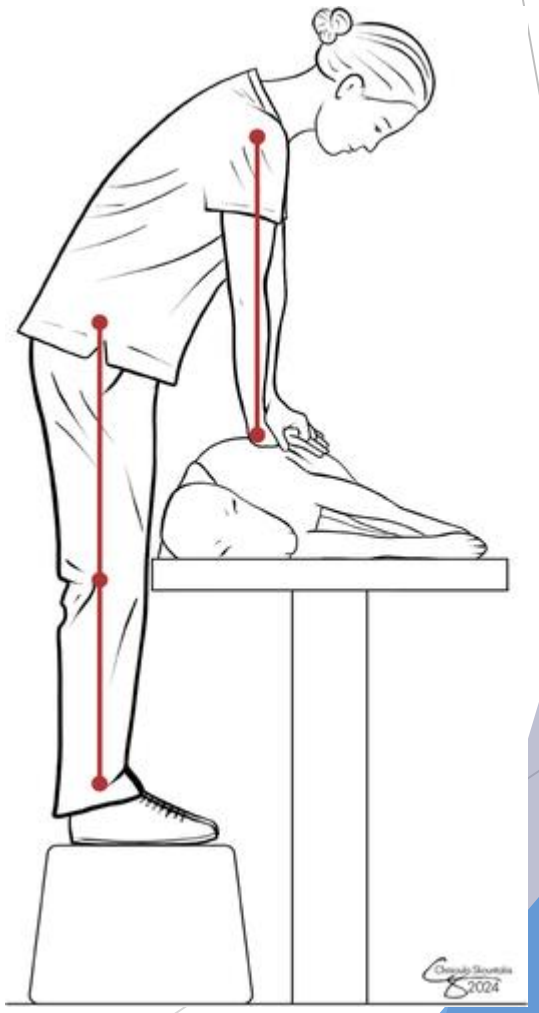
Basic Life Support

- Compressor body positioning
  - Behind patient if lateral
  - Straddle patient if dorsal
  - Shoulders, elbows, and wrists are in alignment
  - Shoulders are vertical over compression point
  - Bend at waist and engage core to perform compressions



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Basic Life Support

- Compression depth
  - Lateral recumbency → 1/3 to 1/2 the width of the chest
  - Dorsal recumbency → 1/4 the width of the chest
- Compression frequency
  - 100-120 compressions / minute

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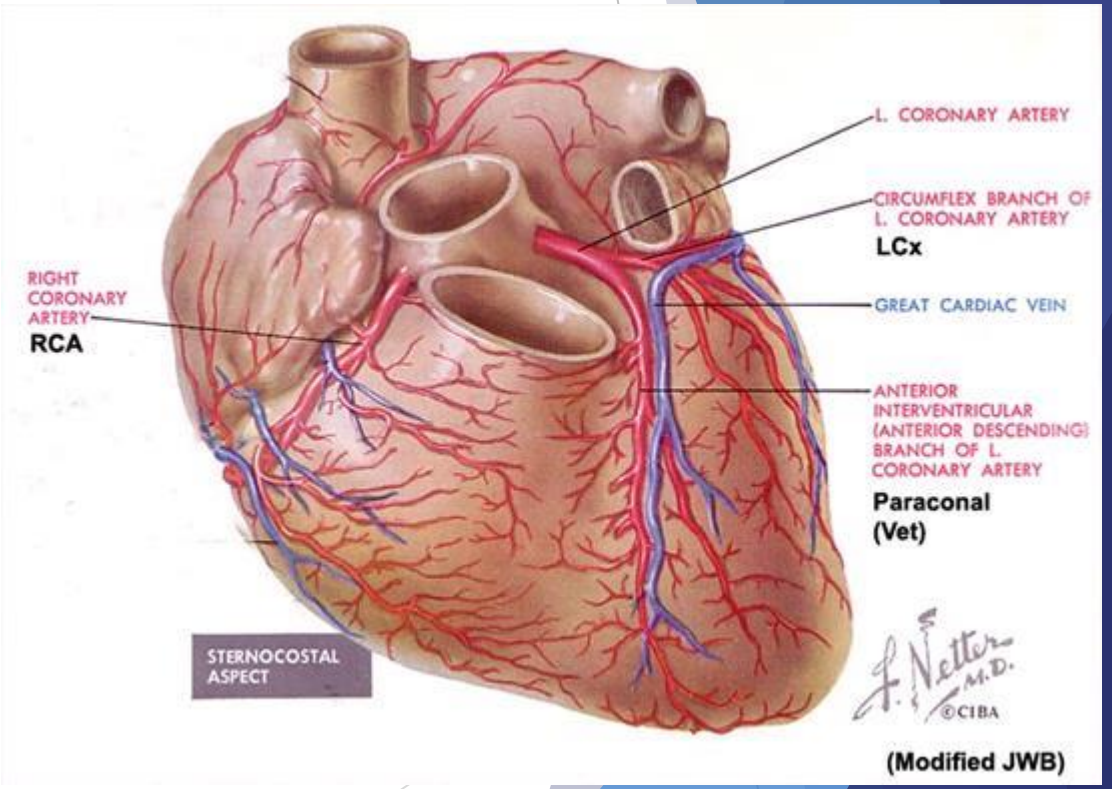
Basic Life Support

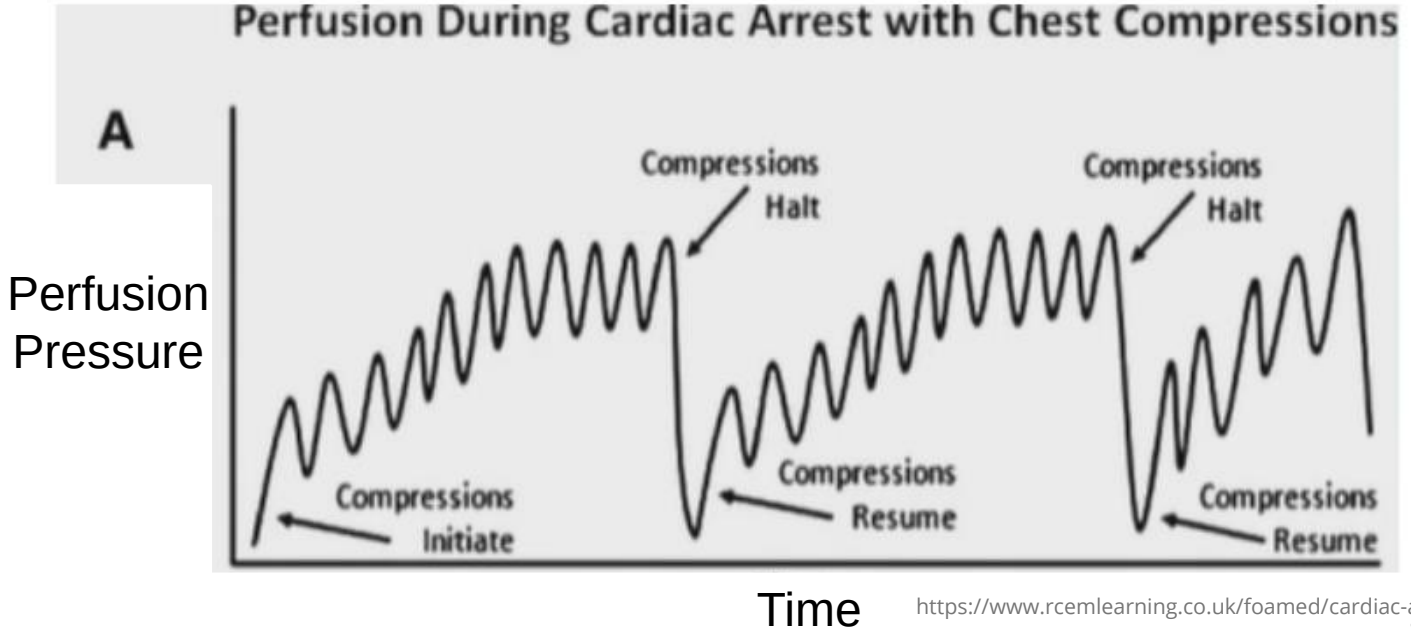
- Chest recoil
  - Release of compression is as important as compression itself
  - Leaning on the chest results in reduced return of blood to the heart and in turn reduced cardiac output
  - Myocardial perfusion occurs during decompression



https://www.vin.com/apputil/content/defaultadv1.aspx?pId=84&id=2993354

Basic Life Support

- Compression cycles
  - 2-minute cycles
  - Optimizes development of adequate coronary perfusion pressure



https://www.rcemlearning.co.uk/foamed/cardiac-arrest-the-als-algorithm-and-beyond

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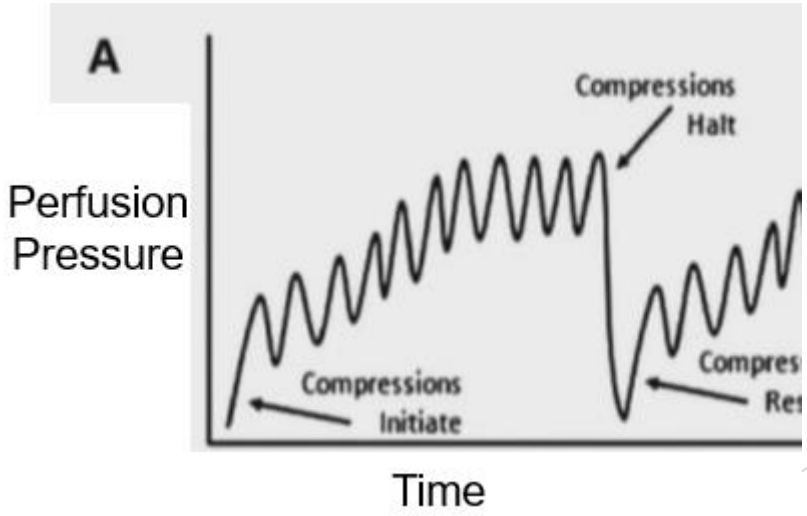
Basic Life Support

- Compressor rotation
  - If possible, new compressor at the end of each 2-minute cycle
  - This reduces compressor fatigue, improves the quality of compressions, and reduces the likelihood of leaning on the patient
  - Efficiency is key!



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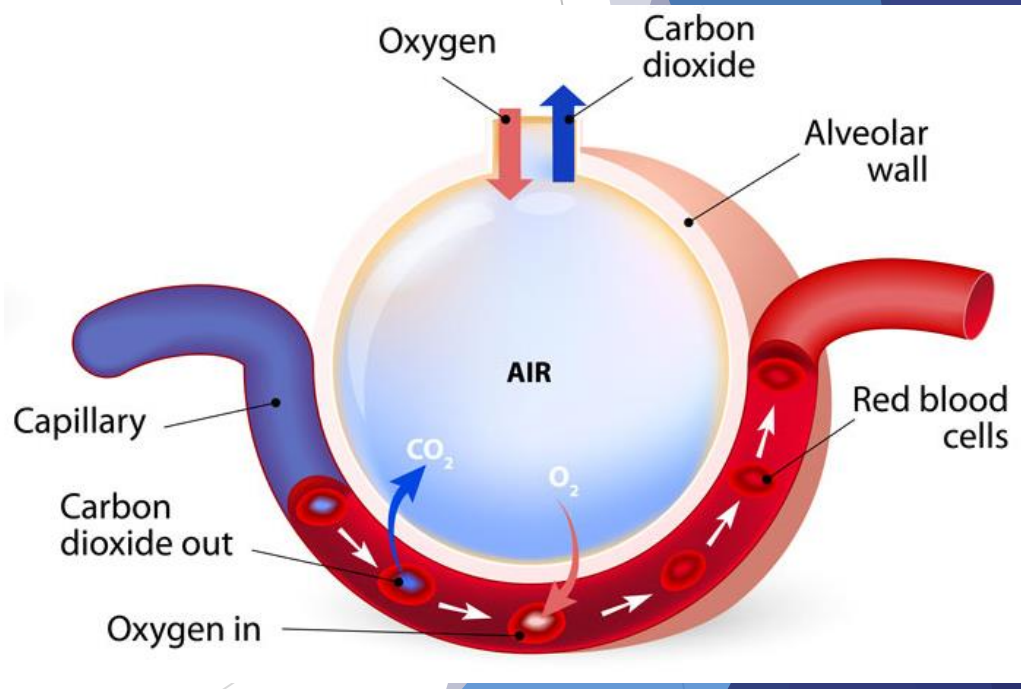
Basic Life Support

- Ventilation and oxygenation
  - Ventilation – removal of CO_2 that is produced by tissues as a by-product of metabolism
  - Oxygenation – transport of oxygen to tissues for metabolism
- Compression only CPR?



https://www.pedilung.com/pediatric-lung-diseases-disorders/anatomy-of-a-childs-lung/alveolus-gas-exchange-pulmonary-alveolus/

Basic Life Support

- Ensure airway is clear
- Options for respiratory support
  - 1) Endotracheal intubation
  - 2) Tight-fitting face mask
  - 3) Mouth-to-nose

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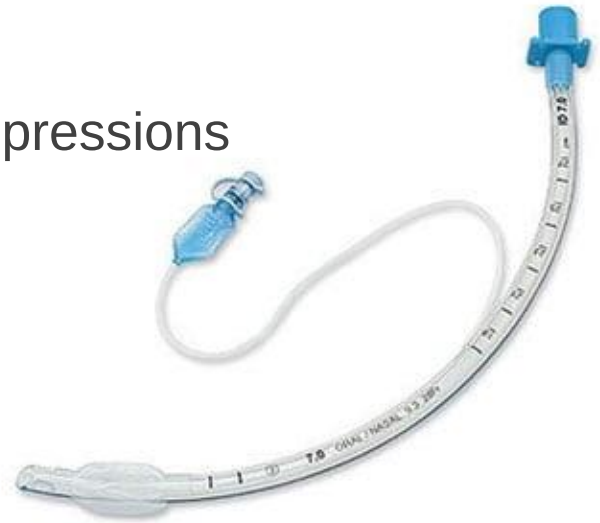
Basic Life Support

- Options for respiratory support
  - Endotracheal intubation
    - Preferred method of respiratory support
    - Should be performed in lateral
    - Cuff should be inflated
    - Breaths can be provided during compressions



https://thinkmdi.net/product/cuffed-endotracheal-tubes/

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Basic Life Support

- Options for respiratory support
  - Mask breathing
    - Can be considered if supplies for intubation are not available
    - Tight-fitting
    - Breaths must be delivered between compressions
      - 30 compressions : 2 breaths

https://jorvet.com/product/anesthesia-mask-canine-5/

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Basic Life Support

- Options for respiratory support
  - Mouth-to-nose
    - Consider risk to rescuer
      - If rescuer risk is high, perform compression only CPR
    - Ensure mouth closed / sealed
    - Extend neck
    - Breaths delivered between compressions
      - 30 compressions : 2 breaths

https://doi.org/10.1111/j.1476-4431.2012.00757.x

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Basic Life Support

- Breath frequency
  - 10 breaths / minute = 1 breath / 6 seconds
    - Reduce positive pressure within the chest

- Avoid hyperventilation and hypoventilation
  - Hyperventilation → ↓ CO_2 → cerebral vasoconstriction → decreased cerebral perfusion
  - Hypoventilation → ↑ CO_2 → cerebral vasodilation → increased intracranial pressure

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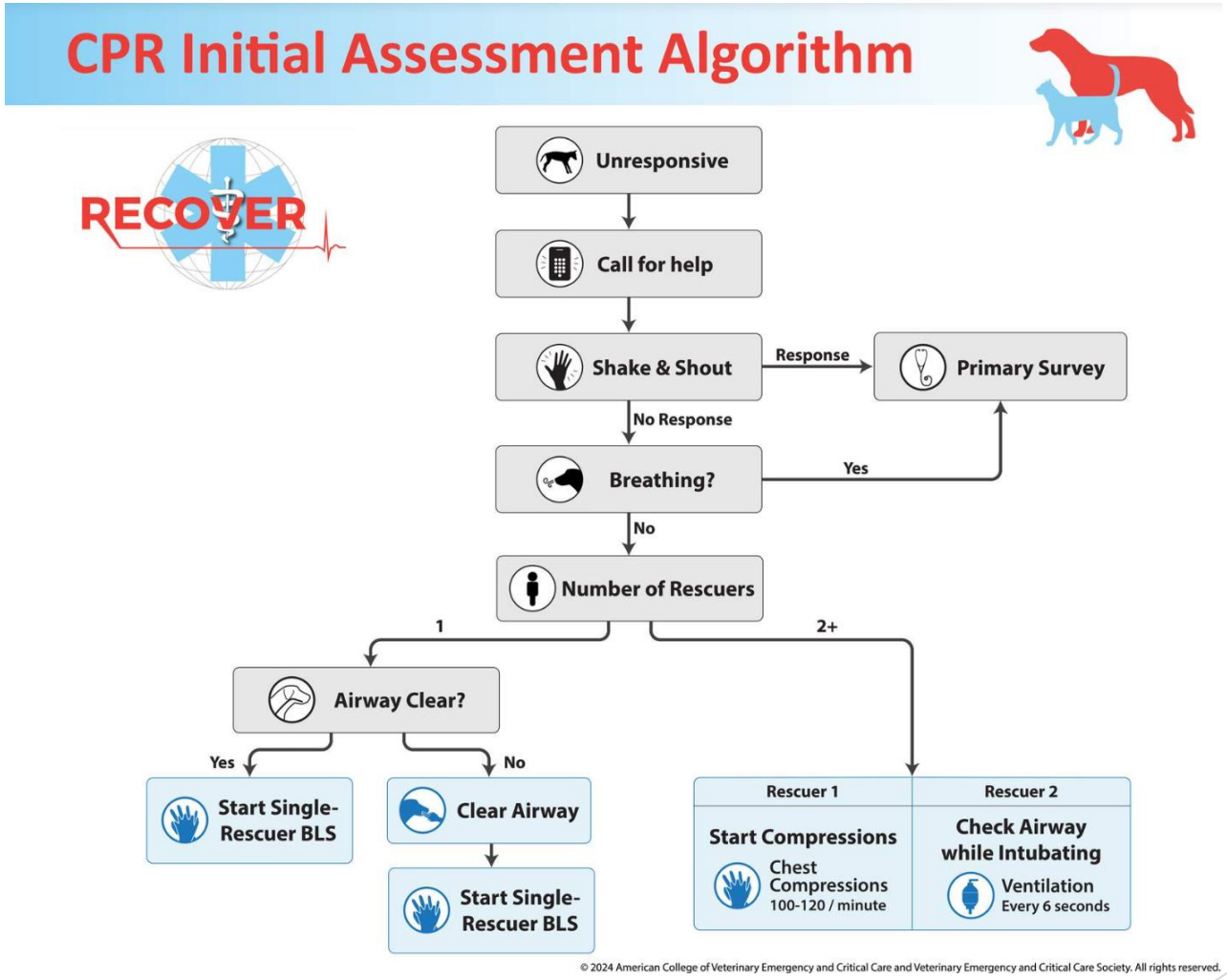
BLS



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Basic Life Support

- Single rescuer CPR
  - Assess the airway and clear any obvious obstructions before starting chest compressions
    - This can happen while calling for help
  - Compression to ventilation ratio
    - 30 compressions : 2 breaths
  - Continue this cycle until:
    - Additional rescuers arrive
    - ROSC is achieved
    - Rescue efforts are terminated

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Basic Life Support

- Multiple rescuer CPR
  - One rescuer should immediately begin chest compressions
    - 100-120 compressions / minute
    - Appropriate hand placement for patient's chest phenotype
  - A second rescuer should secure an airway, ideally via intubation
    - 10 breaths / minute
    - Short inspiratory time
  - 2-minute cycles
    - If fatiguing before 2 minutes is up, replace compressor sooner

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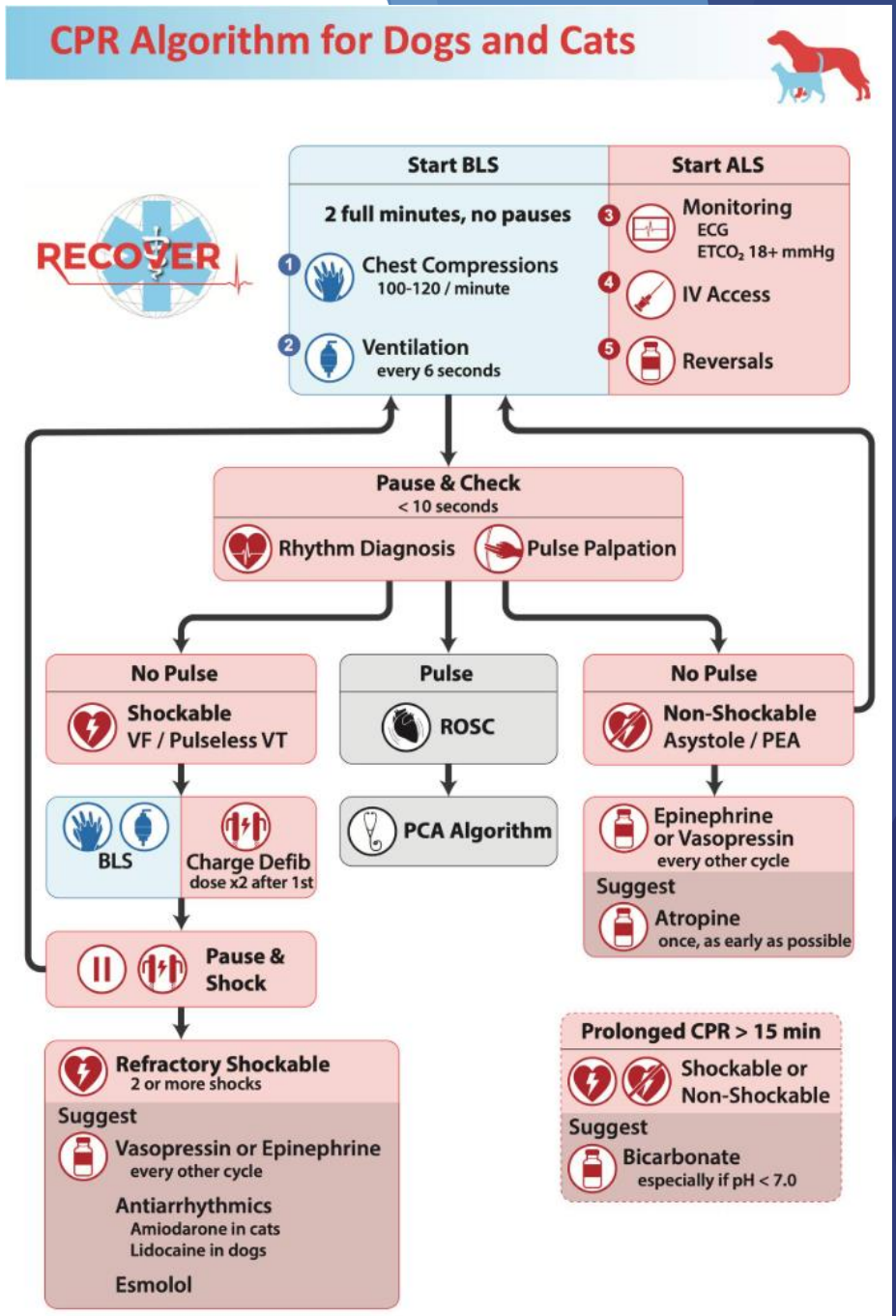
Advanced Life Support

- You've instituted high-quality BLS… now what?
- Your next step is to provide Advanced Life Support (ALS)



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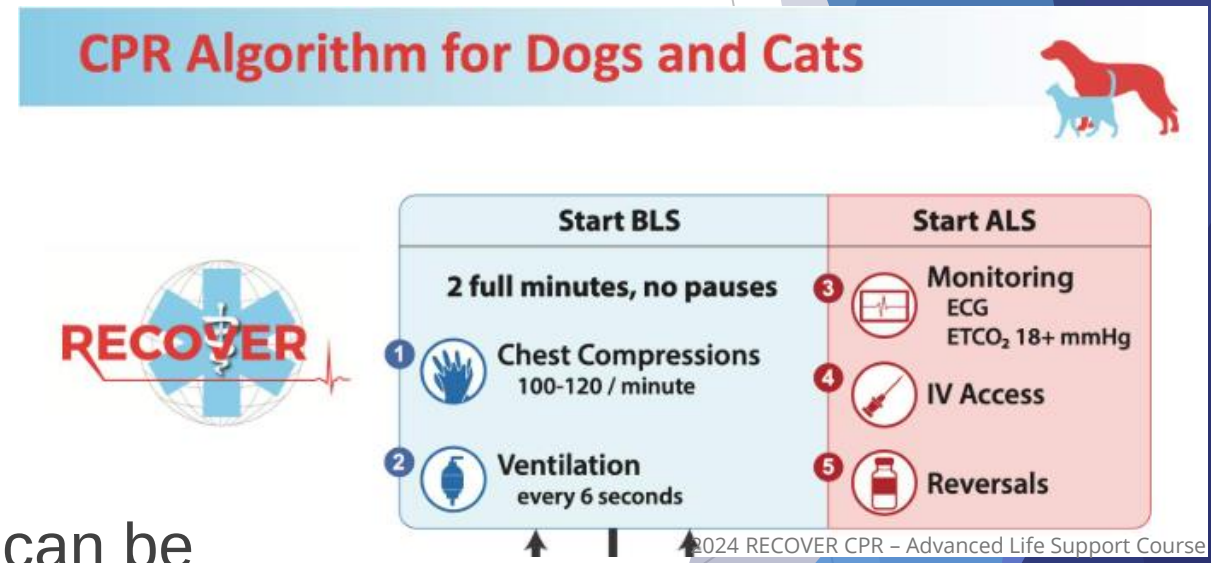
Advanced Life Support

- As previously discussed, BLS always comes first, but once started, we move on to ALS
  - 3) Monitoring
  - 4) IV access
  - 5) Reversals
- If there is enough support, these tasks can be started while BLS is starting



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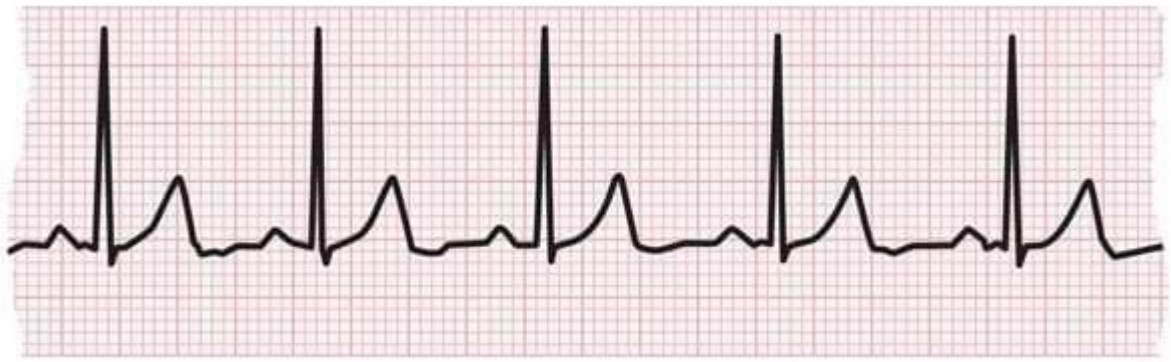
Advanced Life Support

- Monitoring
  - Two primary tools for monitoring during CPR
    - ECG
    - End-tidal CO_2 monitor

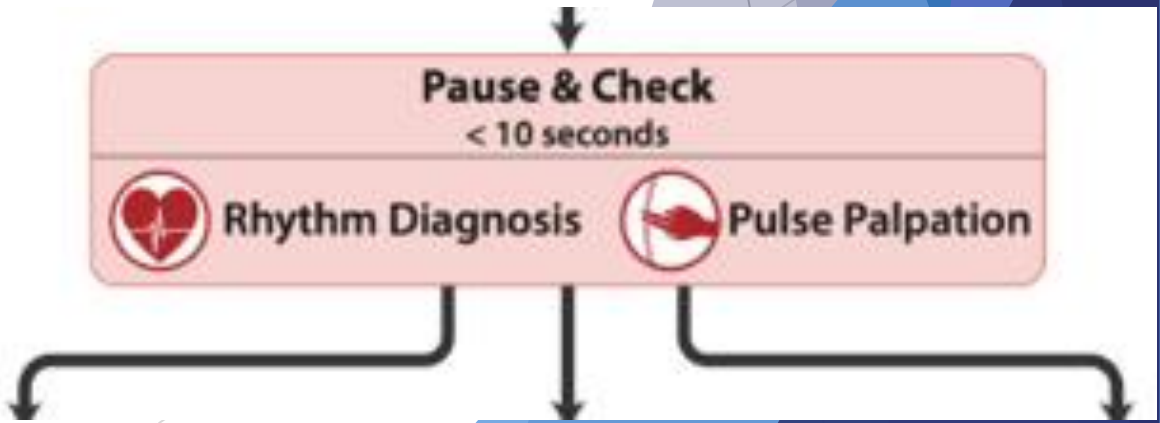


https://www.heart.org/en/health-topics/heart-attack/diagnosing-a-heart-attack/electrocardiogram-ecg-or-ekg

https://www.envihs.com/products/masimo-emma-ii-emergency-capnograph-new

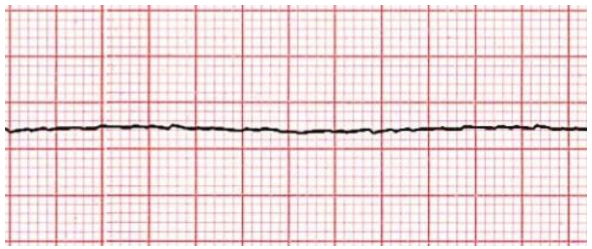
Advanced Life Support

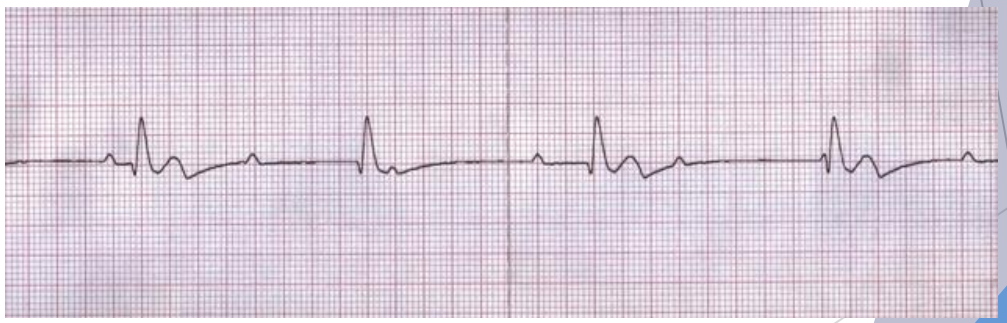
- ECG
  - Can be placed while compressions are ongoing
  - Ideally should avoid alcohol when trying to improve contact
    - Use electrode gel if possible
  - Allows for rhythm assessment during pauses between 2-minute cycles
    - Do not assess ECG during CPR

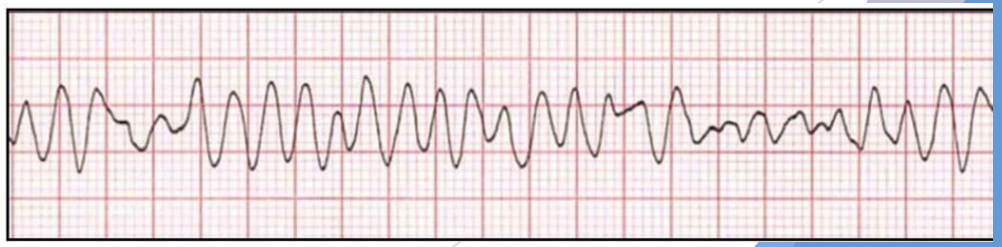


Advanced Life Support

- Most common arrest rhythms
  - Asystole
  - Pulseless electrical activity
  - Ventricular fibrillation







Advanced Life Support

- End-tidal CO_2 monitor
  - Two main factors lead to $ETCO_2$ value
    - Minute ventilation
    - Amount of blood returning from the tissues to the lungs
  - Advantages of $ETCO_2$
    - Motion resistant
    - Can be placed immediately following intubation
    - Can be used to monitor chest compression quality
    - A sudden, substantial increase in $ETCO_2$ can indicate ROSC

https://www.envihs.com/products/masimo-emma-ii-emergency-capnograph-new

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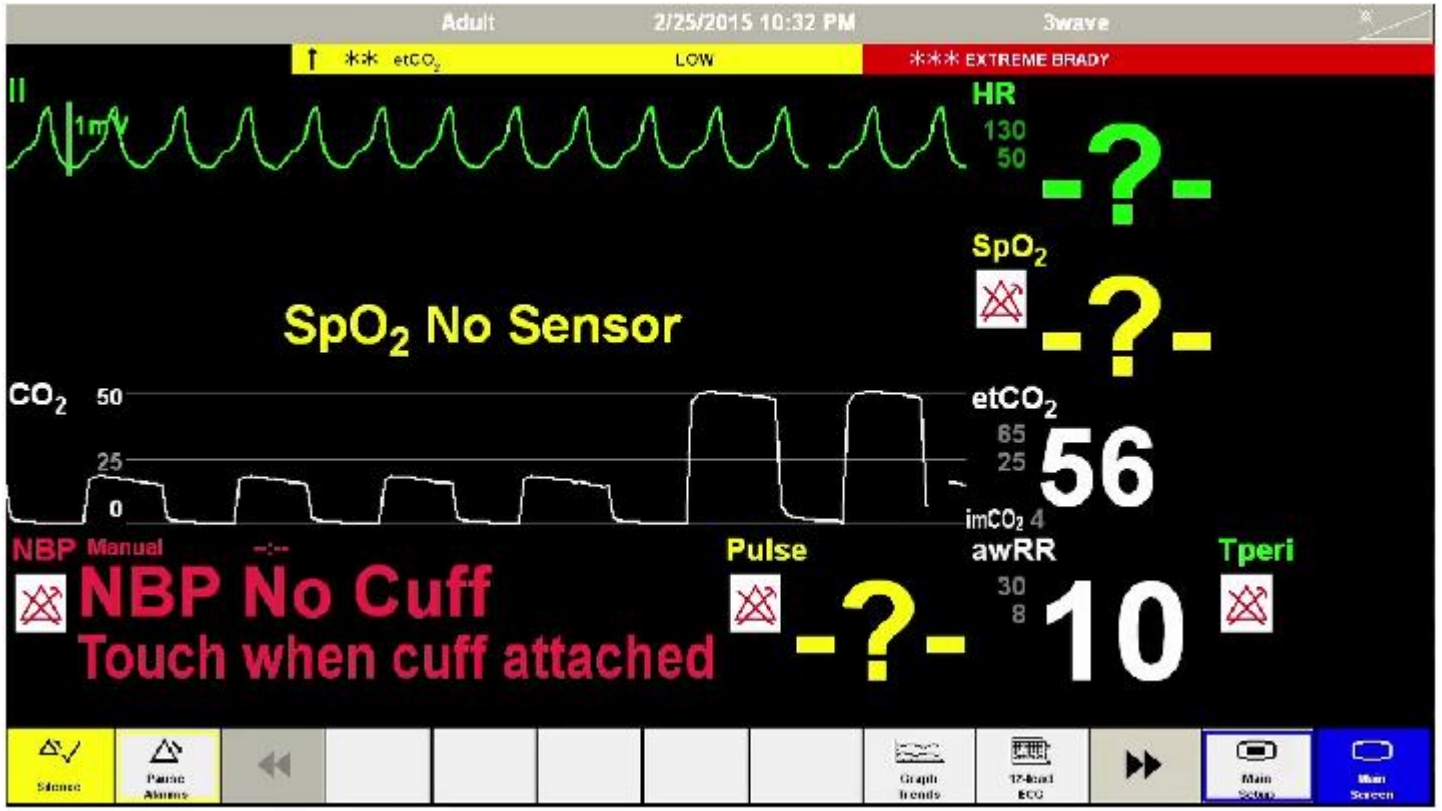
Advanced Life Support



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Advanced Life Support

- What about your other monitoring equipment?

- No!
  - All of these machines rely on pulsatile arterial blood flow

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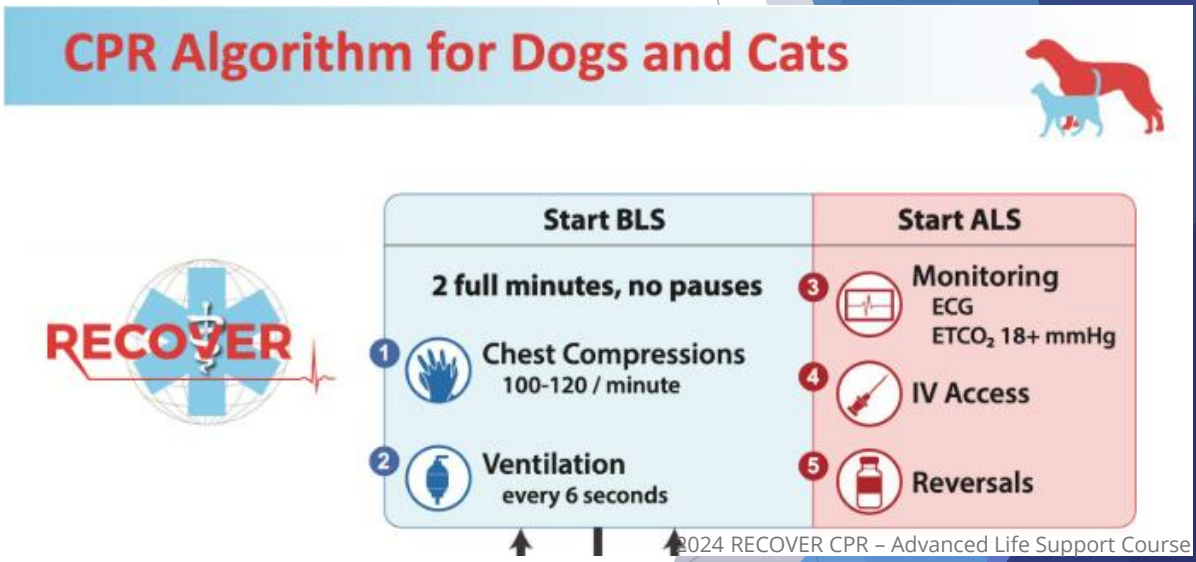
Advanced Life Support

- Intravenous Access
  - Allows administration of reversals and rescue drugs
- If IV catheter already in place, prioritize using catheter closest to the heart



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Advanced Life Support

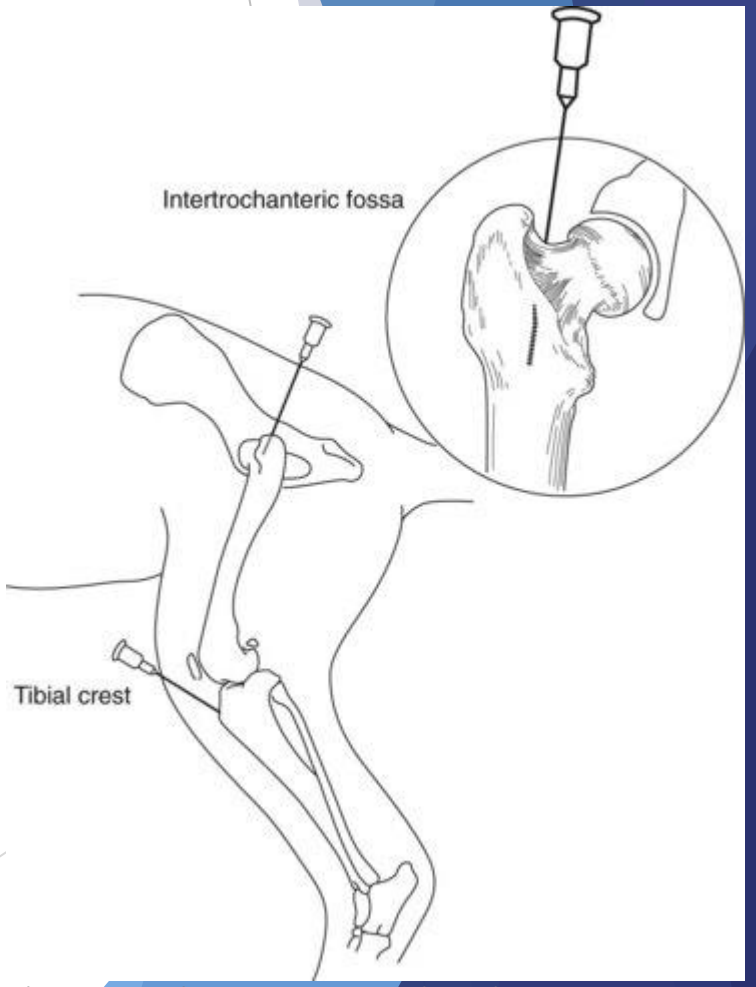
- Intravenous Access
  - Peripheral IV catheter placement
    - Cephalic vs. saphenous vs. external jugular
    - Bigger isn't better
  - Peripheral venous cutdown
    - Can be performed on cephalic, saphenous, or jugular
    - Lateral saphenous tends to be easiest (and most out of the way)

https://www.vin.com/apputil/project/DefaultAdv1.aspx?pId=24437&SAId=-1&catId=137399&id=9382712

Advanced Life Support

- Intravenous Access
  - Intraosseous catheter
    - IO gun
    - 18G or 20G needle in puppies / kittens

https://todaysveterinarynurse.com/emergency-medicine-critical-care/uncommon-iv-catheter-sites-in-small-animals



https://veteriankey.com/emergency-and-critical-care-issues/

Advanced Life Support

- Intratracheal drug administration
  - Epinephrine, atropine, and vasopressin can be administered via endotracheal tube
  - NO sodium bicarbonate
  - Drugs are diluted with saline and administered down the tube using a red rubber catheter
  - Stopgap measure

Advanced Life Support

- Reversals
  - Opioids → naloxone
  - Benzodiazepines → flumazenil
  - α-2 agonists → atipamezole

- In CPA situations, these medications should be administered IV/IO, not subcutaneously or intramuscularly

CPR Dosing Chart for Dogs and Cats

RECOVER

	DRUG	DOSE	Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
			mL	mL	mL	mL	mL	mL	mL	mL	mL	mL	mL	mL
Arrest	Epinephrine (1:1000; 1mg/mL)	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
Arrest	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
Arrest	Atropine (0.4 - 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-Arrhythmic	Amiodarone (50 mg/mL)	5 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhythmic	Lidocaine (20 mg/mL)	2 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhythmic	Esmolol* (10 mg/mL)	0.5 mg/kg		0.13	0.25	0.5	0.75	1	1.3	1.5	1.8	2	2.3	2.5
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
Reversal	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
Reversal	Atipamezole (5 mg/mL)	100 µg/kg		0.06	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Biphasic Defibrillation	External Defib (J)	2 - 4 J/kg		5 J	10 J	20 J	30 J	40 J	50 J	60 J	70 J	80 J	90 J	100 J
Biphasic Defibrillation	Internal Defib (J)	0.2 - 0.4 J/kg		1 J	2 J	2 J	3 J	4 J	5 J	6 J	7 J	8 J	9 J	10 J
			Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50

*Administer esmolol 0.5 mg/kg IV or IO over 3-5 minutes followed by a CRI at 50 mcg/kg/min

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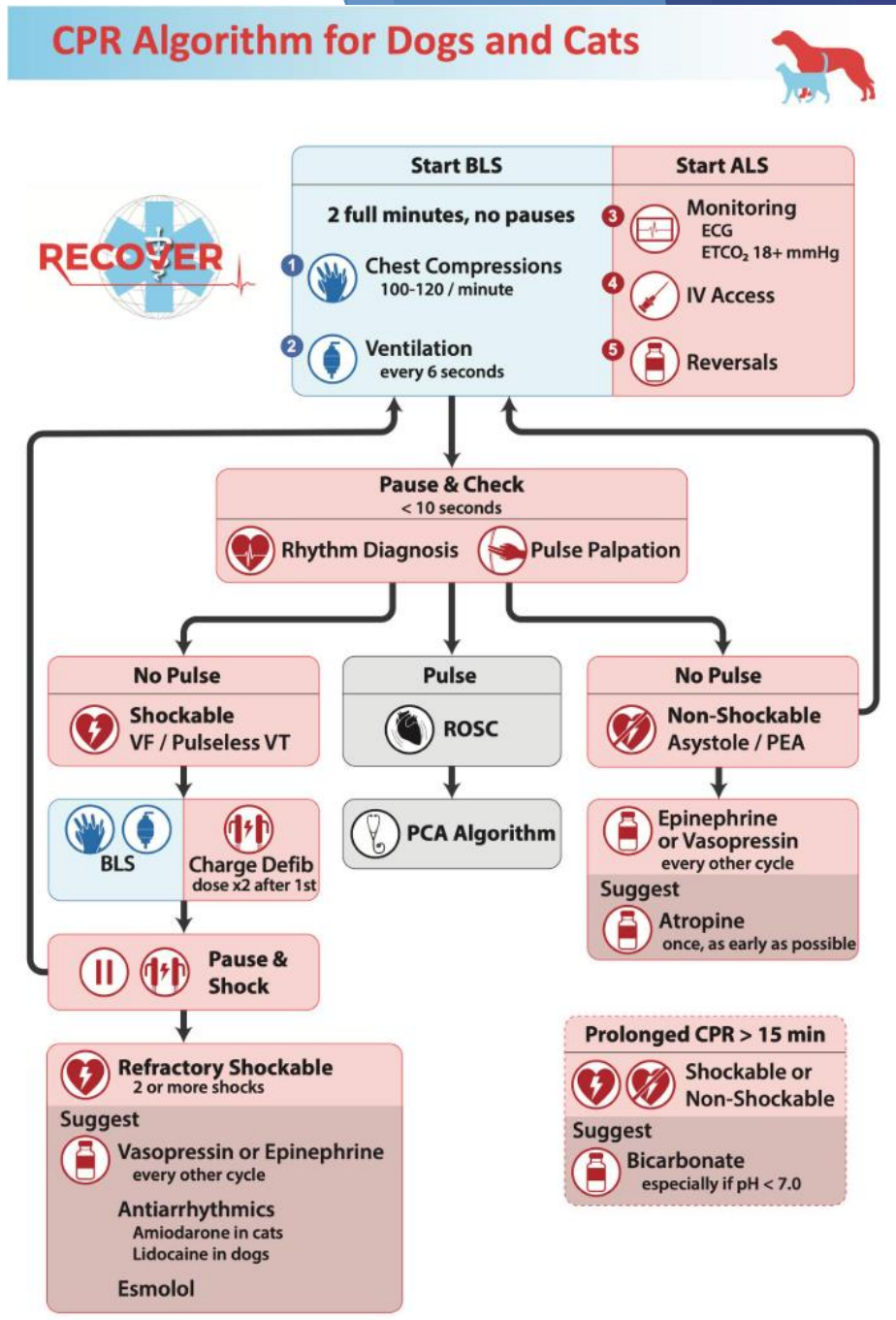
Advanced Life Support

- We’re executing high-quality BLS
- We’ve completed the first 3 steps of ALS
- What’s next?



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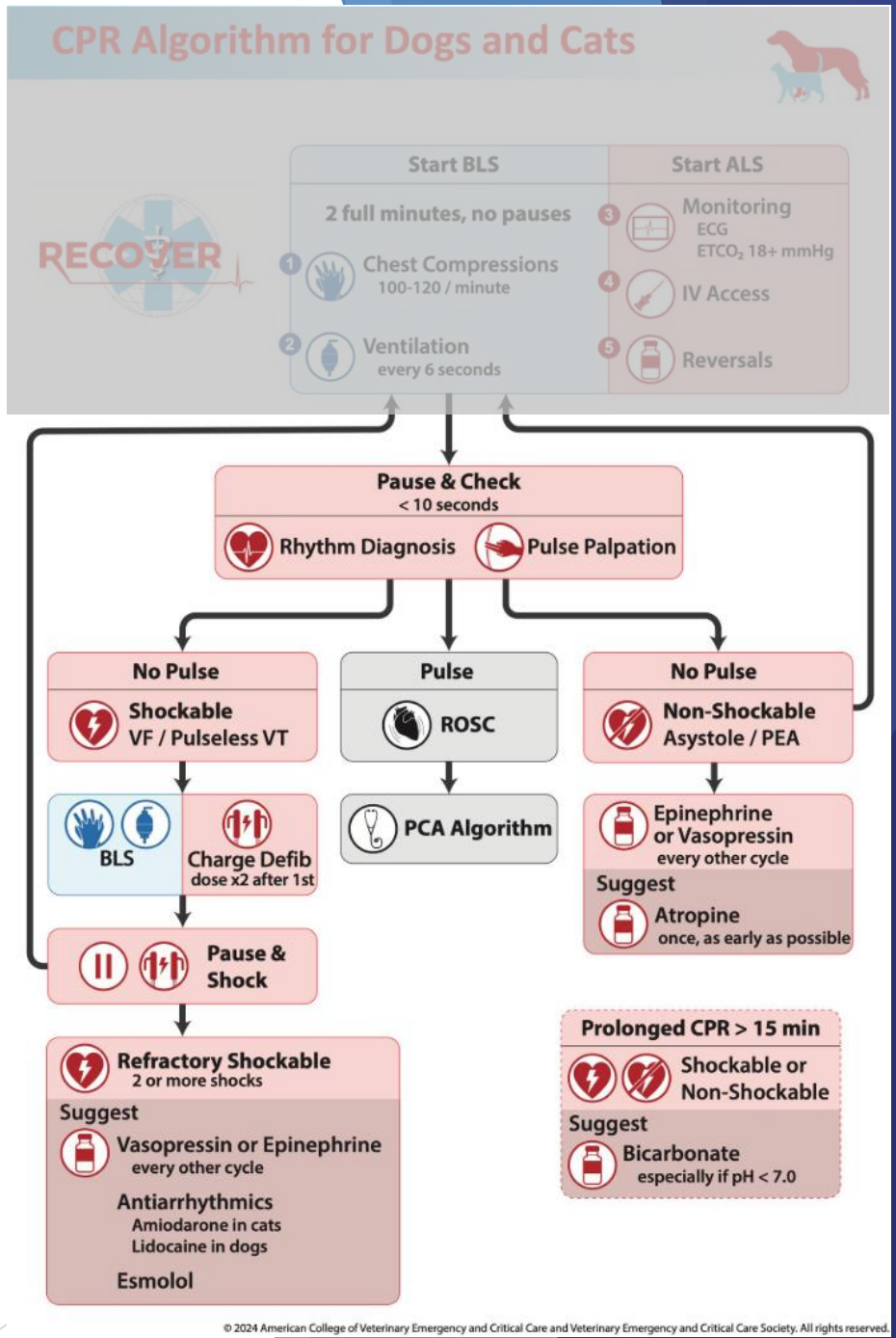
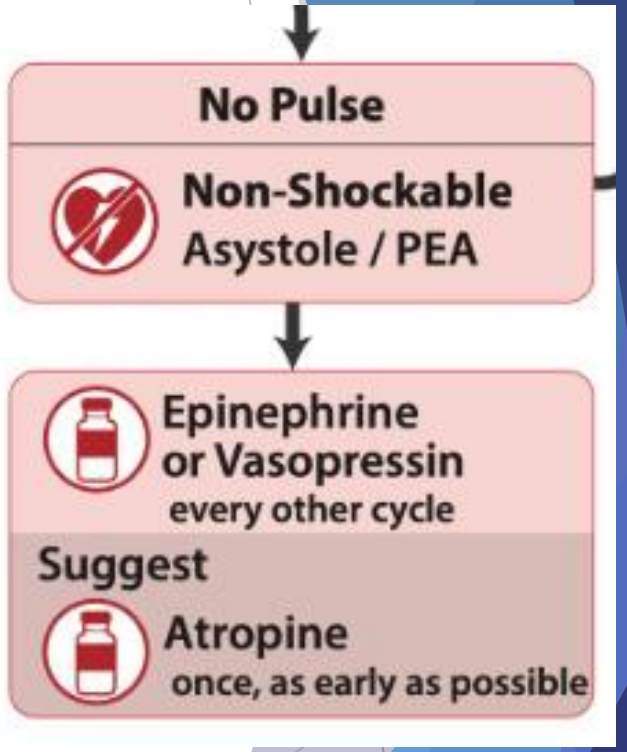
Advanced Life Support

- At the end of each 2-minute cycle, there should be a pause that lasts no more than 5-10 seconds
  - During this time:
    - One team member should feel for a pulse
    - The team should look at the ECG and determine a rhythm diagnosis



Advanced Life Support

- Vasopressors
  - Recommended in ALL patients with non-shockable arrest rhythms
  - Due to short half-lives, recommended that these medications are administered every 3-5 minutes
    - Every other 2-minute cycle
  - Vasopressors increase aortic diastolic pressure → increases myocardial perfusion



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Advanced Life Support

- Vasopressors → epinephrine
  - Catecholamine
  - Normally produced by adrenal medulla

  - Works on α-1, β-1 and β-2 adrenergic receptors
    - α-1 – peripheral vasoconstriction
    - β-1 – increase HR and strength of contractility
    - β-2 – bronchodilation

  - Dose: 0.01 mg/kg IV/IO → 0.1 mL/10 kg body weight
    - 0.02-0.1 mg/kg IT

  - High dose epinephrine no longer recommended

https://entirelypetspharmacy.com/epinephrine-injection-1-mg-1000-sterile-multi-dose-vial-50ml.html

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Advanced Life Support

- Vasopressors → vasopressin
  - AKA: antidiuretic hormone
  - Normally synthesized in the hypothalamus
  - Acts on V_1 receptors causing marked vasoconstriction
  - Dose: 0.8 U/kg IV/IO
    - 4-8 U/kg IT
  - May be more efficacious than epinephrine in prolonged CPR or in patients with severe acidemia

https://eugiaus.com/products/vasopressin-injection-usp-mdv/

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Advanced Life Support

- Parasympatholytics → atropine
  - Act to reduce overall parasympathetic tone (most commonly increased by the vagus nerve) in the body
  - Most useful in cases where high parasympathetic tone may have contributed to the arrest
    - Severe gastrointestinal disturbances (vomiting, diarrhea)
    - Diseases of the respiratory tract (coughing)
    - Ophthalmic manipulation
  - Dose: 0.04-0.054 mg/kg
    - IT: 0.08 – 0.1 mg/kg

https://www.leedstone.com/p/atropine-sulfate-injection

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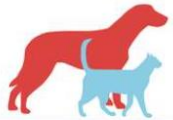
Advanced Life Support

CPR Dosing Chart for Dogs and Cats



	DRUG	DOSE	Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
				mL	mL	mL	mL	mL	mL	mL	mL	mL	mL	mL
Arrest	Epinephrine (1:1000; 1mg/mL)	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
Arrest	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
Arrest	Atropine (0.4 - 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-Arrhythmic	Amiodarone (50 mg/mL)	5 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhythmic	Lidocaine (20 mg/mL)	2 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhythmic	Esmolol* (10 mg/mL)	0.5 mg/kg		0.13	0.25	0.5	0.75	1	1.3	1.5	1.8	2	2.3	2.5
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
Reversal	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
Reversal	Atipamezole (5 mg/mL)	100 µg/kg		0.06	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Biphasic Defibrillation	External Defib (J)	2 - 4 J/kg		5 J	10 J	20 J	30 J	40 J	50 J	60 J	70 J	80 J	90 J	100 J
Biphasic Defibrillation	Internal Defib (J)	0.2 - 0.4 J/kg		1 J	2 J	2 J	3 J	4 J	5 J	6 J	7 J	8 J	9 J	10 J
			Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50

*Administer esmolol 0.5 mg/kg IV or IO over 3-5 minutes followed by a CRI at 50 mcg/kg/min

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Advanced Life Support

- IV fluids
  - Should only be given in cases where there is known or highly suspected hypovolemia
  - Giving a fluid bolus to a euvolemic patient can be detrimental in CPR

https://www.heartlandvetsupply.com/p-5703-lactated-ringers-inj-usp.aspx

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Advanced Life Support

- Steroids
  - Recommended to avoid steroids unless there is a clear indication
  - Patients that may benefit from steroids during CPA
    - Arrest in association with anaphylaxis
    - Patients with known (or highly suspected) hypoadrenocorticism
    - Patients suspected to have CIRCI

https://nexgenvetrx.com/dexamethasone-sp-sodium-phosphate-sterile-injection-4mg-ml-100ml/

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Advanced Life Support

- Bicarbonate
  - With prolonged CPR, severe acidemia can develop due to a build up of lactate and CO_2 in the body
  - Thought that bicarbonate therapy may improve responsiveness of α-1 receptors by improving the blood pH
  - Should only be given in prolonged CPA (>15 minutes) and ideally should have a blood gas identifying a pH <7.0
  - Dose: 1 mEq/kg IV or IO
    - Not to be given IT

https://entirelypetspharmacy.com/vetone-sodium-bicarbonate-8-4-injection-single-dose-vial-100ml.html?gad_source=1&gclid=CjwKCAiA7eO7BhATEiwAm0Ee-ETRHG28PiATS-JK9sQzpy24akbabCjJ3sBM9YA3od6uTvBTFVqKBoChxwQAvD_BwE

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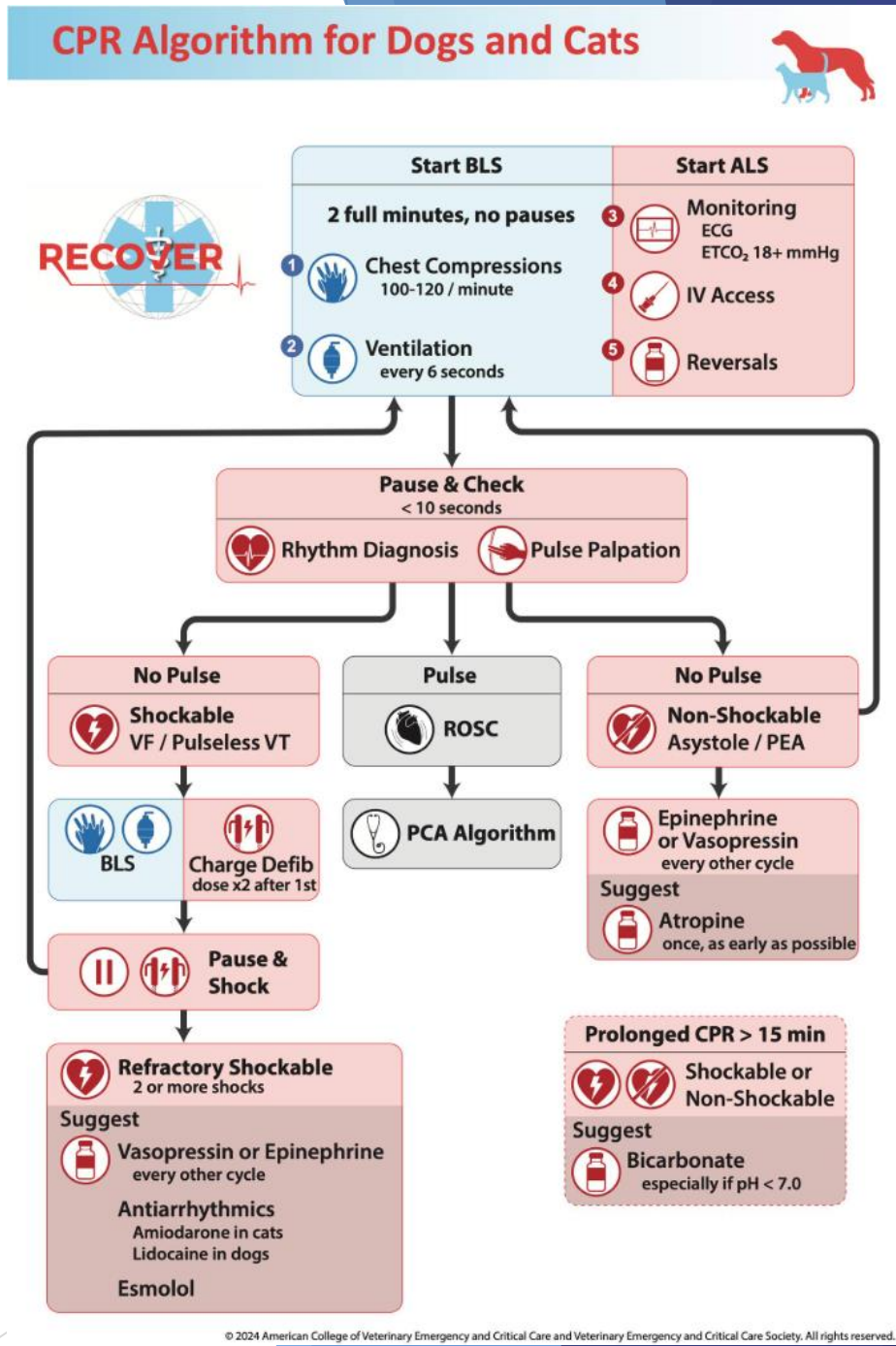
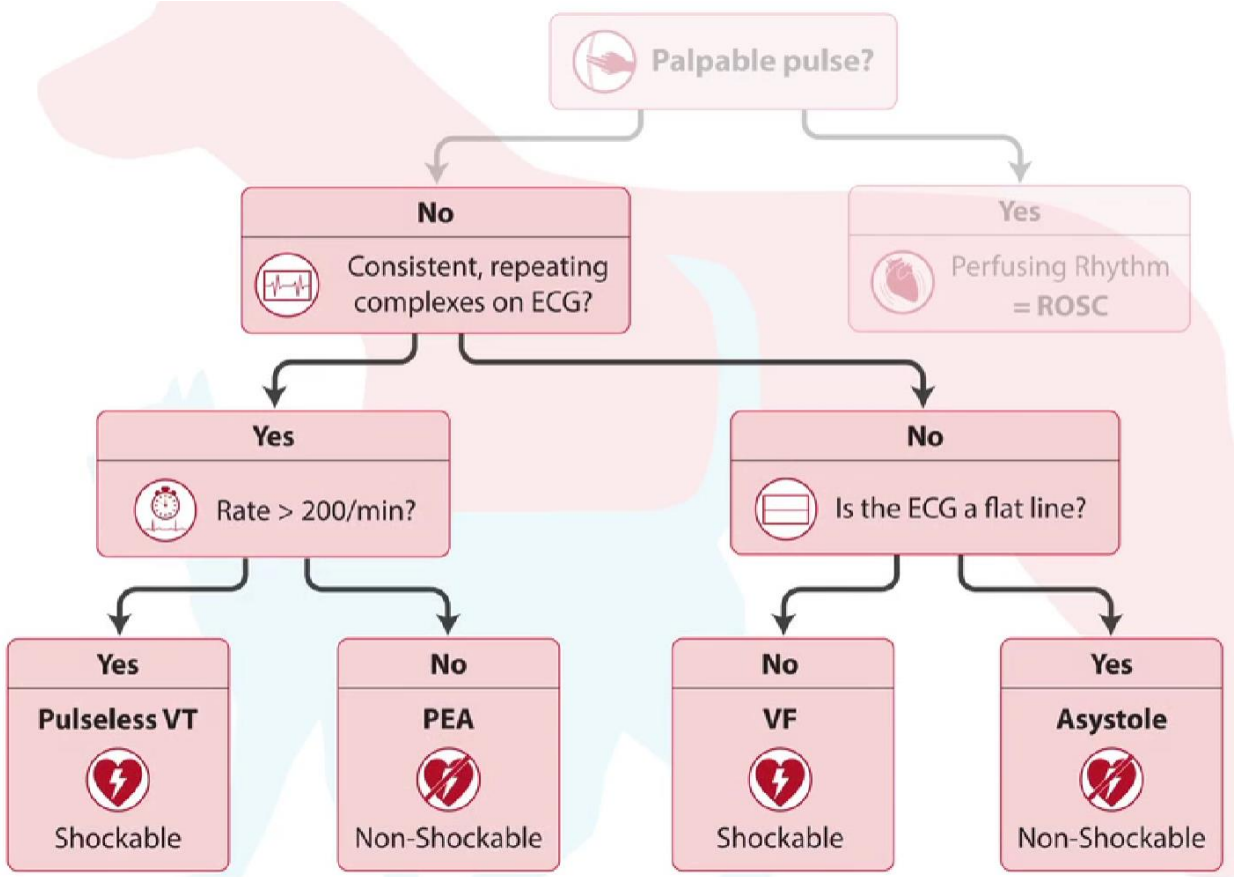
Advanced Life Support

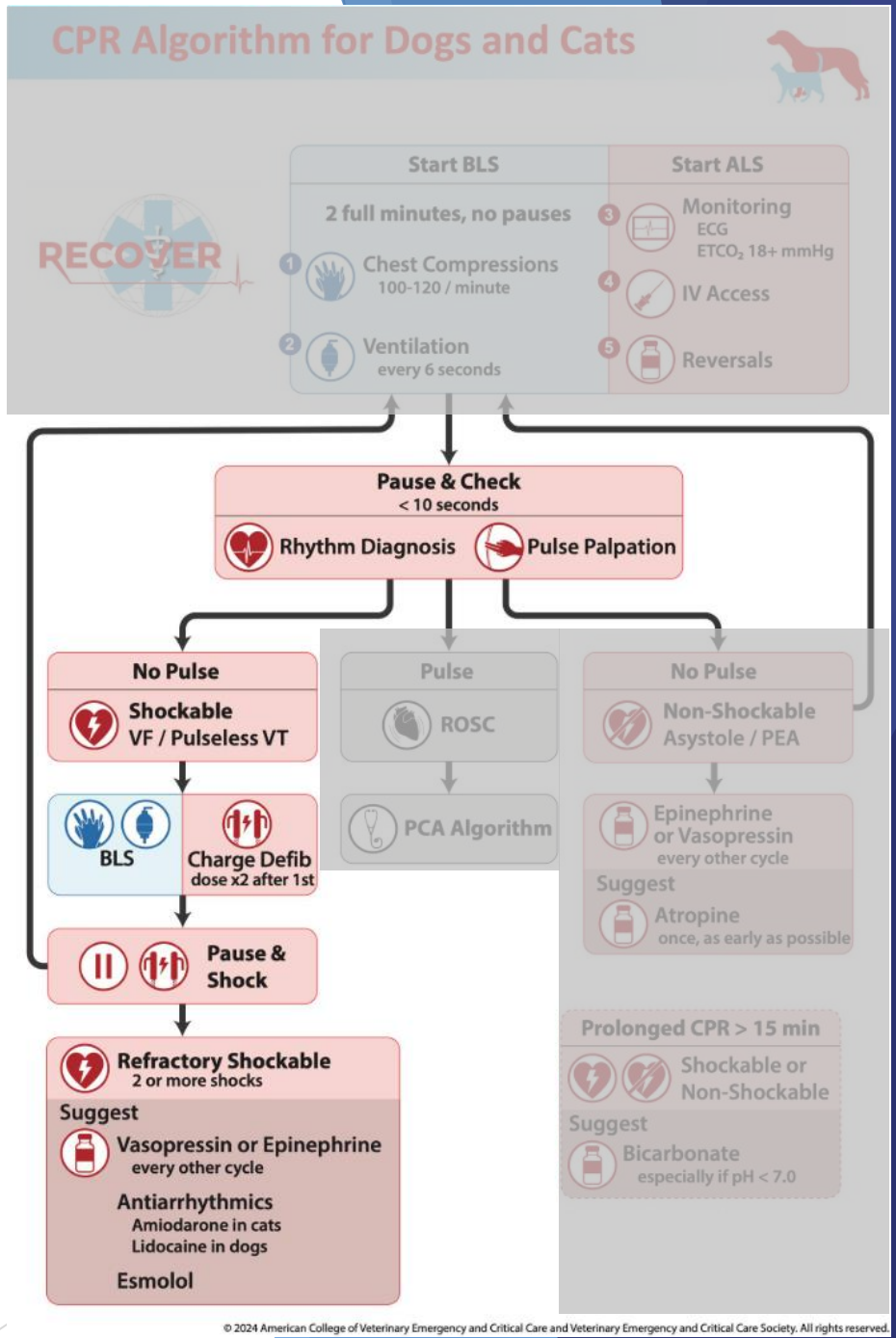
- In the event of non-shockable rhythm:
  - Continue to administer high-quality BLS in 2-minute cycles
  - At the end of a 2-minute cycle, perform a short “pause & check”
  - Administer vasopressors every other 2-minute cycle
    - Every 3-5 minutes
  - This continues until:
    - ROSC is achieved
    - Resuscitation efforts are halted
    - A shockable rhythm is identified during the pause



Advanced Life Support

- Shockable rhythms
  - How do we identify shockable rhythms?





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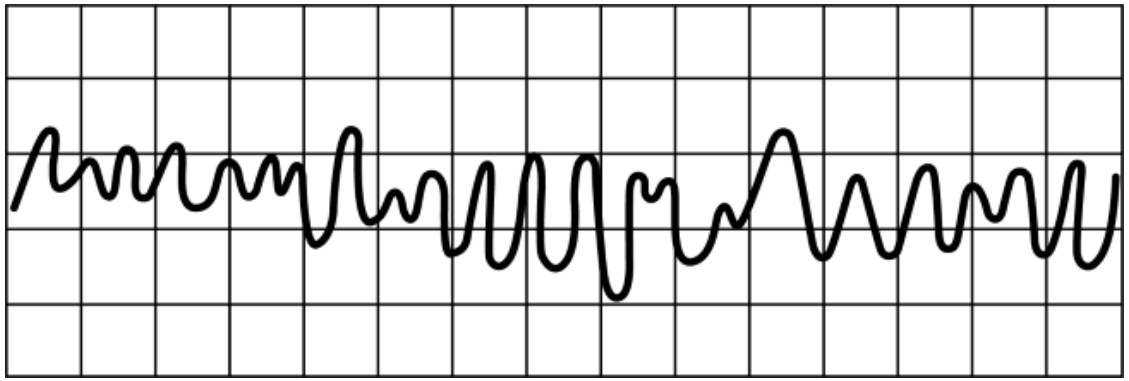
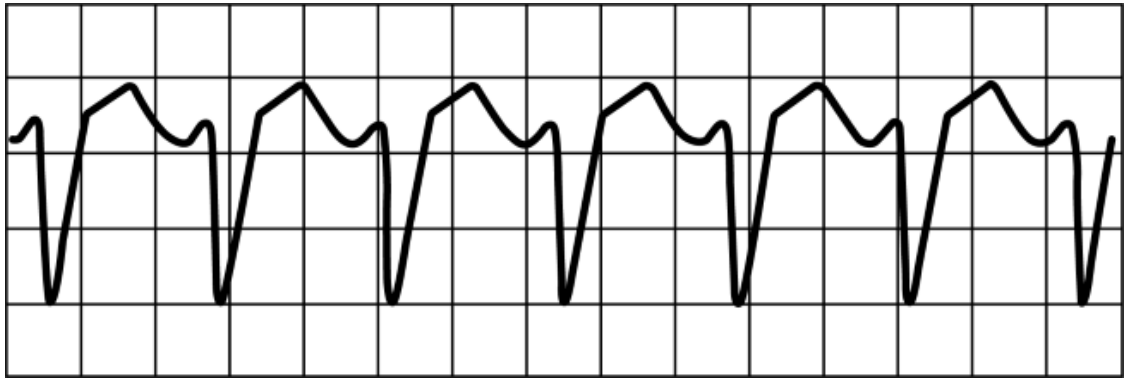
Advanced Life Support

- Shockable rhythms
  - Ventricular fibrillation



  - Pulseless ventricular tachycardia



https://www.mometrix.com/academy/pediatric-advanced-life-support/

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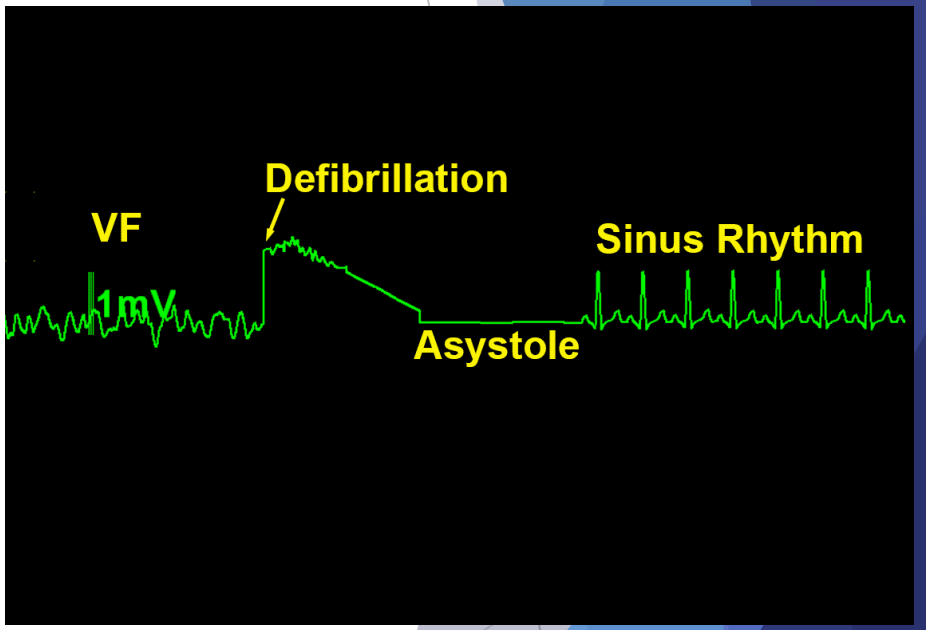
Advanced Life Support

- Electrical defibrillation
  - Goal is to simultaneously depolarize as many cells as possible, returning them to their refractory period, and stopping the ineffective contractions
  - The hope is then that your typical pacemaker cells in the SA node will be able to takeover and return the heart to a normal sinus rhythm



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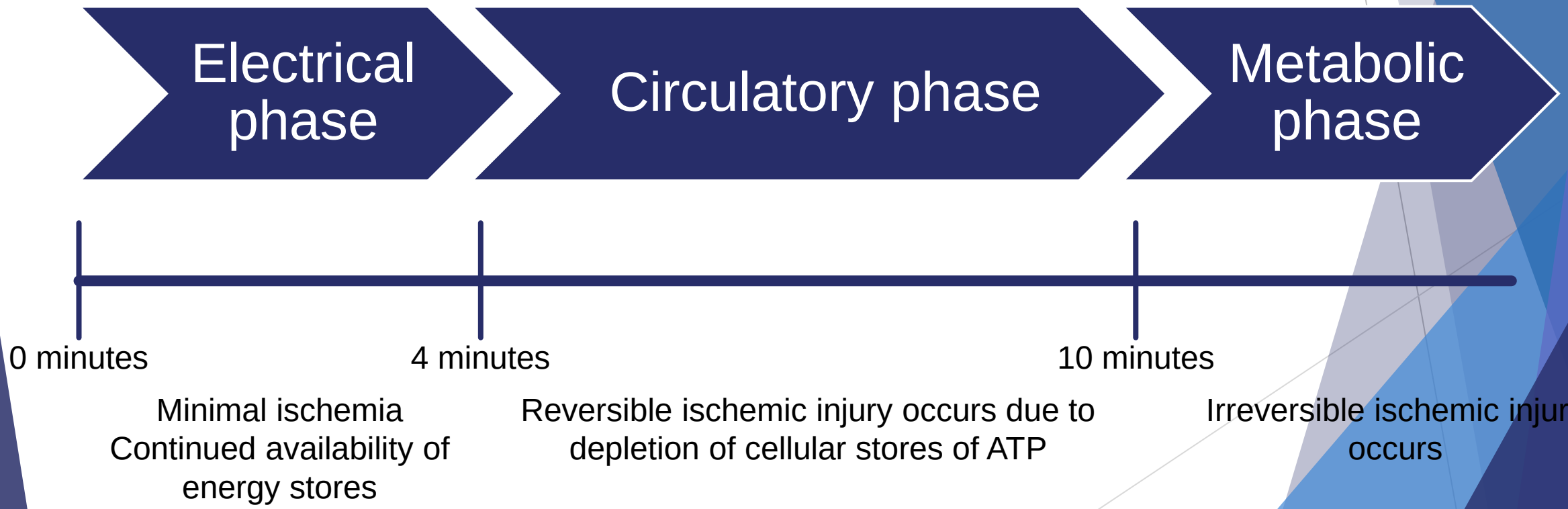
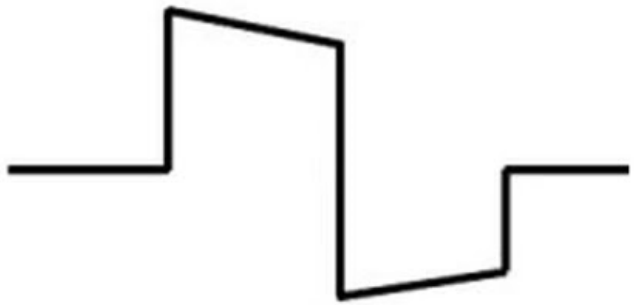
Advanced Life Support



Advanced Life Support

- Defibrillator types
  - Monophasic → delivers electrical current in one direction across patient's chest
  - Biphasic → delivers electrical current in one direction, reverses polarity and deliver current again in opposite direction

Monophasic



Biphasic

https://www.youtube.com/watch?v=_12_ywH8wFU

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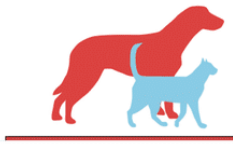
Advanced Life Support

- Defibrillator doses

CPR Dosing Chart for Dogs and Cats



		Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
Monophasic Defibrillation	External Defib (J)	4 - 6 J/kg	10 J	20 J	40 J	60 J	80 J	100 J	120 J	140 J	160 J	180 J	200 J
	Internal Defib (J)	0.5 - 1 J/kg	2 J	3 J	5 J	8 J	10 J	15 J	15 J	20 J	20	20 J	25 J
Biphasic Defibrillation	External Defib (J)	2 - 4 J/kg	5 J	10 J	20 J	30 J	40 J	50 J	60 J	70 J	80 J	90 J	100 J
	Internal Defib (J)	0.2 - 0.4 J/kg	1 J	2 J	2 J	3 J	4 J	5 J	6 J	7 J	8 J	9 J	10 J

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Advanced Life Support

- Electrical defibrillation
  - Avoid use of alcohol on patient's skin
  - If using hand paddles, patient should be in dorsal recumbency and paddles should be placed directly over the heart
  - Press paddles firmly into the chest
  - Ensure yourself and all other personnel have taken their hands off of the patient by stating "CLEAR" and by direct visualization
  - Defibrillate the patient, lower them into lateral recumbency and continue BLS

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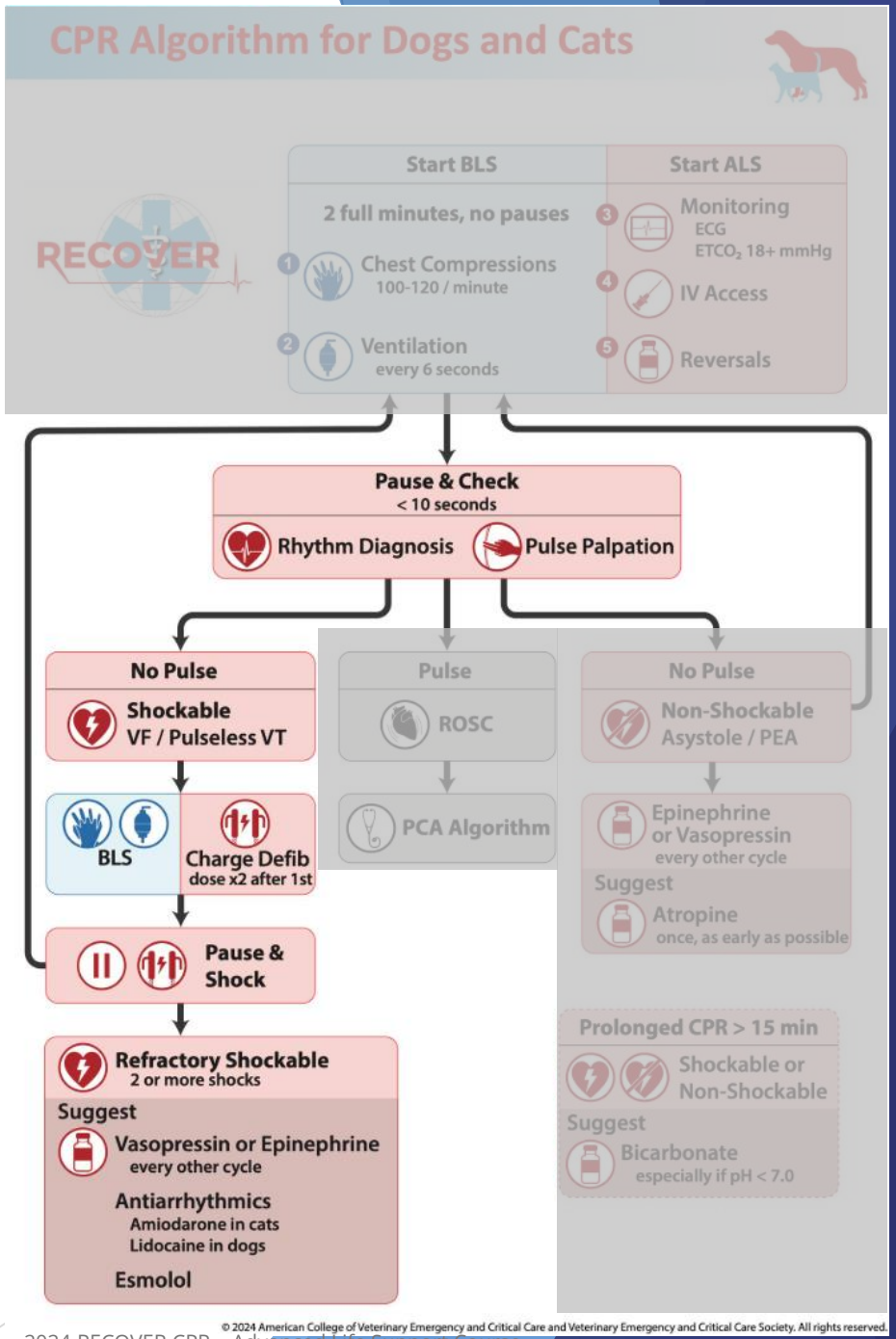
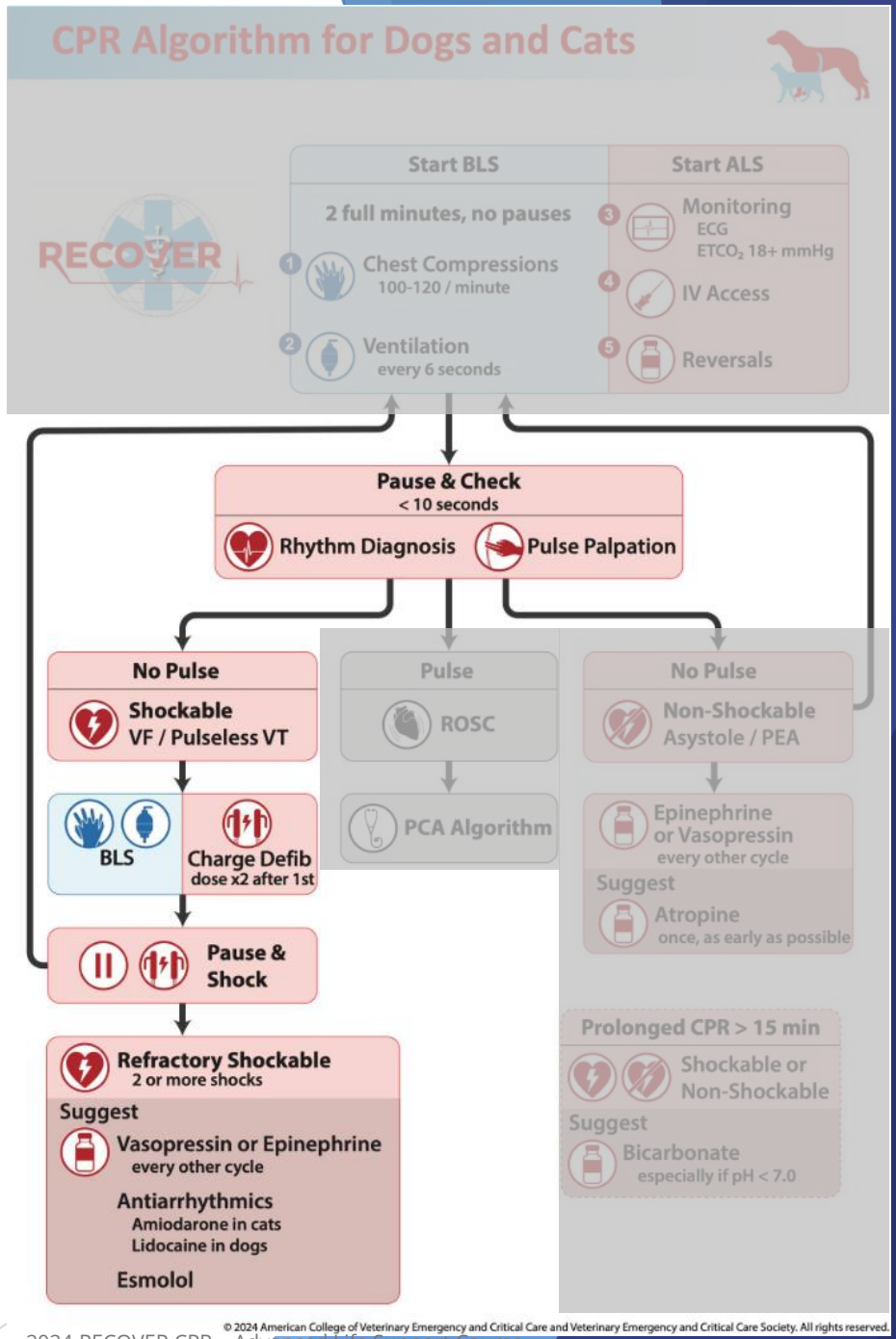
Advanced Life Support

- In the event of a shockable rhythm:
  - Once the rhythm is identified, BLS should be restarted immediately while the defibrillator is readied
    - Dose: 2-4 J/kg (biphasic) or 4-6 J/kg (monophasic)
  - Once defibrillator is charged, get patient into position and defibrillate
  - Once defibrillation is complete, start a 2-minute cycle of BLS
  - At next “pause and check”, assess ECG rhythm



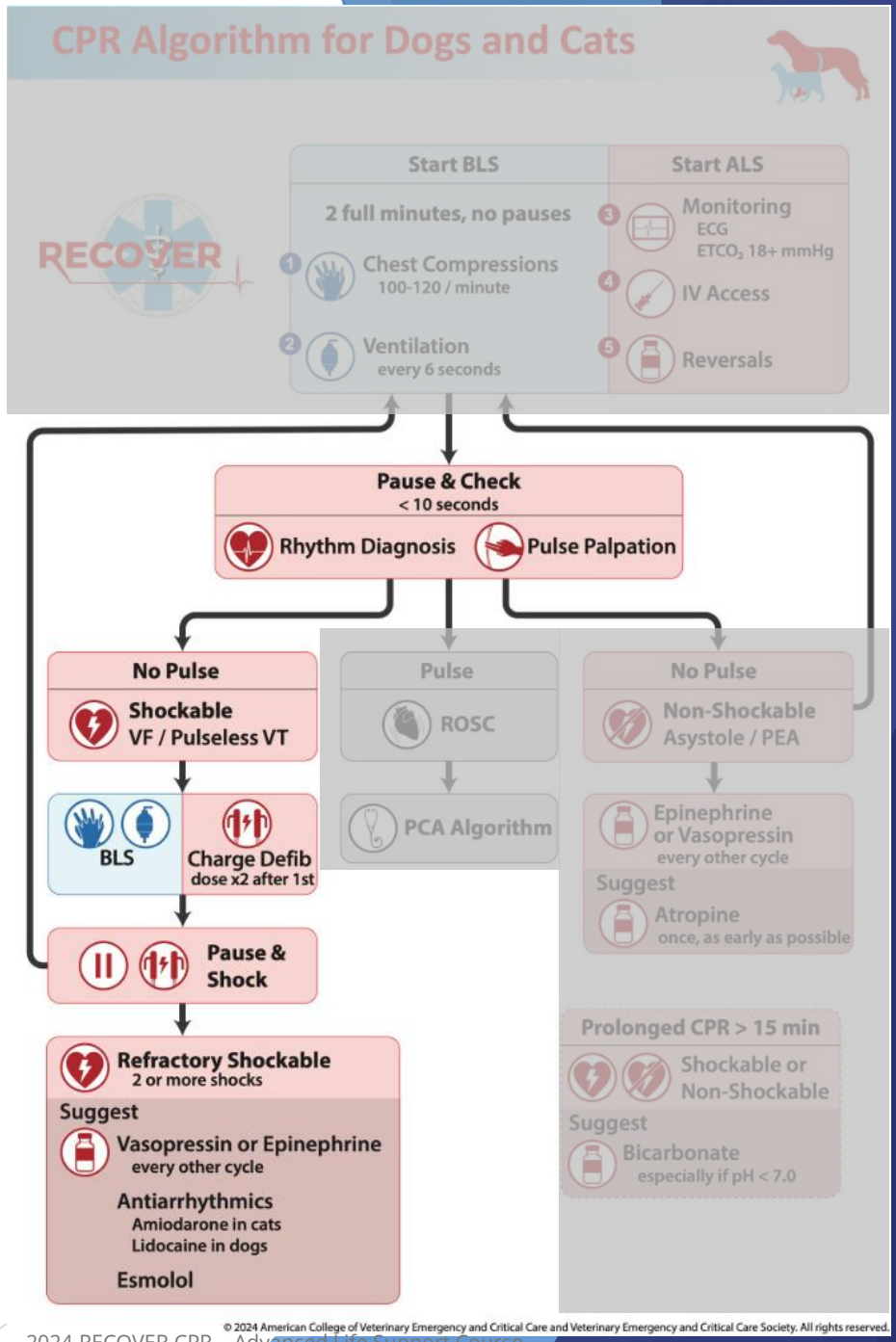
Advanced Life Support

- In the event of a shockable rhythm:
  - If a shockable rhythm is still present, restart BLS and double the defibrillator dose
  - Once defibrillator is charged, defibrillate patient and continue BLS
  - This continues until:
    - ROSC is achieved
    - Resuscitation efforts are halted
    - A non-shockable rhythm is identified during the pause



Advanced Life Support

- Defibrillation should be performed every cycle if patient still has a shockable rhythm
- Once defibrillator dose has been doubled, we do not increase the dose further from there



Advanced Life Support

- Other considerations:
  - Vasopressors
    - When to use:
      - Can be considered in refractory shockable rhythms
    - What to use:
      - Vasopressin (preferable)
      - Epinephrine

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Advanced Life Support

- Other considerations:
  - Antiarrhythmics
    - When to use:
      - Patients with refractory shockable rhythms
    - What to use
      - Lidocaine 2 mg/kg IV/IO
      - Amiodarone 5 mg/kg IV
      - Esmolol 0.5 mg/kg IV/IO

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Advanced Life Support

- Open Chest CPR (OCCPR)
  - In medium- and large-breed dogs, OCCPR is likely to produce better outcomes than closed chest CPR
    - Especially in the face of:
      - Pleural space disease
      - Pericardial effusion
      - Giant breed dogs
      - Diaphragmatic hernias
      - Patients undergoing abdominal or thoracic surgery

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Advanced Life Support

- Open Chest CPR (OCCPR)
  - Prep for a left-sided thoracotomy between the 4th and 5th rib space
  - Incise over the 4th intercostal space using a scalpel, then enter the chest cavity using Mayo scissors to incise through chest wall
  - Retract the ribs
  - Remove the pericardium
  - Directly massage the heart

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Advanced Life Support

- Open Chest CPR (OCCPR)
  - OCCPR should be started as soon as possible
  - Intensive post-ROSC care is necessary
    - Thoroughly flush the chest, close muscle and skin routinely
    - A chest tube should be placed to allow continued evacuation of the chest
    - Consider antibiotics
    - Post-operative analgesia

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Advanced Life Support

- Other considerations:
  - Mechanical defibrillation (precordial thump)
    - Much less effective
    - Should never be used in placed of an electrical defibrillator if one is available
    - Strike directly over the heart
      - Medium to large breed dogs: as much force as possible
      - Small dogs and cats: take care not to hit too hard

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Advanced Life Support

- Setting the team up for success
  - Clear team leader
  - Closed-loop communication
  - Situation monitoring
  - Mutual support

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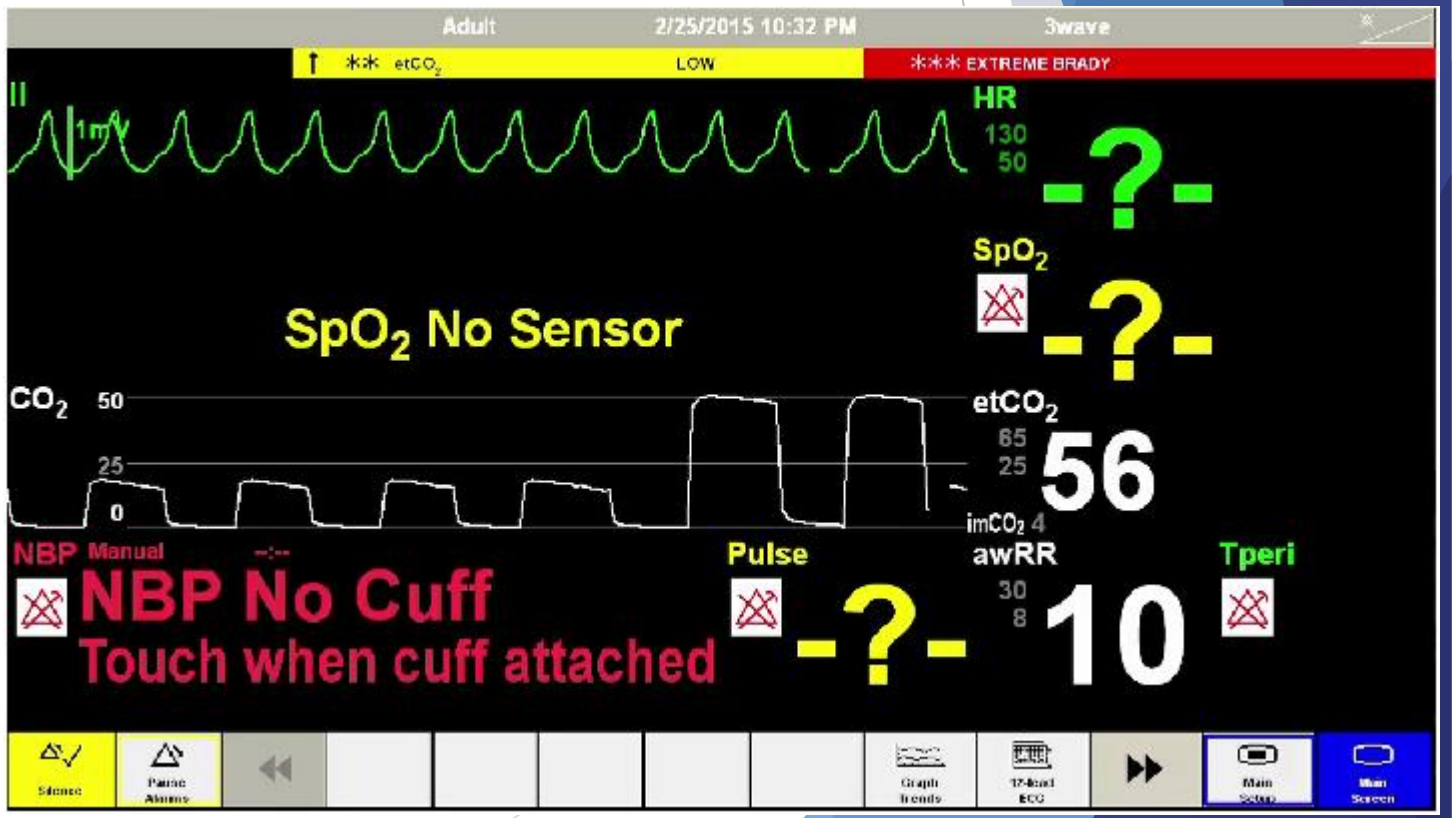
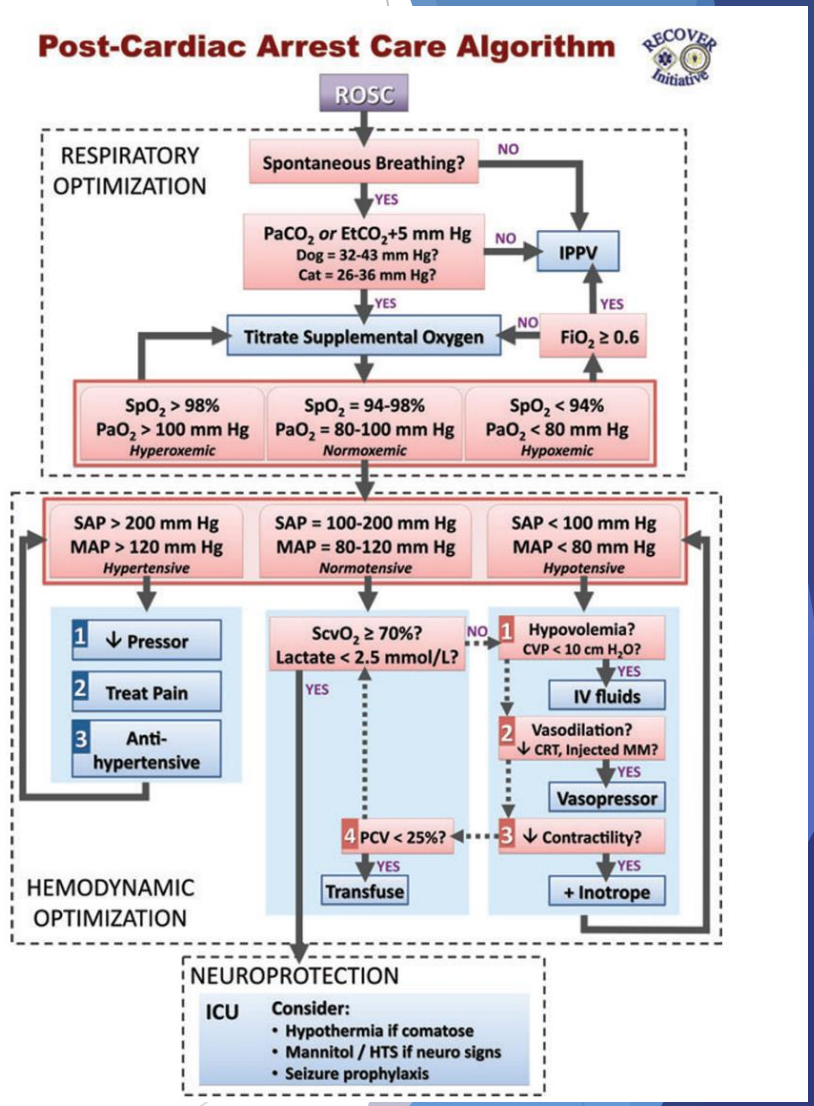
Return of Spontaneous Circulation

- How do we know we got them back?
  - Palpable femoral pulse during “pause and check”
- Stopping a BLS cycle?
  - Only when a sudden, persistent increase in $ETCO_2$ AND evidence of an arterial pulse that is distinct from chest compressions



Post-ROSC Care

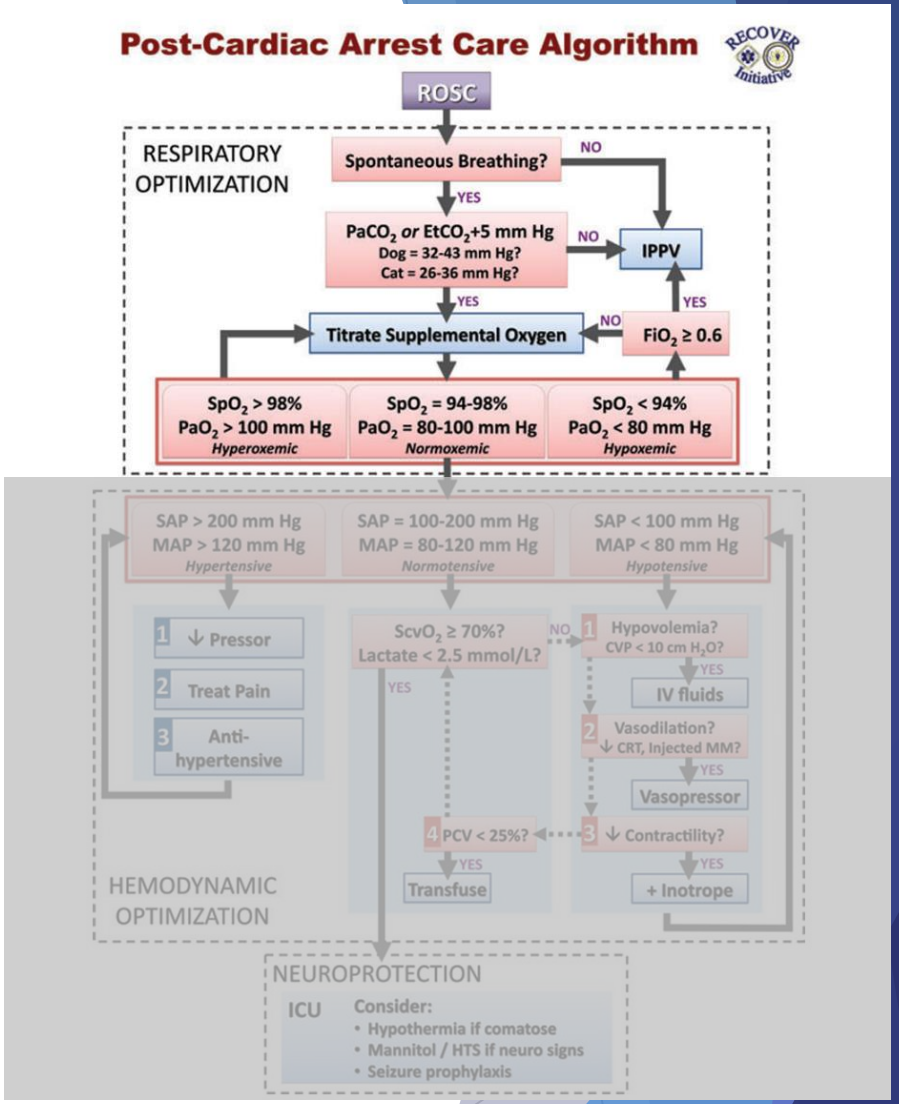
- You got them back… now what?
- Our goal is to optimize care in this critical period
  - Respiratory optimization
  - Hemodynamic optimization
  - Neuroprotection
  - Referral



doi: 10.1111/j.1476-4431.2012.00757.x

Post-ROSC Care

- Respiratory optimization
  - Is the patient spontaneously breathing?
    - If not, we need to provide ventilatory support
  - Aim for normocapnia
    - $ETCO_2$ of 32-43 mmHg in dogs and 26-36 mmHg in cats
  - Aim for patients to be normoxemic
    - Titrate our supplemental oxygen to avoid hyperoxemia and hypoxemia



doi: 10.1111/j.1476-4431.2012.00757.x

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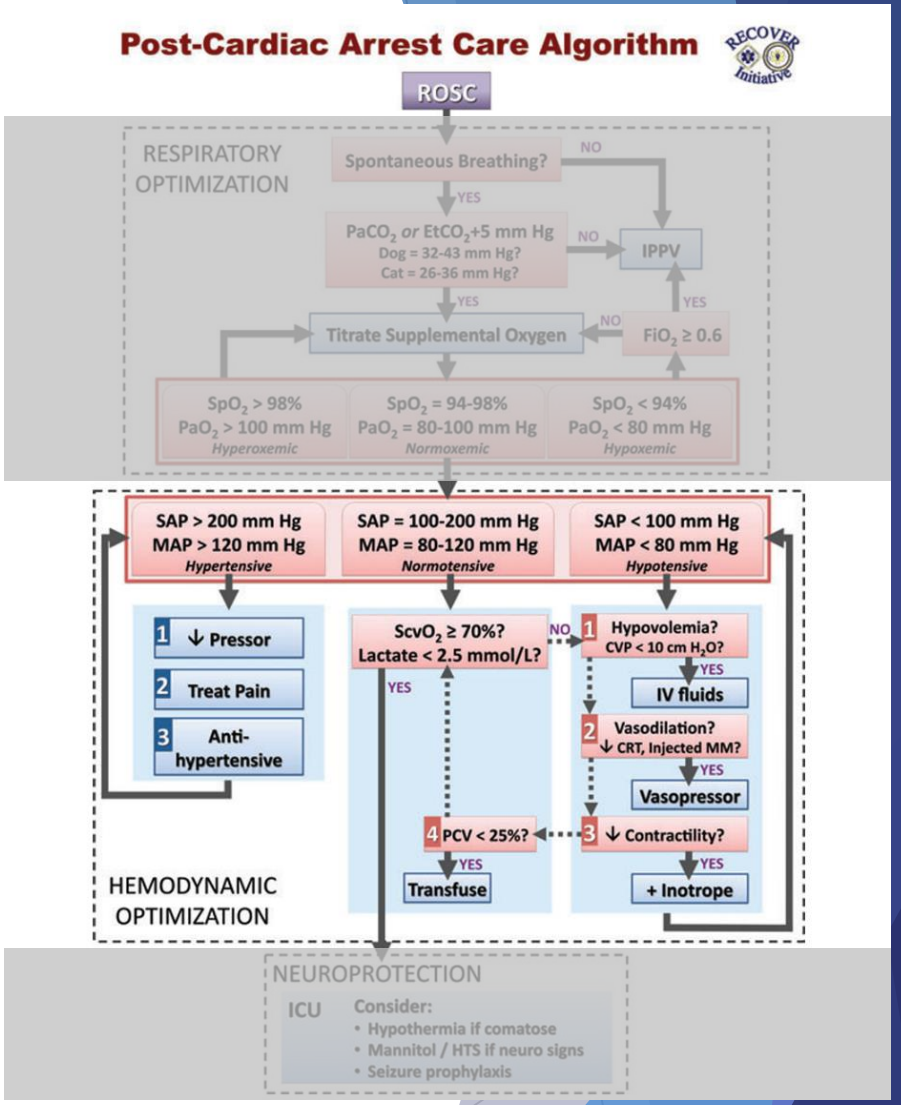
Post-ROSC Care

- Hemodynamic optimization
  - Assessing blood pressure, aiming for normotension
  - If patient is hypotensive, consider:
    - Fluid bolus
    - Vasopressor therapy
    - Positive inotropes
  - If patient is hypertensive, consider:
    - Decreasing pressor therapy
    - Pain medications
    - Anti-hypertensives



doi: 10.1111/j.1476-4431.2012.00757.x

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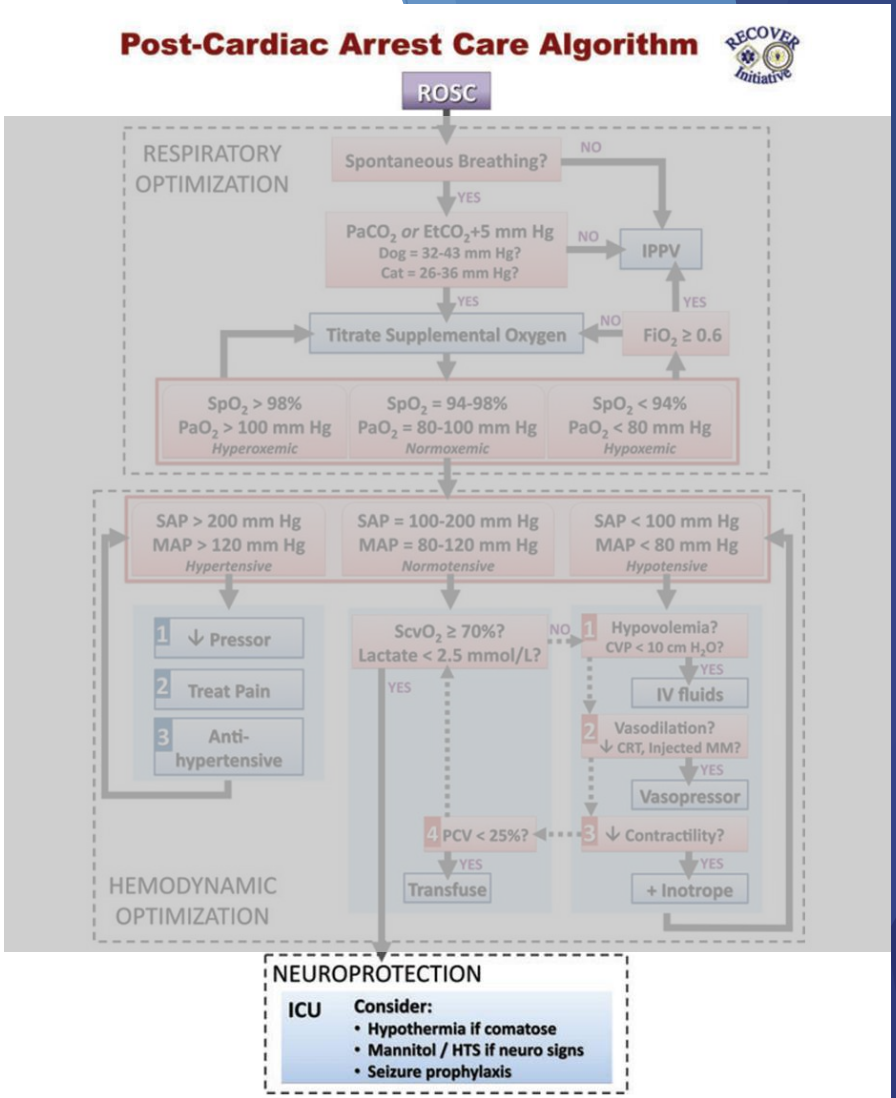
Post-ROSC Care

- Neuroprotection
  - Hypothermia
    - Slow rewarming (0.25-0.5°C/h)
  - Hyperosmotic therapy
    - Hypertonic saline or mannitol
  - Seizure prophylaxis



doi: 10.1111/j.1476-4431.2012.00757.x

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Debriefing

- This is an opportunity to discuss the code as a whole
  - What went well?
  - What could have gone better?
  - What changes can we make to improve?
- Should be led by the team leader
  - Open-ended questions
- Important to ensure the team is in an appropriate mindset for this

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Application

- Preparedness
  - Didactic training – online or in-person RECOVER course
  - Hands-on practice
  - Centrally located crash cart
    - Emergency drugs
    - Ambu bag + ET tubes
    - $ETCO_2$ monitor
  - Cognitive aids
  - Debriefing

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