NIVMA 2025

- [x] All About Opioids!
- [x] Building Individualized Premedication Plans
- [x] Non-Opioid Analgesics
- [x] Managing Hypotension
- CPR – RECOVER updates

Cardiopulmonary Resuscitation

2024 RECOVER GUIDELINES

Steph Sharping, DVM, DVSc, DACVAA

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Why are we here today?

- 30% of variability in patient survival is attributable to CPR training
  - Dane et al. Resuscitation, 47 (2000), pp. 83-87

- CPR skills deteriorate even in trained individuals
  - Anderson et al. Resuscitation, 135 (2019), pp. 153-161

We perform CPR

Overview and Objectives

- What are the RECOVER guidelines?
- Review 5 aspects of veterinary CPR
  - Preparedness and Prevention
  - Basic Life Support (BLS)
  - Advanced Life Support (ALS)
  - Monitoring
  - Post-Cardiac Arrest Care

→ Gain familiarity with updated guidelines

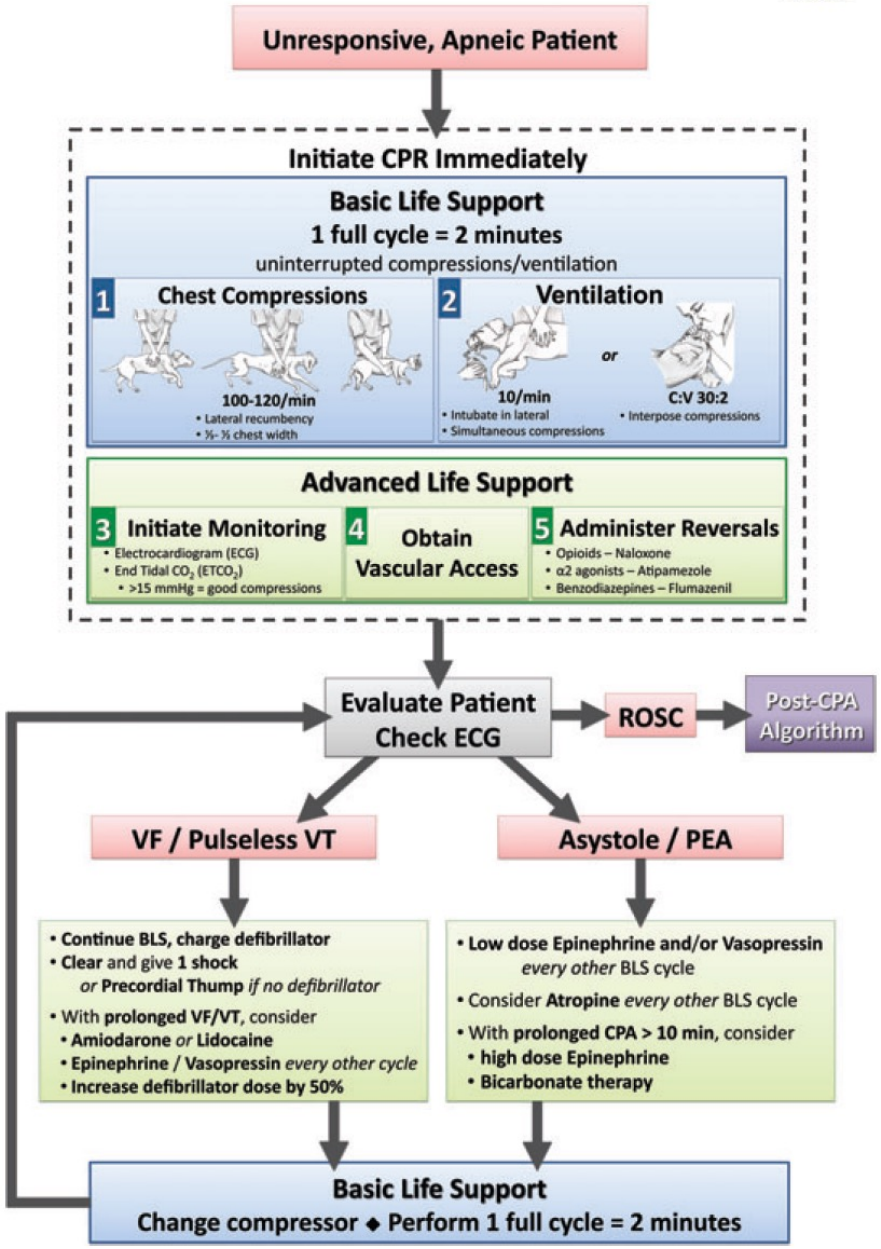
→ Know where to find CPR resources

RECOVER Guidelines

- Reassessment Campaign on Veterinary Resuscitation (RECOVER)
- Need for specific, evidence-based, consensus guidelines for vet CPR
- Prior to these guidelines:
  - < 7% of dogs with CPA survived until discharge vs. 20% of humans

Survival for dogs/cats with CPA during anesthesia ~47%

CPR Algorithm



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; 1mg/ml) every other BLS cycle x3	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	Epi High (1:1000; 1 mg/ml) for prolonged CPR	0.1 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	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 (0.54 mg/ml)	0.04 mg/kg	0.2	0.4	0.8	1.1	1.5	1.9	2.2	2.6	3	3.3	3.7
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
Anti-Arrhyth	Lidocaine (20 mg/ml)	2 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
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
Defib Monophasic	External Defib (J)	4-6 J/kg	10	20	40	60	80	100	120	140	160	180	200
Defib Monophasic	Internal Defib (J)	0.5-1 J/kg	2	3	5	8	10	15	15	20	20	20	25

RECOVER Guidelines

- HOT OFF THE PRESS!

Journal of Veterinary Emergency and Critical Care | WILEY

SPECIAL ARTICLE

2024 RECOVER Guidelines: Updated treatment recommendations for CPR in dogs and cats

Jamie M. Burkitt-Creedon DVM, DACVECC[1] | Manuel Boller Dr med vet, MTR, DACVECC[2,3] | Daniel J. Fletcher PhD, DVM, DACVECC[4] | Benjamin M. Brainard VMC, DACVA, DACVECC[5] | Gareth J. Buckley MA, VetMB, DACVECC, DECVECC[6] | Steven E. Epstein DVM, DACVECC[1] | Erik D. Fausak MSLIS, RVT[7] | Kate Hopper BVSc, PhD, DACVECC[1] | Selena L. Lane DVM, DACVECC[8] | Elizabeth A. Rozanski DVM, DACVECC, DACVIM[9] | Jacob Wolf DVM, DACVECC[10]

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RECOVER Guidelines

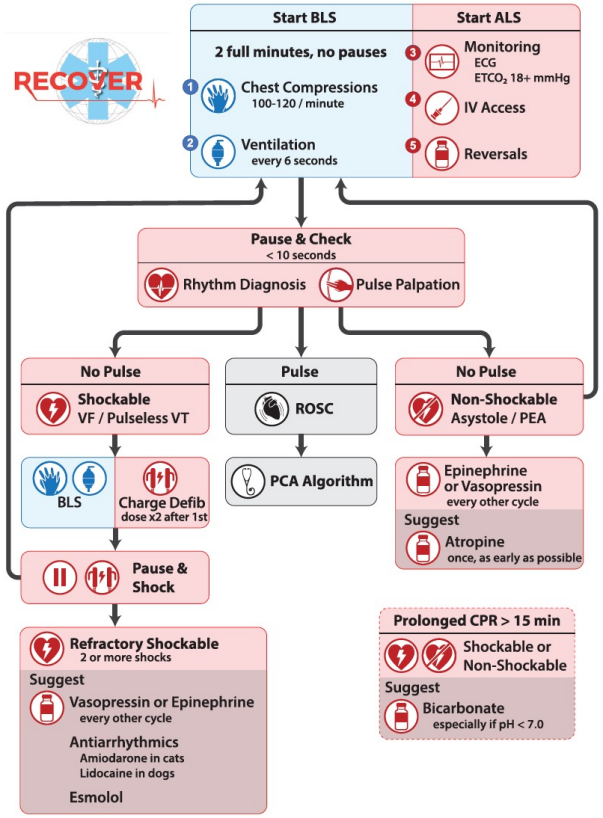
- 5 areas reviewed
  - Preparedness and Prevention
  - ★Basic Life Support (BLS)
  - ★Advanced Life Support (ALS)
  - ★Monitoring
  - Post-Cardiac Arrest Care

Preparedness and Prevention

- Time sensitive, coordinated response improves outcome

Preparedness and Prevention

- Time sensitive, coordinated response improves outcome
- Equipment organization and cognitive aids
  - Readily available
  - Standardized + regularly audited supplies
  - Cognitive aids



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Preparedness and Prevention

- Time sensitive, coordinated response improves outcome
- Equipment organization and cognitive aids
- CPR training
  - Didactic and practical components with feedback (self and external)
  - Refresher courses/mocks at least every 6 months*

Preparedness and Prevention

- Time sensitive, coordinated response improves outcome
- Equipment organization and cognitive aids
- CPR training

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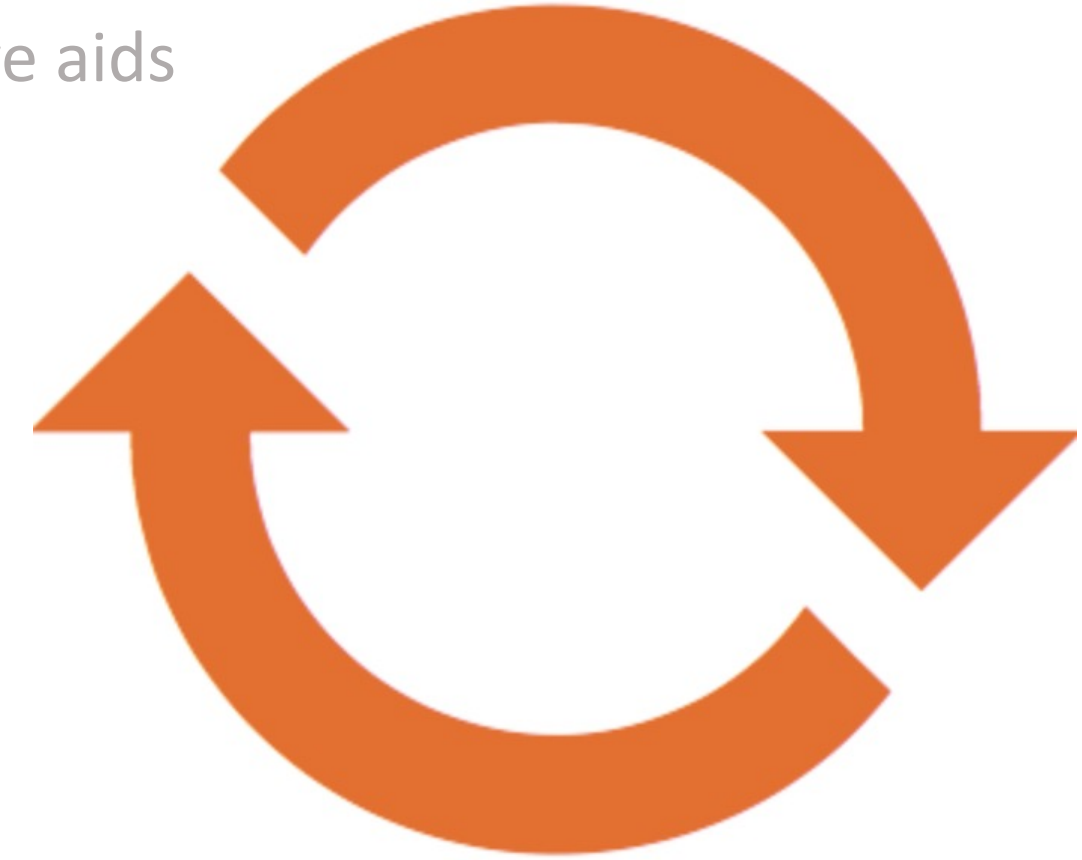
Preparedness and Prevention

- Time sensitive, coordinated response improves outcome
- Equipment organization and cognitive aids
- CPR training
- Team dynamics
  - Anyone can be the team leader!
    - Assign tasks
    - Enforcing rules and procedures
    - Intermittently summarizing code
    - Soliciting input
  - ***Closed loop communication***

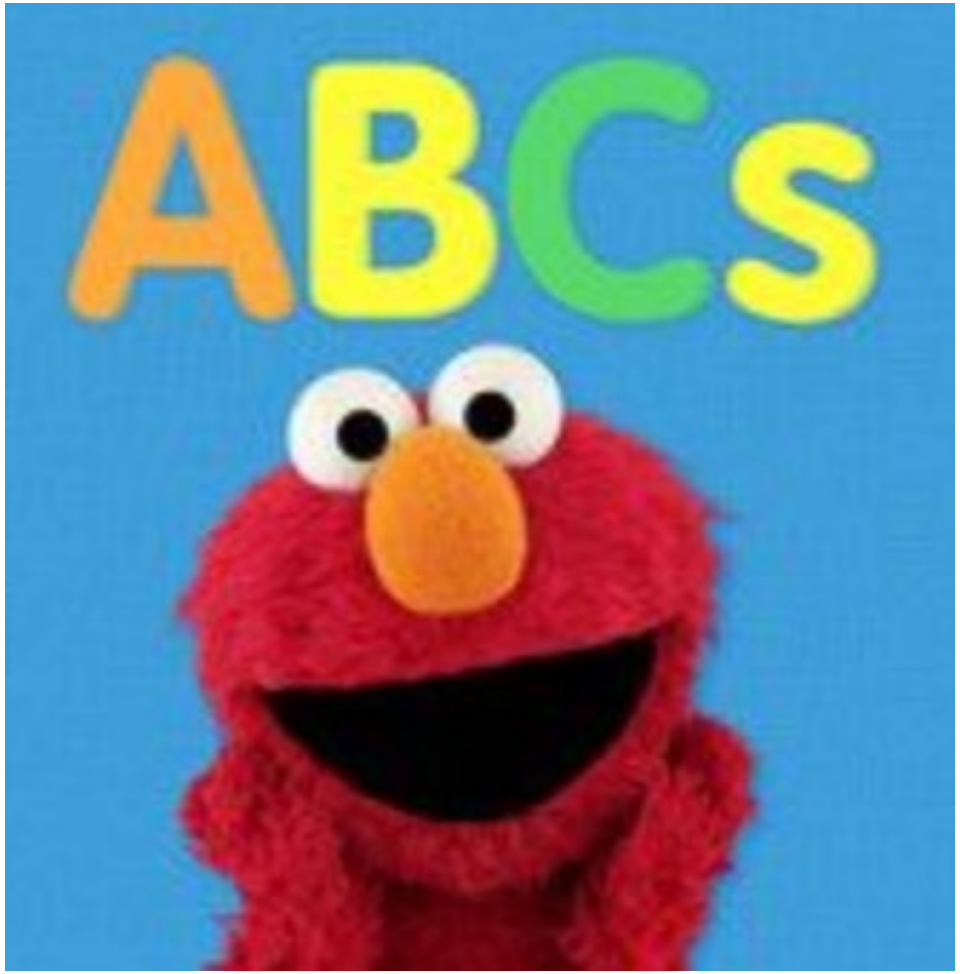


Preparedness and Prevention

- Time sensitive, coordinated response improves outcome
- Equipment organization and cognitive aids
- CPR training
- Team dynamics
- Post-CPR debriefing
  - Avoid blame, opportunity to discuss areas for improvement
  - Root cause analysis

Basic Life Support (BLS)

- BLS:
  - Recognition of CPA
  - Airway
  - Breathing
  - Compressions
- ABC vs CAB?
- Faster initiation improves outcomes
  - Initiate compressions as soon as CPA is identified *or suspected*



Basic Life Support

Recognition

Basic Life Support

Recognition

- **Non-responsive and apneic**
  - Shake and shout

→ START CPR

Basic Life Support

Recognition

- **Non-responsive and apneic**
- **Auscultation**
  Stethoscope
  Esophageal

Basic Life Support

Recognition

- **Non-responsive and apneic**
- **Auscultation**
  Stethoscope
  Esophageal
- **Absent Pulse**
  Doppler
  Arterial line
  Palpation
  SpO_2 wave

Basic Life Support

Recognition

- **Non-responsive and apneic**
- **Auscultation**
  Stethoscope
  Esophageal
- **Absent Pulse**
  Doppler
  Arterial line
  Palpation
  SpO_2 wave
- **ECG**
  Asystole
  PVT
  V. Fibrillation
  PEA

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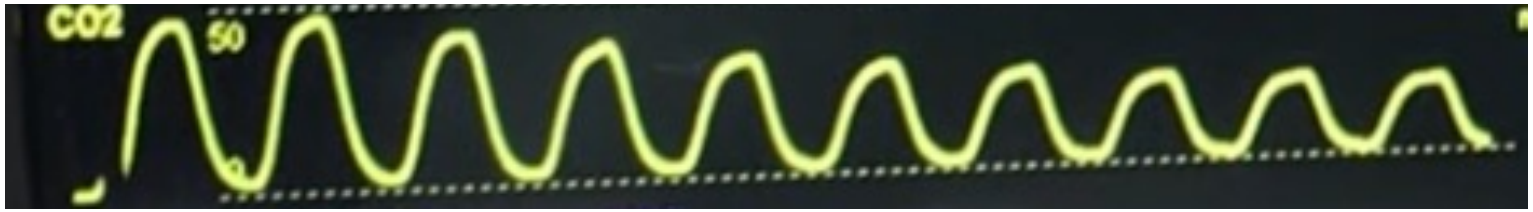
Basic Life Support

Recognition

- **Non-responsive and apneic**
- **Auscultation**
  Stethoscope
  Esophageal
- **Absent Pulse**
  Doppler
  Arterial line
  Palpation
  SpO_2 wave
- **ECG**
  Asystole
  PVT
  V. Fibrillation
  PEA
- **$ETCO_2$**
  Apnea
  Decrease



Basic Life Support

Recognition

- **Non-responsive and apneic**
- **Auscultation**
  Stethoscope
  Esophageal
- **Absent Pulse**
  Doppler
  Arterial line
  Palpation
  SpO_2 wave
- **ECG**
  Asystole
  PVT
  V. Fibrillation
  PEA
- **$ETCO_2$**
  Apnea
  Decrease

- No more than 5-10 seconds to assess
- When in doubt → START CPR


mindray
Passport 12
Adu
04-12-2019 12:33:44 PM
I
X2
Monitor
1mV
ECG
Pleth
SpO2
%
100
90
98
PR
95
PI 2.26
Source SpO2
P1
mmHg
160
90
129/77
(94)
0
CO2
mmHg
50
25 Et
47
awRR
25
Fi
3
Gas
N2O
O2
Iso
MAC
Et 0
91
1.43
1.24
Fi 0
94
1.62
Age 40
NIBP List
PR
Time
NIBP
mmHg
160
80
---/---

Please Start
Temp
°F
101.5
95.0 T1
101.1
Alarm Setup
Main Menu
Current Configuration :Large Animal
Alarm Reset
Alarm Pause
Freeze
Record
NIBP
Menu

Basic Life Support

Chest Compressions

Basic Life Support

Chest Compressions

- How do you position the patient?
- Where do you place your hands?
- How do you position your hands?
- What is your form?
- How deep to compress?
- What rate?

Basic Life Support

Chest Compressions

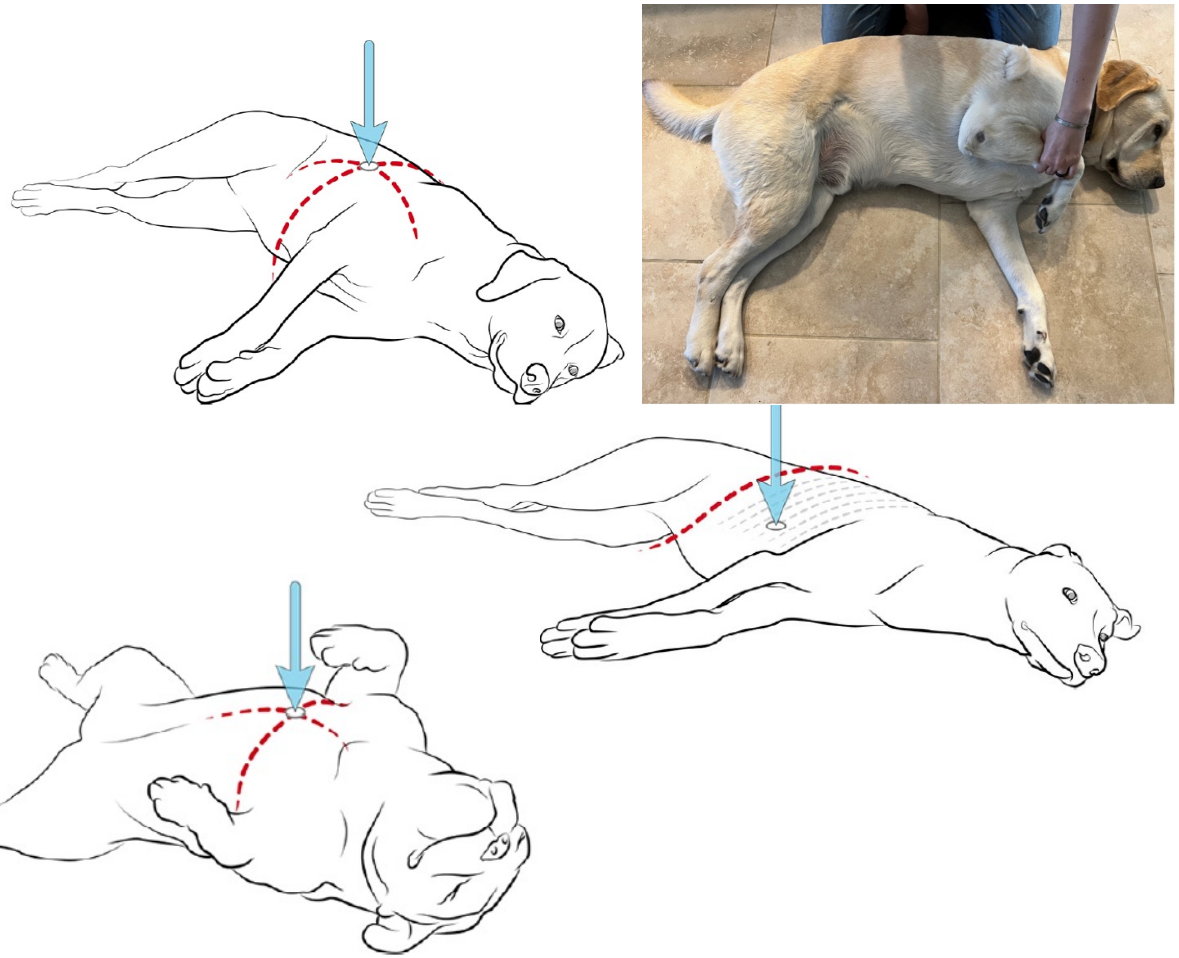
- How do you position the patient?
  - Lateral recumbency
    - Greater LV pressures/aortic flow
    - Higher ROSC rates
    - L or R lateral is okay
  - Dorsal recumbency
    - Wide chested dogs (bulldogs)

Fletcher et al. *JVECC* 22(S1) 2012

Basic Life Support

Chest Compressions

- Where do you place your hands?
  - Depends on conformation
    - Widest part of the chest
    - Over the heart
    - Mid-sternum
  - Cardiac vs thoracic pump
    - Theories
    - Both dynamics likely at play



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Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024
https://www.petmd.com/dog/general-health/how-to-perform-cpr-on-a-dog

Basic Life Support

Chest Compressions

- How do you position your hands?
  - Medium or large patient
    - Palms face downward and stacked
    - Fingers interlaced

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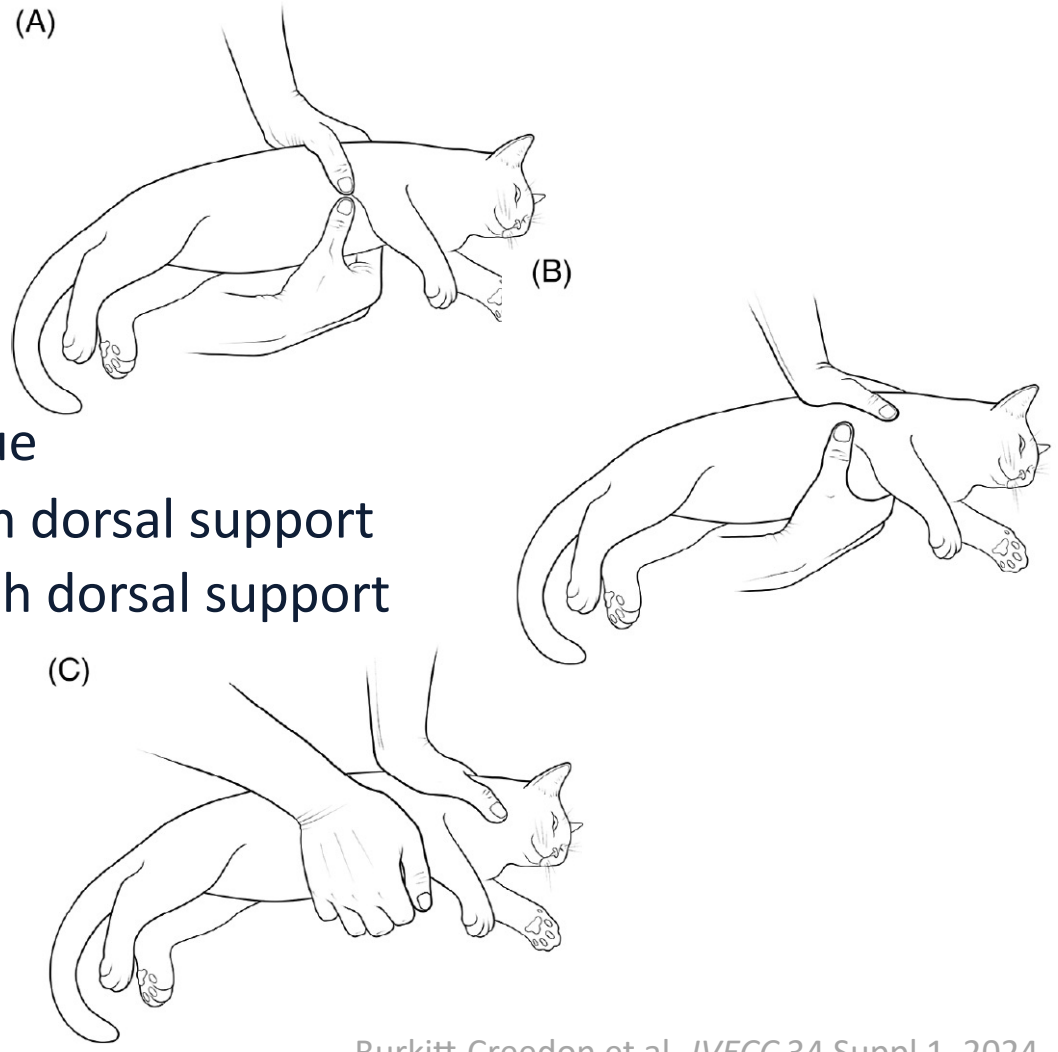
Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Basic Life Support

Chest Compressions

★ • How do you position your hands?

- Small patient
  - (A) Circumferential 2 thumb technique
  - (B) One hand, thumbs to fingers, with dorsal support
  - (C) One hand, palm compression, with dorsal support



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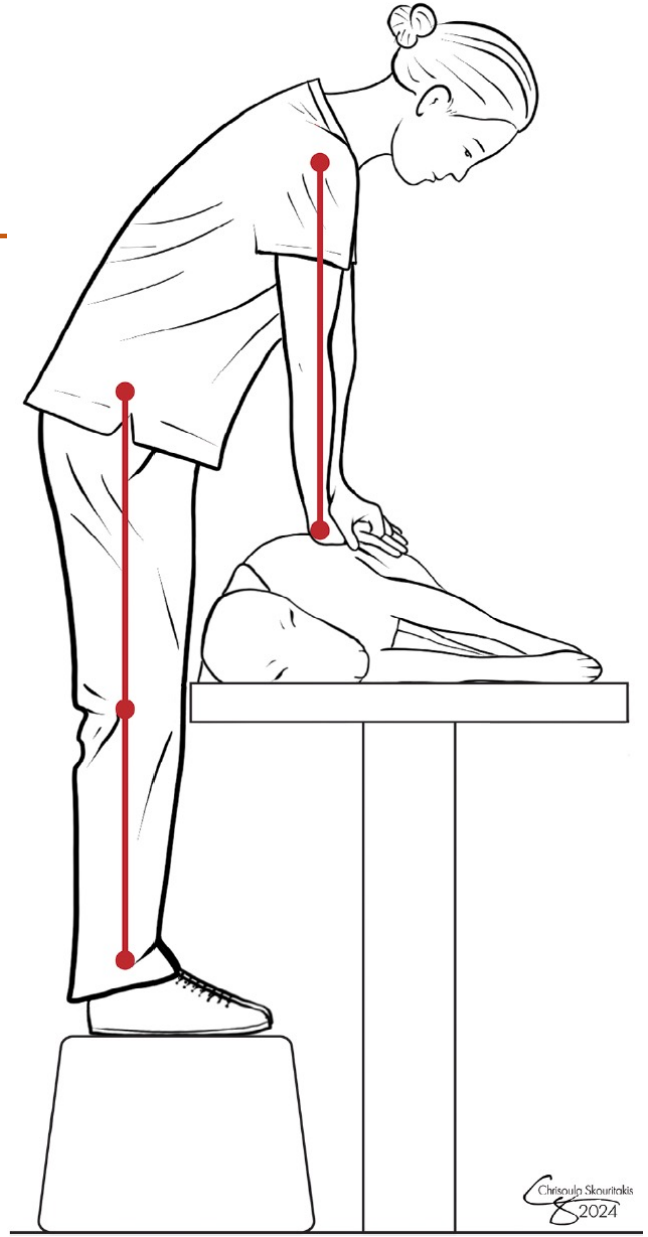
Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Basic Life Support

Chest Compressions

- What is your form?
  - Above patient – standing or kneeling
  - Align shoulders, elbows, wrists
  - Align arms with compression point
  - Align lower body
  - Bend at the hips
  - Core muscles

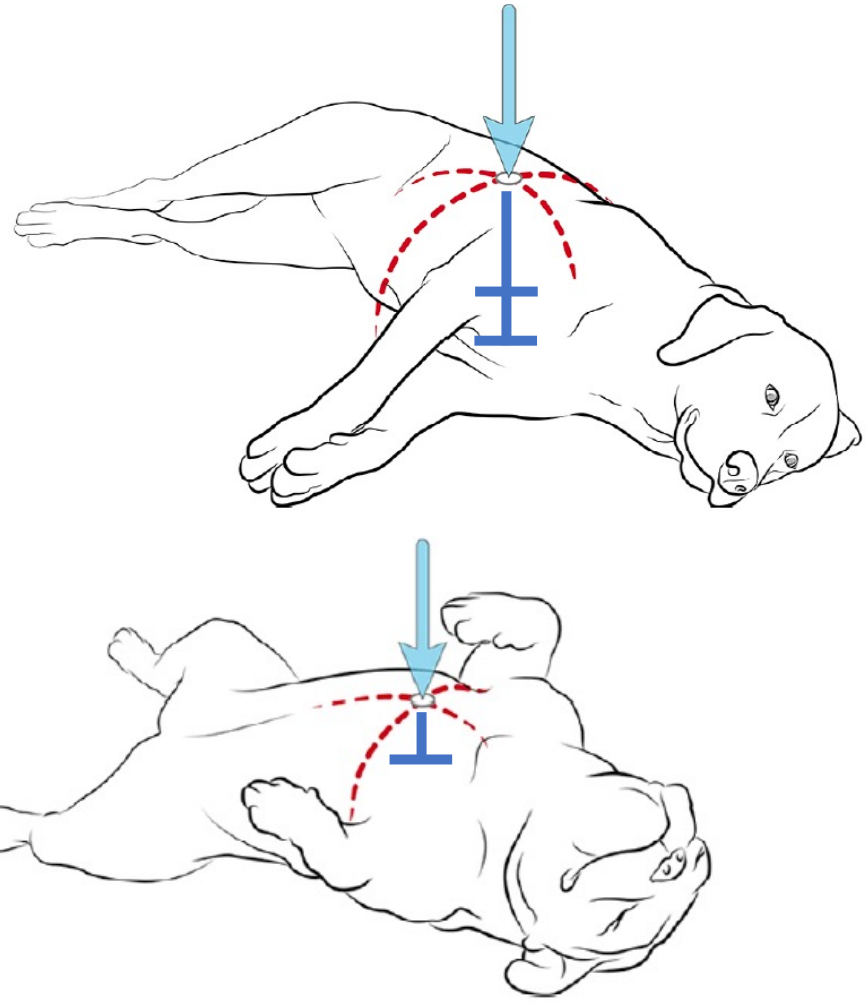


Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Basic Life Support

Chest Compressions

- How deep to compress?
  - In lateral recumbency → 1/3 to 1/2 depth
  - ★ In dorsal recumbency → 1/4 depth



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Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Basic Life Support

Chest Compressions

- What rate?
  - 100 - 120 bpm
  - Full recoil
    - Avoid leaning

Basic Life Support

Chest Compressions

- ✓ Lateral recumbency
- ✓ 1/3 - 1/2 depth (lateral)
- ✓ 100-120/min
- ✓ Full recoil

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Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Basic Life Support

Airway

- Not yet intubated
  - Single-rescuer
    - Quickly check patency of airway
    - Start compressions
  - Multi-rescuer
    - Start compressions immediately
    - Intubate as soon as possible

Do not delay compressions

https://recover.flywheelsites.com/veterinary-professionals/

Basic Life Support

Airway

- ★ Not intubated
  - Breaths via tight fitting face mask and manual resuscitator
  - No facemask?
    - Minimal risk to human – Mouth to snout
    - Risk to human – Compressions only
  - Compression : ventilation = 30:2

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https://www.aliexpress.us/item/3256804246653738.html?gatewayAdapt=glo2usa4itemAdapt

Basic Life Support

Airway

- ★ Not intubated
  - Breaths via tight fitting face mask and manual resuscitator
  - No facemask?
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    - Risk to human – Compressions only
  - Compression : ventilation = 30:2

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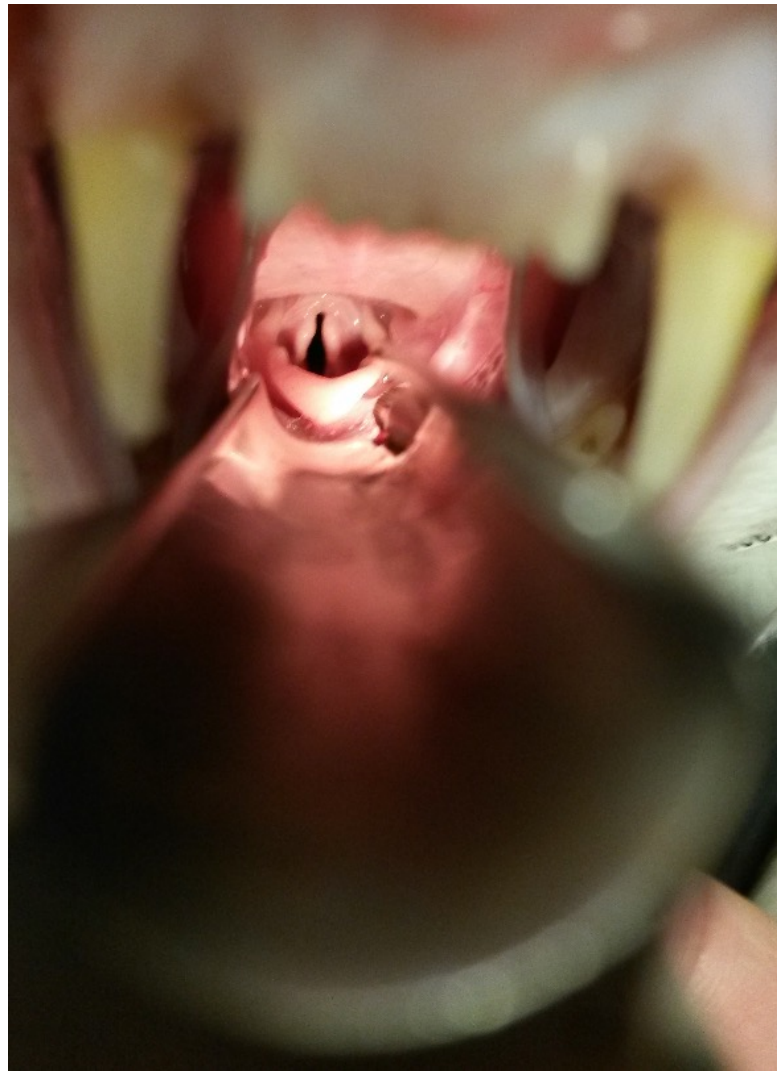
Fletcher et al. *JVECC* 22(S1) 2012

Basic Life Support

Airway

- Intubated
  - Is your patient actually intubated?
  - Is the ETT patent?
  - Is it positioned correctly?

$ETCO_2$ < 12mmHg → Confirm ETT placement



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Basic Life Support (BLS)

Breathing

- ✓ 10 breaths/min
- ✓ 1 sec inspiration

- Visible chest rise, but not excessive
- 100% oxygen
- Anesthesia machine:
  - During compressions: 30-40 cm
  - During pauses: < 20 cmH2O

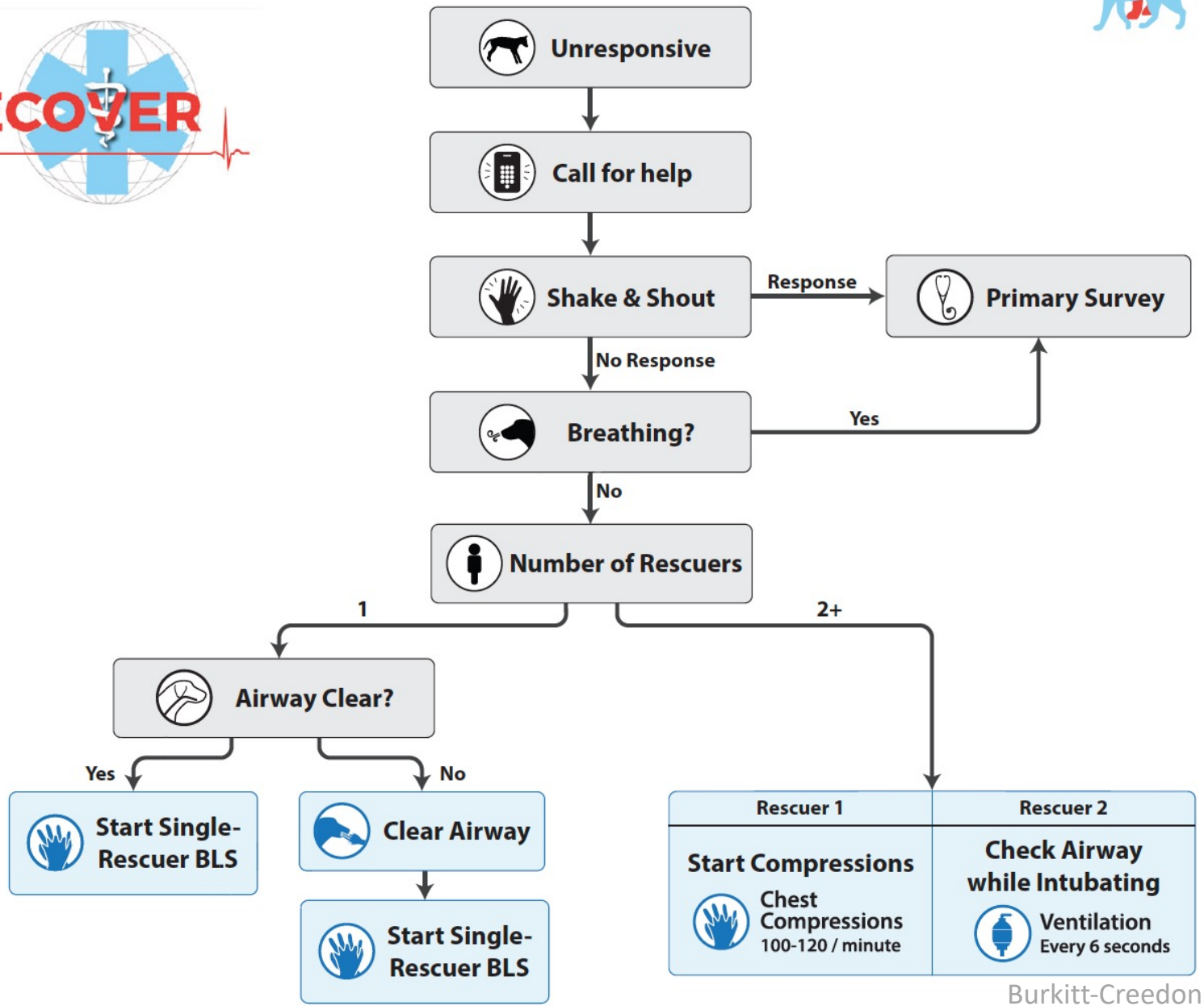
https://www.vetquip.com.au/

Basic Life Support (BLS)

Cycles

- Pause after each cycle:
  - Check ECG and femoral pulse
  - < 10 seconds
- Only interrupt mid-compression for suspected ROSC:
  - Rapid increase in $ETCO_2$ (35 mmHg)
  - Pulse distinct from compressions

CPR Initial Assessment Algorithm



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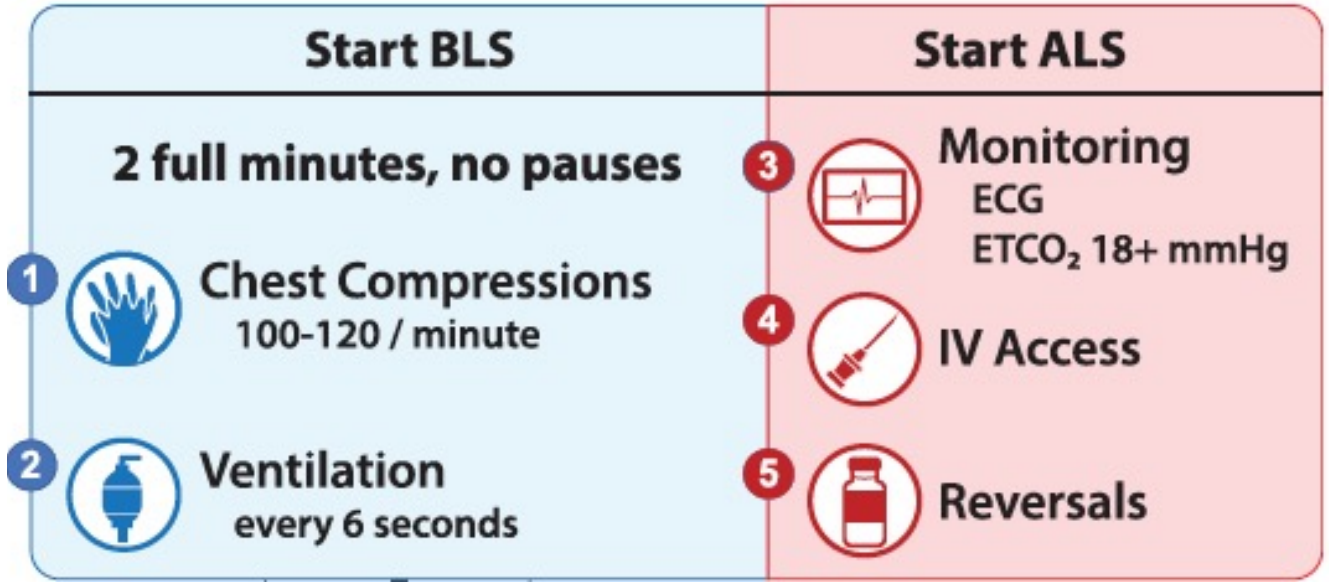
Burkitt-Creedon et al. *JVECC* 34 Suppl 1, 2024

Advanced Life Support (ALS)

- Monitoring
- IV access
- Drugs
- Defibrillation



Advanced Life Support

Pick 2 pieces of monitoring equipment for CPR…

ECG and Capnograph

Advanced Life Support

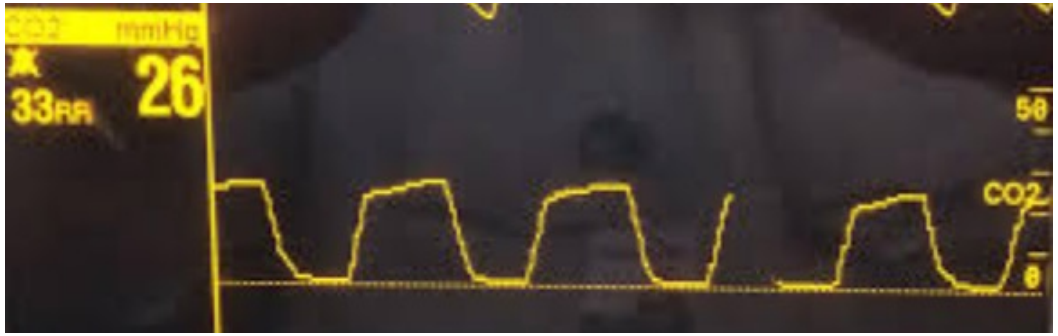
Monitoring

- **ECG**
  - Check rapidly during inter-cycle pauses
  - Do not stop to check
  - Guides therapy
  - Caution in interpretation: disconnected electrodes, motion artifact, PEA

Advanced Life Support

Monitoring

- **Capnography ($ETCO_2$)**
  - ETT placement
  - $ETCO_2$ correlates with pulmonary blood flow if ventilation is stable
  - Indicates efficacy of compressions/CO → Aim for $ETCO_2$ >18 mmHg
  - Early indicator of ROSC



Advanced Life Support

Monitoring

- **Serum K+**
  - Plasma potassium concentration should be measured in all animals undergoing CPR

Advanced Life Support (ALS)

IV Access

- Routes of drug administration
  - Intravenous
  - Intraosseous
  - Intratracheal
    - Only if IV not available
    - Epinephrine, Atropine, Vasopressin
    - Diluted in saline
    - Given via catheter distal to ETT (Close to carina)

Advanced Life Support (ALS)

Drugs

- **Epinephrine**
  - α – Vasoconstriction
    - Centralize blood flow
    - Increase venous return
  - β – Myocardial contractility and rate
    - Positive inotrope and chronotrope
    - ↑ myocardial workload & O_2 consumption
    - Myocardial ischemia → arrhythmias
  - Increase ROSC

★ Dose: 0.01 mg/kg IV
Every other cycle (3-5 min)

Advanced Life Support (ALS)

Drugs

- **Epinephrine**

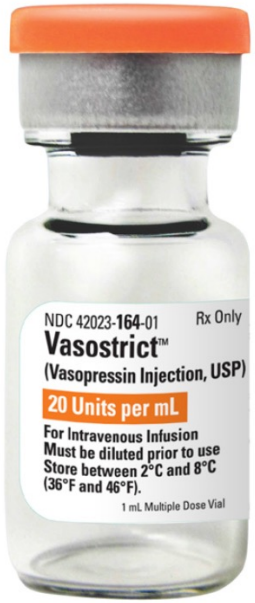
Check
ECG/pulse

Check
ECG/pulse

Advanced Life Support (ALS)

Drugs

- **Vasopressin**
  - V1A – Vasoconstriction
    - Centralize blood flow
    - Increase venous return
  - More effective in acidic environment
  - Lacks β effects ☺
  - Superior to epinephrine?
    - Mixed evidence
    - Equivalent, maybe more benefit



Dose: 0.8 U/kg IV
Alternative to epinephrine

Advanced Life Support (ALS)

Drugs

- **Atropine**
  - Parasympatholytic
  - Little evidence of benefit in humans
  - Little evidence of harm
    - **<u>> 0.1 mg/kg is detrimental</u>**
  - Give once if high vagal tone is suspected
    - Brachycephalics
    - Opioids, dexmedetomidine
    - Vagal reflexes

★ Dose: 0.04-0.054 mg/kg IV (0.1 mL/kg)
Single dose near beginning of CPR

Advanced Life Support (ALS)

Drugs

- Reversal agents
  - Discontinue all drugs → Turn ISO off
  - Possible reversals: **Naloxone**, **Flumazenil**, **Atipamezole**
    - Naloxone – after other interventions in place
    - Other agents – "May be considered"
  - *Atipamezole* - Potential for harm, no data

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Advanced Life Support (ALS)

Drugs

- Antiarrhythmics
  - Administered for refractory shockable rhythms
  - **Lidocaine**
    - Dogs
    - Dose: 2 mg/kg IV

  - **Amiodarone**
    - Cats
    - Dose: 5 mg/kg IV

Advanced Life Support (ALS)

Drugs

- Antiarrhythmics
  - Administered for refractory shockable rhythms
  - **Esmolol**
    - Dogs and cats
    - Co-administered during refractory shockable rhythms
    - Counteracts pro-arrhythmogenic β effects of other CPR drugs (epinephrine)
    - Dose: 0.5 mg/kg IV over 3-5 min → CRI 50 ug/kg/min

Advanced Life Support (ALS)

Drugs

- **Sodium bicarbonate**
  - Acidemia is common
  - Consider with prolonged CPR (>15 min)
  - Especially if pH < 7.0

Dose: 1 mEq/kg IV
Once during prolonged CPR

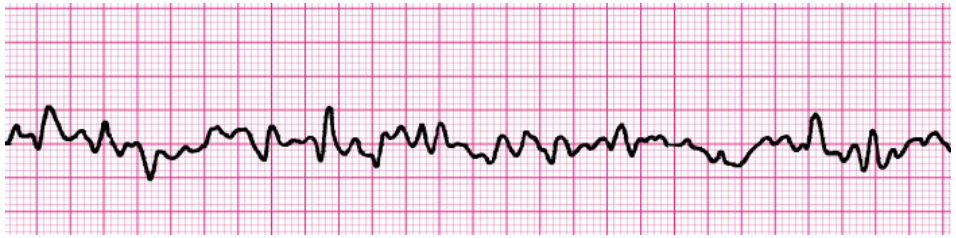
Advanced Life Support (ALS)

Defibrillation

- Shockable rhythms

Pulseless ventricular tachycardia (PVT)

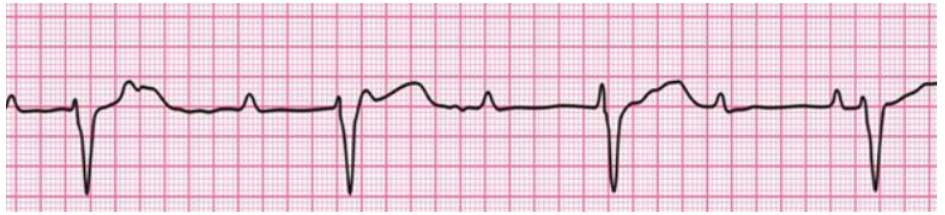
Ventricular fibrillation



- Non-Shockable rhythms

Asystole

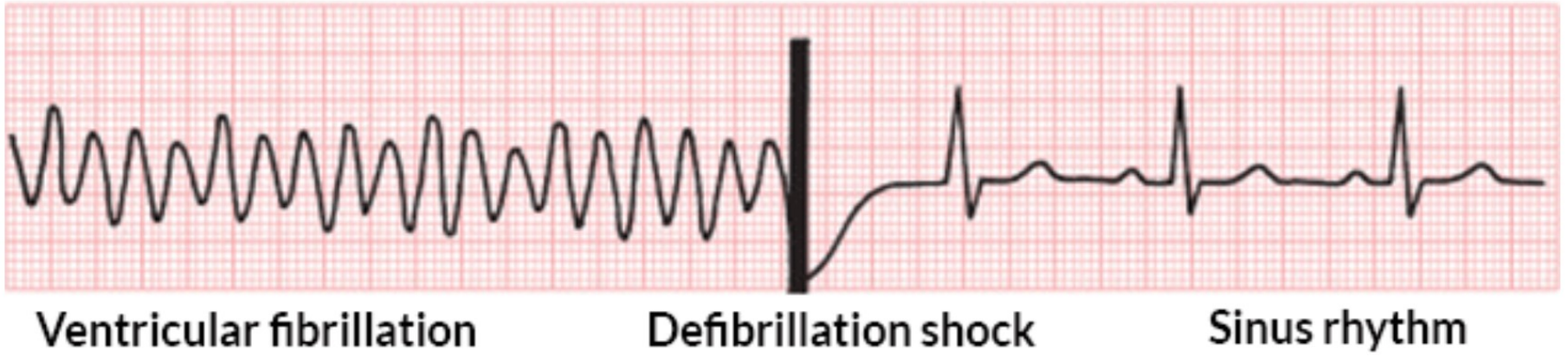
Pulseless electrical activity



Advanced Life Support (ALS)

Defibrillation

- What does defibrillation do?
  - "Quiets the room"

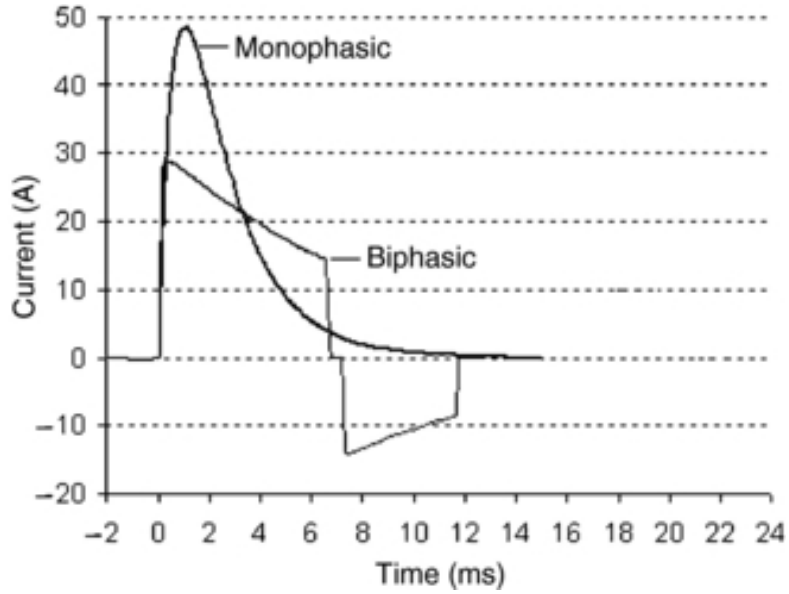


Goldberger AL, Goldberger ZD, Shvilkin A. Pacemakers and implantable cardioverter–defibrillators: Essentials for clinicians. https://www.sciencedirect.com/science/article/pii/B9780323401692000226. May 12, 2017. Accessed January 15, 2019.

Advanced Life Support (ALS)

Defibrillation

- 2 Types of defibrillators
  - Monophasic
    - Unidirectional, higher current
  - ✓ Biphasic
    - 'To and from', lower current
    - 2 J/kg
    - Recommended



- If first attempt fails, double the dose for the second and subsequent attempts
- Possible myocardial damage with high current

Tang et al. *Lab Anim Invest* 120(3), 2001

Advanced Life Support (ALS)

Defibrillation

- Precordial thump
  - Mechanical defibrillation
  - The ‘cost-effective’ mostly ineffective version of the defibrillator
  - Only used if electrical defibrillator is not available

Advanced Life Support (ALS)

Defibrillation

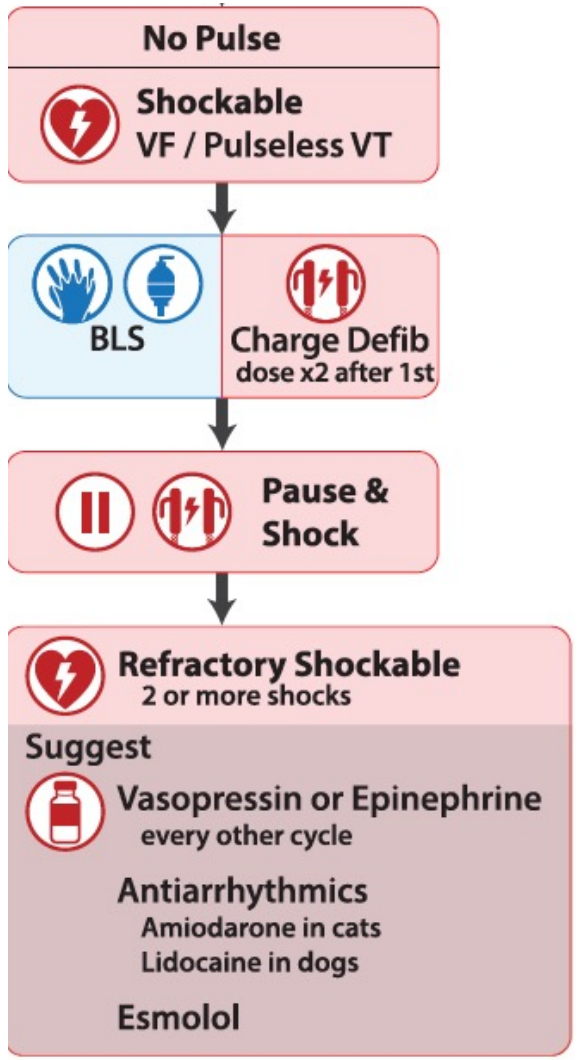
- Proper technique
  - Dorsal recumbency → Paddles across the heart
  - Defibrillator paste or gel – No alcohol!
  - “CLEAR”
  - Between 2 minute compression cycles
  - Immediately resume compressions after shocking

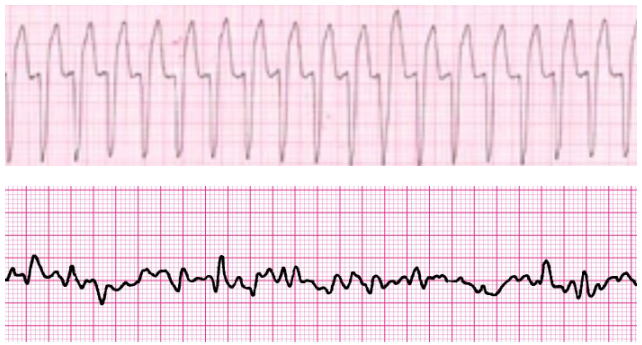
Advanced Life Support (ALS)

Defibrillation

- Defibrillation as part of the process
  - Shockable rhythm
  - Compressions for 2 min while preparing defibrillator
  - Shock during pause
  - Immediately resume compressions for 2 min
  - Assess rhythm during pause
  - Still shockable?
    - Double the shock dose
    - Epinephrine or vasopressin
    - Antiarrhythmics: Lidocaine (dog), amiodarone (cat)
    - Esmolol: Consider LD and CRI

Asystole = success!





RECOVER

Start BLS

2 full minutes, no pauses

1. **Chest Compressions** 100-120 / minute
2. **Ventilation** every 6 seconds

Start ALS

3. **Monitoring** ECG $ETCO_2$ 18+ mmHg
4. **IV Access**
5. **Reversals**

Pause & Check < 10 seconds

Rhythm Diagnosis | **Pulse Palpation**

No Pulse

Shockable VF / Pulseless VT

BLS | **Charge Defib** dose x2 after 1st

Pause & Shock

Refractory Shockable 2 or more shocks

Suggest

- **Vasopressin or Epinephrine** every other cycle
- **Antiarrhythmics**
  - Amiodarone in cats
  - Lidocaine in dogs
- **Esmolol**

Pulse

ROSC

PCA Algorithm

No Pulse

Non-Shockable Asystole / PEA

Epinephrine or Vasopressin every other cycle

Suggest

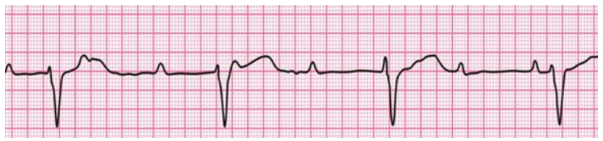
Atropine once, as early as possible

Prolonged CPR > 15 min

Shockable or Non-Shockable

Suggest

Bicarbonate especially if pH < 7.0



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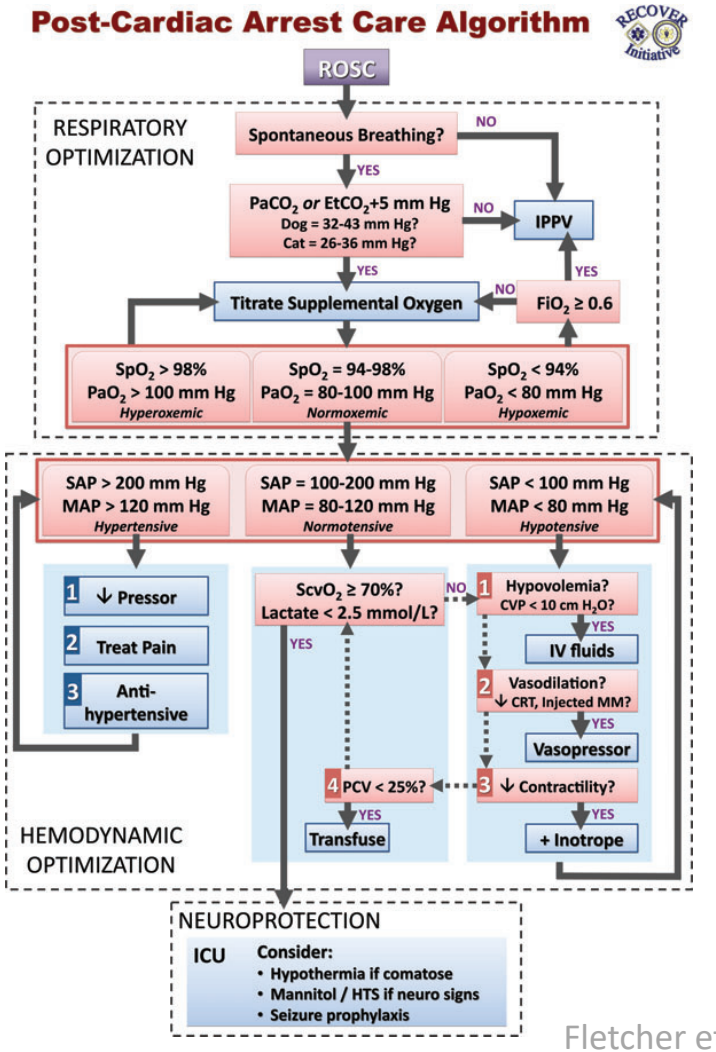
Post-Arrest Care

- Many patients will re-arrest
- Causes of death:
  - Multiple organ failure
  - Cardiogenic shock
  - Anoxic brain injury
- Goals:
  - Normotension
  - Normocapnia
  - Normoxemia
  - Protect cerebral function



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Fletcher et al. *JVECC* 22(S1) 2012

Putting it all together

- Rapid recognition + initiation of compressions
- Team work + communication
- Uninterrupted 2 minute cycles of BLS/ALS
  - Compressions → 100-120/min, 1/3-1/2 depth, recoil
  - Airway → ensure intubated + patent ETT
  - Ventilation → 10 bpm, 1 sec inspiration
  - Epinephrine 0.01 mg/kg +/- Atropine 0.04 mg/kg
- Rapidly check ECG for shockable rhythm
- Monitor – ECG and ETCO2

https://stock.adobe.com/images/dog-giving-thumbs-up/598649413

Questions, Comments, Discussion?

SPECIAL ARTICLE

2024 RECOVER Guidelines: Updated treatment recommendations for CPR in dogs and cats

Jamie M. Burkitt-Creedon DVM, DACVECC[1] | Manuel Boller Dr med vet, MTR, DACVECC[2,3] | Daniel J. Fletcher PhD, DVM, DACVECC[4] | Benjamin M. Brainard VMC, DACVA, DACVECC[5] | Gareth J. Buckley MA, VetMB, DACVECC, DECVECC[6] | Steven E. Epstein DVM, DACVECC[1] | Erik D. Fausak MSLIS, RVT[7] | Kate Hopper BVSc, PhD, DACVECC[1] | Selena L. Lane DVM, DACVECC[8] | Elizabeth A. Rozanski DVM, DACVECC, DACVIM[9] | Jacob Wolf DVM, DACVECC[10]

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