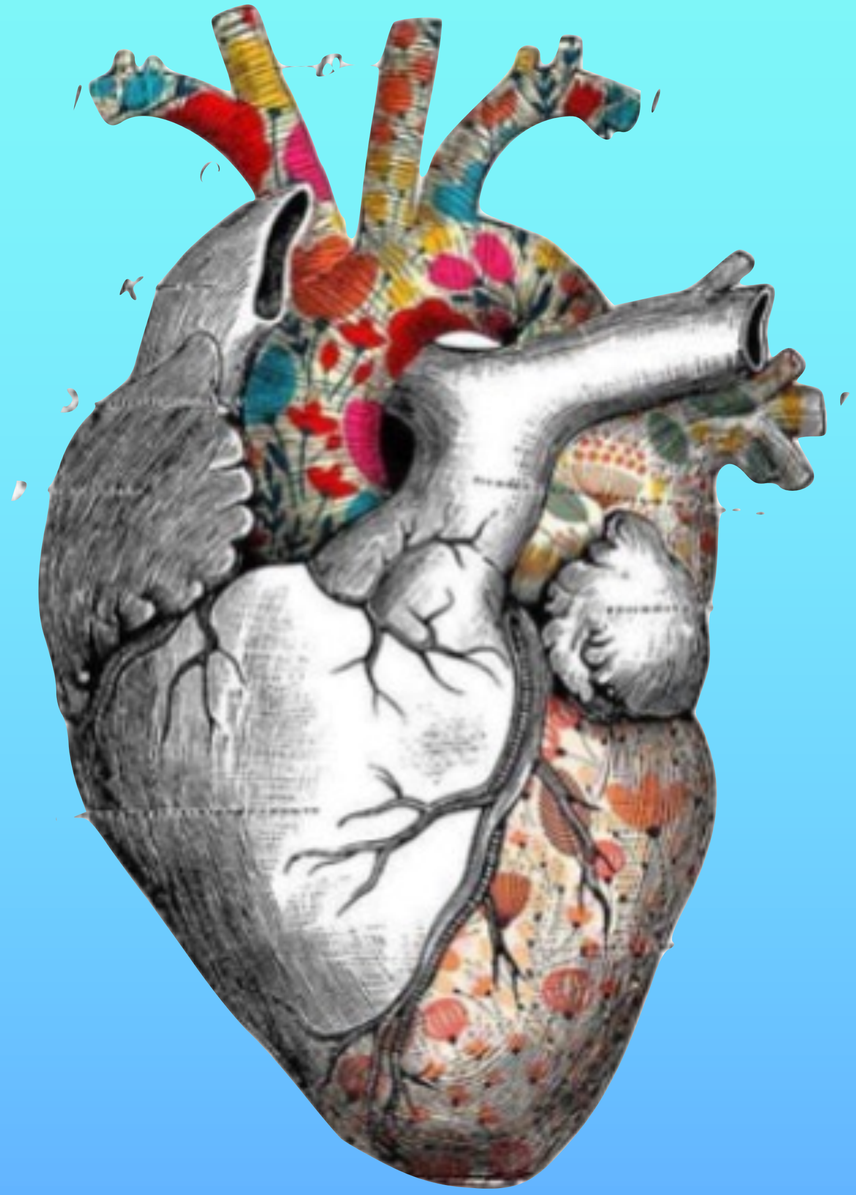
VETERINARY MEDICINE

ADVANCED LIFE SUPPORT

REVIEW AND UPDATE

LEANDRO FADEL |DVM, MSC
ASSISTANT CLINICAL PROFESSOR
SMALL ANIMAL EMERGENCY CARE



WHY IS IT IMPORTANT?

A 2016 STUDY CONDUCTED IN PARIS, FRANCE, INDICATED THAT OHCA PATIENTS HAD A SURVIVAL RATE OF **0%** IF THE FOLLOWING THREE CRITERIA WERE MET BY THE PATIENT:

1) THE PATIENT DIDN'T ARREST IN FRONT OF RESCUERS;
2) THE PATIENT HAD A NON-SHOCKABLE RHYTHM; AND
3) THE PATIENT DIDN'T RESPOND TO TWO ROUNDS OF EPINEPHRINE.

JABRE P, BOUGOUIN W, DUMAS F, ET AL. EARLY IDENTIFICATION OF PATIENTS WITH OUT-OF-HOSPITAL CARDIAC ARREST WITH NO CHANCE OF SURVIVAL AND CONSIDERATION FOR ORGAN DONATION. ANN INTERN MED. 2016;165(11):770-778.

VET STATS

Special Article

Journal of Veterinary Emergency and Critical Care **22**(S1) 2012, pp S13–S25
doi: 10.1111/j.1476-4431.2012.00752.x

RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 2: Preparedness and prevention

Maureen McMichael, DVM, DACVECC; Jennifer Herring, DVM; Daniel J. Fletcher, PhD, DVM, DACVECC; Manuel Boller, Dr. med. vet., MTR, DACVECC and the RECOVER Preparedness and Prevention Domain Worksheet Authors

Summary of the evidence

The overall survival rate in dogs and cats with cardiac arrest, regardless of etiology (anesthetic arrest, ICU arrest), ranges from 4% to 9.6% (LOE 2, good/supporting; LOE 6, good/supporting; LOE 4, fair/supporting; LOE 4, fair/supporting, respectively)[15–18] compared to in-hospital survival rates of 10% to 20% in humans (LOE 6, good/supporting, 22 only).[10,19–22] A recent veterinary prospective obser-

Received: 29 October 2022 | Revised: 28 November 2022 | Accepted: 29 November 2022

DOI: 10.1111/vec.13273

Journal of Veterinary Emergency and Critical Care | WILEY

SPECIAL ARTICLE

Reassessment Campaign on Veterinary Resuscitation (RECOVER) Initiative small animal CPR registry report 2016–2021

Sabrina N. Hoehne[1] | Anusha Balakrishnan[2] | Deborah C. Silverstein[3] | Armi M. Pigott[4] | Kelly M. Tart[5] | Elizabeth A. Rozanski[6] | Lisa L. Powell[7] | Manuel Boller[8,9] | On behalf of Reassessment Campaign on Veterinary Resuscitation (RECOVER) CPR Registry Subcommittee

Measurements and Main Results: Sixteen hospitals in the United States, Europe, and Australia contributed data on 709 CPR events to the registry. One hundred and forty-two (28%) dogs and 58 (30%) cats attained return of spontaneous circulation (ROSC), 62 (12%) dogs and 25 (13%) cats had ROSC >20 minutes, and 14 (3%) dogs and 4 (2%) cats survived to hospital discharge. The reason for CPR discontinuation was reported as owner choice in 321 cases (63%). The most common suspected causes for CPA were respiratory failure ($n = 142$, 20%), heart failure ($n = 86$, 12%), and hemorrhage ($n = 76$, 11%).

Conclusion: The RECOVER CPR registry contains the first multicenter data set on small animal CPR. It confirms poor outcomes associated with CPA, emphasizing the need for large-sized studies to gain adequate information on characteristics associated with favorable outcomes.

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DOI: 10.1111/vec.13382

Journal of Veterinary Emergency and Critical Care

WILEY

LETTER TO THE EDITOR

2024 RECOVER CPR Guidelines

Dear Editor,

It is with great enthusiasm that the Co-Chairs of the Reassessment Campaign on Veterinary Resuscitation (RECOVER) Initiative present 5 papers on veterinary CPR in an upcoming special supplement issue of the *Journal of Veterinary Emergency and Critical Care*. The articles include evidence-based treatment recommendations on Basic Life Support, Advanced Life Support, and Monitoring during CPR in dogs and cats, domains of Prevention and Preparedness, Post-cardiac Arrest Care, and Newborn Resuscitation is underway. From thereon, RECOVER will release updates on Guidelines and provide treatment recommendations for new topics on a rolling basis as new evidence emerges.

Respectfully,

The RECOVER Initiative Co-Chairs

CPR Algorithm

RECOVER Initiative

Unresponsive, Apneic Patient

Initiate CPR Immediately

Basic Life Support
1 full cycle = 2 minutes
uninterrupted compressions/ventilation

1 Chest Compressions
100-120/min
- Lateral recumbency
- ⅓- ½ chest width

2 Ventilation
10/min
- Intubate in lateral
- Simultaneous compressions

or

C:V 30:2
- Interpose compressions

Advanced Life Support

3 Initiate Monitoring
- Electrocardiogram (ECG)
- End Tidal CO_2 ($ETCO_2$)
- >15 mmHg = good compressions

4 Obtain Vascular Access

5 Administer Reversals
- Opioids – Naloxone
- α2 agonists – Atipamezole
- Benzodiazepines – Flumazenil

Evaluate Patient Check ECG

ROSC → **Post-CPA Algorithm**

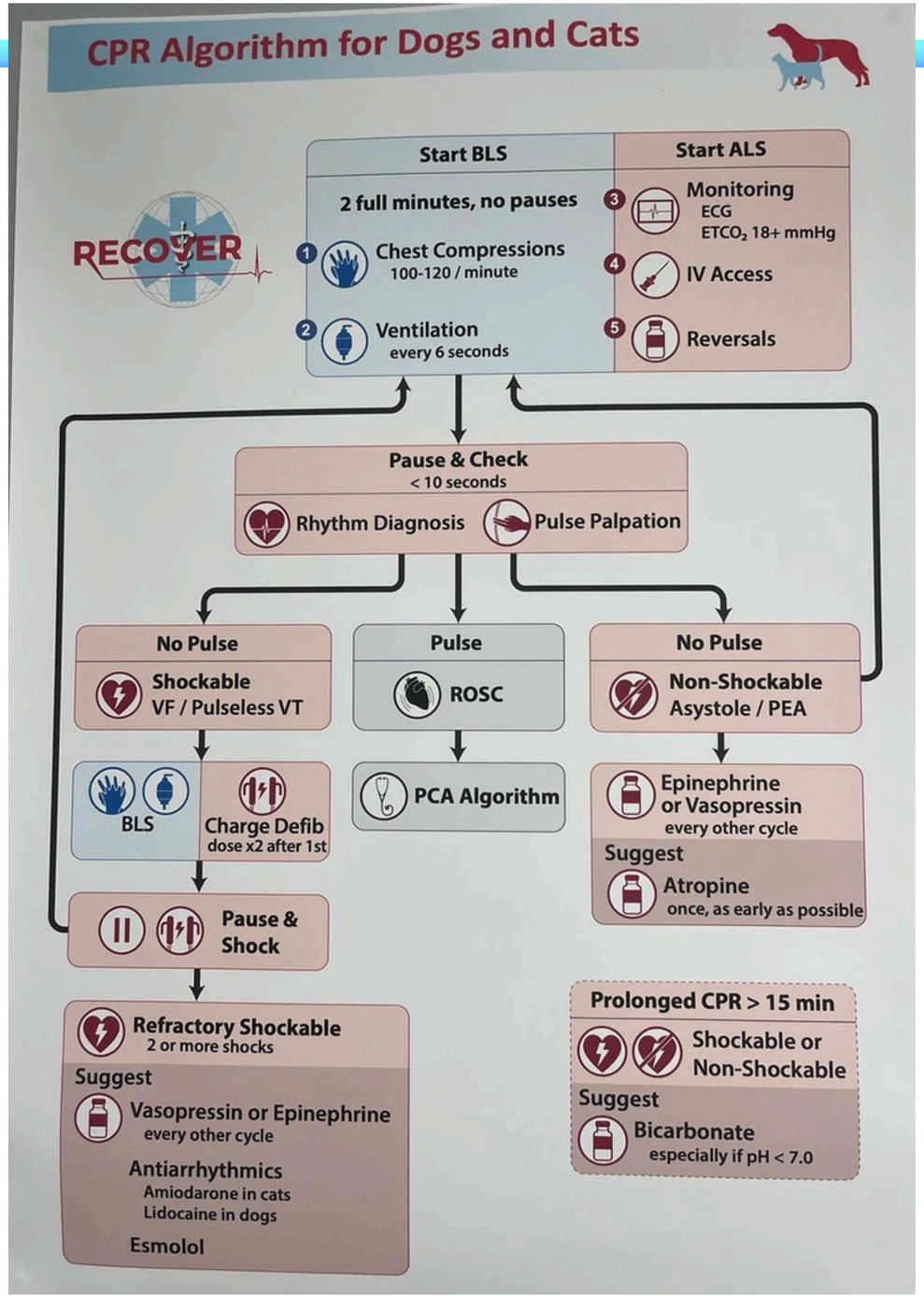
VF / Pulseless VT

- **Continue BLS, charge defibrillator**
- **Clear** and give **1 shock**
  or **Precordial Thump** *if no defibrillator*
- With **prolonged VF/VT**, consider
  - **Amiodarone** *or* **Lidocaine**
  - **Epinephrine / Vasopressin** *every other cycle*
  - **Increase defibrillator dose by 50%**

Asystole / PEA

- **Low dose Epinephrine and/or Vasopressin** *every other* BLS cycle
- Consider **Atropine** *every other* BLS cycle
- With **prolonged CPA > 10 min**, consider
  - **high dose Epinephrine**
  - **Bicarbonate therapy**

Basic Life Support
Change compressor ◆ Perform 1 full cycle = 2 minutes



Robba *et al. Intensive Care Medicine Experimental* 2020, **8**(Suppl 1):19
https://doi.org/10.1186/s40635-020-00307-1

Intensive Care Medicine
Experimental

REVIEW **Open Access**

Pathophysiology and clinical consequences of arterial blood gases and pH after cardiac arrest

Chiara Robba[1*], Dorota Siwicka-Gieroba[2], Andras Sikter[3], Denise Battaglini[1], Wojciech Dąbrowski[2], Marcus J. Schultz[4], Evert de Jonge[5], Chloe Grim[5], Patricia RM Rocco[6] and Paolo Pelosi[1,7]

From 4th International Symposium on Acute Pulmonary Injury and Translational Research - INSPIRES 2019
Dresden, Germany. 25-26 November 2019

PATHOPHYSIOLOGY IN CPA

METABOLIC CONSEQUENCES

➡ ***Canine model (Ann Med Emerg 17:667-671):***

Late stage: metabolic acidosis

In cardiomyocytes (Am J Physiol 254:H20-H27):

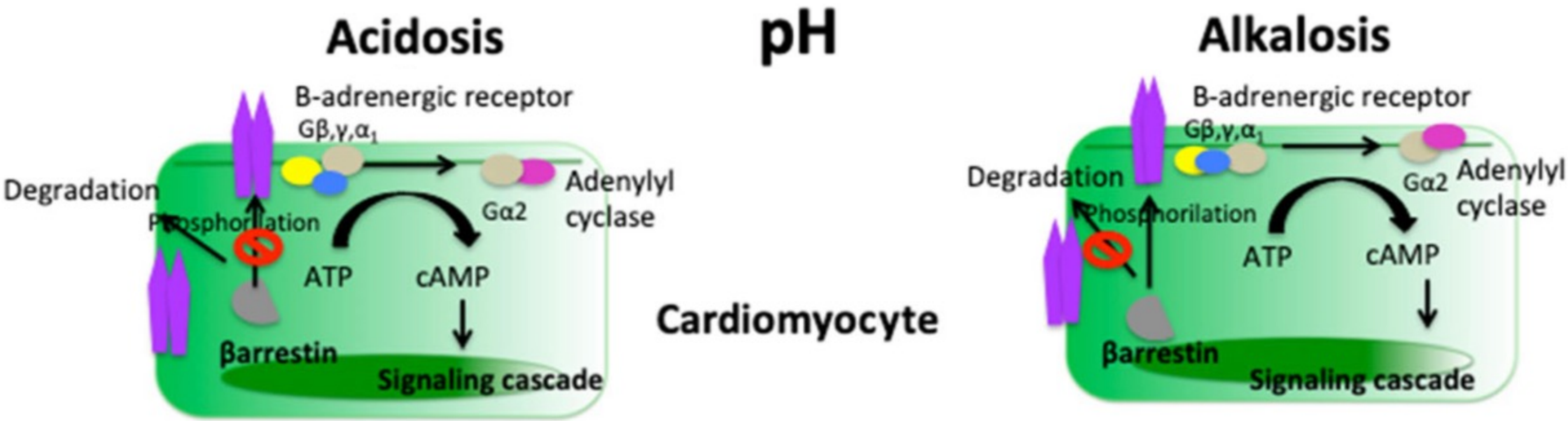
Extra- and intracellular acidosis reduces the number of adrenoceptors, especially beta-adrenergic

Decreased response to catecholamines and contractility will drop

Sample type	Arterial		
FO_2(I)	100.0 %		
Location	[redacted]		
Note			
Blood Gas Values			
↕ pH	6.956		[7.350 - 7.450]
↑ pCO_2	155	mmHg	[35.0 - 45.0]
↓ pO_2	35.0	mmHg	[75.0 - 100]
Acid Base Status			
$cHCO_3^-(P,st)_c$	22.5	mmol/L	
$cBase(B)_c$	-1.5	mmol/L	[-3.0 - 3.0]
Electrolyte Values			
↑ cK^+	5.7	mmol/L	[3.4 - 5.5]
cNa^+	144	mmol/L	[136 - 146]
cCa^{2+}	1.30	mmol/L	[1.15 - 1.30]
? $cCa^{2+}(7.4)_c$		mmol/L	
↑ cCl^-	107	mmol/L	[94 - 107]
Metabolite Values			
↑ cGlu	10.2	mmol/L	[3.9 - 5.8]
cLac	1.2	mmol/L	[0.5 - 2.0]
Oxygen Status			
↓ ctHb	81	g/L	[130 - 180]
↓ sO_2	46.0	%	[95.0 - 100.0]
$p50_c$	37.16	mmHg	
$pO_2(a/A)_e$	6.3	%	
FMetHb	0.1	%	[0.0 - 1.5]
FCOHb	1.2	%	[0.0 - 1.5]
$p50(st)_c$	22.64	mmHg	
$FShunt_e$	59.4	%	
FO_2Hb	45.4	%	[-]
Hct_c	25.2	%	

PATHOPHYSIOLOGY IN CPA

METABOLIC CONSEQUENCES



Robba *et al. Intensive Care Medicine Experimental* 2020, **8**(Suppl 1):19

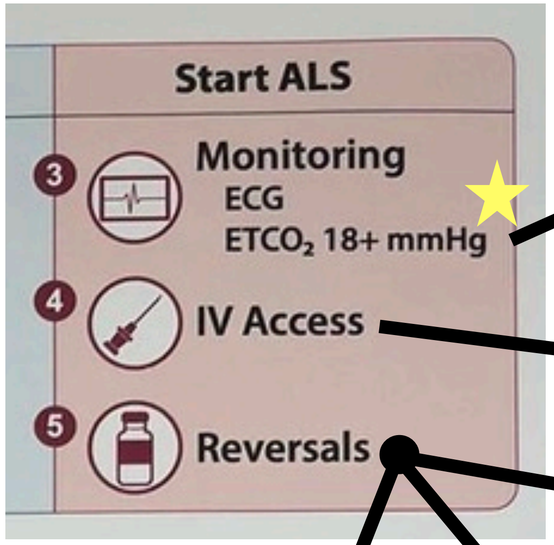
Special Article

Journal of Veterinary Emergency and Critical Care **22**(S1) 2012, pp S44–S64
doi: 10.1111/j.1476-4431.2012.00755.x

RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 4: Advanced life support

Elizabeth A. Rozanski, DVM, DACVECC, DACVIM; John E. Rush, DVM, MS, DACVIM, DACVECC; Gareth J. Buckley, MA VetMB, DACVECC; Daniel J. Fletcher, PhD, DVM, DACVECC; Manuel Boller, Dr med vet, MTR, DACVECC and the RECOVER Advanced Life Support Domain Worksheet Authors

ALS - ADVANCED LIFE SUPPORT



Previous recommendation was EtCO2 higher than 15 mmHg, **new recommendation is greater than 18 mmHg**

Don't forget that IO is an option!

Naloxone

0.04 mg/kg

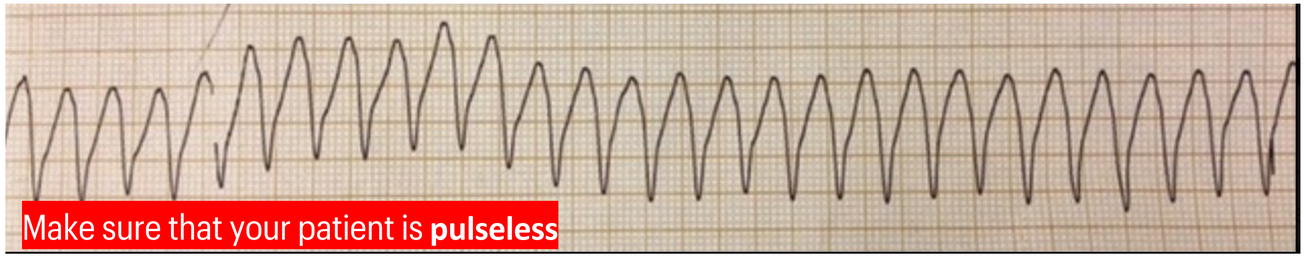
Flumazenil

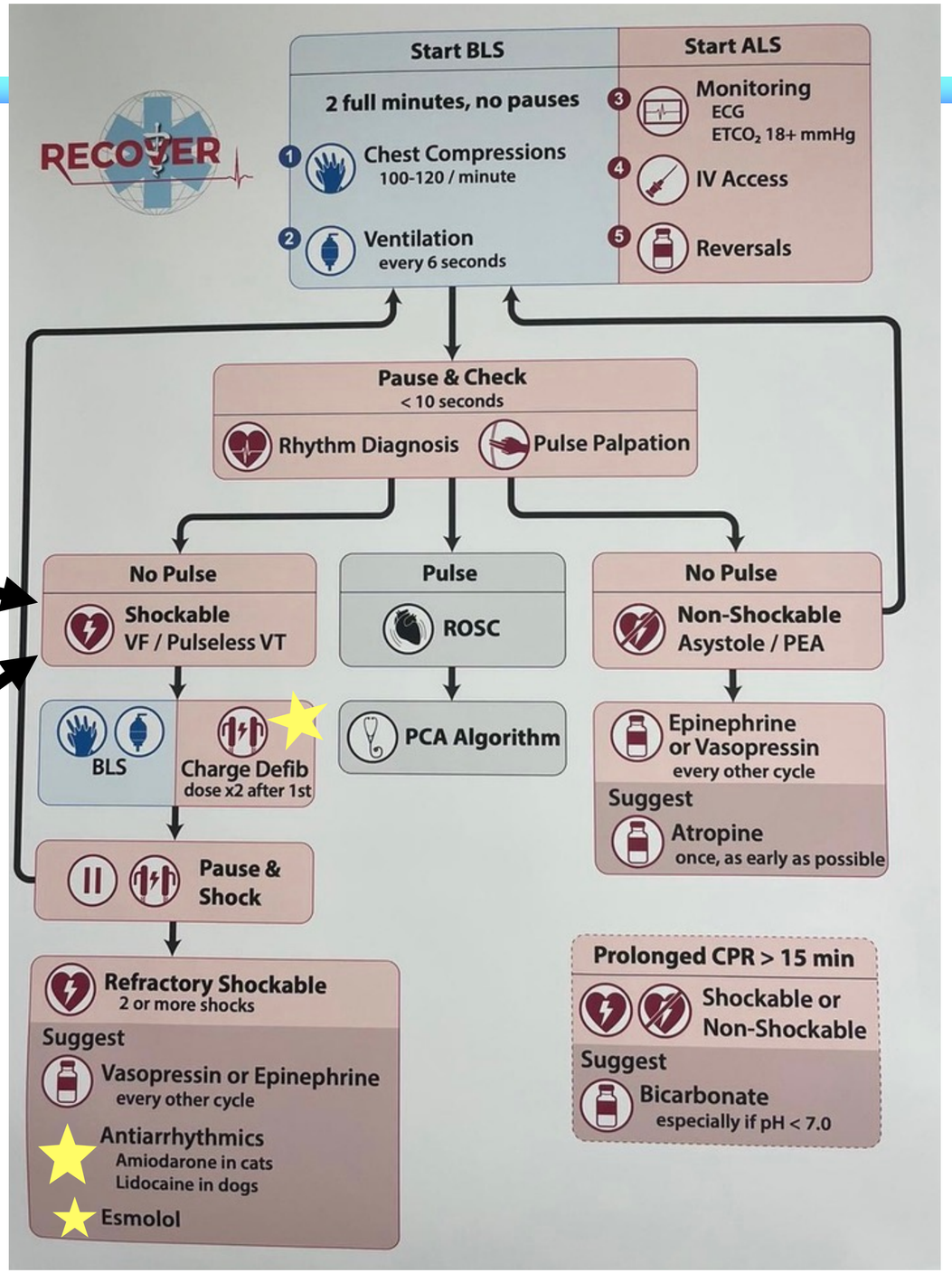
0.01 mg/kg

Atipamezole

5 µg/kg

RHYTHM DIAGNOSIS





DEFIBRILLATION

EQUIPMENT/TECHNIQUE

Biphasic is recommended instead of monophasic

Degree of recommendation: I-A

Monophasic external defibrillation should be started a 4-6 J/kg and biphasic at 2-4 J/kg

Grade of recommendation: IIa-B

Single shock is recommended instead of 3 shocks in a row

Grade of recommendation: I-B

DEFIBRILLATION

ENERGY

Increasing energy is acceptable when there is failure after the first shock

Grade of recommendation: IIa-B

HOW MUCH?? → ***Double!***

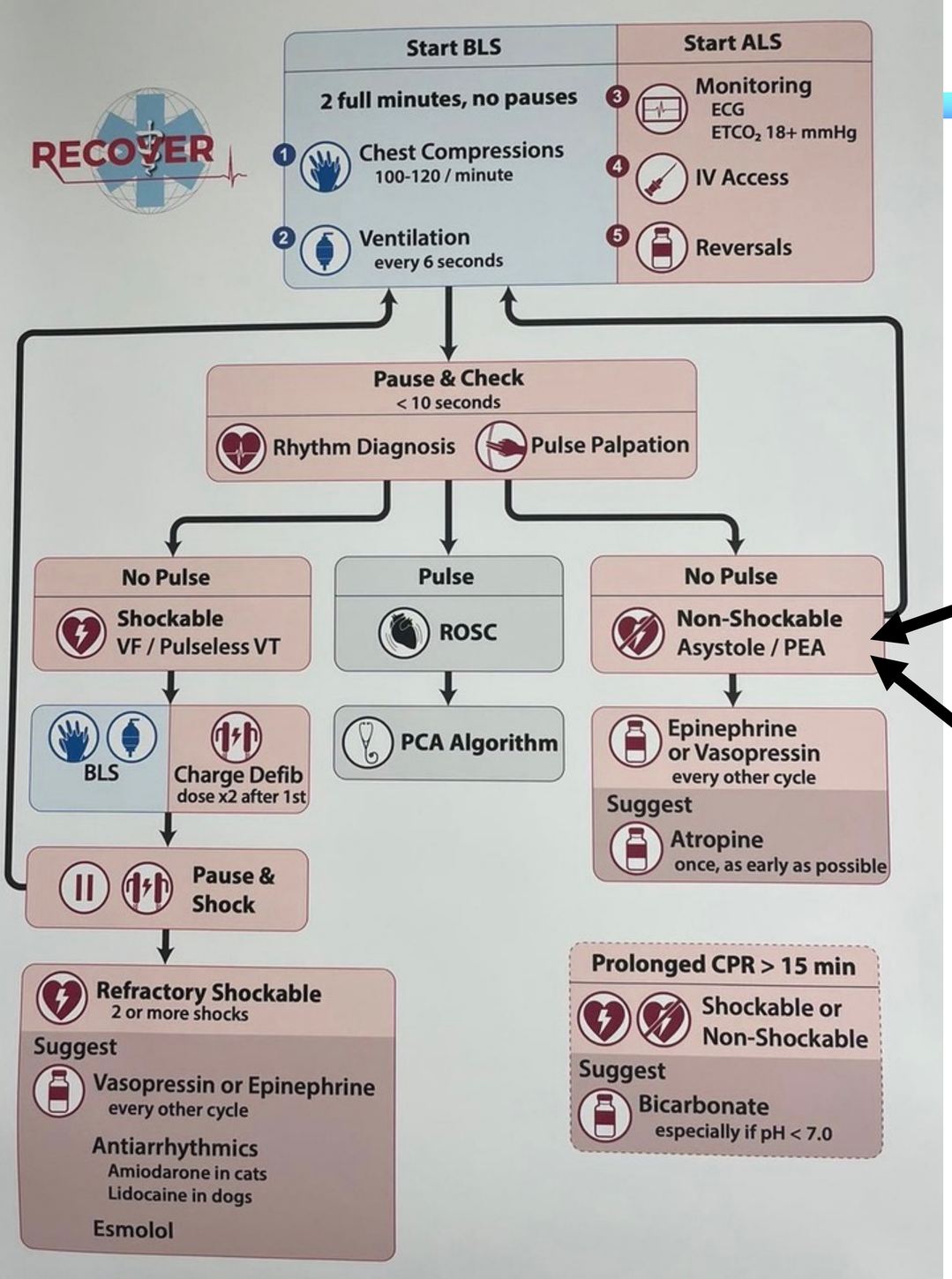
RECOVER 2024 Recommendation!

ANTIARRHYTHMICS

When patient is refractory to defibrillation

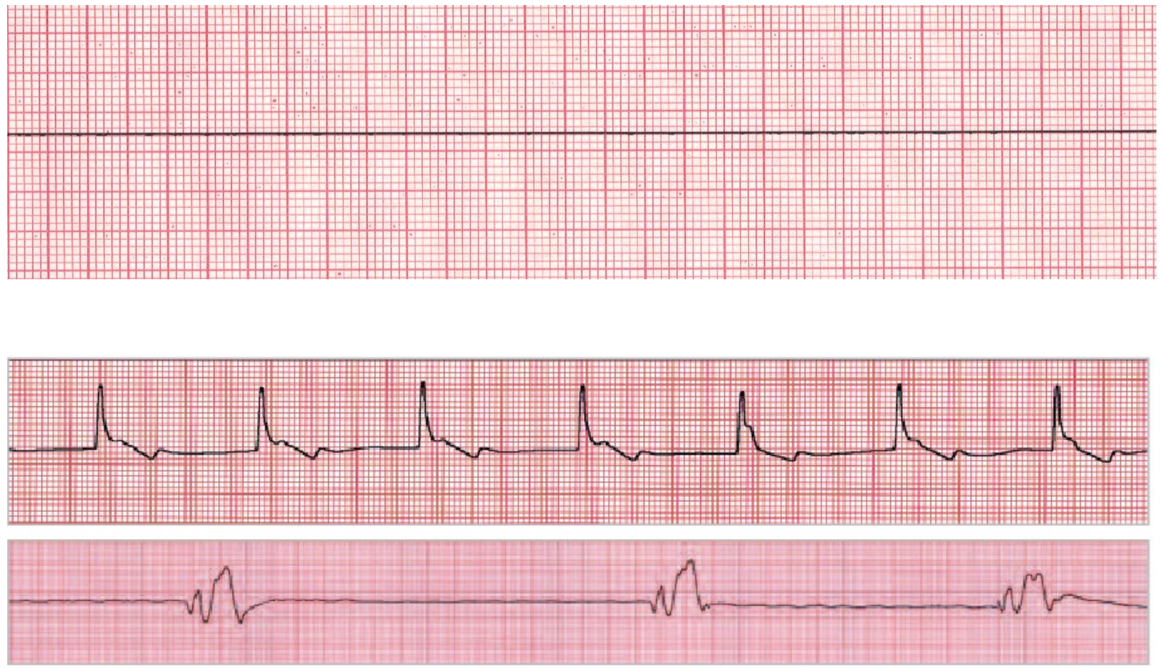
- *Start antiarrhythmic drug*
  - *For dogs: Lidocaine*
  - *For cats: Amiodarone*
- *Beta-blocker*
  - *Esmolol: especially to decrease adrenergic drive*

RECOVER 2024 Recommendation!



RECOVER

RHYTHM DIAGNOSIS



EPINEPHRINE

VASOPRESSOR

Use of 0.01 mg/kg every 3-5 minutes

Recommendation: I-B

Most studies show that high doses of adrenaline do not improve ROSC or other outcomes

3 Studies in Small Dog Populations

Level of evidence: GE 3

RECOVER 2024 will recommend against high epi doses

EPINEPHRINE

VASOPRESSOR

DeBehnke DJ, Angelos MG, Leasure JE. Use of cardiopulmonary bypass, high-dose epinephrine, and standard-dose epinephrine in resuscitation from post-countershock electromechanical dissociation. Ann Emerg Med 1992; 21(9):1051–1057.

No differences between low and high doses

Brunette DD, Jameson SJ. Comparison of standard versus high-dose epinephrine in the resuscitation of cardiac arrest in dogs. Ann Emerg Med 1990; 19(1):8–11.

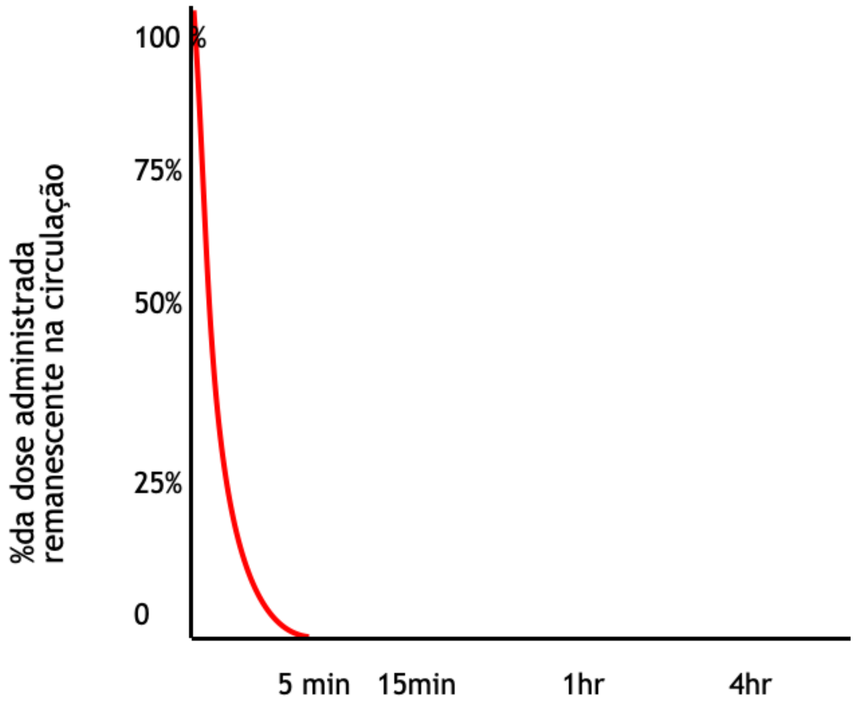
There are no differences between low and high doses, both centrally and intracardially. Low dose required longer CPR time

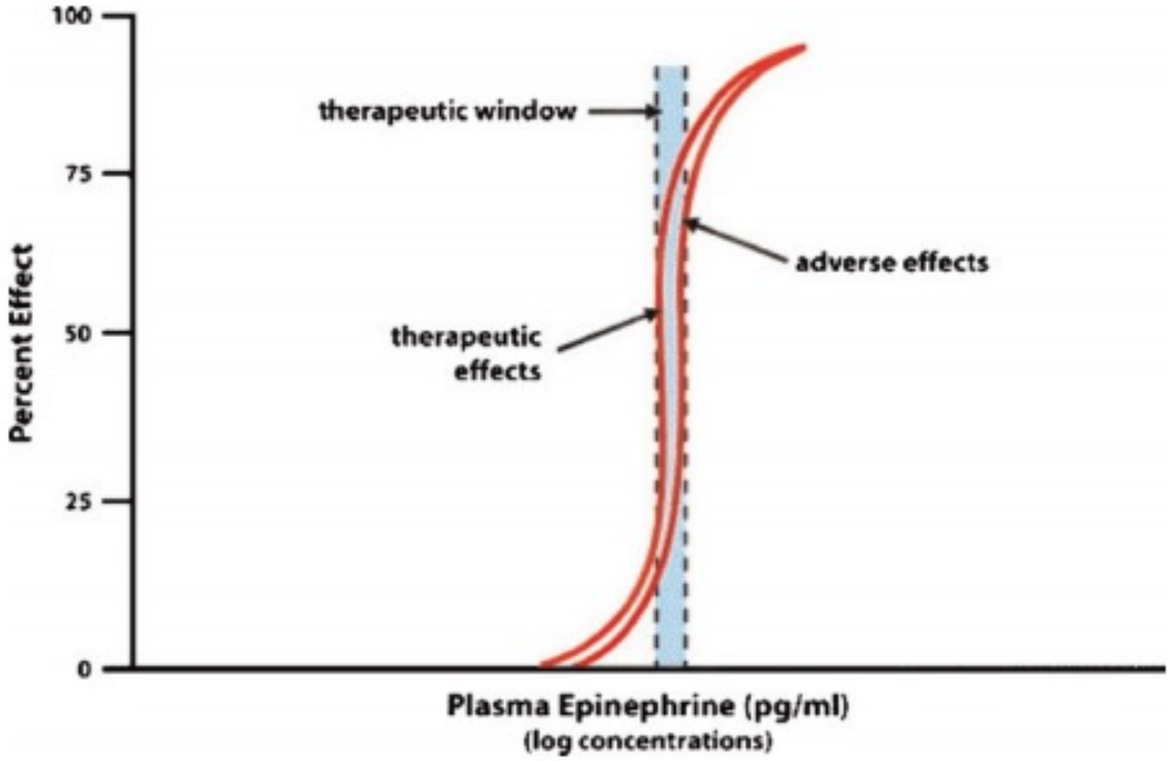
Roberts D, Landolfo K, Dobson K, et al. The effects of methoxamine and epinephrine on survival and regional distribution of cardiac output in dogs with prolonged ventricular fibrillation. Chest 1990; 98(4):999–1005.

High dose improved cerebral flow but with subsequent deterioration of global hemodynamics

EPINEPHRINE

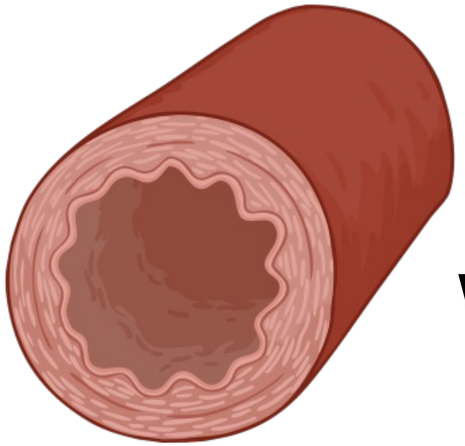
VASOPRESSOR





VASOPRESSINA

VASOPRESSOR

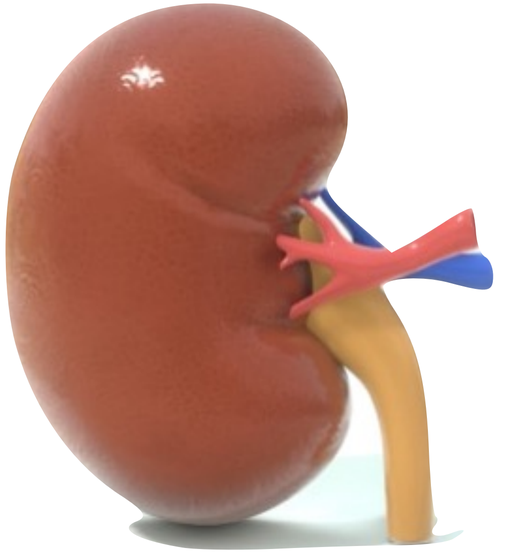


V1 Receptors

Increase in peripheral vascular resistance

V2 receptors

Volume Retention



Increased blood pressure

VASOPRESSIN

VASOPRESSOR

Use of 0.8 U/kg as a substitute for or in combination with adrenaline every 3-5 minutes

Recommendation: IIb-B

Human studies suggest a possible advantage in some subgroups:

Asystole

Prolonged PCR

CPR for hypovolemia

VASOPRESSIN

VASOPRESSOR

Aung K, Htay T. Vasopressin for cardiac arrest: a systematic review and meta-analysis. Arch Intern Med 2005; 165(1):17–24.

Wyer PC, Perera P, Jin Z, et al. Vasopressin or epinephrine for out-of-hospital cardiac arrest. Ann Emerg Med 2006; 48(1):86–97.

No differences between adrenaline and vasopressin

Biondi-Zoccai GGL, Abbate A, Parisi Q, et al. Is vasopressin superior to adrenaline or placebo in the management of cardiac arrest? A meta-analysis. Resuscitation 2003; 59(2):221–224.

It may have experimental benefit, but it does not translate into benefit in clinical trials

VASOPRESSINE

VASOPRESSOR

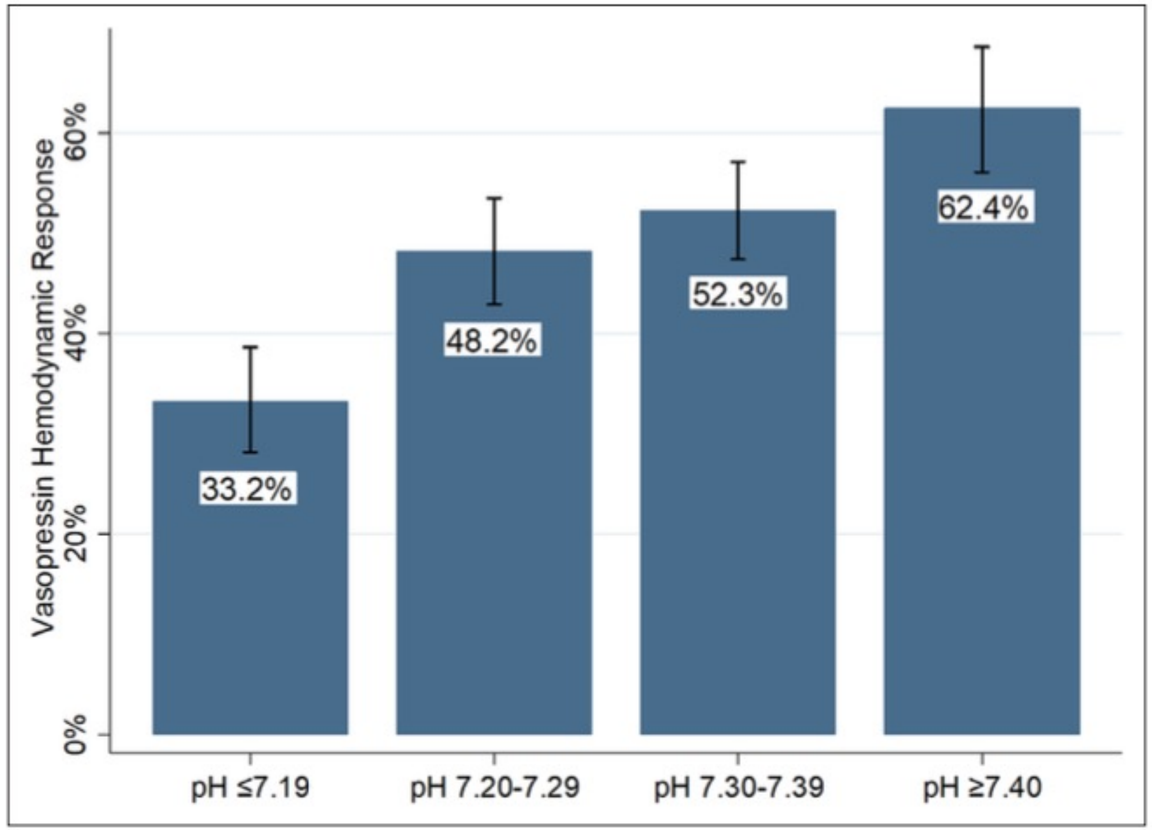


Figure 1. Vasopressin hemodynamic response by arterial pH group at vasopressin initiation. Proportion of patients with a hemodynamic response at 6 hr after vasopressin initiation by arterial pH group. Error bars represent 95% CIs. Overall $p < 0.01$ by χ^2.

ORIGINAL CLINICAL REPORT

OPEN

Association of Arterial pH With Hemodynamic Response to Vasopressin in Patients With Septic Shock: An Observational Cohort Study

Seth R. Bauer, PharmD[1,2]
Gretchen L. Sacha, PharmD[1]
Matthew T. Siuba, DO[2,3]
Simon W. Lam, PharmD, MS[1,2]
Anita J. Reddy, MD, MBA[2,3]
Abhijit Duggal, MD, MPH, MSc[2,3]
Vidula Vachharajani, MD[2,3,4]

OBJECTIVES: Vasopressin is reported to retain vasoconstrictive activity in the setting of acidemia, but preclinical models are inconsistent and studies have not evaluated the clinical effectiveness of vasopressin based on arterial pH. This study sought to determine the association between arterial pH and blood pressure after vasopressin initiation in septic shock.

DESIGN: This retrospective, multicenter, observational cohort study evaluated the association of arterial pH at the time of vasopressin initiation with hemodynamic response to vasopressin and change in catecholamine dose after vasopressin initiation. Hemodynamic response was defined as a catecholamine dose decrease with mean arterial pressure greater than or equal to 65 mm Hg at 6 hours after vasopressin initiation.

SETTING: Patients from eight hospitals in a health system were evaluated.

PATIENTS: Patients with septic shock initiated on vasopressin as a catecholamine adjunct between January 2012 and November 2017 were screened for inclusion.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: A total of 1,350 patients were included. At the time of vasopressin initiation patients were severely ill with arterial pH 7.28 ± 0.13, Sequential Organ Failure Assessment 14.1 ± 3.5, lactate 5.6 ± 4.6 mmol/L, and norepinephrine-equivalent catecholamine dose 32.3 ± 25.4 μg/min. After adjusting for lactate and Sequential Organ Failure Assessment with multivariable logistic regression, lower arterial pH was independently associated with lower odds of hemodynamic response to vasopressin (for each 0.1 unit arterial pH was below 7.40, response odds ratio 0.79; 95% CI, 0.72–0.87). For each 0.1 unit the pH was below 7.40 at vasopressin initiation, the norepinephrine-equivalent catecholamine dose increased by 1.5 μg/min (95% CI, 0.5–2.5 μg/min) at 1 hour, and increased by 2.5 μg/min (95% CI, 1.4–3.5 μg/min) at 6 hours after vasopressin initiation.

CONCLUSIONS: Compared with higher arterial pH, patients with septic shock and low arterial pH had lower odds of vasopressin response and higher catecholamine doses after vasopressin initiation. Similar to other vasopressors, the clinical effectiveness of vasopressin appears to be impaired in the setting of acidemia.

KEY WORDS: acidosis; sepsis; septic shock; norepinephrine; vasoconstrictor agents; vasopressin

Sepsis is the leading cause of death in hospitalized patients (1). Septic shock, a subset of sepsis clinically identified by infection-induced hypotension requiring vasopressors with hyperlactatemia, has a mortality rate of 33% in North America (2, 3). Over half of patients with septic shock have concomitant acidemia, at least in part due to lactic acidosis (4–6). Acidemia causes

DOI: 10.1097/CCE.0000000000000634

ATROPINE

VAGOLYTIC THERAPY

In arrests associated with increased vagal tone, atropine should be acceptable (IIa-B)

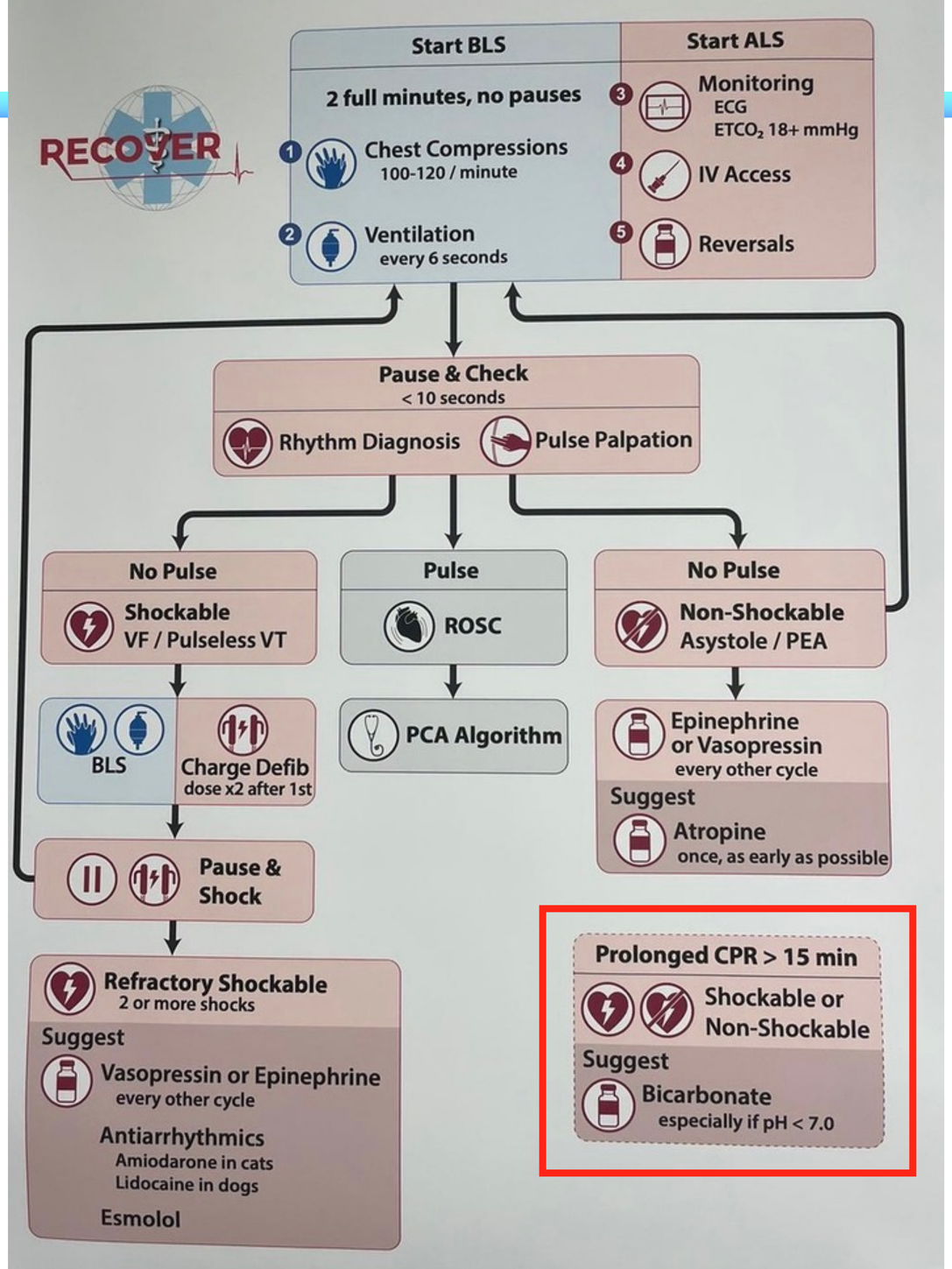
Routine use of atropine (IIb-C) should be considered

Maximum dose of 0.04 mg/kg

Avoid fractional doses

Delayed inhibition of muscarinic receptors (m2) and may cause bradycardia

RECOVER 2024 will recommend just once 


RECOVER
Start BLS
2 full minutes, no pauses
1 Chest Compressions
100-120 / minute
2 Ventilation
every 6 seconds
Start ALS
3 Monitoring
ECG
ETCO2 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

BICARBONATE

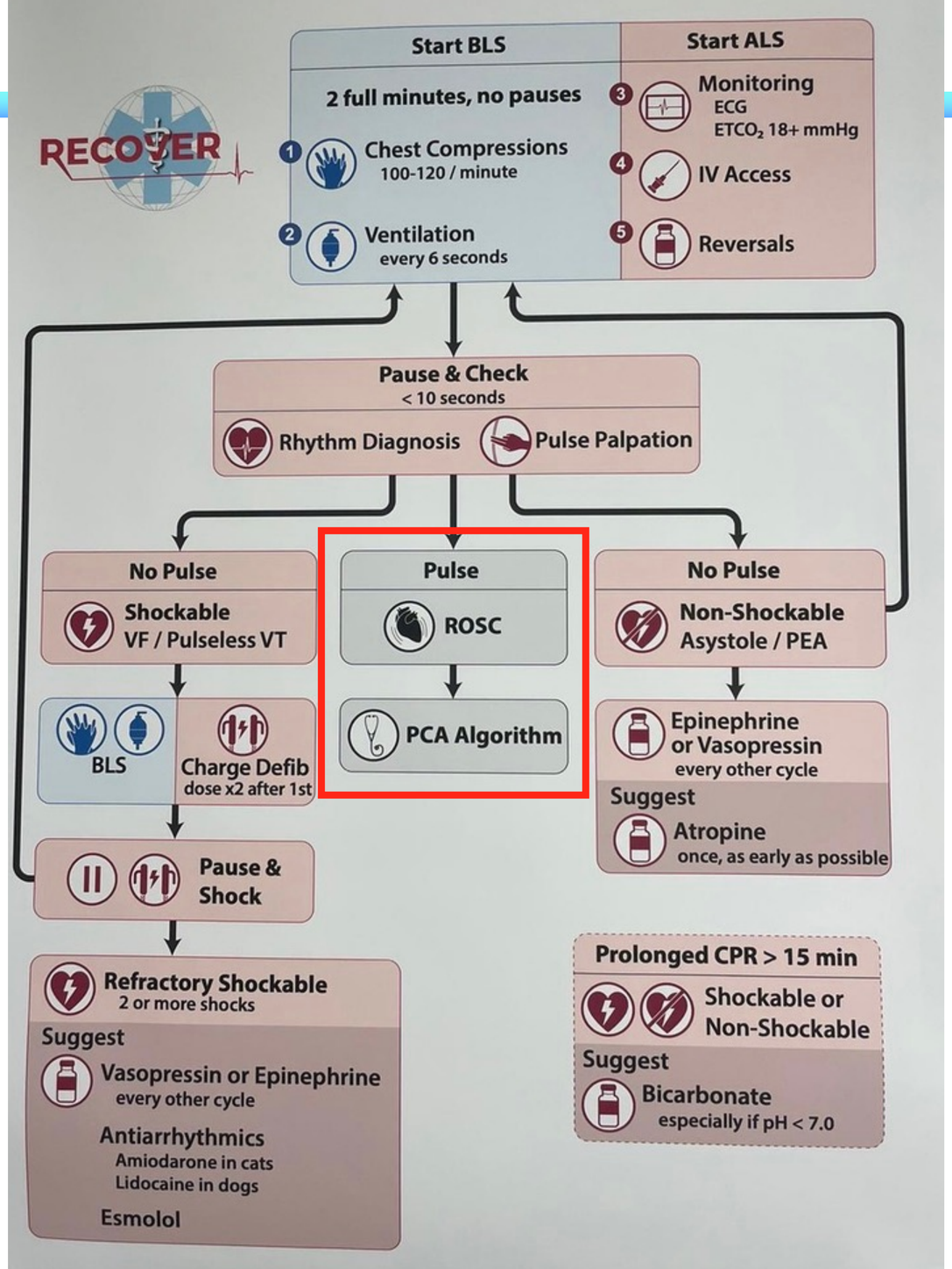
It's in acidosis, can I use bicarbonate?

Yes!

When?

If CPR longer than 10-15 min +/- pH< 7.0

4 studies in dogs with LOE 3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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

SHOCK - ROSC

POST-RESUSCITATION

Jozwiak *et al. Ann. Intensive Care (2020) 10:170*
https://doi.org/10.1186/s13613-020-00788-z

Annals of Intensive Care

REVIEW Open Access

Post-resuscitation shock: recent advances in pathophysiology and treatment

Mathieu Jozwiak[1,2*], Wulfran Bougouin[3,4,5,10], Guillaume Geri[6,7,8,10], David Grimaldi[9,10] and Alain Cariou[1,2,4,5,10]

Intensive Care Med (2021) 47:369–421
https://doi.org/10.1007/s00134-021-06368-4

CONFERENCE REPORTS AND EXPERT PANEL

European Resuscitation Council and European Society of Intensive Care Medicine guidelines 2021: post-resuscitation care

Jerry P. Nolan[1,2*], Claudio Sandroni[3,4], Bernd W. Böttiger[5], Alain Cariou[6], Tobias Cronberg[7], Hans Friberg[8], Cornelia Genbrugge[9,10], Kirstie Haywood[11], Gisela Lilja[12], Véronique R. M. Moulaert[13], Nikolaos Nikolaou[14], Theresa Mariero Olasveengen[15], Markus B. Skrifvars[16], Fabio Taccone[17] and Jasmeet Soar[18]

SHOCK – ROSC

POST-RESUSCITATION

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REVIEW Open Access

Post-resuscitation shock: recent advances in pathophysiology and treatment

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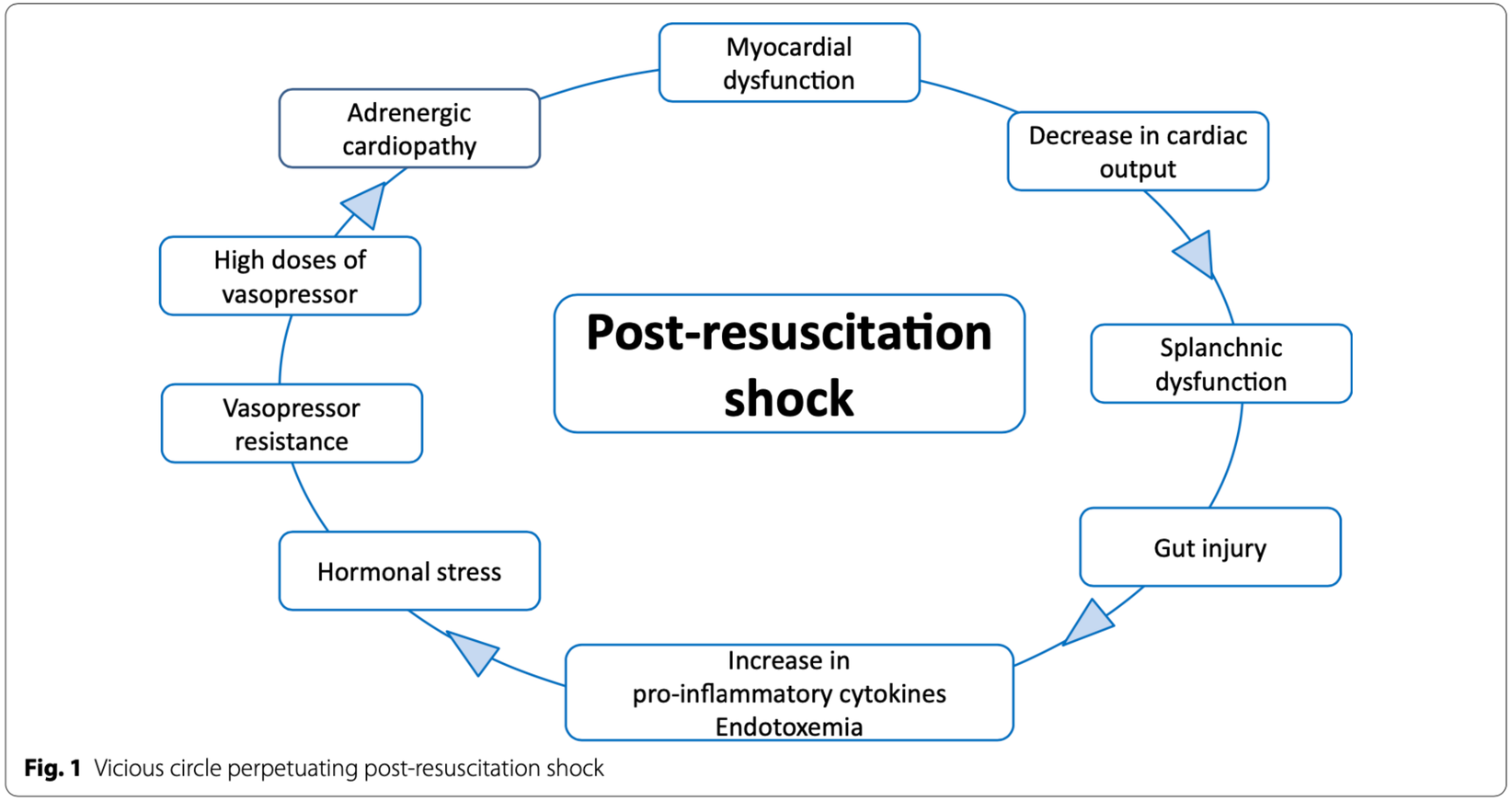
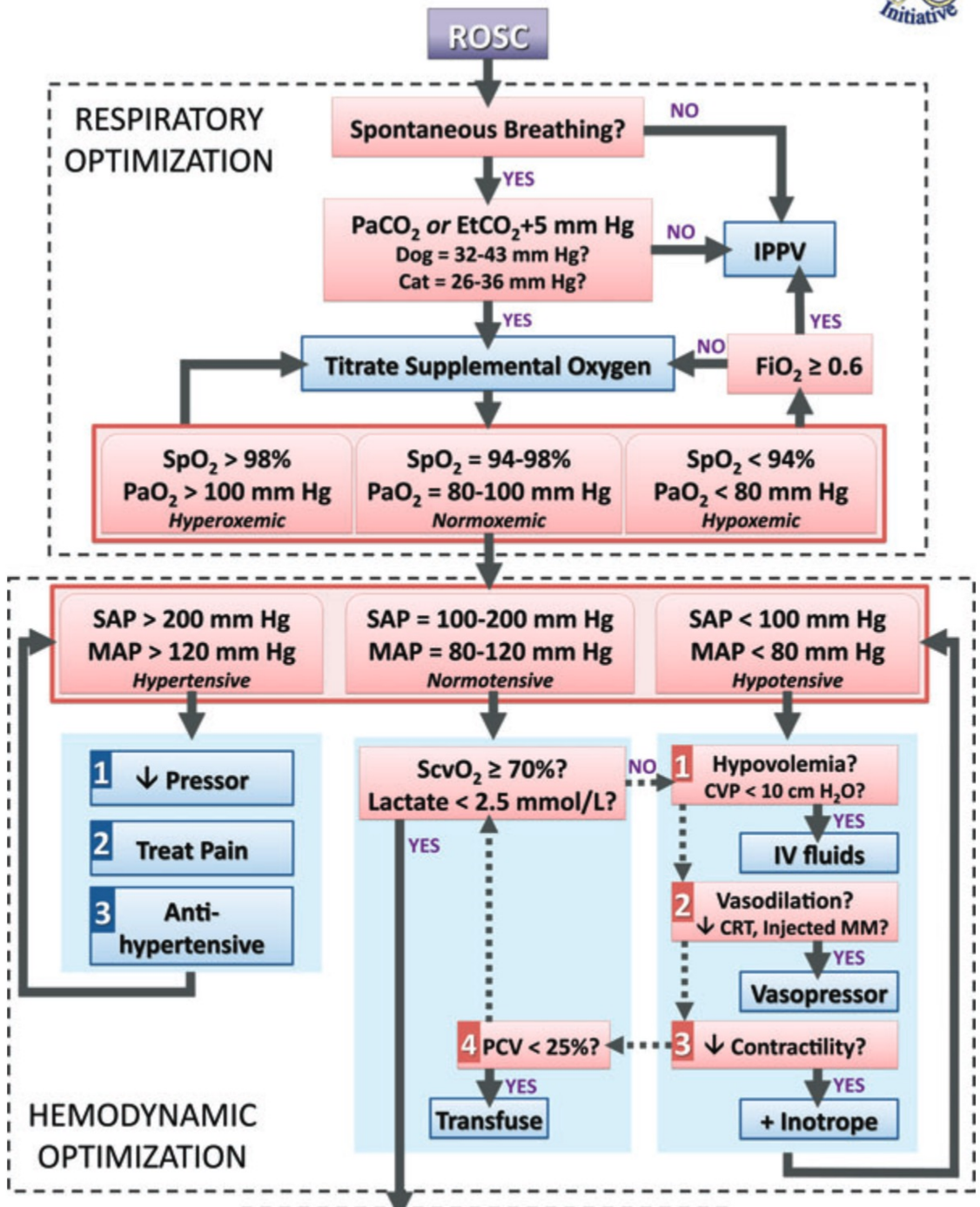


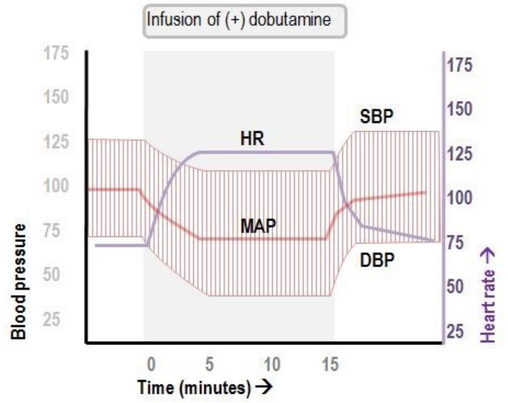
Fig. 1 Vicious circle perpetuating post-resuscitation shock

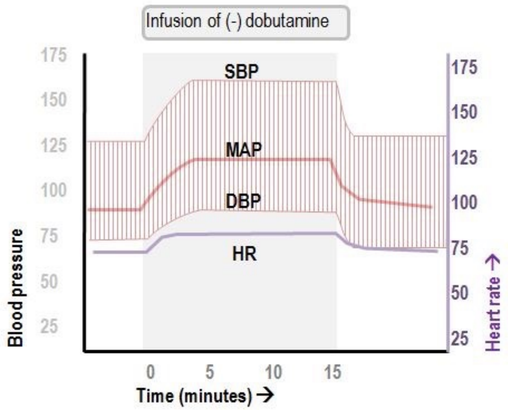
Post-Cardiac Arrest Care Algorithm



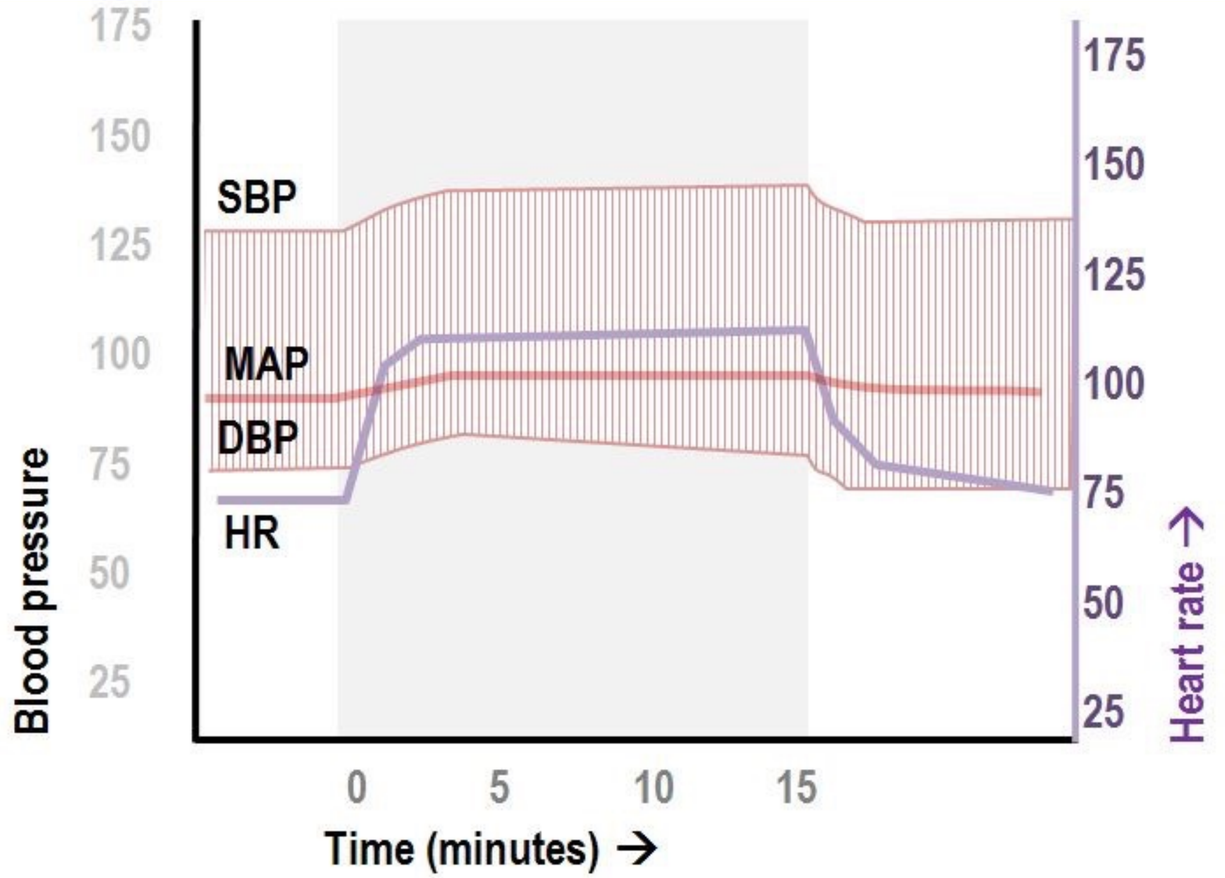
DOBUTAMINE

INOTROPIC





Racemic mixture of 2 stereoisomers



DOBUTAMINE

INOTROPIC

Adrenoceptors	(+) stereoisomer	(-) stereoisomer	Racemate
Alpha-1	High affinity but no agonist activity; thus this stereoisomer acts as a *competitive alpha-antagonist*	High affinity and potent partial agonist activity; thus this stereoisomer acts as a partial agonist	The net result is moderate partial agonist activity
Beta-1	More potent full agonist	Less potent full agonist	Potent full agonist activity
Beta-2	Low potency full agonist	Low potency full agonist	Low potency full agonist

REVERSIBLE CAUSES

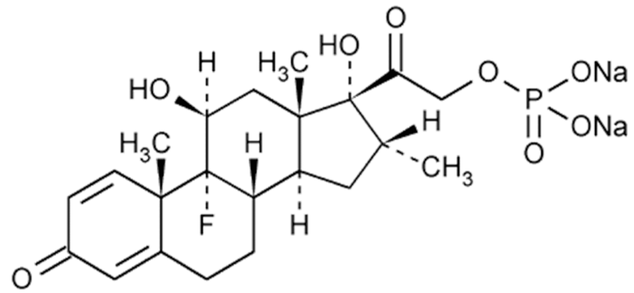
5H	H ~~5~~T
HYPOVOLEMIA	TOXINS
HYPOXIA	TAMPONADE
HYDROGEN ION (Acidosis)	TENSION PNEUMOTHORAX
HYPO / HYPERKALEMIA	~~THROMBOSIS (Massive MI)~~
HYPOTHERMIA	THROMBOSIS (Massive PE)

OTHER PHARM. THERAPY

OTHER DRUGS

Steroids: ***Not recommended***

Degree of recommendation: III-C



(b) Dexamethasone sodium phosphate (DexSP)

OTHER PHARM. THERAPY

ELECTROLYTES

Mg:

Not recommended, but should be considered in torsade de pointes

Grade of recommendation: IIb-B

Ca:

Not recommended,but should be considered in moderate hypocalcemia

Grade of recommendation: IIb-C

K:

Hypokalemia should be treated during CPR

Grade of recommendation: I-B

Dr. Fadel – Companion

- This QR Code will take you to a feedback form for this session.
- If you have a smartphone, please hold up your phone's camera and let it register the QR code.
- A "URL" should appear. Click the URL and fill out the feedback form.

OSU VETERINARY MEDICINE

Thank you for your feedback!