Get With The Guidelines®-Resuscitation:

Physiologic-Directed CPR

American Heart Association | American Stroke Association
life is why
GET WITH THE GUIDELINES. RESUSCITATION

March 20, 2019

Presenter:
Robert Michael Sutton MD MSCE FAAP FCCM
Associate Professor of Anesthesia, Critical Care, and Pediatrics

Meet Our Presenter

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Associate Professor of Anesthesia, Critical Care, and Pediatrics

Chair: Resuscitation Committee at The Children's Hospital of Philadelphia

Medical Lead: Preventing Codes Outside the ICU

Co-Director: Resuscitation Science Research Program

Department of Anesthesiology and Critical Care Medicine

University of Pennsylvania School of Medicine

Personalizing Resuscitation with Physiologic-Directed CPR

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University of Pennsylvania School of Medicine

March 16th, 2019

Presenter Disclosure Information

Current Research Support:	NIH NHLBI (PI R01 – clinical) NIH NHLBI (PI R01 – clinical) NIH NHLBI (Co-I R01 – large animal) NIH NICHD (Co-I R21 – large animal) Mallinckrodt Pharma (Co-I – large animal)
Past Research Support:	NIH NICHD (PI K23) Laerdal Foundation / Laerdal Corporation Zoll medical
Intellectual Conflicts:	Chair Elect: AHA GWTG-R Pediatric Research Task Force 2015 and 2018 PALS writing group member Member: ECC Systems of Care Committee Member: ECC Pediatric Emphasis Group Member: ECC Science Review Task Force
Speaking Honoraria:	Zoll Medical for Pediatric CPR Quality Talk

Objectives

At the conclusion of this talk, participants will be able to:

Understand the concept, the targets, and the potential practical application of physiologic-directed CPR.

INVASIVE HEMODYNAMIC MONITORING DURING CPR

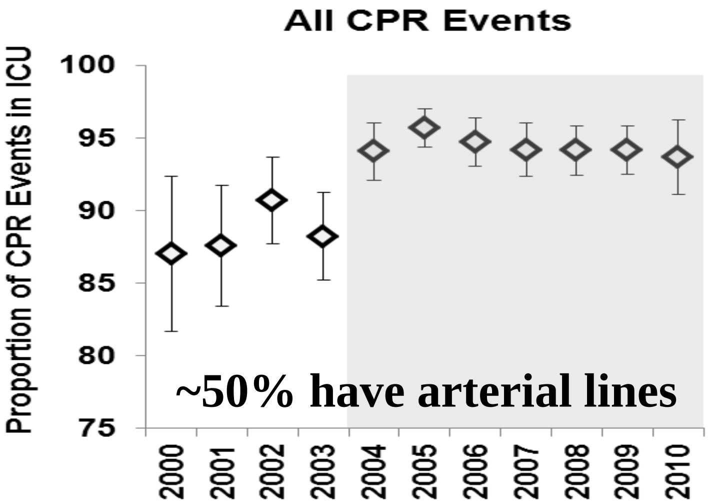
American Heart Association®
GUIDELINES 2015 CPR & ECC

Recommendation:

- For patients with invasive hemodynamic monitoring in place at the time of arrest, it may be reasonable for rescuers to use blood pressure to guide CPR quality. No specific values can be recommended.

Why?

- Arrests most often occur in ICUs
- Many have arterial lines in place
- Two randomized controlled animal studies demonstrated improved survival with such an approach
  (Sutton, Resuscitation 2013 and AJRCCM 2014)
- Not studied in humans… yet



Berg, CCM 2013

END TIDAL MONITORING TO GUIDE CPR QUALITY

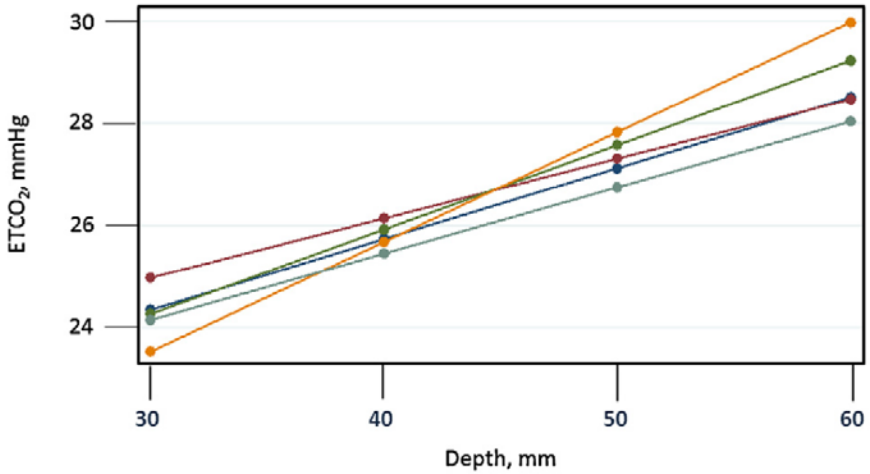
American Heart Association® GUIDELINES 2015 CPR & ECC

Recommendation:

- $ETCO_2$ monitoring may be considered to evaluate the quality of chest compressions, but specific values to guide therapy have not been established in children.

Why?

- No pediatric evidence to support that $ETCO_2$ monitoring during arrest improves outcomes…
- But $ETCO_2$ values during adult CPR correlate with CC depth and ventilation rate.
- Low end tidal associated with death



Sheak, Resuscitation 2015; Sanders, JAMA 1989

A 4 year old presents with fever, bacteremia, and hypotension. The child receives 60cc/kg of isotonic fluid. Blood pressure is now 100/50. Heart rate is normal for age. Extremities are warm. I would start the following vasopressor infusion:

A. Epinephrine

B. Norepinephrine

C. Vasopressin

D. Dobutamine

E. None

A 4 year old intubated ICU patient has a cardiac arrest. An arterial line is in place at the time of the arrest. Etiology is presumed to be respiratory decompensation. With chest compressions alone, the arterial blood pressure is 100/50. The first vasopressor I would give to treat this cardiac arrest is:

A. Epinephrine

B. Norepinephrine

C. Vasopressin

D. Isoproterenol

E. None

Rescuer-Centric Vs. Patient-Centric

Rescuer

Performance

"Mechanics"
Rate
Depth
Release Velocity
Interruptions

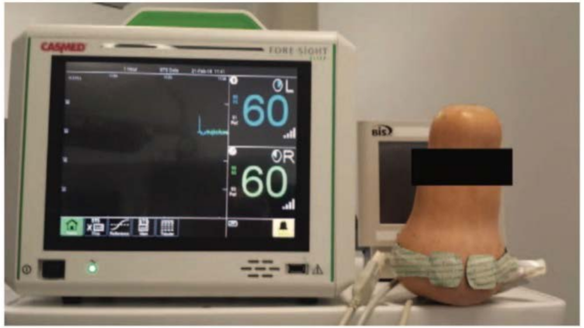
Time to
Shift the Focus

Patient

Physiology

CoPP
DBP
$ETCO_2$
NIRS (rSO_2)

Landmark Studies Change Talks



Experimental setup. A butternut squash is being studied. The oximetry probes are applied transversely at the widest level. The optical sensors are affixed side to side with the light emitting diodes positioned laterally. A portion of the subject was obscured to ensure anonymity.

Eur J Anaesthesiol. 2018 Jul 16. doi: 10.1097/EJA.0000000000000855. [Epub ahead of print]

Near-infrared spectroscopy in vegetables and humans: An observational study.

Kahn RA[1], Anyanwu A.

Author information

Abstract

BACKGROUND: Cerebral near-infrared spectroscopy (NIRS) of tissue oxygen saturation is claimed to be a surrogate marker for global cerebral perfusion. Increasingly, NIRS target-based therapy has been used during cardiac surgery in the hope of decreasing the incidence of adverse neurological outcome.

OBJECTIVES: We report NIRS values for some common vegetables and faculty at a world-class medical institution.

DESIGN: Observational nonblinded study.

SETTING: Single tertiary care institution and local urban vegetable market.

PARTICIPANTS: Five yams (Dioscorea cayenensis), five courgettes (Cucurbita pepo) and five butternut squashes (Cucurbita moschata) were studied. Five cardiothoracic surgeons and anaesthesiologists were the control group.

INTERVENTIONS: None.

MAIN OUTCOME MEASURES: NIRS value of each species.

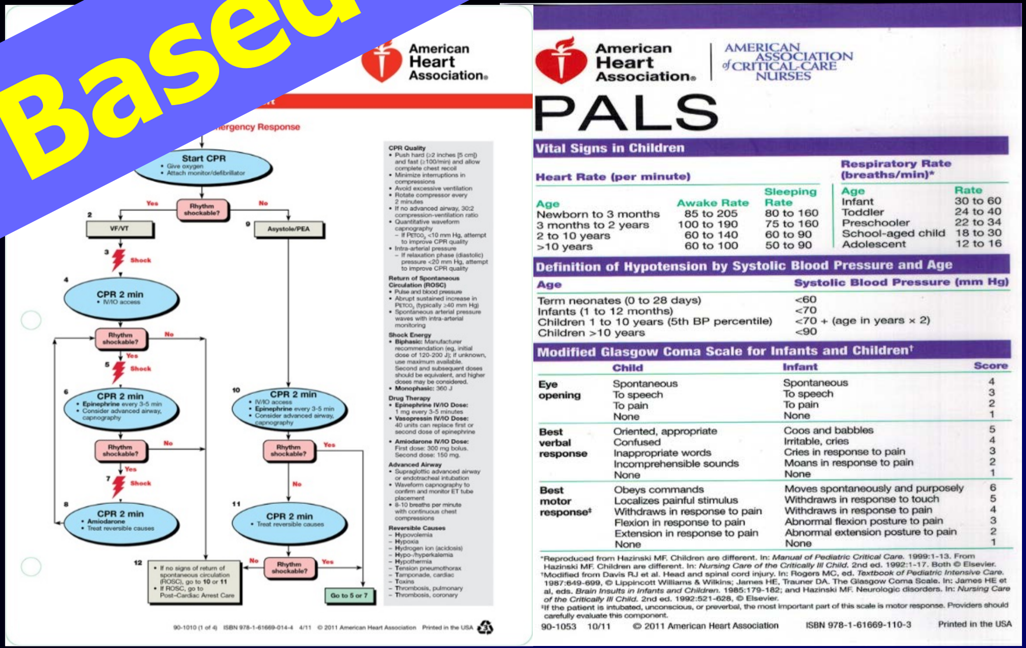
RESULTS: Mean NIRS value for the control group was 71% [95% confidence interval (CI) 68 to 74] and was similar to that of the yellow squashes [75% (95% CI 74 to 76)]. These values were significantly greater than the NIRS measurements of both the butternut squash and yam [63% (95% CI 62 to 64) and 64% (95% CI 63 to 65), respectively, $P<0.01$].

CONCLUSION: Commonly eaten vegetables have NIRS measurements similar to those seen in healthy humans.

Lots of different physiology

O... package?

Non-Precision Based Medicine



American Heart Association | AMERICAN ASSOCIATION of CRITICAL-CARE NURSES

PALS

Vital Signs in Children

Heart Rate (per minute)

Age	Awake Rate	Sleeping Rate
Newborn to 3 months	85 to 205	80 to 160
3 months to 2 years	100 to 190	75 to 160
2 to 10 years	60 to 140	60 to 90
>10 years	60 to 100	50 to 90

Respiratory Rate (breaths/min)*

Age	Rate
Infant	30 to 60
Toddler	24 to 40
Preschooler	22 to 34
School-aged child	18 to 30
Adolescent	12 to 16

Definition of Hypotension by Systolic Blood Pressure and Age

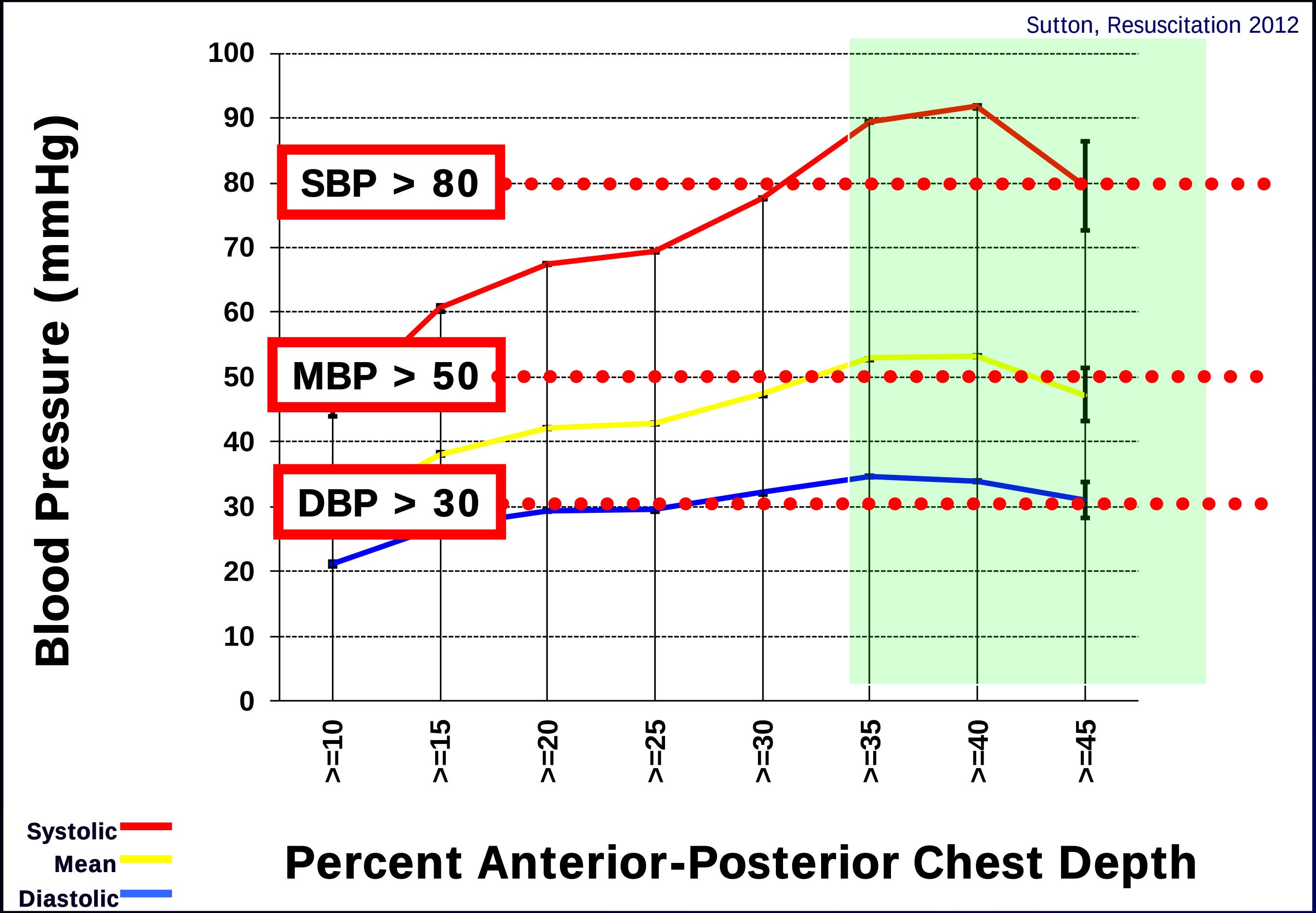
Age	Systolic Blood Pressure (mm Hg)
Term neonates (0 to 28 days)	<60
Infants (1 to 12 months)	<70
Children 1 to 10 years (5th BP percentile)	<70 + (age in years × 2)
Children >10 years	<90

Modified Glasgow Coma Scale for Infants and Children†

	Child	Infant	Score
Eye opening	Spontaneous	Spontaneous	4
	To speech	To speech	3
	To pain	To pain	2
	None	None	1
Best verbal response	Oriented, appropriate	Coos and babbles	5
	Confused	Irritable, cries	4
	Inappropriate words	Cries in response to pain	3
	Incomprehensible sounds	Moans in response to pain	2
	None	None	1
Best motor response‡	Obeys commands	Moves spontaneously and purposely	6
	Localizes painful stimulus	Withdraws in response to touch	5
	Withdraws in response to pain	Withdraws in response to pain	4
	Flexion in response to pain	Abnormal flexion posture to pain	3
	Extension in response to pain	Abnormal extension posture to pain	2
	None	None	1

90-1053 10/11 © 2011 American Heart Association ISBN 978-1-61669-110-3 Printed in the USA

Push Hard = Better Pediatric BPs



Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

ELSEVIER

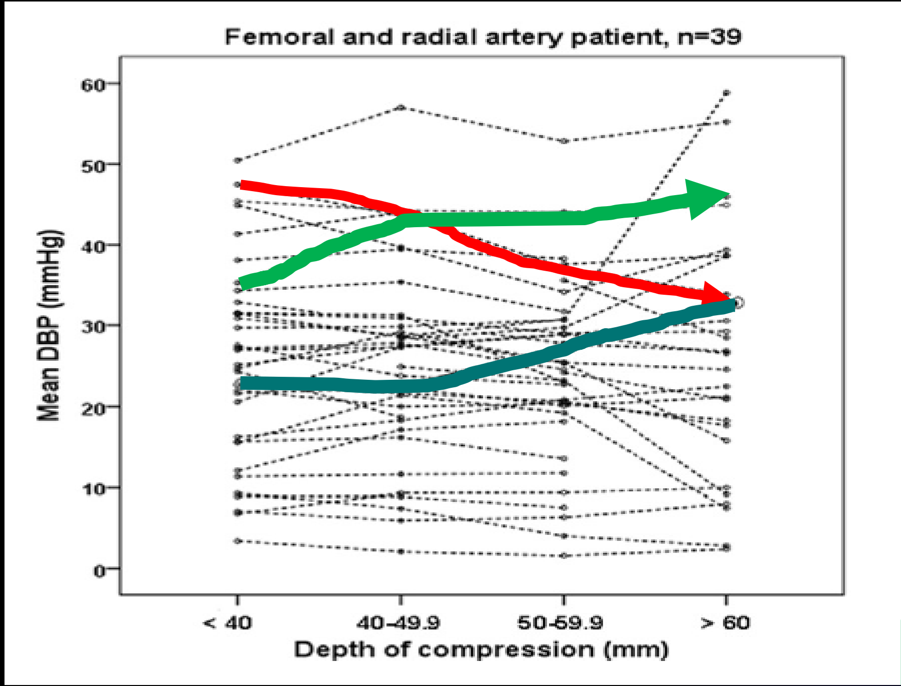
EUROPEAN RESUSCITATION COUNCIL

Clinical Paper

Resuscitation. 2015 Nov;96:163-9.

Simultaneous beat-to-beat assessment of arterial blood pressure and quality of cardiopulmonary resuscitation in out-of-hospital and in-hospital settings☆

Marko Sainio[a,b,*], Sanna Hoppu[a], Heini Huhtala[c], Joar Eilevstjønn[d], Klaus T. Olkkola[e], Jyrki Tenhunen[a,f]



OHCA and IHCA

39 Patients

~42000 Compressions

Substantial heterogeneity

	Femoral artery recording $n = 24$	Radial artery recording $n = 15$
Male, No. (%)	18 (75)	10 (67)
Age, mean (SD), y	65.5 (18)	64.1 (17)
Location of arrest, No.		
IHCA	20	15
OHCA	4	0
Time from CA to EMS or MET arrival, median (IQR), min	2 (0, 3)	1 (0, 2)
Interval from CA to ABP measure, median (IQR), min	13 (9, 18)	4 (3, 10)

A 2013 Consensus Statement from the AHA recommended which of the following physiologic CPR quality targets*:

A. Diastolic blood pressure > 30mmHg

B. Coronary Perfusion Pressure > 20mmHg

C. $ETCO_2$ > 10mmHg

D. NIRs > 50%

*Based on almost NO pediatric data

AHA Consensus Statement

CPR Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital

A Consensus Statement From the American Heart Association

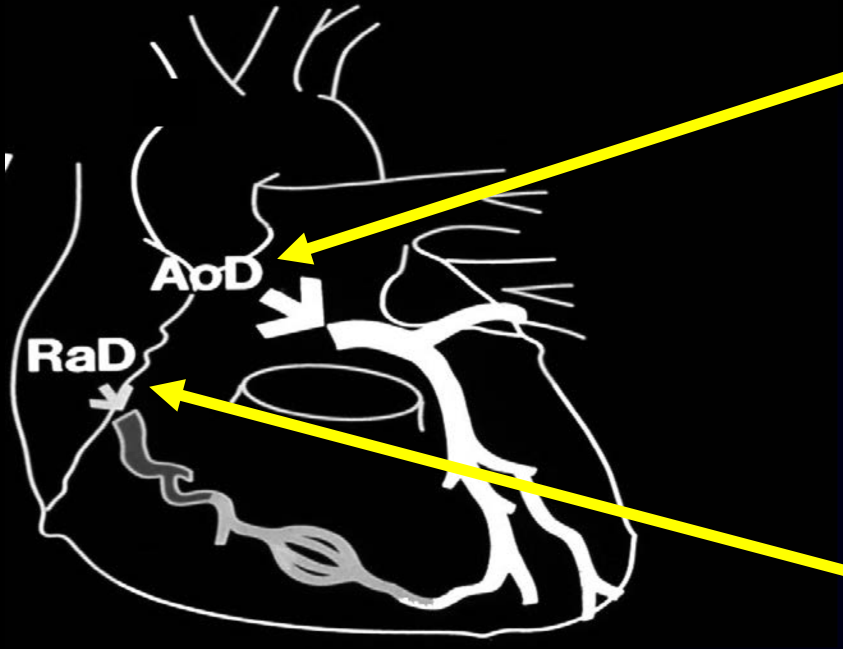
Endorsed by the American College of Emergency Physicians

- **Monitor the patient's response to the resuscitation effort**
  - **Coronary perfusion pressure > 20mmHg**
  - **Diastolic pressure > 25mmHg**
  - **End Tidal Carbon Dioxide > 20mmHg**

Meaney Circulation 2013

Coronary Perfusion Pressure (CoPP)

Pressure gradient that drives myocardial blood flow



Upstream Pressure

CoPP

Downstream Pressure

Crile, Experimental Medicine 1906; Sanders, CCM 1984; Michael, CCM 1984; Kern, Resus 1988

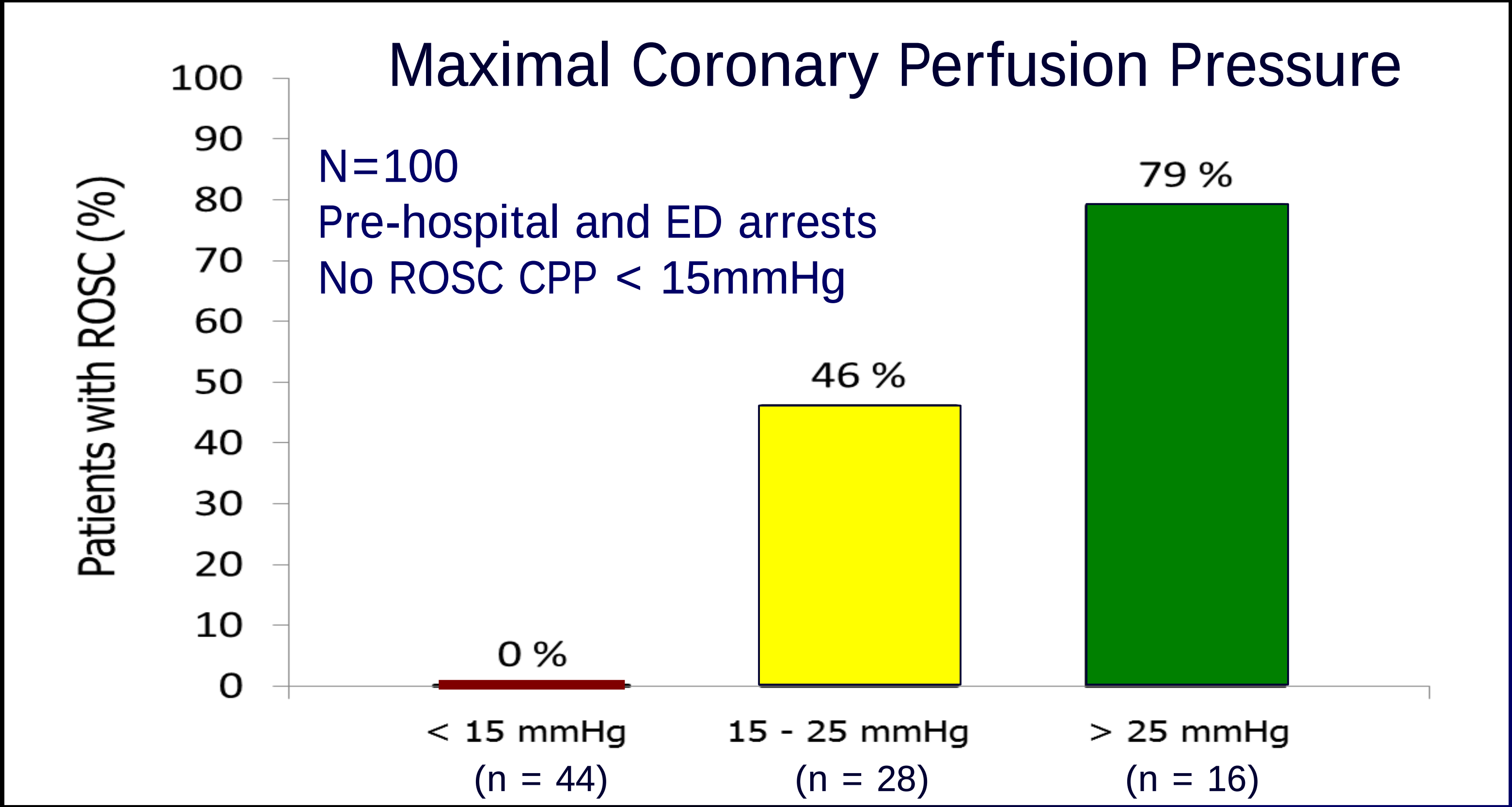
What are the right «goals» to target?

“ One… presses ***deep*** in the heart region

Effectiveness Measured by Monitoring Patient Response

Maas, Berlin Klin Wochenschr 1892

CoPP Higher in Patients with ROSC



Paradis, JAMA 1990

Among these markers of CPR quality, which one has been associated with improved survival to hospital discharge with favorable neurological outcome after pediatric cardiac arrest?

A. Chest compression rate 100-120 per minute

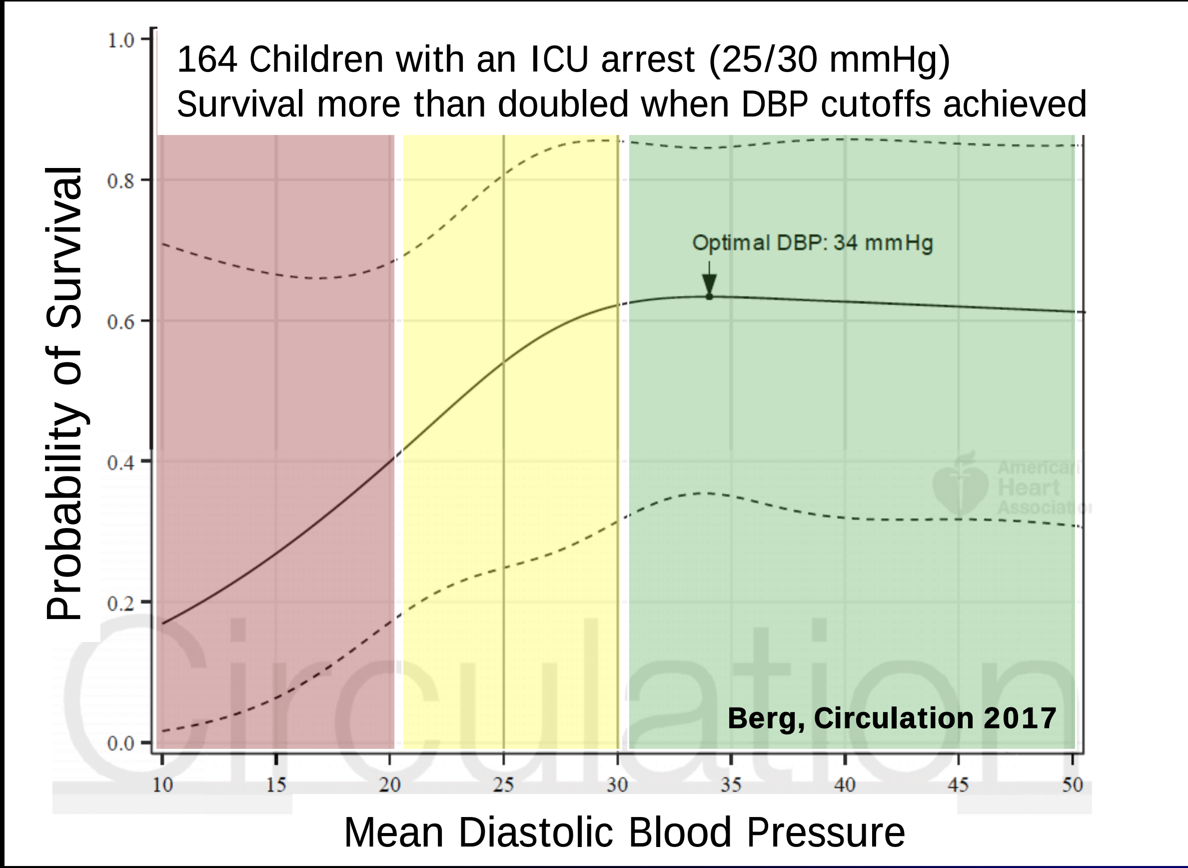
B. DBP ≥ 25mmHg in infants, ≥ 30mmHg in older children

C. $ETCO_2$ during CPR ≥ 20mmHg

D. Depth of compression > 50 mm

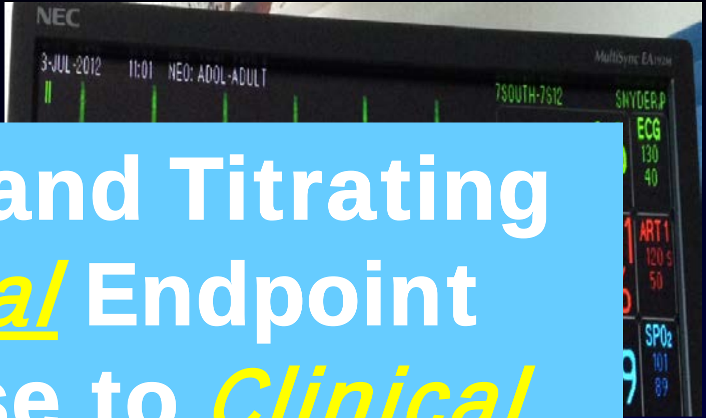
DBP indicates diastolic blood pressure

DBP Higher in Kids Who Survive



Hemodynamic-Directed Training Tools

Collaboration
with Biomedical Engineers



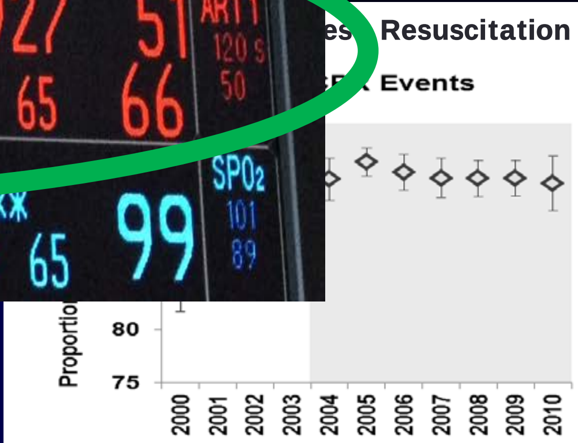
Monitoring and Titrating to a *Clinical* Endpoint makes sense to *Clinical* Care Providers

TABLE 3. Multivariable Model Adjusted for Clustering on Subject

Wolfe, PEC 2015

	OR	95% CI	P[a]
Acquisition			
Posttraining	5.2	1.3–21.2	0.02
Retention[a]			
12 h	4.4	1.3–14.9	*0.018*
3 mo	4.1	1.2–13.9	*0.023*

In-Hospital CPR ≈ Out-of- Hospital CPR

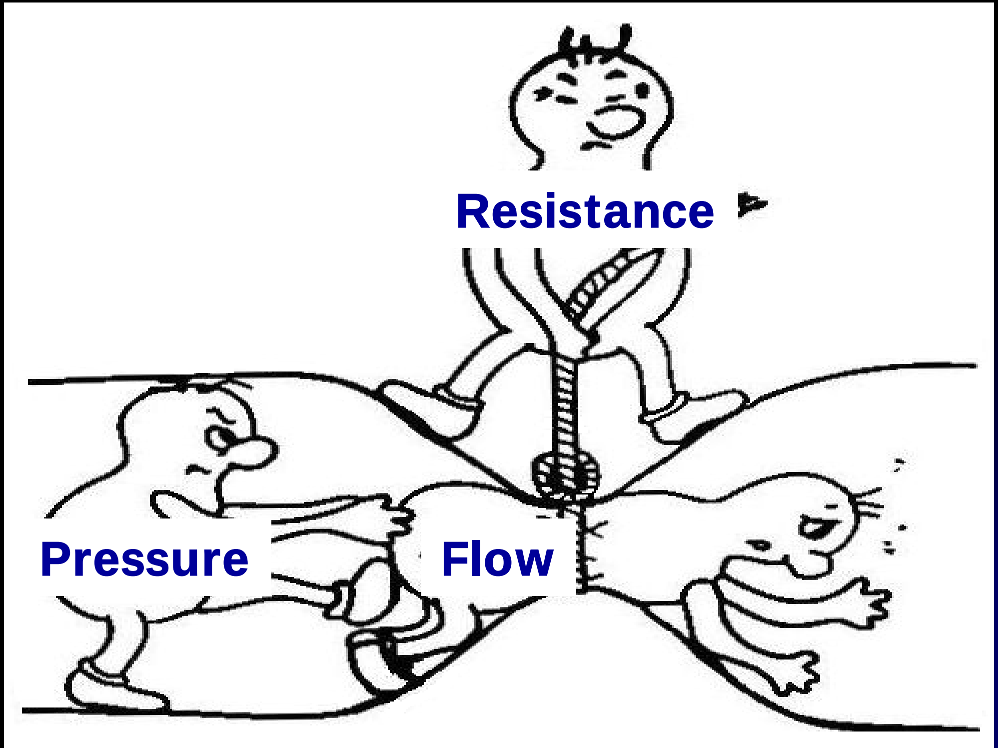


Berg et. al., CCM 2013

JUST LOOK UP!

Merchant, Crit Care Med 2011; Girotra, NEJM 2012

Pressure ≠ Flow



Expired CO_2 ($ETCO_2$) Represents Flow

Better CCs
Move more blood

Higher $ETCO_2$

Blood flows out to the body

Gas exchange in the tissues:
CO_2 is picked up

Translational Evidence: End-Tidal CO_2 is Proportional to Cardiac Output

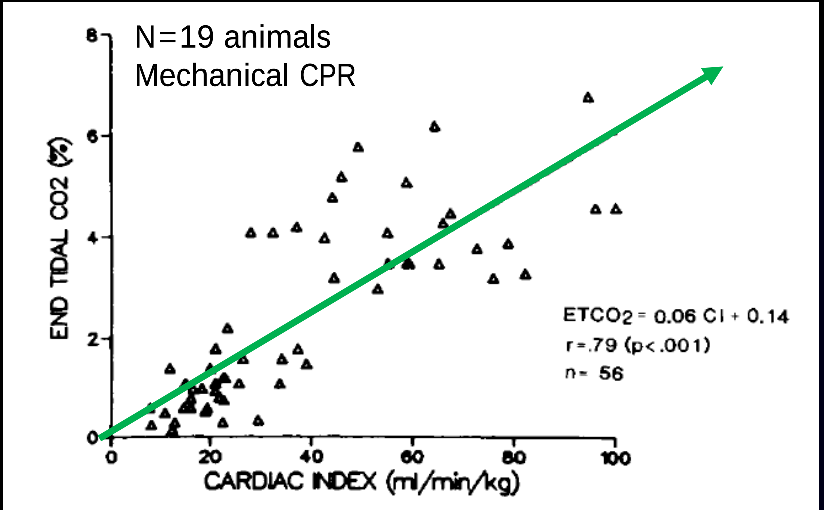
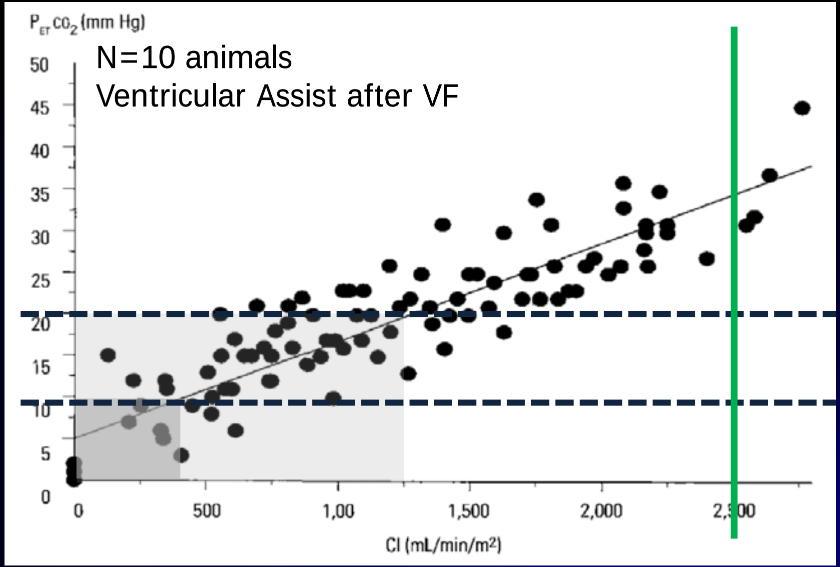


FIG. 4. Relationship between $ETCO_2$ and cardiac output.

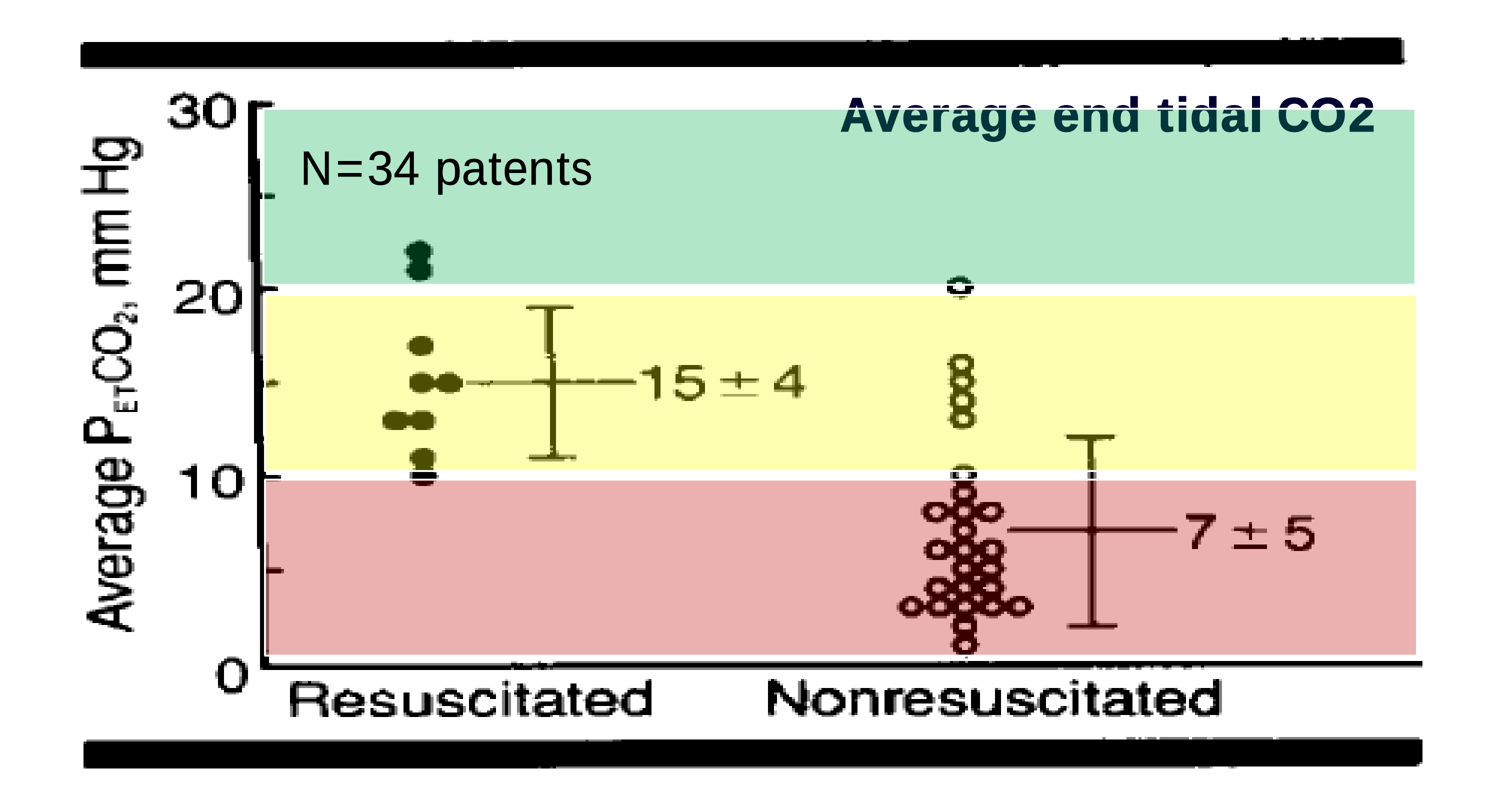


Weil, Crit Care Med 1985

Idris, Ann Emerg Med 1994

Slide adapted from Neumar SCCM 2018

ETCO$_2$ in Adult IHCA / OHCA



Sanders, JAMA 1989

Resuscitation 89 (2015) 149–154

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

ELSEVIER

RESUSCITATION

Clinical Paper

Resuscitation. 2015 Apr;89:149-54.

Quantitative relationship between end-tidal carbon dioxide and CPR quality during both in-hospital and out-of-hospital cardiac arrest☆

CrossMark

Kelsey R. Sheak[a], Douglas J. Wiebe[b], Marion Leary[a], Saeed Babaeizadeh[d], Trevor C. Yuen[c], Dana Zive[f], Pamela C. Owens[e], Dana P. Edelson[c], Mohamud R. Daya[f], Ahamed H. Idris[e], Benjamin S. Abella[a,*]

583 cardiac arrest events (both OHCA and IHCA)
~30,000 chest compressions analyzed

Table 4

Assessment of overall case resuscitation characteristics by clinical outcomes.

	ROSC	No ROSC	*p*-Value	Survival to discharge	No survival to discharge	*p*-Value
Rate (cpm)	109.0 ± 8.4	110.0 ± 9.7	NS	110.0 ± 7.6	[illegible] ± 9.4	NS
Depth (mm)	44.5 ± 8.0	43.8 ± 8.5	NS	44.9 ± 7.7	44.0 ± 8.3	NS
$ETCO_2$ (mmHg)	34.5 ± 4.5	[illegible]	<.001	[illegible]	[illegible]	<.001

All values are means ± standard deviation. cpm, compressions per minute; NS, not significant.

Rescuer-Centric Targets Not Different

Patient-Centric Physiology Different

No Signal During Pediatric CPR

CPCCRN
Collaborative Pediatric Critical Care Research Network

Multicenter study of 43 intubated children (HLHS excluded)

Primary evaluation: AHA target of 20mmHg

	ROSC ≥ 20 min		Survival to Hospital Discharge	
	Relative Risk (95% CI)	P-value	Relative Risk (95% CI)	P-value
Mean ETCO2 (mmHg) over the first ten minutes	1.01 (0.99, 1.03)	0.605	0.99 (0.95, 1.04)	0.783
Mean ETCO2 over the first ten minutes > 20 mmHg	1.32 (0.89, 1.95)	0.162	0.92 (0.41, 2.08)	0.839
Mean ETCO2 over the first ten minutes > 25 mmHg	1.02 (0.72, 1.45)	0.899	0.86 (0.36, 2.06)	0.728
Mean ETCO2 over the first ten minutes > 30 mmHg	1.05 (0.64, 1.74)	0.848	0.86 (0.24, 3.06)	0.818
Mean ETCO2 categories		0.237		0.988
< 20 mmHg	Reference		Reference	
20 - < 25 mmHg	1.56 (1.01, 2.42)		1.03 (0.36, 2.93)	
25 - < 30 mmHg	1.17 (0.72, 1.92)		0.88 (0.29, 2.63)	
≥ 30 mmHg	1.26 (0.73, 2.19)		0.84 (0.22, 3.20)	
All ETCO2 < 10 mmHg	0.71 (0.25, 2.00)	0.520	0.60 (0.11, 3.39)	0.562
All ETCO2 < 15 mmHg	0.88 (0.55, 1.41)	0.593	1.17 (0.45, 3.02)	0.748
All ETCO2 < 20 mmHg	1.03 (0.70, 1.50)	0.886	1.28 (0.55, 3.00)	0.563

Berg, Resuscitation 2018

A Sudden Increase in Partial Pressure End-Tidal Carbon Dioxide at the Moment of Return of Spontaneous Circulation

Pokorná 2010

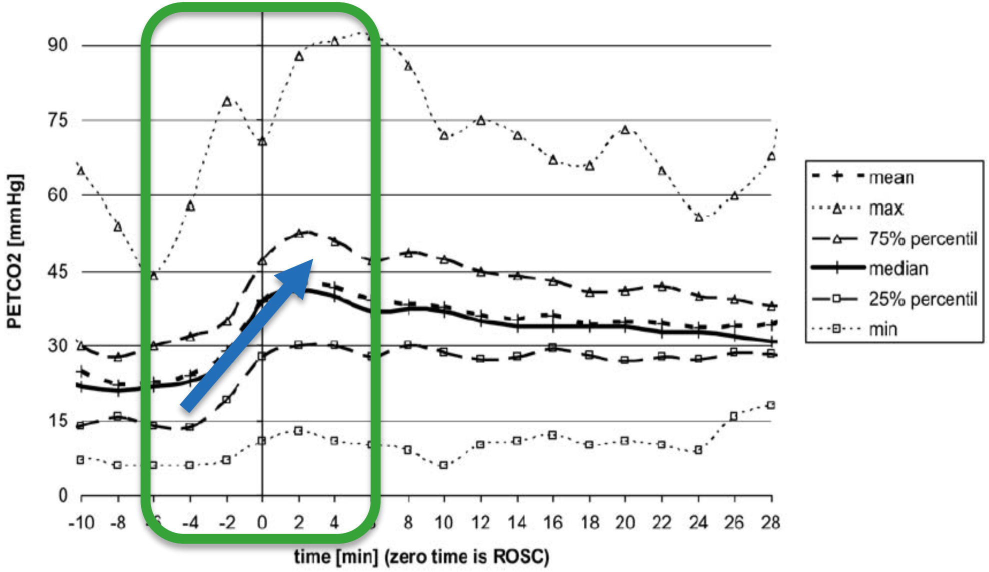
Out-of-hospital cardiac arrest

Adults (n=108)

2 Groups

- 59 with single episode of ROSC
- 49 with no signs of ROSC

ROSC = pulse



$ETCO_2$ ~10mmHg higher after ROSC (27 vs. 37)

Kalenda 1978, Falk 1988, Lui CT 2016

End-tidal carbon dioxide monitoring during CPR may be unreliable in the following clinical circumstances:

A. Leak around invasive airways

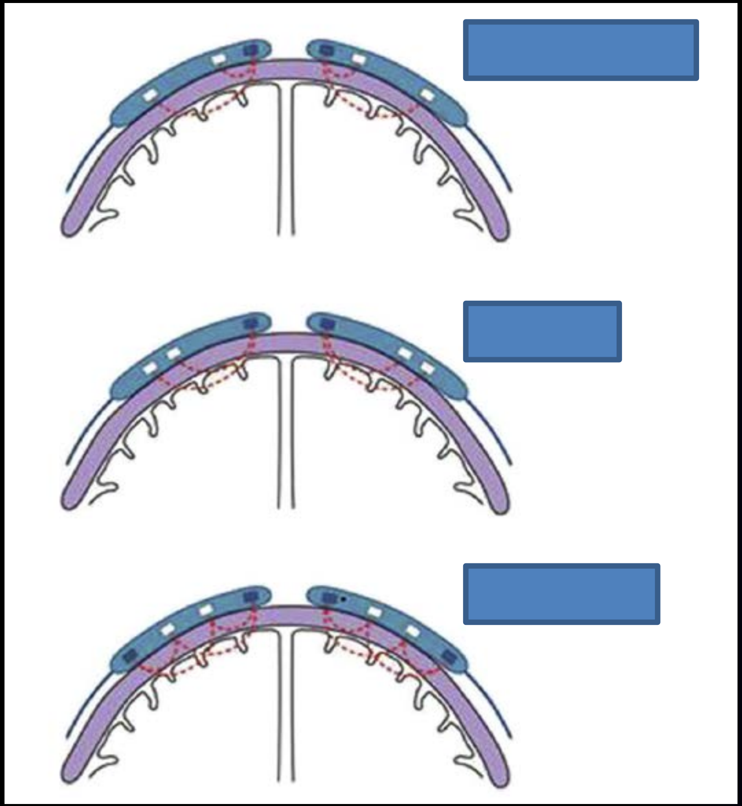
B. Vasopressor administration

C. Sodium bicarbonate administration

D. All of the above

Callaham, Crit Care Med 1992; Tang W, Circulation 1991; von Planta M, J Clin Pharmacol

Cerebral Oxygen Saturation: NIRS



Non-invasive

Subtle differences

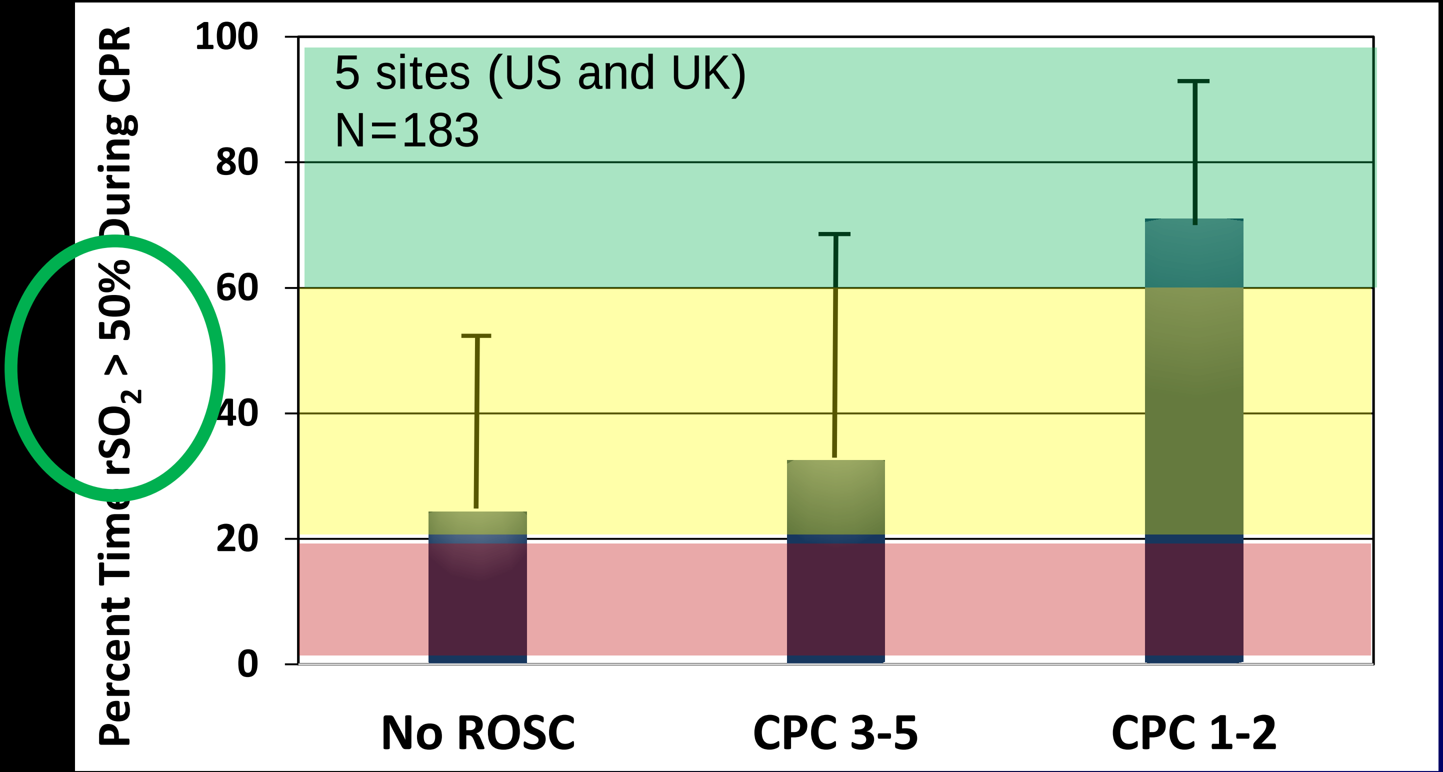
- emitters, detectors
- lowest detectable values
- ambient light sensitivity

Can measure CPR quality when pulsatile flow is not present

Genbrugge, Journal of Emergency Medicine, 2016

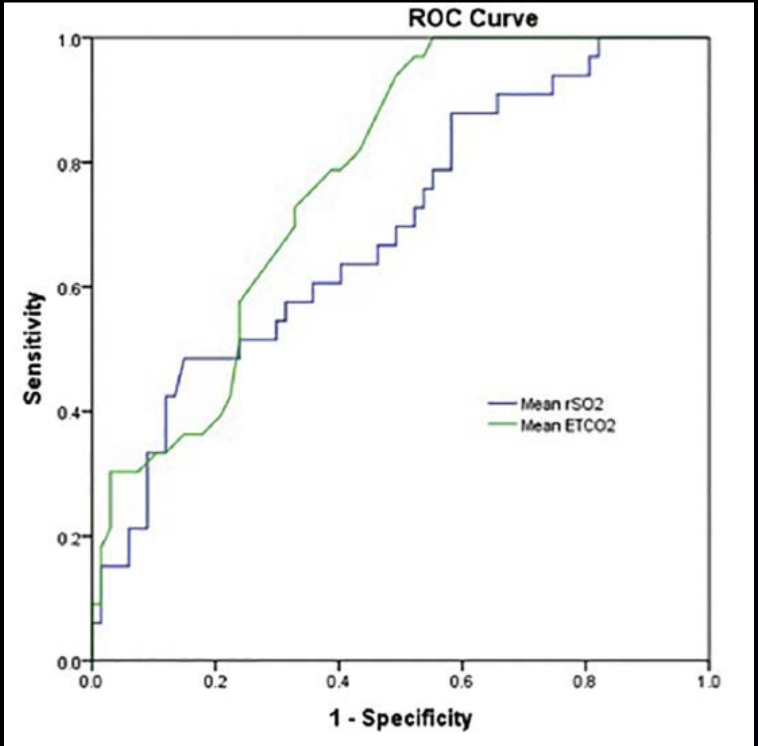
Cerebral Oximetry During Cardiac Arrest: A Multicenter Study of Neurologic Outcomes and Survival*

Parnia, CCM 2016



Cerebral oximetry versus end tidal CO_2 in predicting ROSC after cardiac arrest

Adam J. Singer, MD[a,*], Robert T. Nguyen, MD, MPH[b], Shreyas T. Ravishankar, MD[b],
Elinor Randi Schoenfeld, PhD[c], Henry C. Thode Jr, PhD[a], Mark C. Henry, MD[a], Sam Parnia, MD, PhD[b]



ED patients with OHCA (n=100)

AUCs were similar (~0.7)

Poor correlation

$ETCO_2$ more sensitive

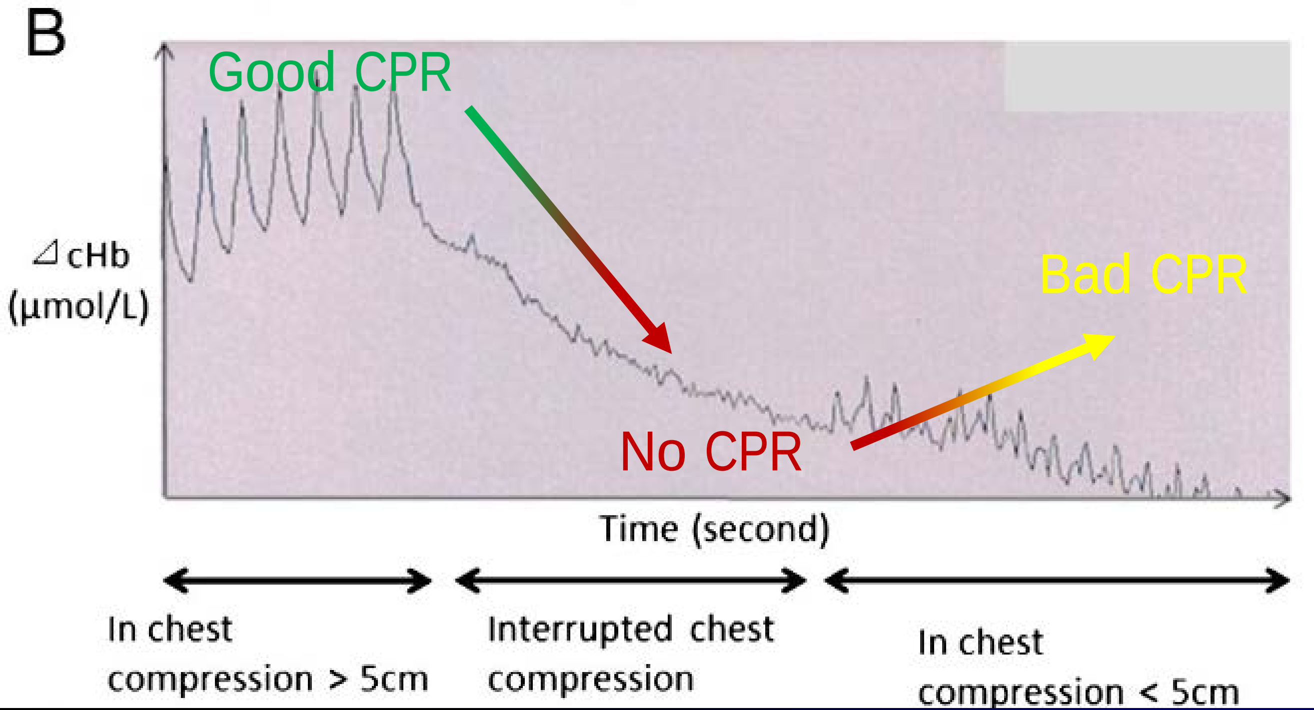
rSO_2 more specific

Parnia, American Journal of Emergency Medicine 2018

Brief Report
American Journal of Emergency Medicine 31 (2013) 1504–1508

A new method to detect cerebral blood flow waveform in synchrony with chest compression by near-infrared spectroscopy during CPR

Yasuaki Koyama, MD *, Takafumi Wada, MD, Brandon D. Lohman, MD, Yuka Takamatsu, MD, Junichi Matsumoto, MD, Shigeki Fujitani, MD, Yasuhiko Taira, MD



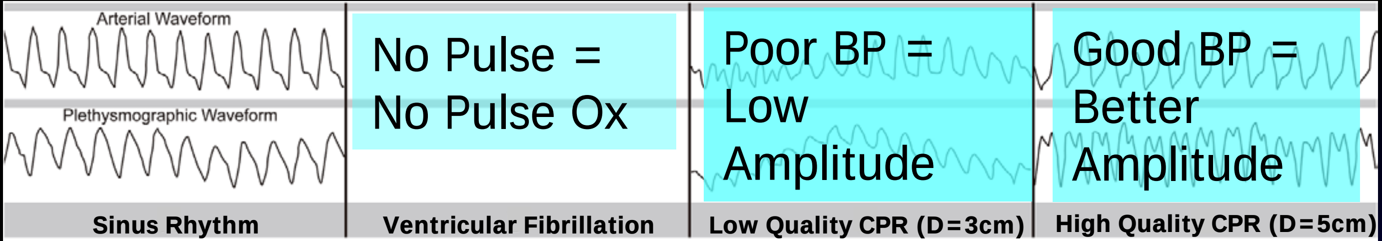
RESEARCH ARTICLE

PLOS | ONE

Pulse Oximetry: A Non-Invasive, Novel Marker for the Quality of Chest Compressions in Porcine Models of Cardiac Arrest

Jun Xu[1☯], Chen Li[2☯], Liangliang Zheng[3☯], Fei Han[4], Yan Li[1], Joseph Walline[5], Yangyang Fu[1], Dongqi Yao[1], Xiaocui Zhang[4], Hui Zhang[1], Huadong Zhu[1], Shubin Guo[1], Zhong Wang[6], Xuezhong Yu[1]*

PLOS ONE | DOI:10.1371/journal.pone.0139707 October 20, 2015

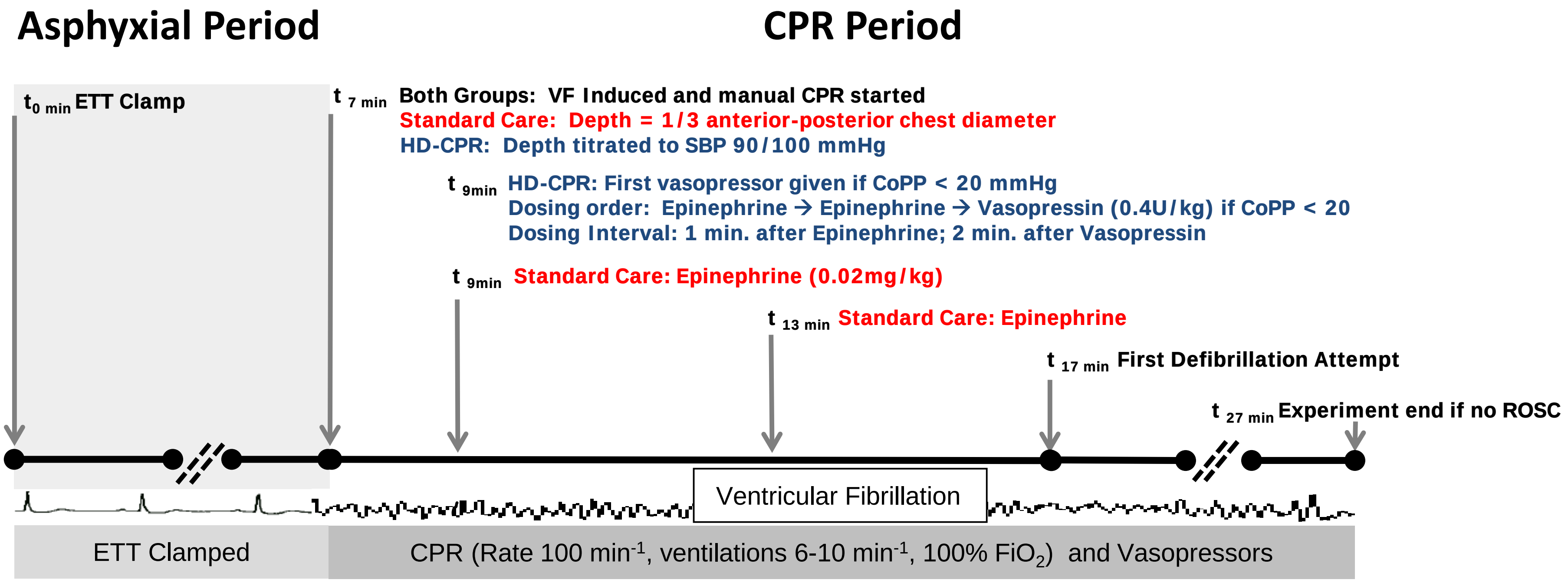


		Low Quality (3cm)	High Quality (5cm)	*t/U*	*P*
HR (bpm)	3min	104±6	104±5	0.251	0.803
	6min	103±3	103±3	0.245	0.808
	9min	103±3	103±2	0.532	0.599
	3min	12±4	19±4	-4.830	<0.001
$P_{ET}CO_2$ (mmHg)	6min	13±4	19±4	-3.948	<0.001
	9min	12±4	18±4	-4.690	<0.001
	3min	14.6±9.8	25.0±17.5	-2.146	0.040
	3min	14±10	21±5	-2.301	0.028
CPP (mmHg)	6min	15±10	21±5	-2.221	0.034
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3min	70±62	189±129	-3.317	0.003
Amp (PVA)	6min	71±63	194±132	-3.379	0.003
	9min	79±81	188±119	-3.081	0.005
	3min	2215±852	3191±556	-3.872	0.001
AUC (PVPG)	6min	2211±781	3193±517	-4.231	<0.001
	9min	2022±665	3067±522	-5.001	<0.001

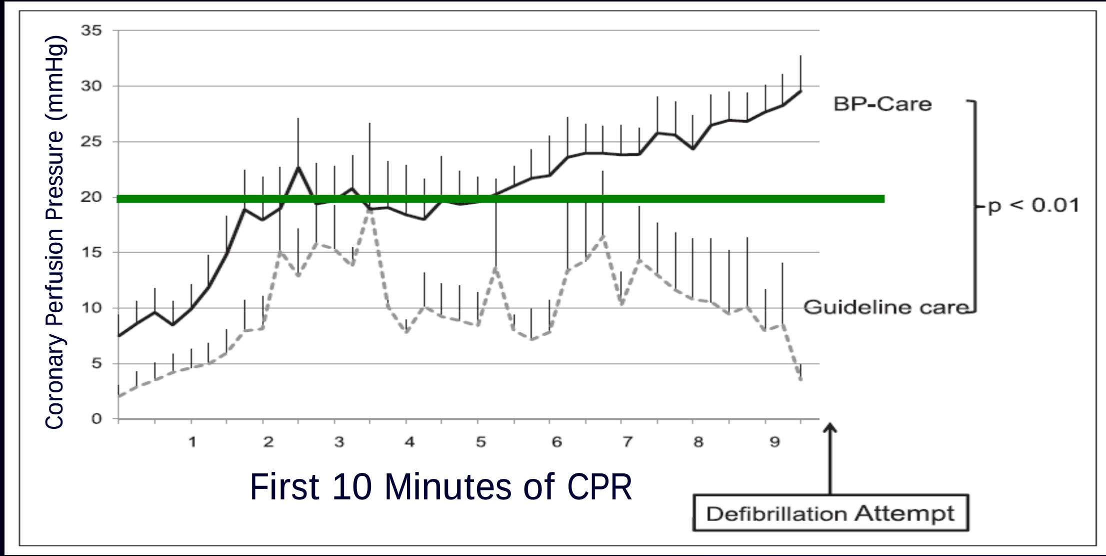
Can we alter our resuscitation technique to improve outcomes?

A translational perspective

Hemodynamic-Directed CPR (HD-CPR)



Asphyxia-Associated Cardiac Arrest



	Depth 51 (n=10)	CPP-20 (n=10)	p
Survival [n (%)]			
45 Minute ICU Survival	1 (10)	9 (90)	p = 0.001
24 Hour Survival	0 (0)	8 (80)	p = 0.001
Good Neurological Outcome	0 (0)	7 (70)	p = 0.003

Sutton, Resuscitation 2013; Friess, CCM 2013; Sutton, AJRCCM 2014; Naim, CCM 2016; Morgan, AJRCCM 2017; Morgan, Resuscitation 2017

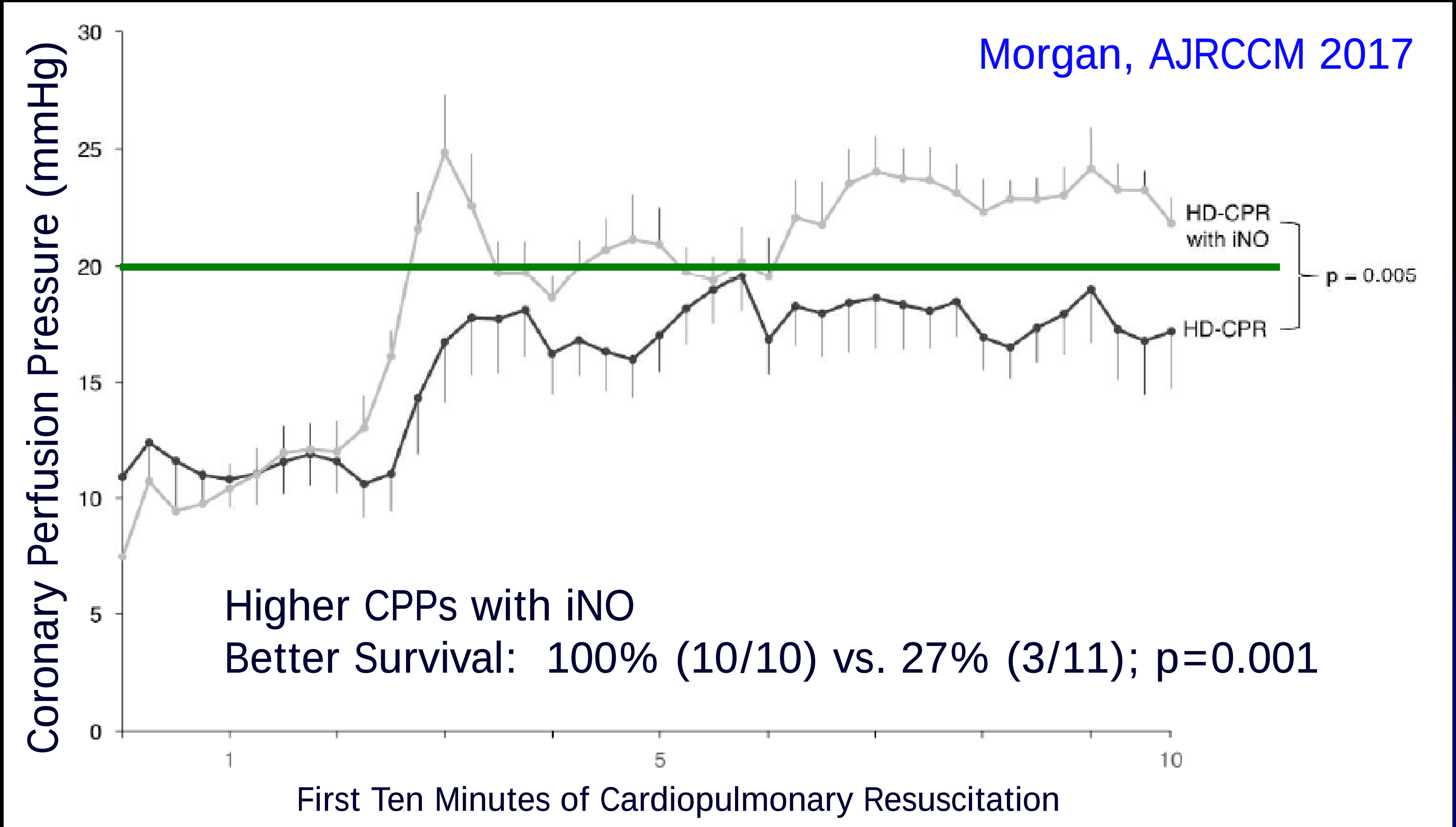
What's next?

Pediatric asphyxia model
Adult asphyxia model
Adult VF model

But what about a progressive shock state?

- LPS model
- The first 3 animals with HD-CPR died
- Pulmonary HTN key physiologic roadblock

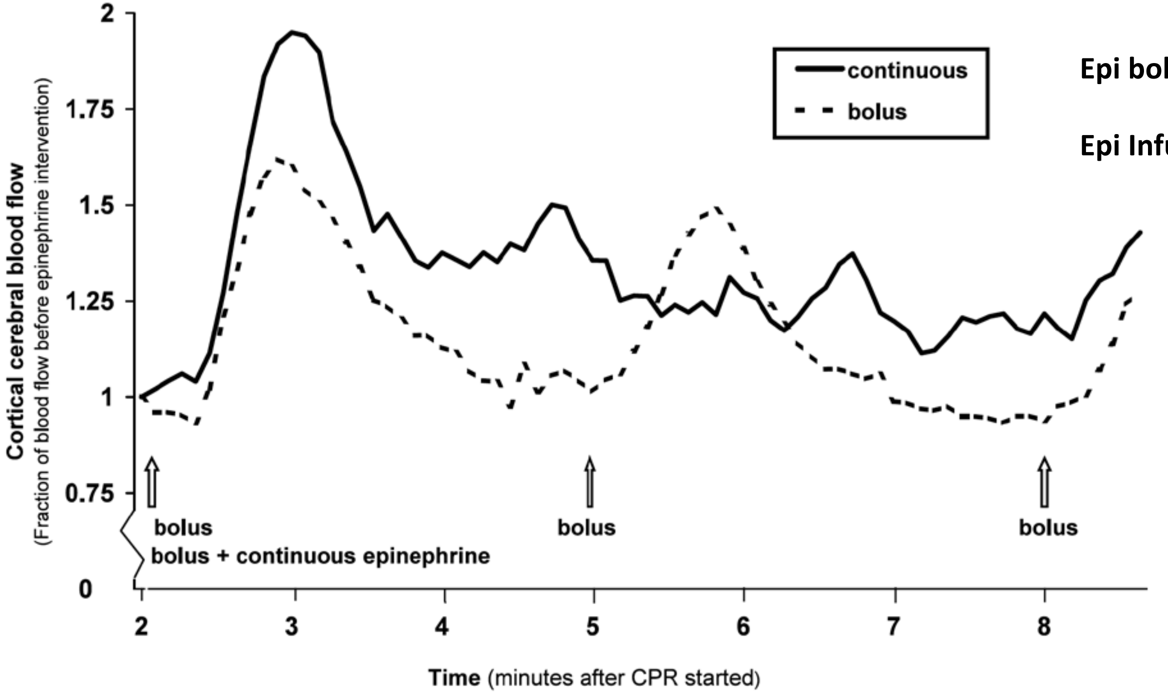
Shock Associated Cardiac Arrest



Bolus vs. Bolus + Continuous Epinephrine During CPR

N=24 animals
Laser Doppler CBF

Johansson Resuscitation 2003

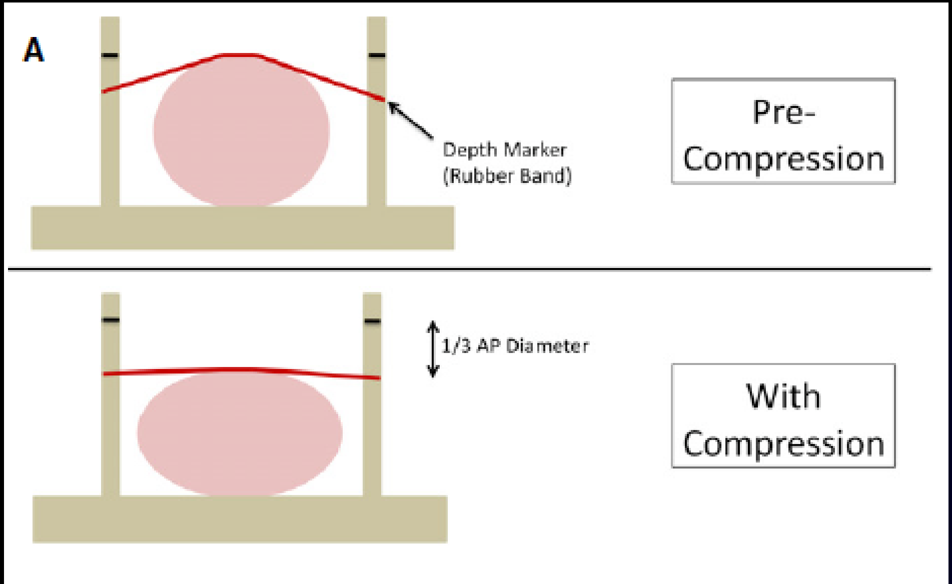


Epi bolus: 20 ug/kg

Epi Infusion: 10 ug/kg/min

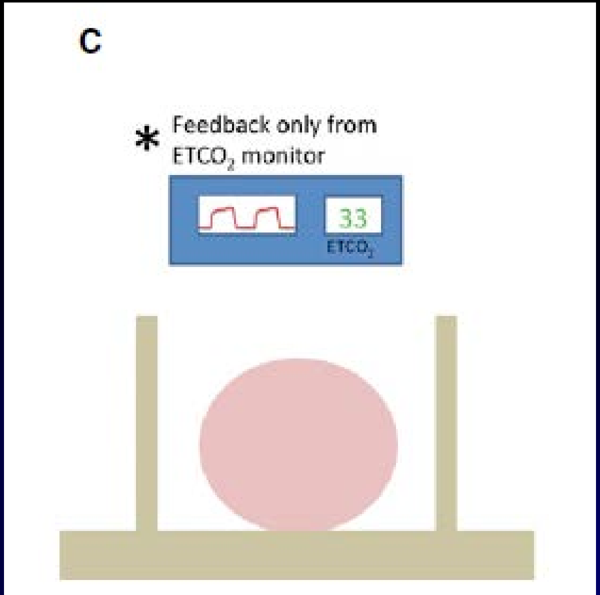
P=0.009

End Tidal CO_2 Guided Cardiopulmonary Resuscitation



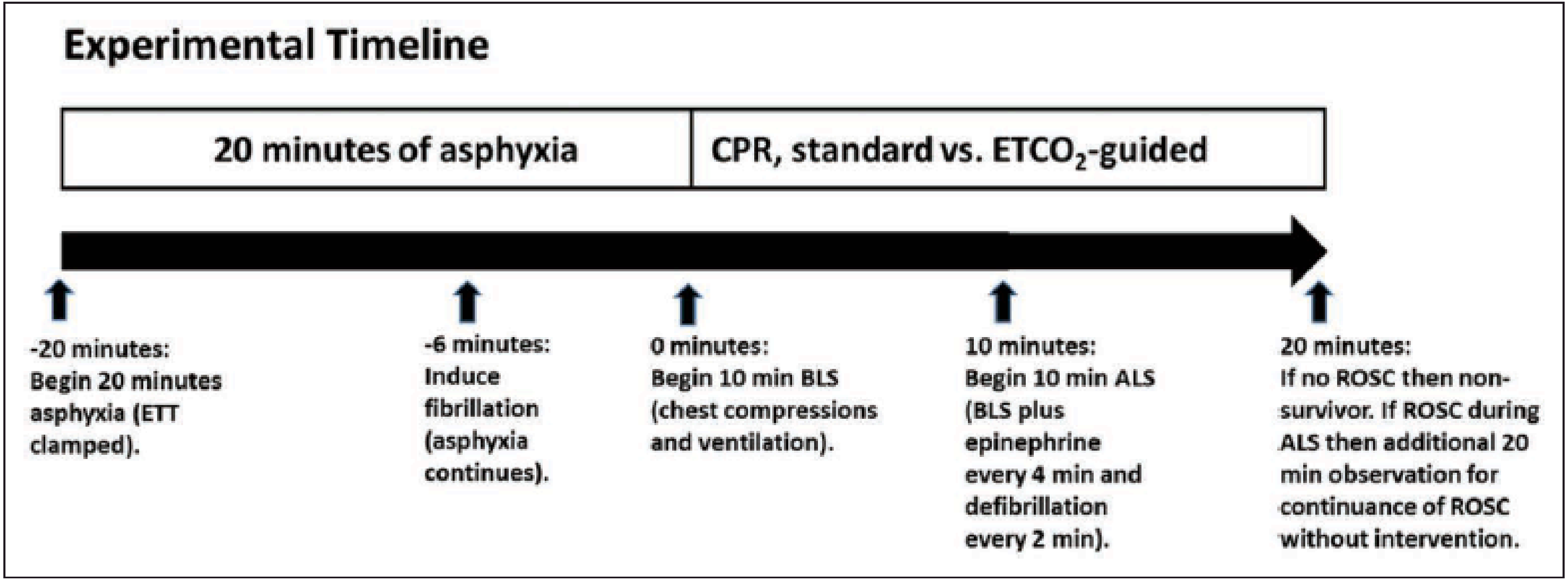
Feedback optimized

VS



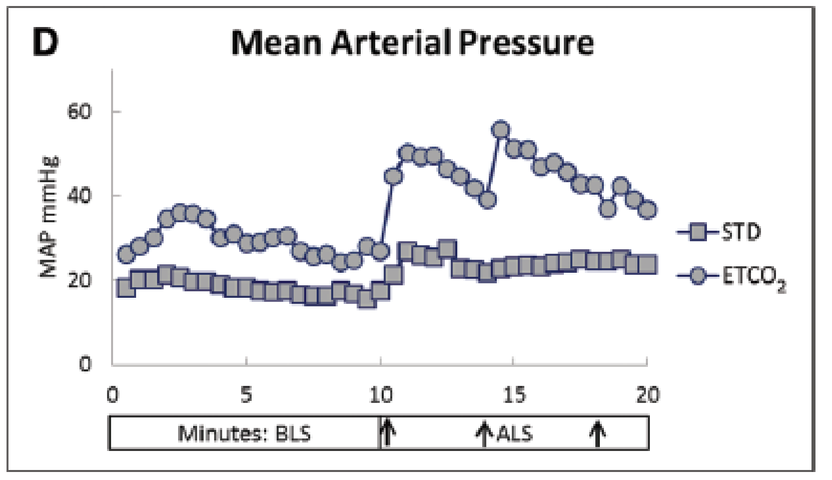
$ETCO_2$ Guided

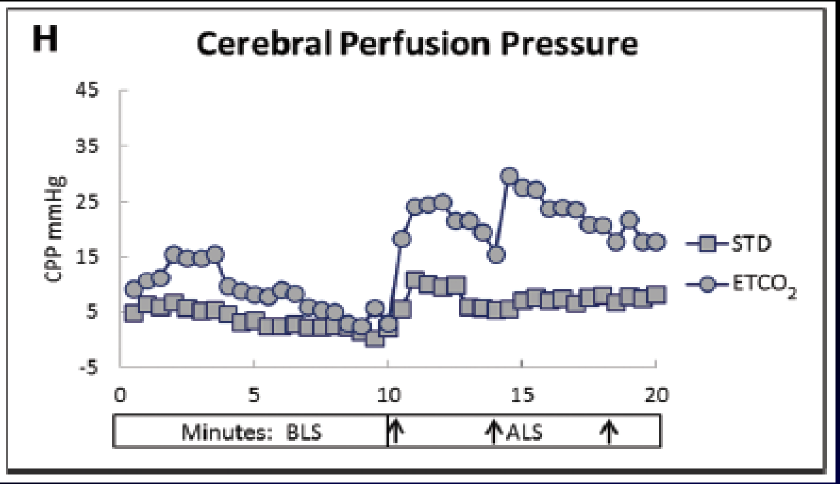
Hamrick, JAHA 2014; PCCM 2017



Hamrick, JAHA 2014; PCCM 2017

End Tidal CO_2 Guided CPR: Neonatal Asphyxial Arrest

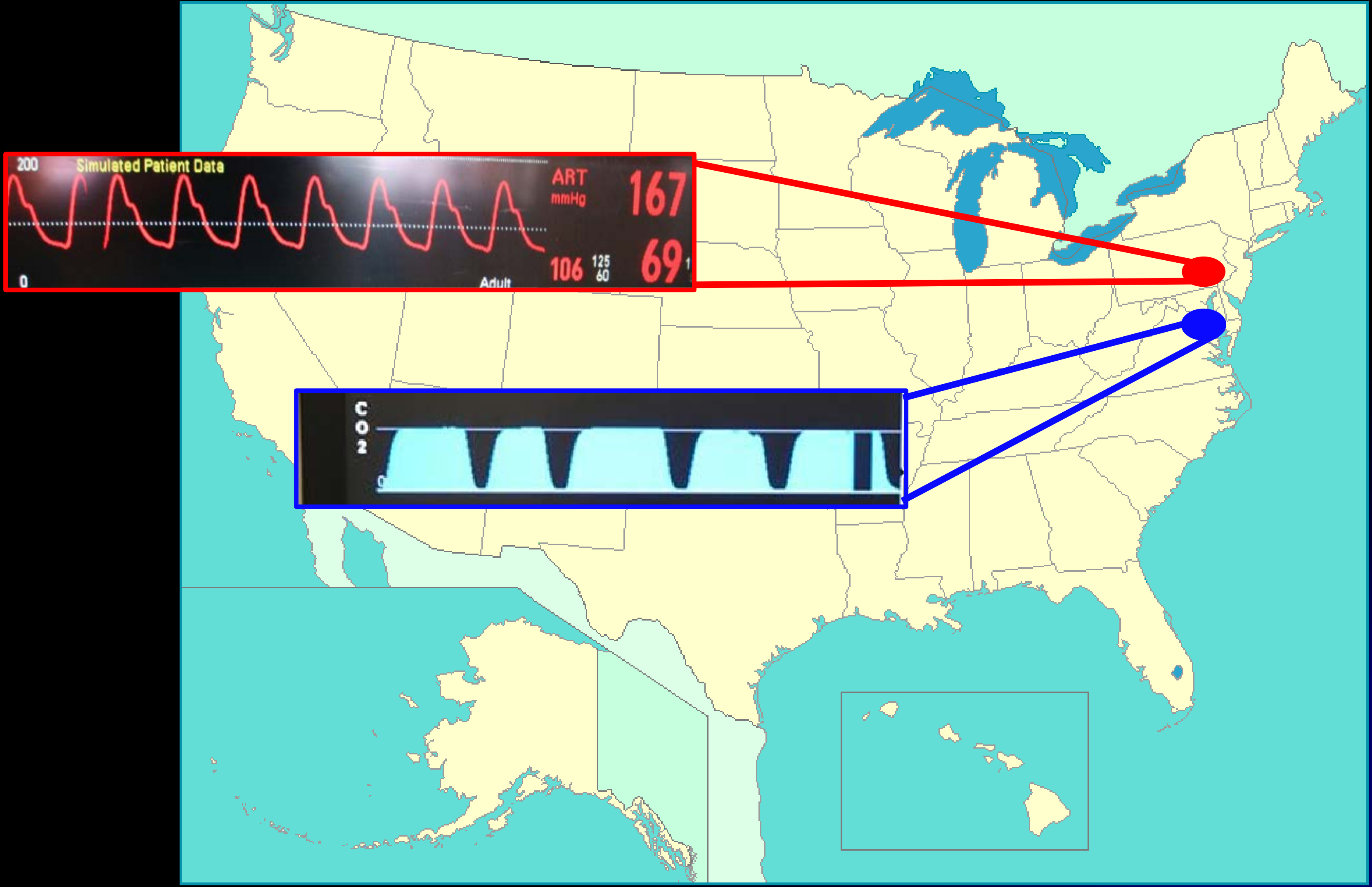




Variables	End-Tidal Co_2 Group	Standard Group	*p*
Outcome results			
Successful ROSC, *n* (%)	7/14 (50)	2/14 (14)	0.04

Hamrick, JAHA 2014; PCCM 2017

So if you had to pick...

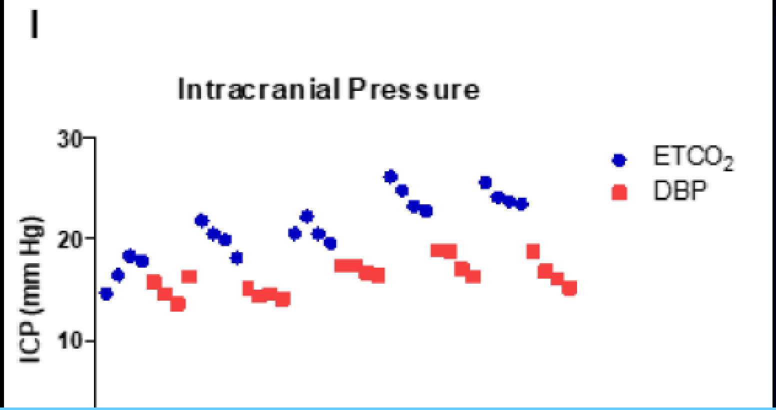

200
Simulated Patient Data
ART
mmHg
167
106
125
60
69
0
Adult
CO2
0

Pilot Study to Compare the Use of End-Tidal Carbon Dioxide–Guided and Diastolic Blood Pressure–Guided Chest Compression Delivery in a Swine Model of Neonatal Asphyxial Cardiac Arrest

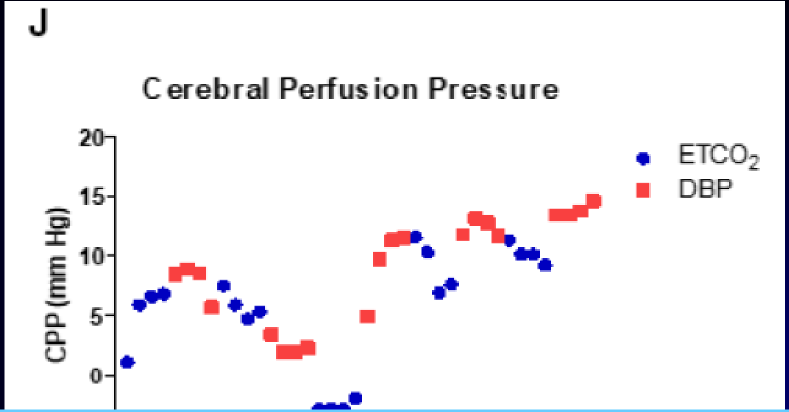
JAHA, 2018

Caitlin E. O'Brien, MD, MPH; Michael Reyes, BA; Polan T. Santos, MD; Sophia E. Heitmiller, MHS; Ewa Kulikowicz, MS; Sapna R. Kudchadkar, MD, PhD; Jennifer K. Lee, MD; Elizabeth A. Hunt, MD, MPH, PhD; Raymond C. Koehler, PhD; Donald H. Shaffner, MD

End-tidal



DBP



Method specific physiologic changes

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

ELSEVIER

EUROPEAN RESUSCITATION COUNCIL

Experimental paper

Morgan 2016

A quantitative comparison of physiologic indicators of cardiopulmonary resuscitation quality: Diastolic blood pressure versus end-tidal carbon dioxide☆

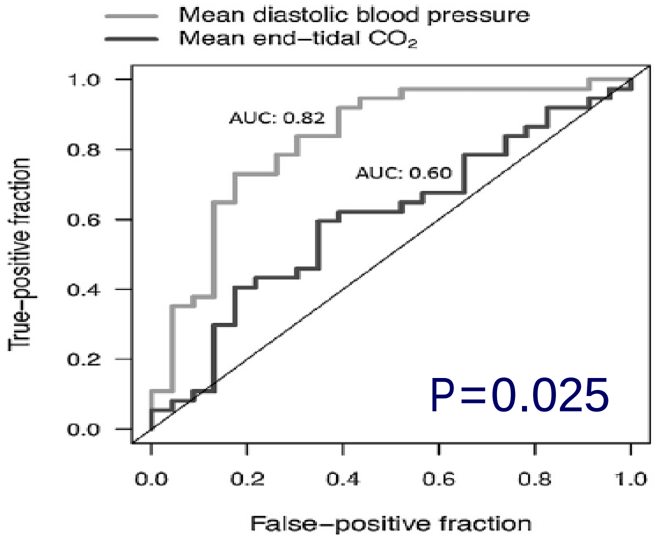
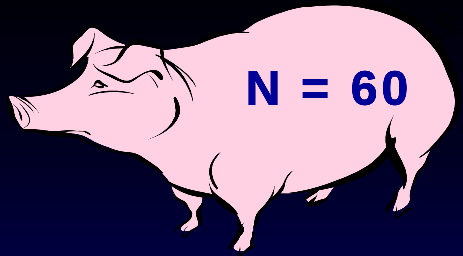


Fig. 3. Receiver operating characteristic curves evaluating the ability of diastolic blood Pressure and end-tidal carbon dioxide to discriminate between survivors and non-survivors. Area under the curve (AUC) of DBP: 0.82, 95% CI: (0.70, 0.93). AUC of $ETCO_2$: 0.60, 95% CI: (0.45, 0.74).



DBP performed better than $ETCO_2$

True across all models

- asphyxia
- VF

Optimal DBP target: ~34mmHg

The technique is not broadly implemented...

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Physiologic monitoring of CPR quality during adult cardiac arrest: A propensity-matched cohort study☆

Robert M. Sutton[a,*], Benjamin French[b], Peter A. Meaney[a], Alexis A. Topjian[a], Christopher S. Parshuram[c], Dana P. Edelson[d], Stephen Schexnayder[e], Benjamin S. Abella[f], Raina M. Merchant[f], Melania Bembea[g], Robert. A. Berg[a], Vinay M. Nadkarni[a], for the American Heart Association's Get With The Guidelines–Resuscitation Investigators

- 4% used $ETCO_2$
- 30% used diastolic pressure
- Event survival increased more than 20% when physiology was used

Clinical paper

Evaluation of out-of-hospital cardiac arrest using transesophageal echocardiography in the emergency department

Felipe Teran[a,b,*], *Anthony J. Dean*[a], *Claire Centeno*[b], *Nova L. Panebianco*[a], *Amy J. Zeidan*[c], *Wilma Chan*[a], *Benjamin S. Abella*[a,b]

RESUSCITATION 137 (2019) 140 – 147

EUROPEAN RESUSCITATION COUNCIL

MELAX**		LV, LA and RV chambers LV Outflow Tract Aortic root Mitral and Aortic Valves	Determination of area of maximal compression (AMC) during CPR

9 / 17 cases with AMC over LV outflow tract

TEE used to reposition to appropriate AMC

Disclaimer

The interpretation of the literature / opinions rendered by me do not necessarily reflect the official policy or position of the American Heart Association or its volunteers, the Children's Hospital of Philadelphia, the University of Pennsylvania, or anyone else for that matter.

Please direct complaints to Dr. Robert A. Berg, Division Chief, bergra@chop.edu

A Card for Your Pocket: 2030?

Minute 1

Ensure High Quality Chest Compressions

Evaluate Rhythm:

- If VF/pVT, prompt defibrillation
- If PEA, consider early echocardiogram (Box A)

Draw arterial blood gas (q6 min)

Consider physiologic monitor placement

Prepare for vasopressor, fluid, and inhaled nitric oxide administration

Minute 2-6

Assessment of Hemodynamic Goals

Consider reassessment every 1 minute

CVP during CC pauses

< 10

- Consider fluid bolus
- Consider ITD

> 20

Consider POCUS

Diastolic BP During CC

< Age specific target

- Epinephrine up to every 1 minute
- Consider epinephrine infusion (minute 5)
- Consider vasopressin rescue

Systolic BP During CC

< Age specific target

- Increase CC Depth / Rate
- Consider epinephrine
- Optimize CC Impulse with POCUS

Minute 6

Consider activation of E-CPR Protocol

Consider Ventilation Adjustment (Box B)

Details

High Quality CPR Mechanics

- Depth: > 1/3 AP Chest Depth
- Rate: 100-120/min
- Ensure full chest recoil
- Minimize interruptions

Diastolic BP Targets

≥ 25mmHg in infants

≥ 30mmHg in children > 1 year

Systolic BP Targets

≥ 60mmHg in infants

≥ 80mmHg in children > 1 year

Epinephrine

Bolus: 0.01 mg/kg

Infusion: 0.001 mg/kg/min

Vasopressin Rescue / Replacement

Consider 0.4 units/kg/dose:

- after 2nd epinephrine dose
- high probability of PHTN

Box A: POCUS

PEA:

- Treat pneumothoraces / effusions
- Sepsis / PHTN: Consider iNO 80ppm
- If high probability of PE, consider tPA

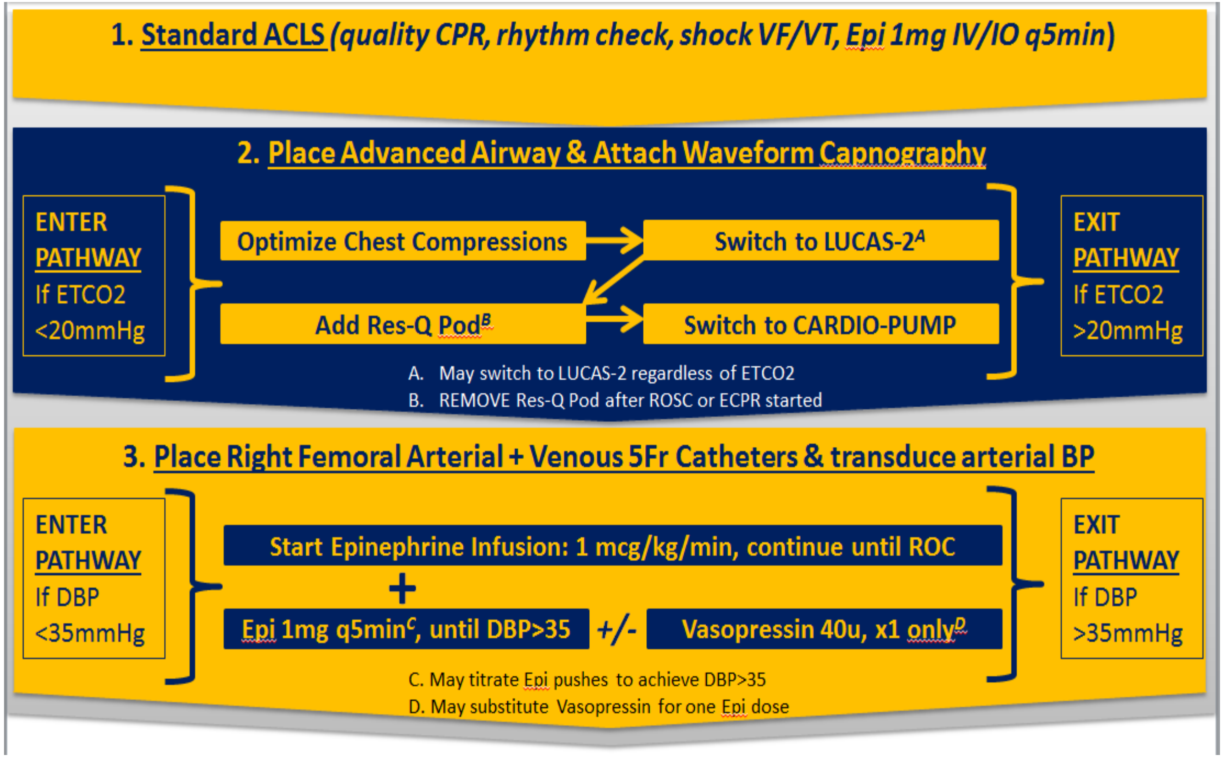
Box B: Ventilation

Respiratory etiology and BP at goal:

- Consider ventilation rate increase

Adult Goal-Directed CPR Algorithm

Univ. of Michigan Emergency Department



Conclusions

- Physiologic-directed CPR is not a new concept
- Decades of experimental evidence
- Targeting underlying pathophysiology is key
  - More than just BP or end tidal or regional saturation
- Human trials are needed to obtain the evidence necessary to support widespread implementation

It’s why we do what we do!

If not us, who?

THANK YOU

Personalizing Resuscitation with Physiologic-Directed CPR

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Chair: Resuscitation Committee at The Children's Hospital of Philadelphia

Medical Lead: Preventing Codes Outside the ICU

Co-Director: Resuscitation Science Research Program

Department of Anesthesiology and Critical Care Medicine

University of Pennsylvania School of Medicine

March 16th, 2019


Q
&
A

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