Controversies in Chest Compressions & Airway Management During CPR

Bob Berg

No Financial Conflicts of Interest

- Employment: University of Pennsylvania
- AHA Volunteer
  - **AHA GWTG-R & Systems of Care committees**
  - Past Chair, **GWTG-R** Committee
  - Past Chair, **BLS** Committee
  - Past Chair, **PALS** Committee
  - **2015 ILCOR BLS** Evidence Evaluation
  - **2015 AHA Systems of Care Guidelines**
- Grants: **NICHD, NHLBI**
- **Intellectual Conflicts of Interest**

  >25 yrs of Cardiac Arrest & CPR Research

Introduction

Chest compressions

- **Hands-only CPR**
- **“Physiologic-directed/patient-centered CPR”**

Tracheal Intubation during in-hospital CPR

“Closed-chest massage”

Kouwenhoven, Jude, Knickerbocker, JAMA 1960

- While studying defibrillation in small dogs
  - Ao pressure increased with paddles
  - Adequate circulation for 30 min of CC-only CPR
- 20 patients: asphyxia in peri-op setting
  - 20/20 survived the cardiac arrest
  - 14/20 long-term survivors

Arterial Blood Pressure during CPR

Jude, JAMA 1961

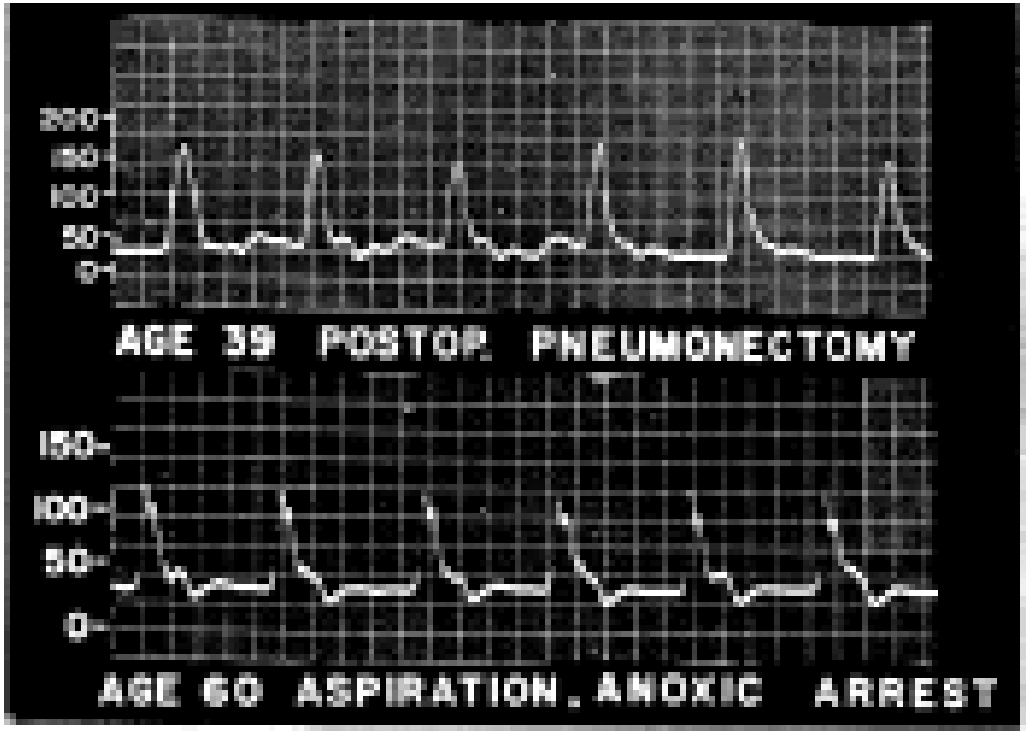
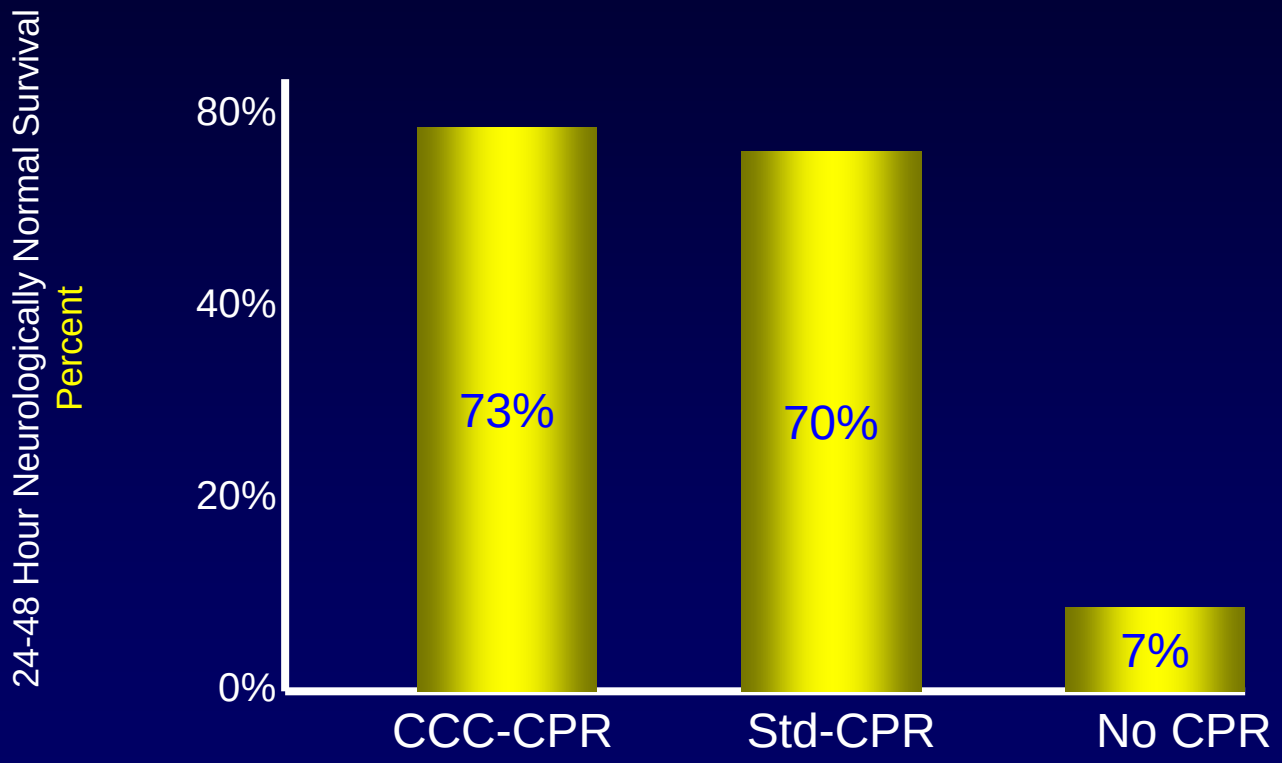


Fig. 3.—Examples of arterial blood pressure developed

CCC-CPR vs “Standard CPR” for VF

24-48 Hr Survival in 169 swine in 6 studies



University of Arizona Sarver Heart Center CPR Research Group

Why isn't Rescue Breathing necessary initially for VF?

- Excellent SaO_2 at time of VF

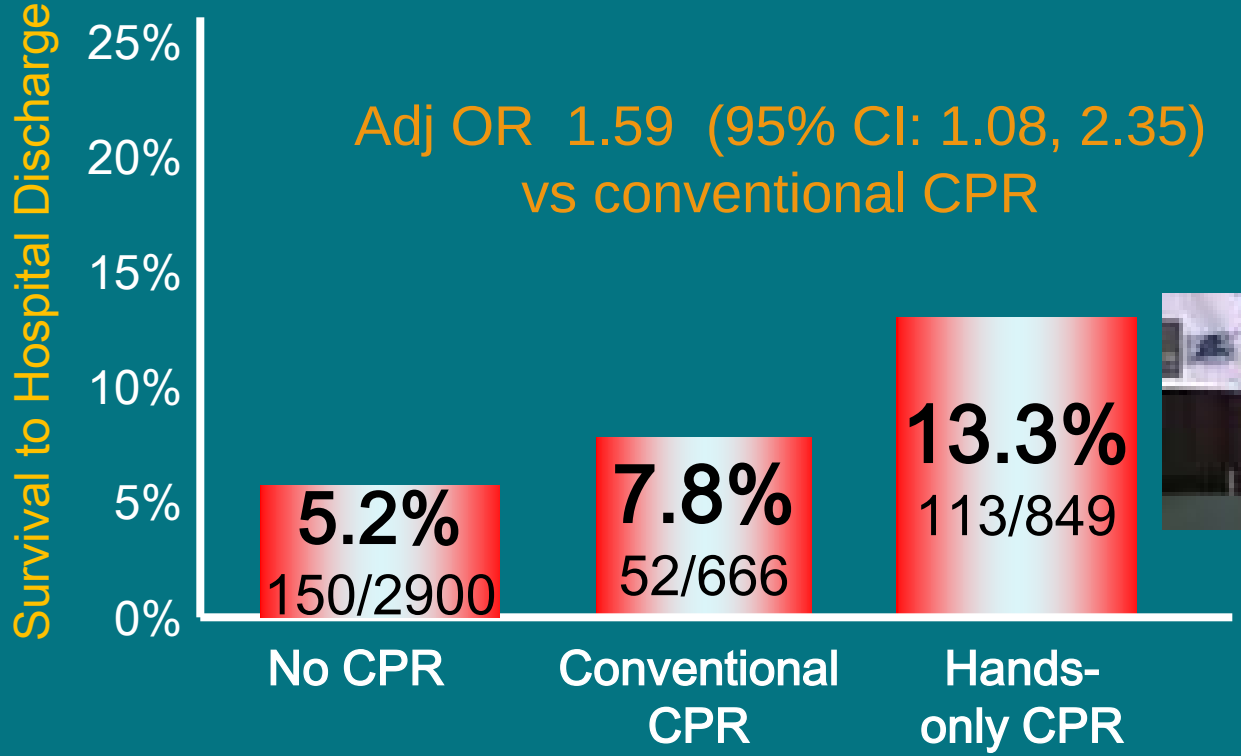
Rescue breathing is life-saving for asphyxia cardiac arrests

Clark *AEM* 1992 Bang Resus 2003 Bobrow *Circ* 2008

- Compression-induced ventilation

American Heart Association. | American Stroke Association.
Learn and Live.

Survival by Layperson Bystander CPR Type



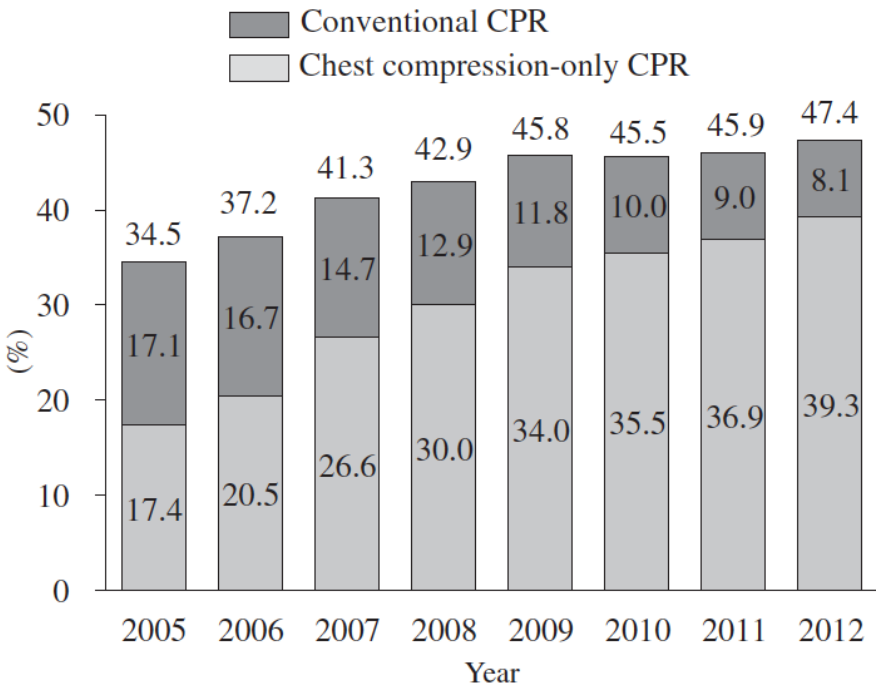
Bobrow, Spaite, Berg et al. JAMA 2010

Dissemination of CC-only CPR and Survival after adult OHCA

816,835 OHCAs

No CPR	57.1%
CC-only CPR	**30.6%**
Conventional CPR	12.3%

Iwami, Circulation 2015



Dissemination of CC-only CPR and Survival after adult OHCA

	CC-CPR (n=249,970)	Conventional CPR (n=100,469)	No CPR (n=465,946)	P
Prehospital ROSC	15818 (6.3)	7982 (7.9)	24163 (5.2)	<0.001
1-month survival	10685 (4.3)	5717 (5.7)	16636 (3.6)	<0.001
CPC 1 or 2	4846 (1.9)	2690 (2.7)	5762 (1.2)	<0.001

Iwami, Circulation 2015

Dissemination of CC-only CPR and Survival after adult OHCA

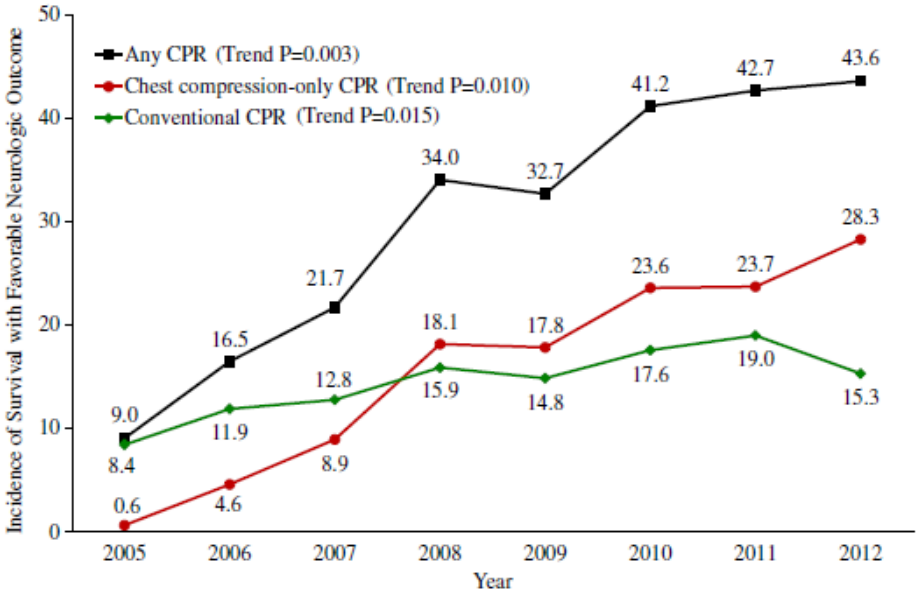
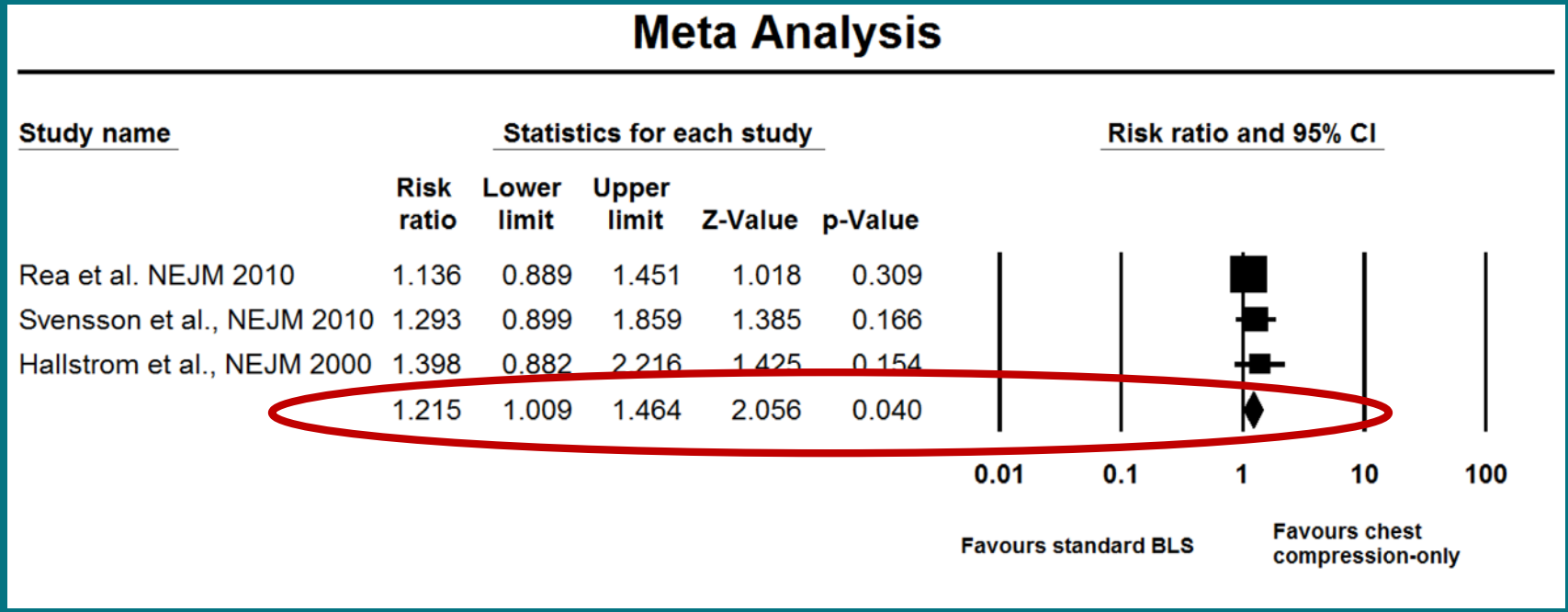


Figure 3. Trends in the incidence of survival with favorable neurological outcome per 10 million population, attributed to the type of bystander-initiated cardiopulmonary resuscitation (CPR). The trends were tested with Poisson regression models.

Iwami, Circulation 2015

Dispatcher-assisted CPR RCTs



Hupfl, Lancet 2010

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®

Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital: A Consensus Statement From the American Heart Association

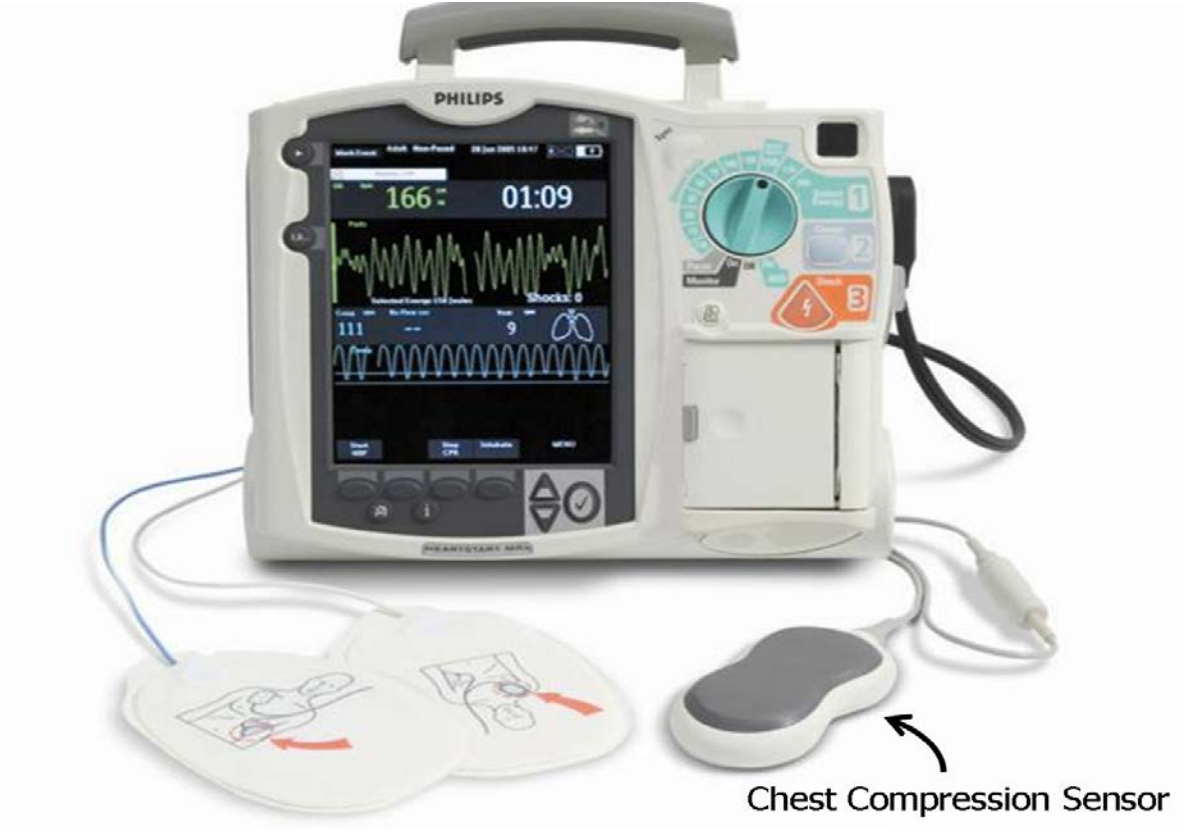
Peter A. Meaney, Bentley J. Bobrow, Mary E. Mancini, Jim Christenson, Allan R. de Caen, Farhan Bhanji, Benjamin S. Abella, Monica E. Kleinman, Dana P. Edelson, Robert A. Berg, Tom P. Aufderheide, Venu Menon and Marion Leary

November 2013

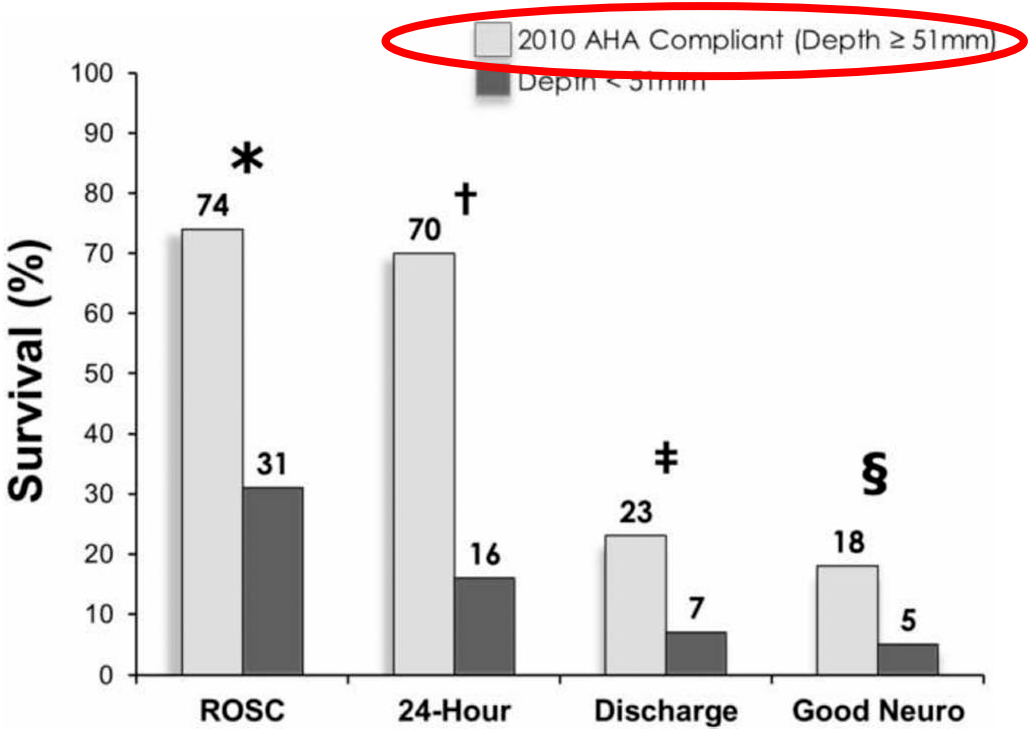
"High quality CPR is the primary component influencing survival"

"Monitor CPR," but what targets?

Measure CC Rate, Depth, and Leaning



CPR QUALITY MAKES A DIFFERENCE



Sutton, *Resuscitation 2014*

Do we have the right CPR targets to monitor?

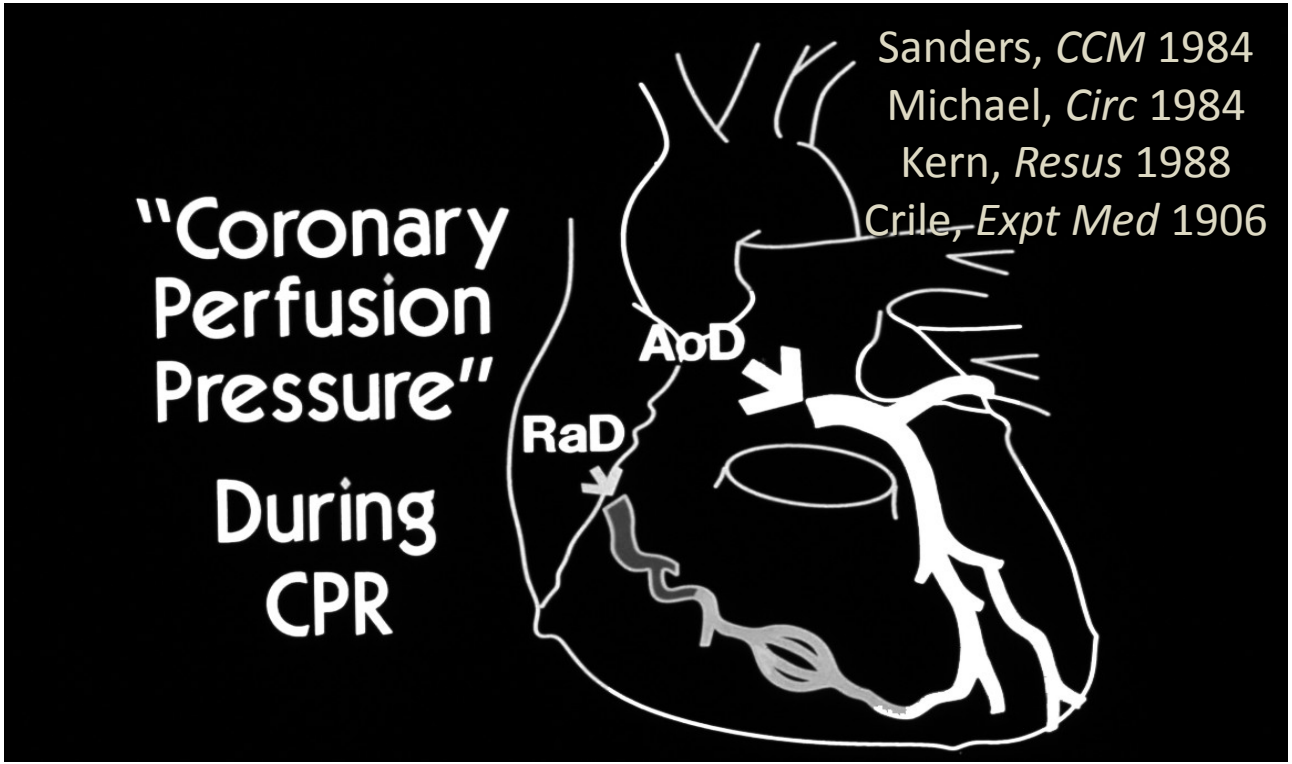
Rescuer-centric goals (2 inches/5 cm)

versus

Patient-centric hemodynamic goals

Coronary Perfusion Pressure

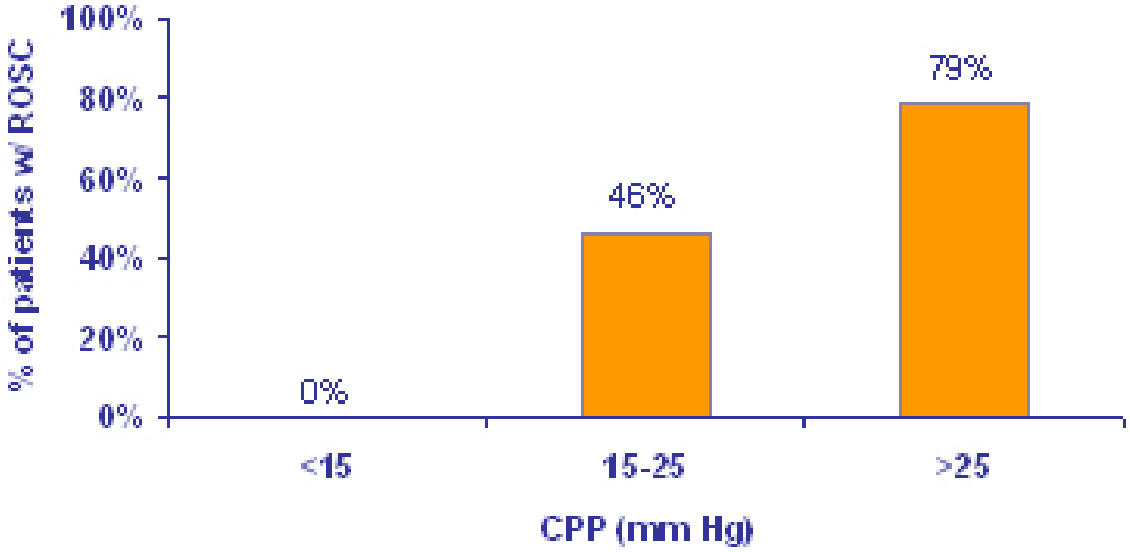
Critically Important for Successful CPR



CoPP >20 mmHg; AoD >30 mmHg

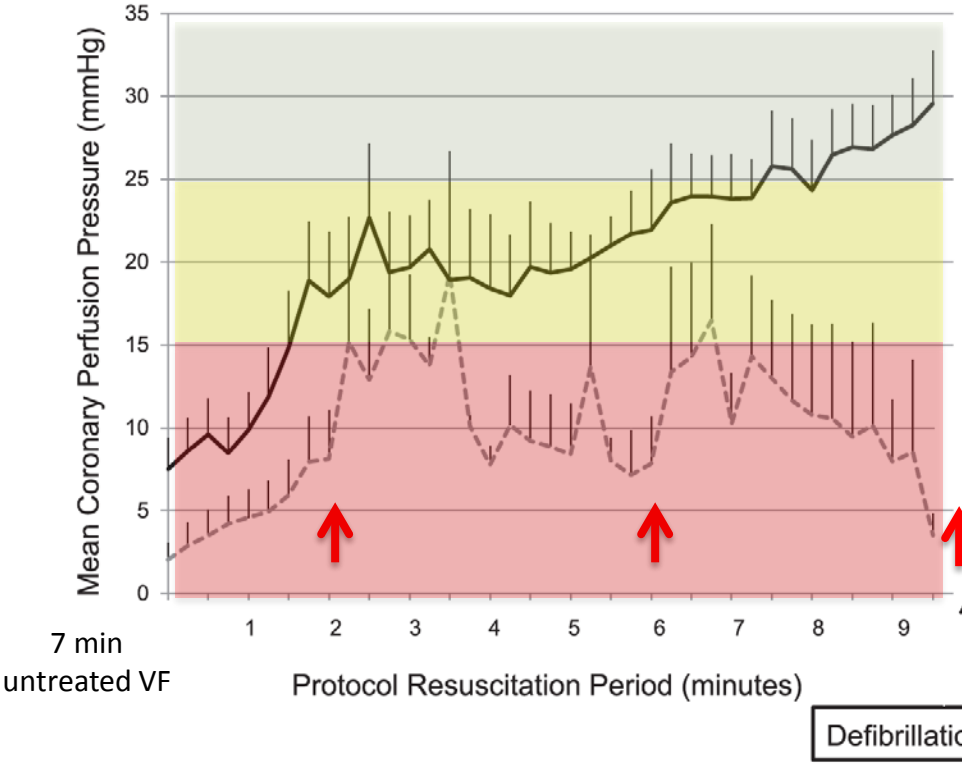
Coronary Perfusion Pressure during CPR

Adult OHCA



Paradis, JAMA 1990

Blood Pressure Guided CPR Improve Outcomes In Swine Cardiac Arrest Model



BP-Guided Care

CC depth titrated to SBP > 100 mmHg

If CPP < 20 mmHg, Epi 0.02 mg/kg qmin prn x 2, then vasopressin 0.4 U/kg. Repeat sequence after 2 min prn

5/8 (63%) favorable neurologic outcome

Standard Guideline Care (provider-centric)

Standard CC depth

Epi 0.02 mg/kg every 4 minute

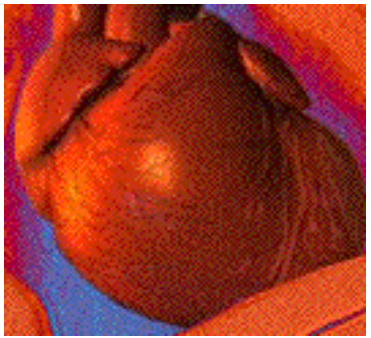
0/8 (0%) favorable neurologic outcome

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

PICqCPR

CPCCRN

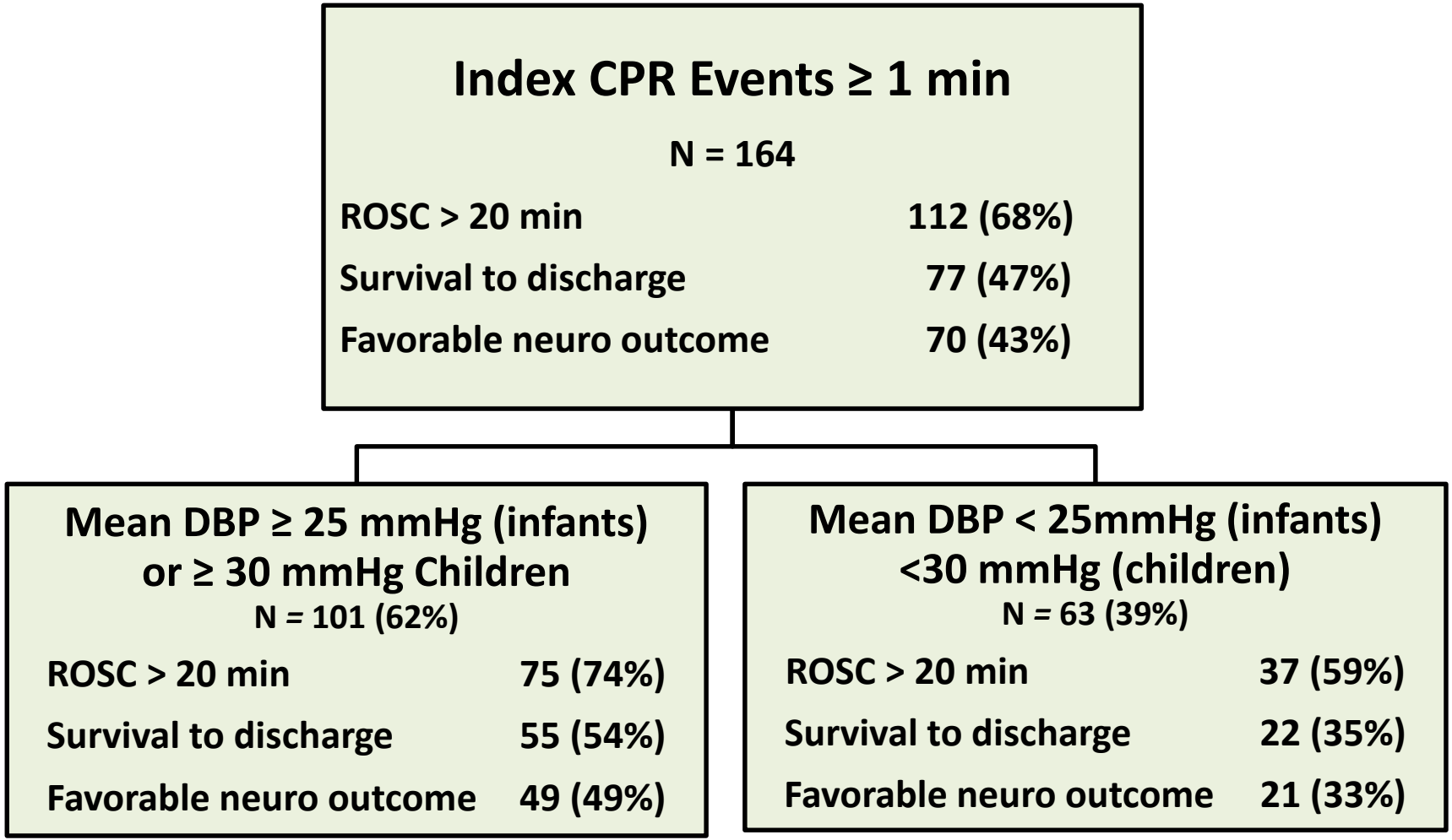
NICHD
Collaborative Pediatric Critical Care Research Network



Relationship of Arterial DBP (from start of CPR until up to 10 minutes) with Survival Outcomes

Berg, Sutton, Nadkarni & CPCCRN investigators

PAS Abstract 2017


Index CPR Events ≥ 1 min
N = 164
ROSC > 20 min 112 (68%)
Survival to discharge 77 (47%)
Favorable neuro outcome 70 (43%)
Mean DBP ≥ 25 mmHg (infants) or ≥ 30 mmHg Children
N = 101 (62%)
ROSC > 20 min 75 (74%)
Survival to discharge 55 (54%)
Favorable neuro outcome 49 (49%)
Mean DBP < 25mmHg (infants) <30 mmHg (children)
N = 63 (39%)
ROSC > 20 min 37 (59%)
Survival to discharge 22 (35%)
Favorable neuro outcome 21 (33%)

Association of mean DBP ≥25/30mmHg with Outcomes (N=163)

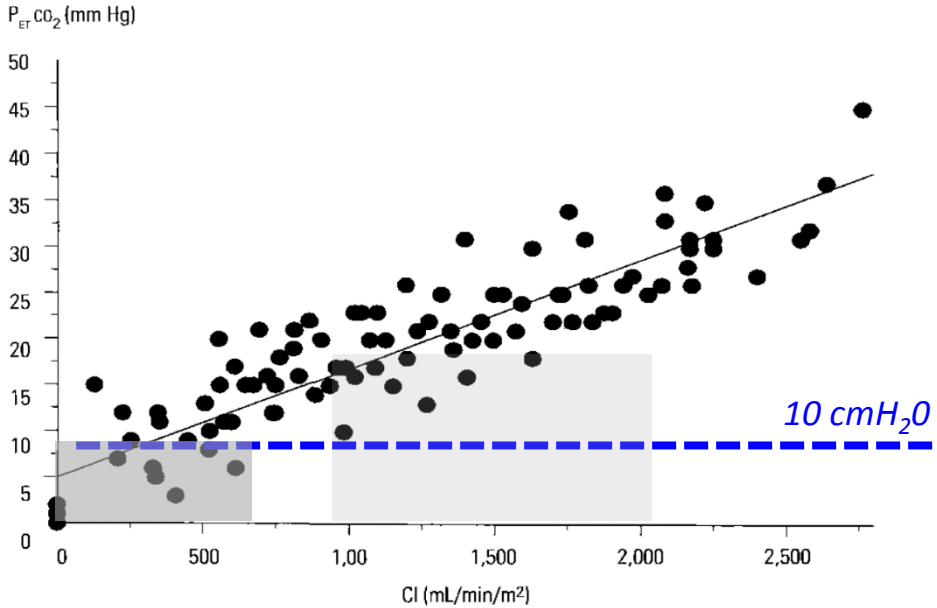
	aRR (95%CI)	P-value
ROSC	1.2 (1.0, 1.6)	0.07
Surv to d/c	**1.7 (1.2, 2.6)**	**0.003**
Survive with Favorable Neuro	**1.6 (1.1, 2.5)**	**0.01**

Waveform Capnography During CPR

B.

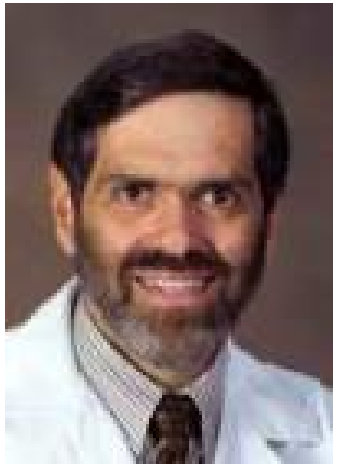
Capnography to monitor effectiveness of resuscitation efforts. This second capnography tracing displays the P_{ETCO_2} in mm Hg on the vertical axis over time. This patient is intubated and receiving CPR. Note that the ventilation rate is approximately 8 to 10 breaths per minute. Chest compressions are given continuously at a rate of slightly faster than 100/min but are not visible with this tracing. The initial P_{ETCO_2} is less than 12.5 mm Hg during the first minute, indicating very low blood flow. The P_{ETCO_2} increases to between 12.5 and 25 mm Hg during the second and third minutes, consistent with the increase in blood flow with ongoing resuscitation. Return of spontaneous circulation (ROSC) occurs during the fourth minute. ROSC is recognized by the abrupt increase in the P_{ETCO_2} (visible just after the fourth vertical line) to over 40 mm Hg, which is consistent with a substantial improvement in blood flow.

End-Tidal CO_2 is Proportional to Cardiac Output During Swine CPR



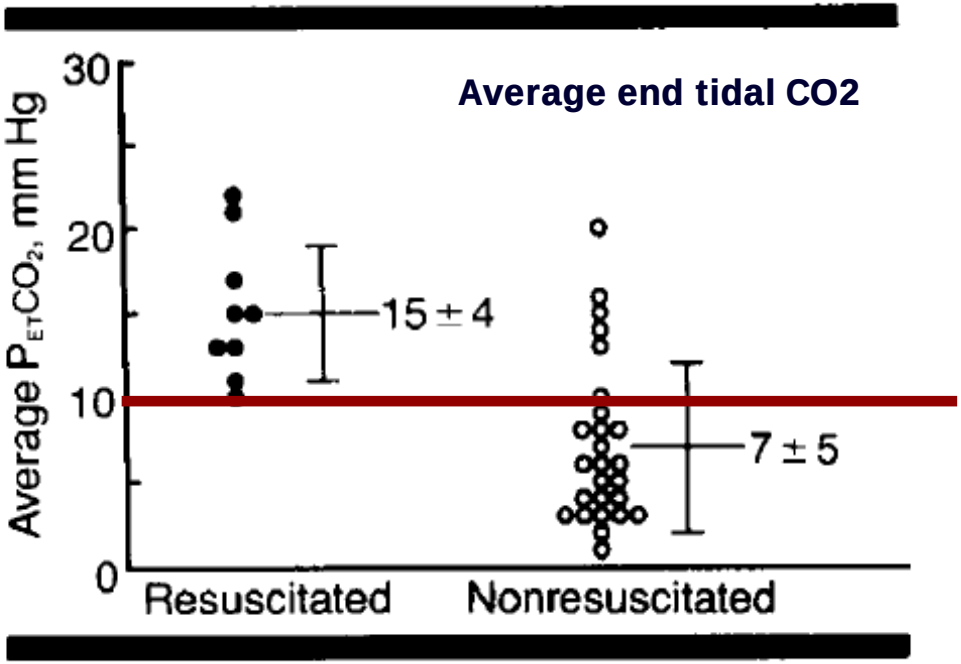
Idris, Ann Emerg Med 1994

Normal Cardiac Index 2.6-4.2 ml/min/m^2



ETCO2 in adult OHCA

Sanders, JAMA 1989



End-Tidal CO_2 Prognostication during CPR

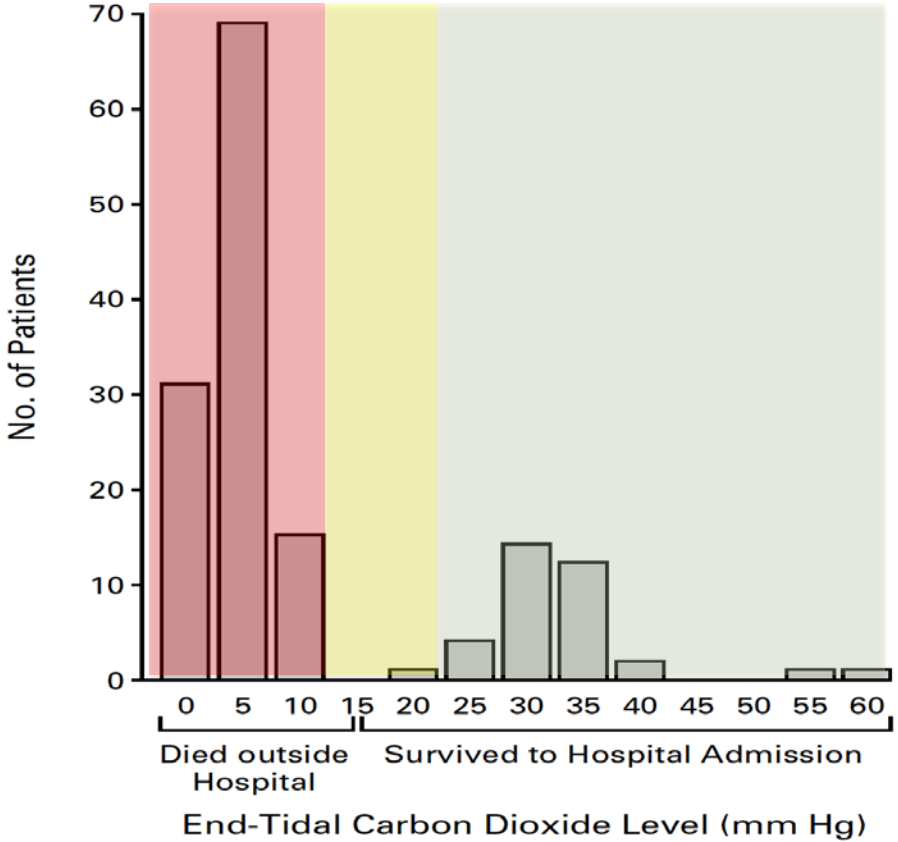


TABLE 1. END-TIDAL CARBON DIOXIDE VALUES IN PATIENTS WHO SURVIVED TO HOSPITAL ADMISSION AND IN THOSE WHO DID NOT.

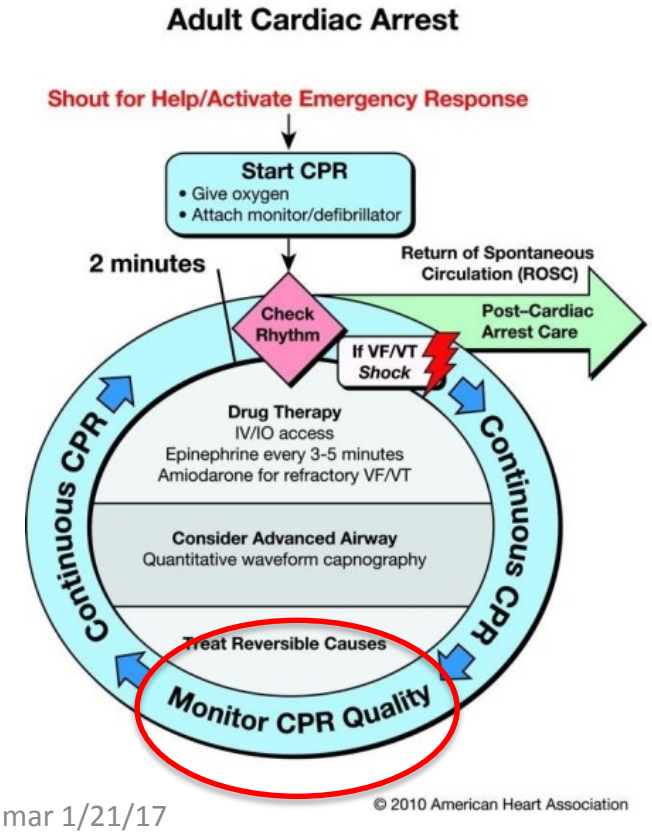
VARIABLE	NONSURVIVORS (N = 115)	SURVIVORS (N = 35)	P VALUE*
	mean ±SD (range)		
Age (yr)	68.0±13.8 (31–95)	71.5±13.0 (27–90)	0.19
End-tidal carbon dioxide (mm Hg)†			
Initial	12.3±6.9 (3–50)	13.2±4.6 (5–22)	0.93
Final	4.4±2.9 (0–10)	32.8±7.4 (18–58)	<0.001

*P values were calculated with the Wilcoxon rank–sum statistic.

†Initial end-tidal carbon dioxide levels were determined immediately upon intubation. Final end-tidal carbon dioxide levels were determined after 20 minutes of advanced cardiac life support.

Levine NEJM 1998

Goal-Directed CPR?



ACLS 2015 Focused Update

Although no clinical study has examined whether titrating resuscitative efforts to physiologic parameters during CPR improves outcome, it may be reasonable to use physiologic parameters (quantitative waveform capnography, arterial diastolic pressure) when feasible to monitor and optimize CPR quality, guide vasopressor therapy, and detect ROSC. (Class IIb, LOE C-EO)

Potential CPR Physiologic Goals

Parameter	Futility	Goal	References
Coronary Perfusion Pressure	**<15 mmHg**	**>25 mmHg**	Paradis 1990 Kern 1988
Arterial Relaxation Pressure	**<20 mmHg**	**>30 mmHg**	Paradis 1990 Berg abstr 2017
End-Tidal CO_2 ($PetCO_2$)	**<10 mmHg**	**>20 mmHg**	Levine 1998

Modified from Neumar 1/21/17

Tracheal Intubation during Pediatric CPR

Hypothesis: "Tracheal intubation during cardiac arrest would be associated with improved outcome"

2294 time-dependent propensity matched IHCAs

Survival to Hospital Discharge

36% TI vs 41% not TI during CPR

aRR 0.89 (95%CI 0.81-0.99), P=0.03

Mechanism: ?interruptions, CPR quality, bag-mask often adequate?

Message: TI during CPR is high risk

Andersen, JAMA 2016

Tracheal Intubation during Adult CPR

86,628 time-dependent propensity matched IHCAs

Survival to Hospital Discharge

16.3% TI vs 19.4% not TI

aRR 0.84 (95%CI 0.81-0.87), P<0.001

Favorable Neuro (CPC 1 or 2): aRR 0.97 (95%CI 0.75-0.81)

Although the study design does not eliminate potential for confounding, these findings do not support early tracheal intubation for in-hospital cardiac arrest

Andersen, JAMA 2016

Conclusion

Chest compressions

- **Hands-only CPR can be life-saving**
- **“Physiologic-directed/patient-centered CPR” is the way of the future**

Tracheal Intubation during CPR is a high risk intervention