Science Behind CPR Update from 2010

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FRAMING THE DISCUSSION

NO ONE SURVIVES CARDIAC ARREST, EXCEPT ON TV

Conflicts of Interest

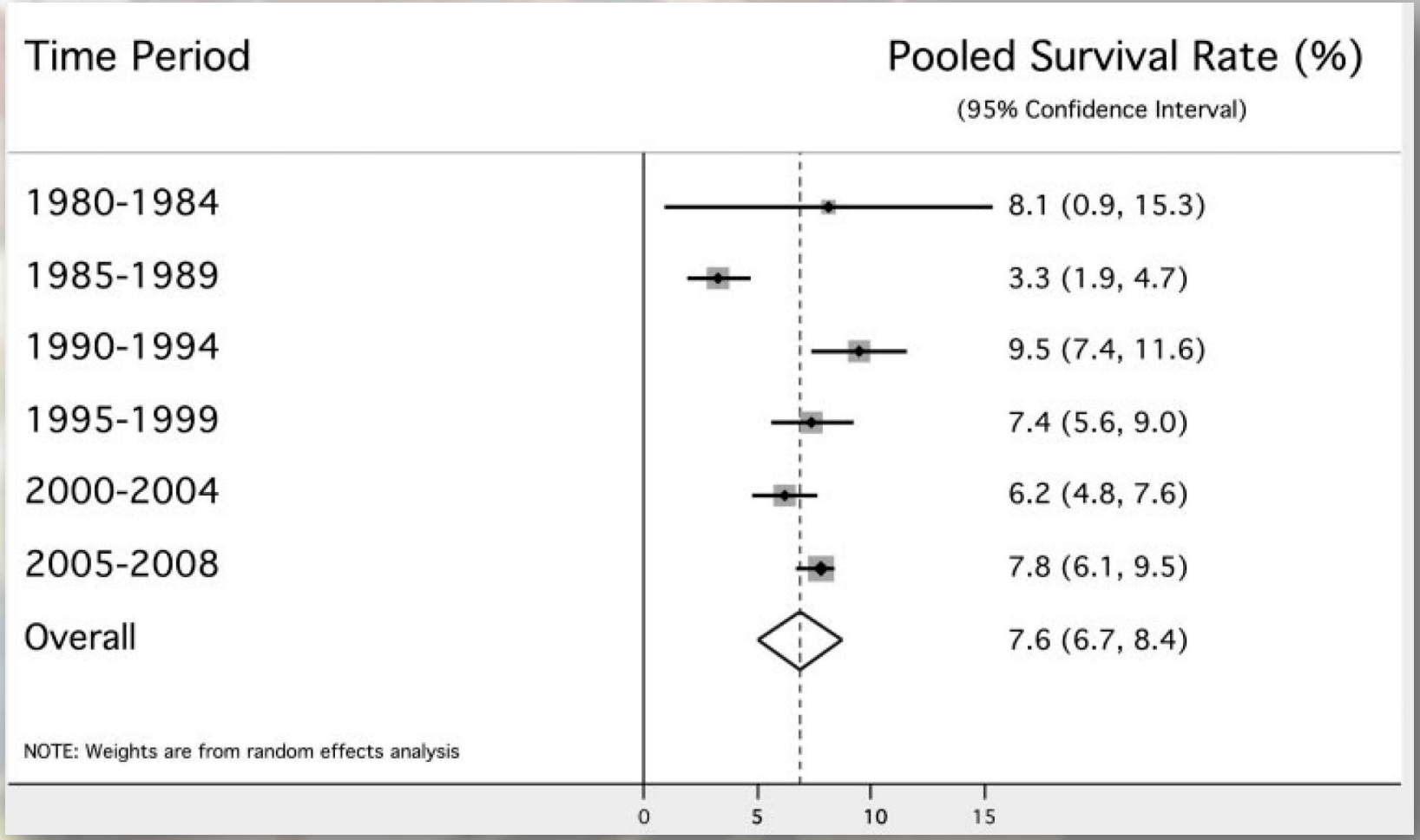
- Sadly, I have no financial or industrial conflicts of interest to disclose.
- Off label discussion: Induced Hypothermia

CPR

EASY TO BE PESSIMISTIC

OHCA survival to hospital discharge by 5-year time periods n = 141,581

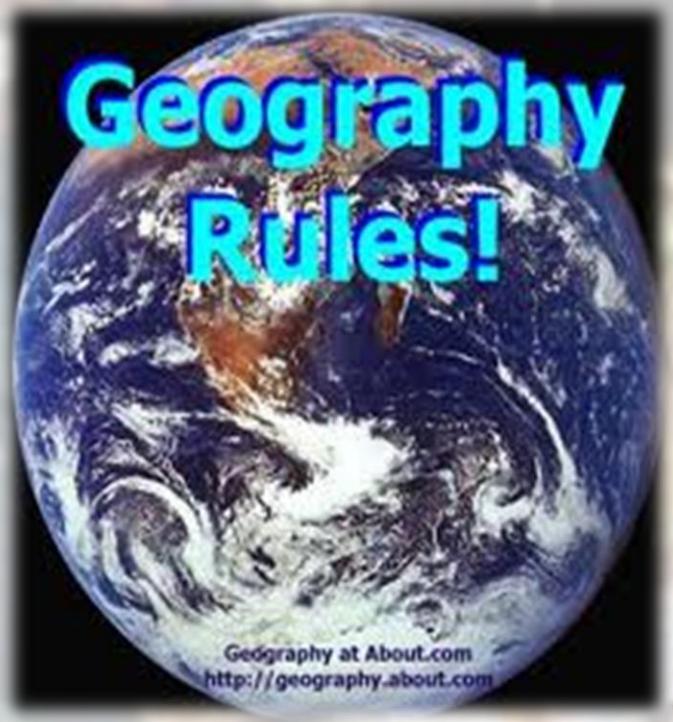
Overall 7.6%

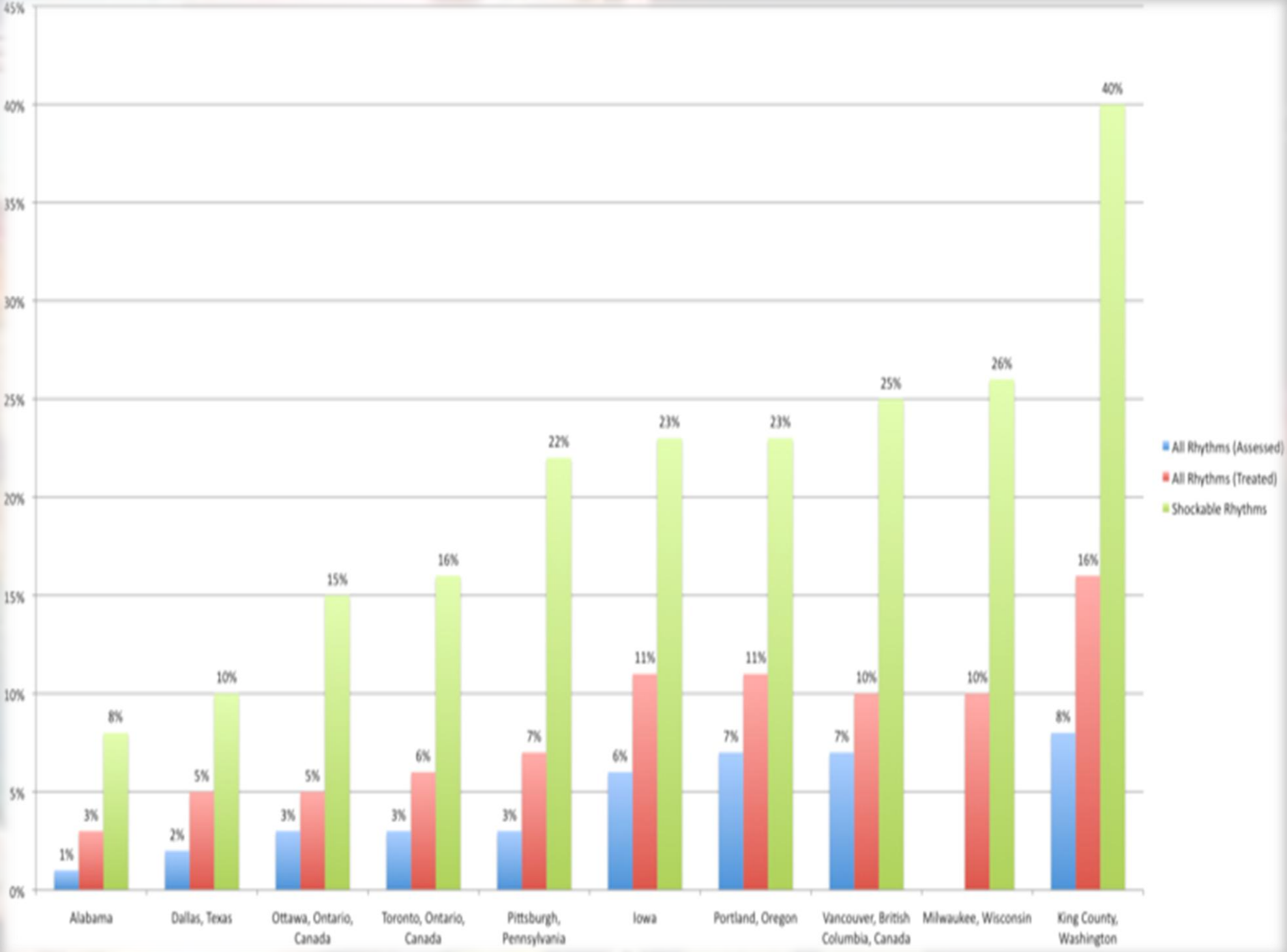


Circ Cardiovasc Qual Outcomes. 2010;3:63-81

Geography

WHAT GIVES YOU THE BEST CHANCE OF SURVIVAL?


Geography
Rules!
Geography at About.com
http://geography.about.com


45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
1%
3%
8%
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5%
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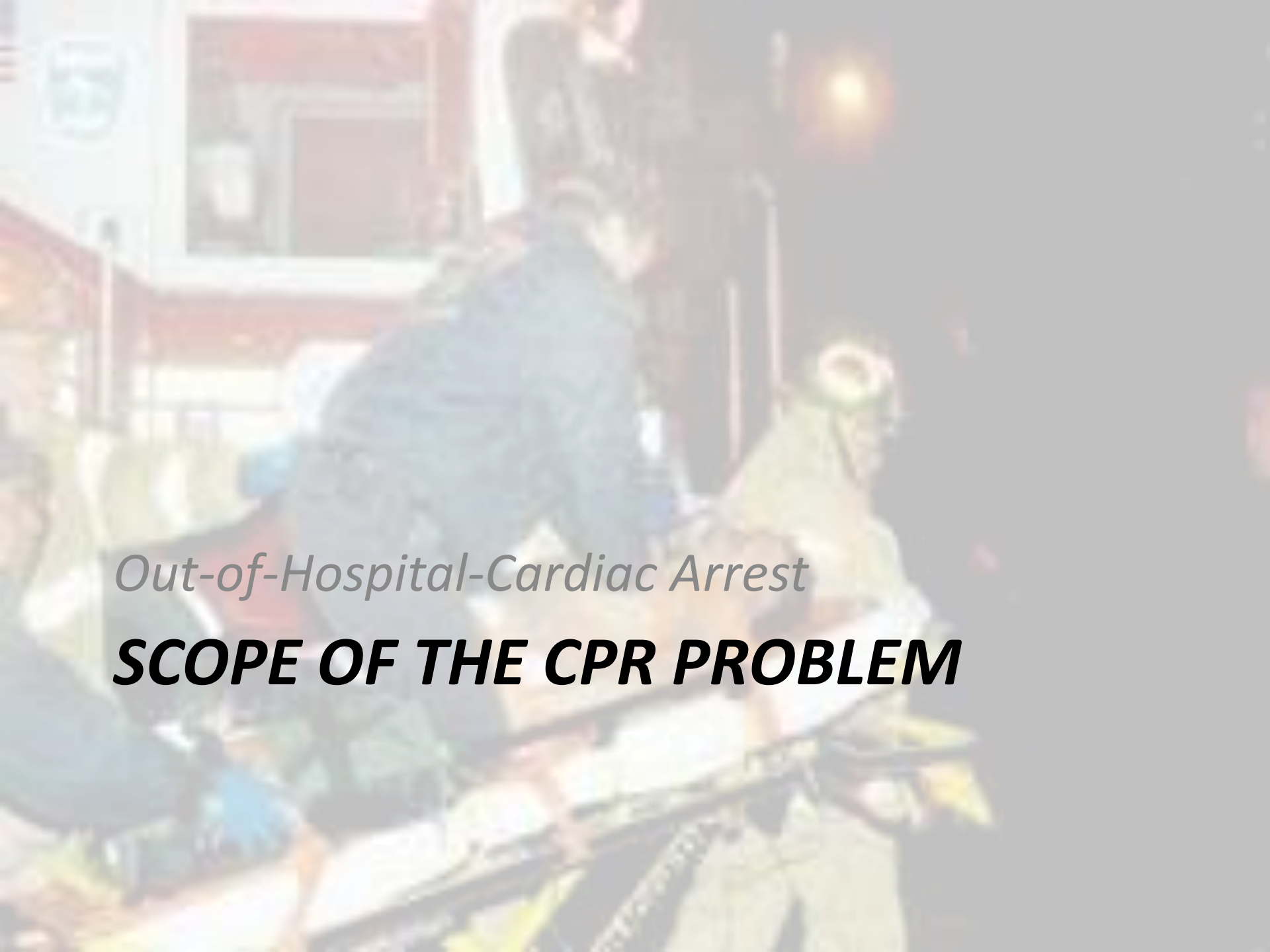
25%
10%
26%
8%
16%
40%
Alabama
Dallas, Texas
Ottawa, Ontario, Canada
Toronto, Ontario, Canada
Pittsburgh, Pennsylvania
Iowa
Portland, Oregon
Vancouver, British Columbia, Canada
Milwaukee, Wisconsin
King County, Washington
All Rhythms (Assessed)
All Rhythms (Treated)
Shockable Rhythms

Si's First Rule of Resuscitation

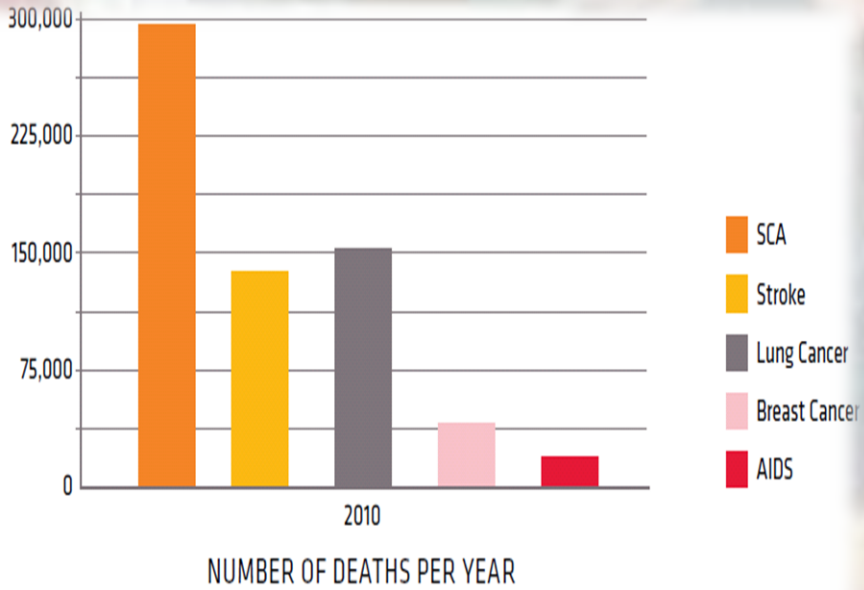
Live Where You Have a Better Chance of Survival



Out-of-Hospital-Cardiac Arrest

SCOPE OF THE CPR PROBLEM

Sudden Cardiac Arrest



Statistical Update	Out-of-Hospital Cardiac Arrest		
	Incidence	Bystander CPR (overall)	Survivor rate* (overall)
2013	359,400	40.1%	9.5%
2012	382,800	41.0%	11.4%

1. American Heart Association. Heart Disease and Stroke Statistics—2010 Update.
2. Jemal A, Siegel R, Xu J, et al. Cancer statistics, 2010. CA Cancer J Clin. 2010 Jul 7. [Epub ahead of print]
3. Centers for Disease Control. HIV prevalence estimates—United States, 2006. MMWR 57(39), 3 October 2008.

Out-of-Hospital-Cardiac Arrest

WHY ARE WE FAILING?

Why are we failing?

- Airway
- Breathing
- Circulation
- Technology
- Transport

Out-of-Hospital-Cardiac Arrest

SCIENCE BEHIND CPR

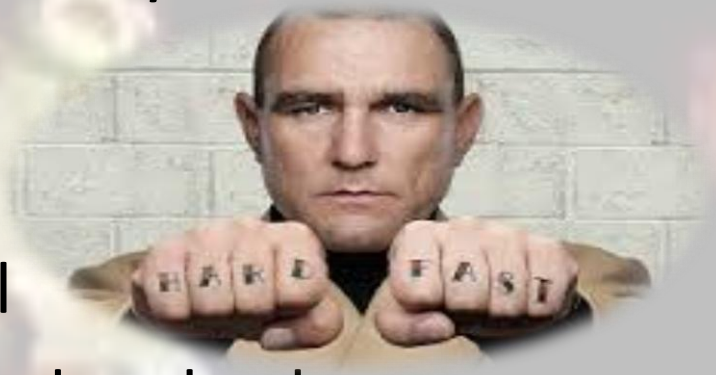
HIGH QUALITY CPR

ACLS: De-emphasis of Devices, Drugs and other Distracters

- Focus on high-quality CPR and defibrillation

PREHOSPITAL HIGH QUALITY CPR

- Goal: High quality means continuous chest compressions with *<u>limited</u> interruptions*
  - Rate: 100 – 120/min
  - Depth: 2 inches
  - Allow for complete chest recoil
  - Change every 2 minutes with pulse check
    - not to exceed 5 seconds
  - Address airway 2 cycles unless indicated earlier

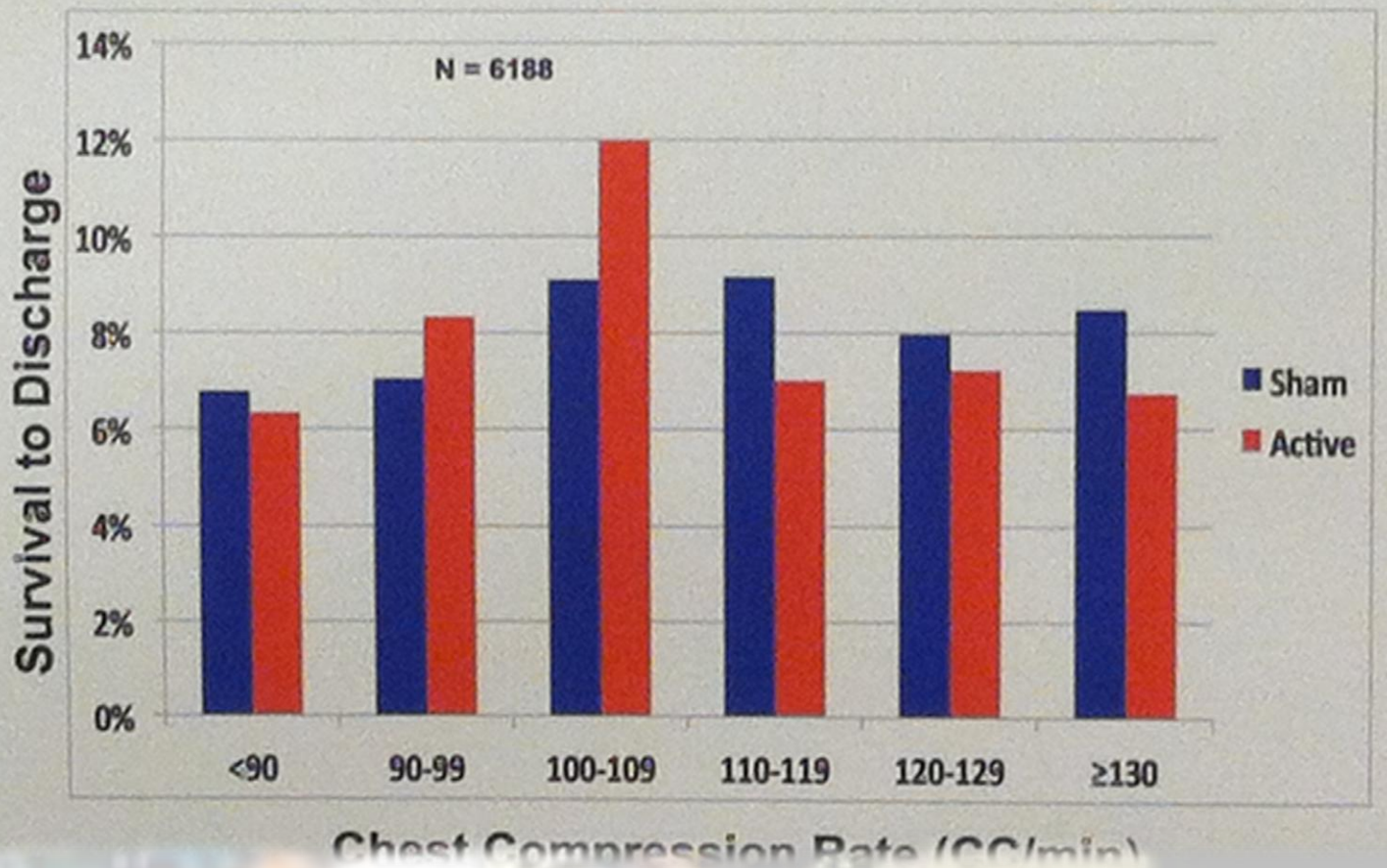


Why 100 – 120 Rate?

- Study measured rates from 2005 – 2007
- 3098 patients enrolled
- Mean compression rate 112
- ROSC peaked at 120
- ROSC declined markedly < 75
  - In this study ROSC not associated with hospital discharge

Idris AH et al. Relationship between chest compression rates and outcomes from cardiac arrest. Circulation 2012 Jun 19; 125:3004.

Why 100 – 120 Rate?



Chest Compression Fraction & Survival

Graph shows survival as it relates to chest compression fraction:

- Move from lower levels of CCF to intermediate has significant benefit
- Supports evidence that increasing pre-shock coronary and cerebral blood flow can improve outcomes

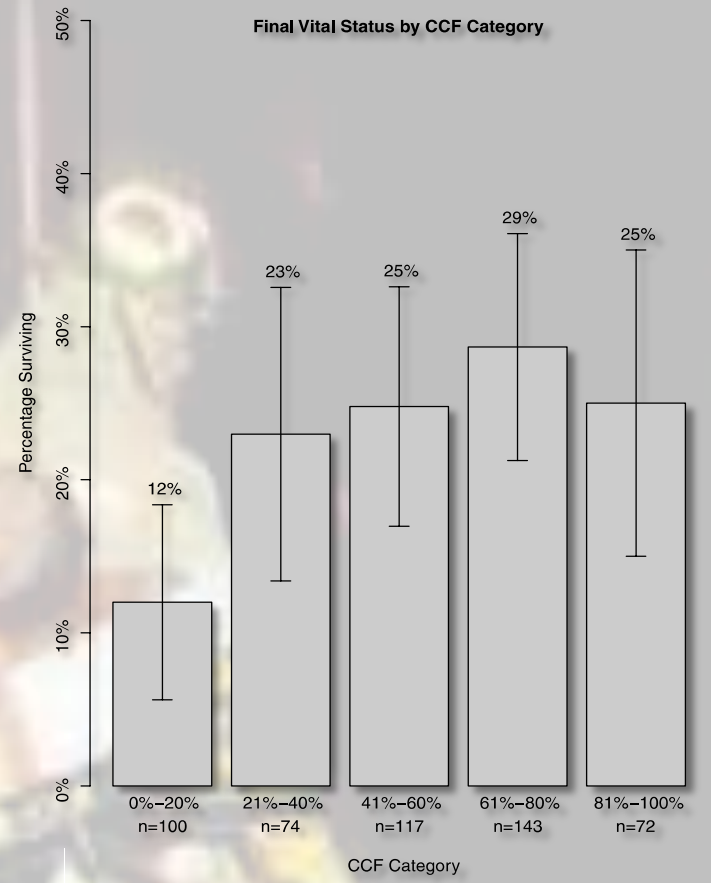


Figure 2. Survival to discharge for each category of chest compression fraction.

Increased chest compression fraction is independently predictive of better survival

Depth and Speed Matter

- ROC Study
- 1029 Adult patients including 58 EMS agencies
- Median compression rate is 106
- Median compression depth is 37.5 mm
- 53 % with compression depth < 38 mm
- 92 % with compression depth < 50 mm
  - Faster compression rate = less depth
- **Survival improved with depth > 38 mm**

Stiell IG et al. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation? Crit Care Med 2012 Jan 5

Depth and Speed Matter

- CC Depth and survival in OHCA 2008 - 11
- 593 adults with OHCA
  - 23% & ROSC
  - 11% survived
  - 8% had good CPC
- Mean compression depth
  - 16% - < 38 mm
  - 36% - 38 – 51 mm
  - 47% - > 51 mm

  - **Better outcome with mean of 53 versus 49 mm**
  - Vadeboncoeur T et al. Chest compression depth and survival in out-of-hospital cardiac arrest. Resuscitation 2013 Oct 12 -

Why 2 Minutes?

- 45 Providers, single rescuer CPR – 10 minutes
- Child and Adult manikins with AV feedback
- Mean compression rate remained > 100
- Adequate compressions
  - Fell from 85 % to < 40 % over 10 minutes
  - < 70 % after 90 seconds in child
  - < 70 % after 120 seconds in adult
- Self reported fatigue low by 2 minutes

Badaki-Makun O et al. Chest compression quality over time in pediatric resuscitations. Pediatrics 2013 Mar; 131:e797.

Si's First Rule of Resuscitation

Pump Hard and Fast Jack

See things in a new way so you can

GET (RE)STOKED

Dogma

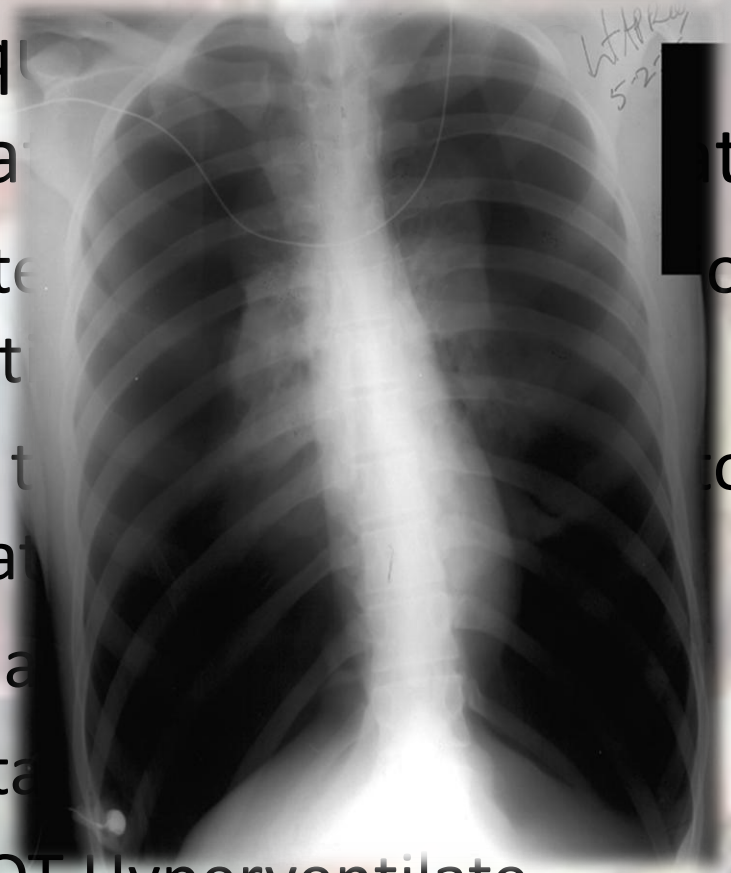
WHY CAN'T WE LET GO OF THE AIRWAY

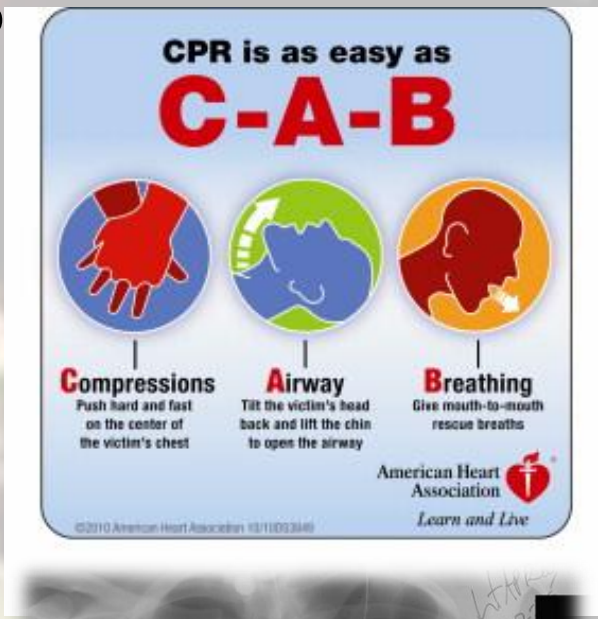

One, two three, BREATHE
He's dead, Jim

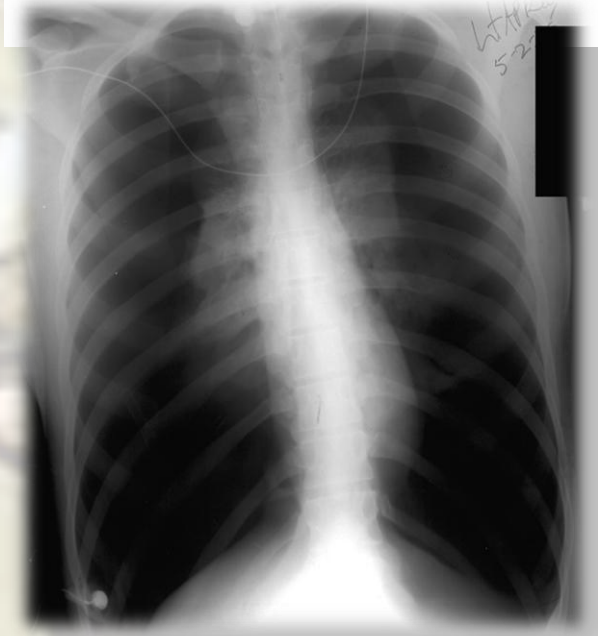
PREHOSPITAL HIGH QUALITY VENTILATIONS

Goal: High qu[illegible]
hyperventila[illegible]tion

- Don't inte[illegible]on for insert[illegible]
  - Adult t[illegible]o de-saturat[illegible]
  - Ventila[illegible]
  - Mainta[illegible]
  - Do NOT Hyperventilate

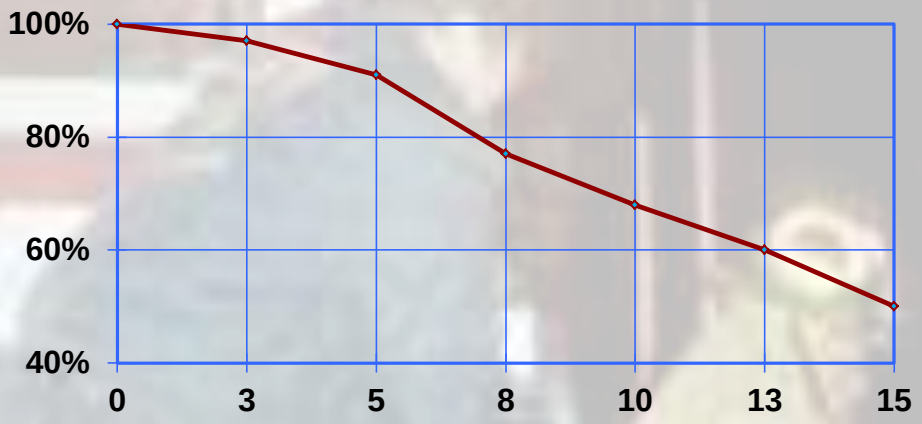




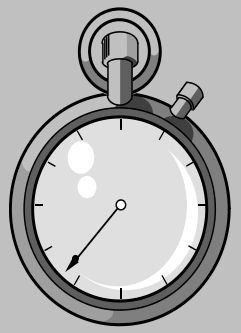


PREHOSPITAL HIGH QUALITY VENTILATIONS

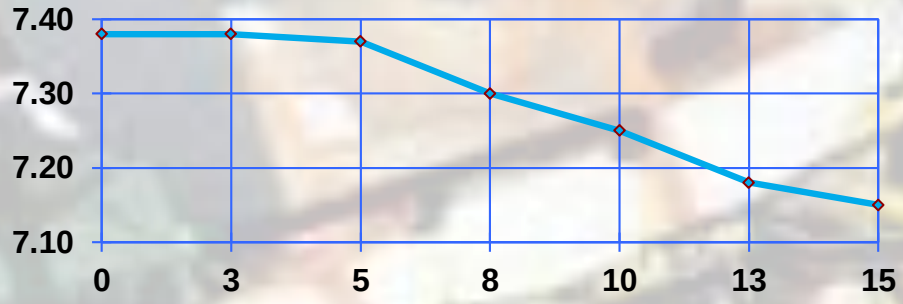
Oxygen Saturation



min



Arterial pH



min

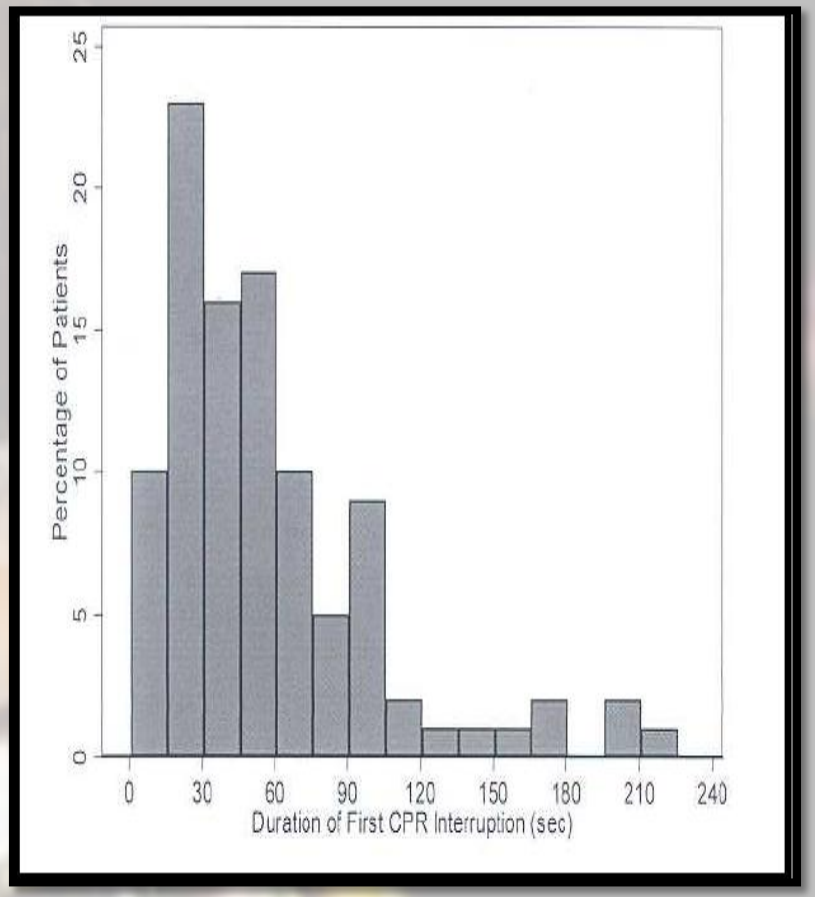
Advanced Airway Placement

Interruptions in CCC

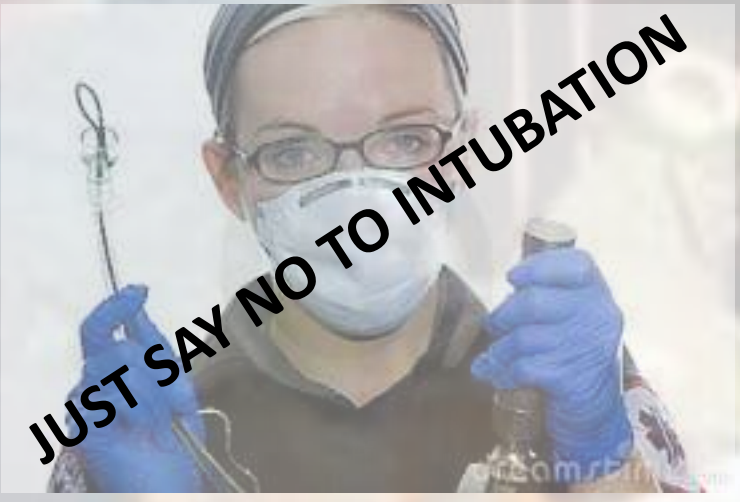
- 100 cases reviewed
- Median 2 intubation attempts

- Median duration of interruption for 1st attempt = **46.5 sec**.

- Median total interruptions for all attempts = **109.5 sec**



Interruptions in Cardiopulmonary Resuscitation From Paramedic Endotracheal Intubation (WANG 2009)


JUST SAY NO TO INTUBATION

Why De-emphasis of Airway?

- Nationwide Japanese Registry 649,654
- ETT or BIAD Good Neurological Outcome 1 %
- BVM Good Neurological Outcome 3 %

Kohei Hasegawa, MD, MPH; Atsushi Hiraide, MD, PhD; Yuchiao Chang, PhD; David F. M. Brown, MD JAMA. 2013;309(3):257-266. doi:10.1001/jama.2012.187612.

Why De-emphasis of Airway?

- 170 Post-arrest patients with hypothermia
- 45 % survived to hospital discharge
- Survivors had lower median PaO2 198 mmHg
  - Nonsurvivors PaO2 254 mmHg
- Good neurological outcome 197 mmHg
  - Poor neurological outcome 247 mmHg
- Increased oxygen in first 24 hours
  - 1.5 times more likely to have poor outcome

Janz DR et al. Hyperoxia is associated with increased mortality in patients treated with mild therapeutic hypothermia after sudden cardiac arrest. *Crit Care Med* 2012 Dec; 40:3135.

Si's First Rule of Resuscitation

Forget about the airway initially…Jack

Easy

DEFIBRILLATION

Perishock Pause

Independent Predictor of Survival

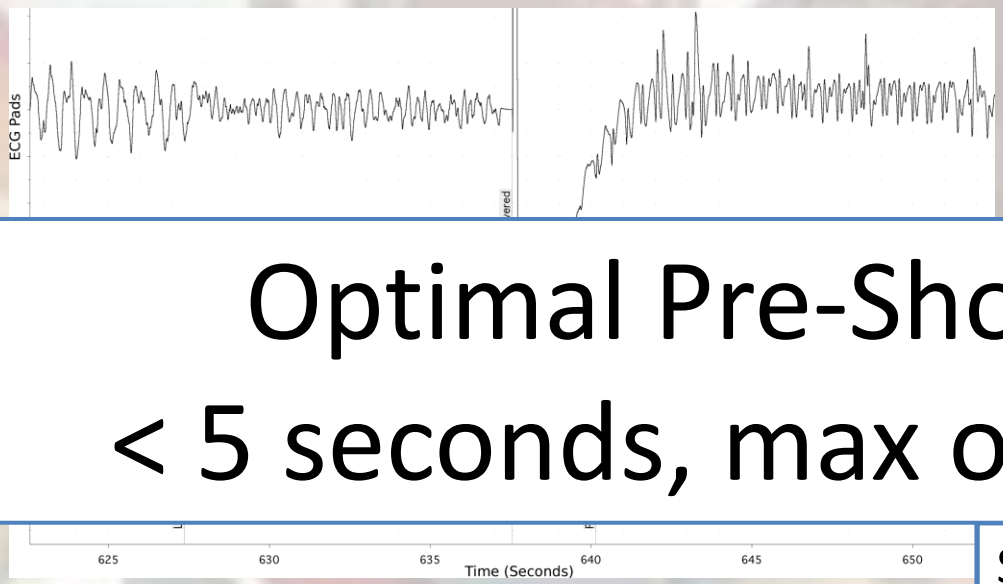


Figure 1. Diagram of preshock, postshock, and perishock pause. Preshock pause of 10 seconds, postshock pause of 2.3 seconds and perishock pause of 12.3 seconds depicted in the impedance channel of the cardiopulmonary resuscitation process file.

Perishock Pause = interruption in chest compressions before and after defibrillatory shock

Optimal Pre-Shock Pause:
< 5 seconds, max of 10 seconds

Resuscitation Science

Perishock Pause

An Independent Predictor of Survival From Out-of-Hospital Shockable Cardiac Arrest

Sheldon Cheskes, MD; Robert H. Schmicker, MS; Jim Christenson, MD; David D. Salcido, MPH; Tom Rea, MD; Judy Powell, RN; Dana P. Edelson, MD; Rebecca Sell, MD; Susanne May, PhD; James J. Menegazzi, PhD; Lois Van Ottingham, RN, BSN; Michele Olsufka, BSN; Sarah Pennington, RN; Jacob Simonini, ACP; Robert A. Berg, MD; Ian Stiell, MD, MSc; Ahamed Idris, MD; Blair Bigham, MSc; Laurie Morrison, MD, MSc; on behalf of the Resuscitation Outcomes Consortium (ROC) Investigators

Study showed that odds of survival were significantly lower for patients with:

1. Pre-shock pause > 20 seconds
2. Peri-shock pause > 40 seconds

Perishock Pause
Independent Predictor of Survival

- Resuscitation Outcomes Consortium (ROC)
- PRIMED trial 2013

- Odds of survival with good CPC
  - Pre-shock: Highest in shocks < 10 seconds
  - Peri-shock: Highest in shocks < 20 seconds
- OR for survival:
  - Decreases 6% for every 5 second delay

- Cheskes S et al. The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial. Resuscitation 2013 Oct 28; [e-pub ahead of print]. (http://dx.doi.org/10.1016/j.resuscitation.2013.10.014)

PREHOSPITAL

What about a machine?

- Mechanical CC versus conventional CPR
- European trial using the LUCAS device
- 2589 patients
- 4 hour survival 24% for both groups
- ROSC, survival to discharge, CPC scores
  - **NO DIFFERENCE**

- Rubertsson S et al. Mechanical chest compressions and simultaneous defibrillation vs conventional cardiopulmonary resuscitation in out-of-hospital cardiac arrest: The LINC randomized trial. JAMA 2013 Nov 17 -

What about a machine?

- Meta-analysis, 12 studies 2013
- 8 load-distributing / 4 piston-driven
- 6538 patients
- OR of ROSC 1.53
  - OR 1.62 for load-distributing
  - OR 1.25 for piston-driven
  - Survival not measured in this study

- Westfall M et al. Mechanical versus manual chest compressions in out-of-hospital cardiac arrest: A meta-analysis. Crit Care Med 2013 May 8

Summary

- **What results in optimal survival?**
- High-quality, uninterrupted CPR
- Early Defibrillation
- Prevention of Hyperventilation and Hyper-oxygenation