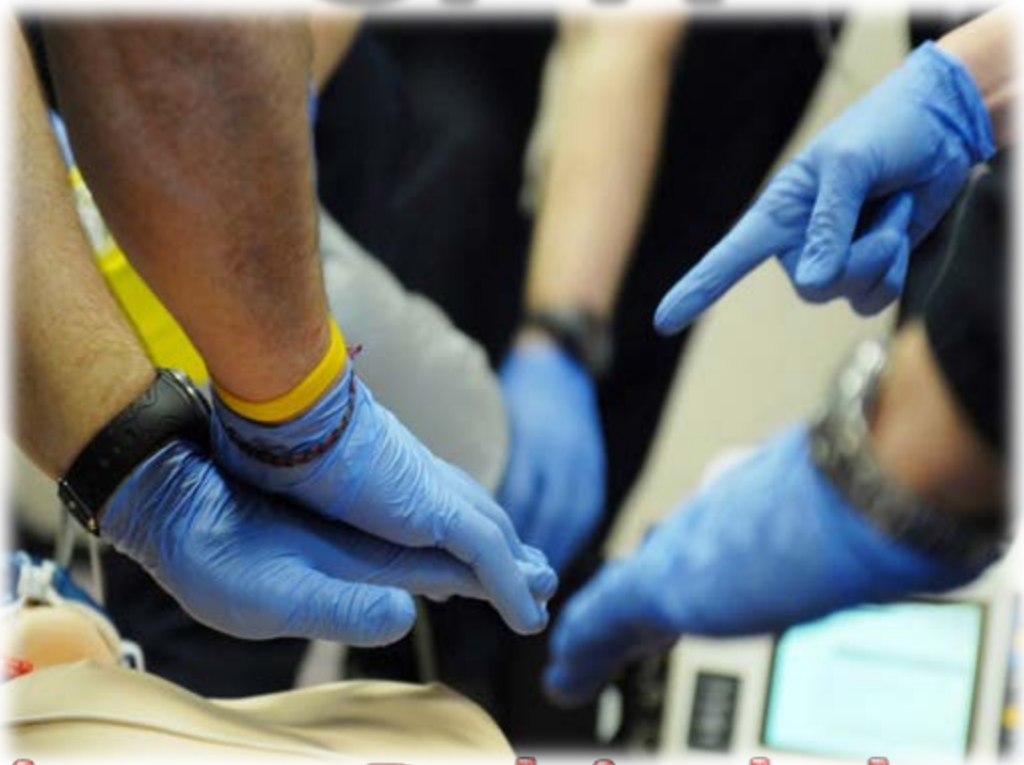
CPR



The Science Behind the Hands

Center for Progress in Resuscitation
University of Washington

Public Health
Seattle & King County

City of Seattle Fire Dept.

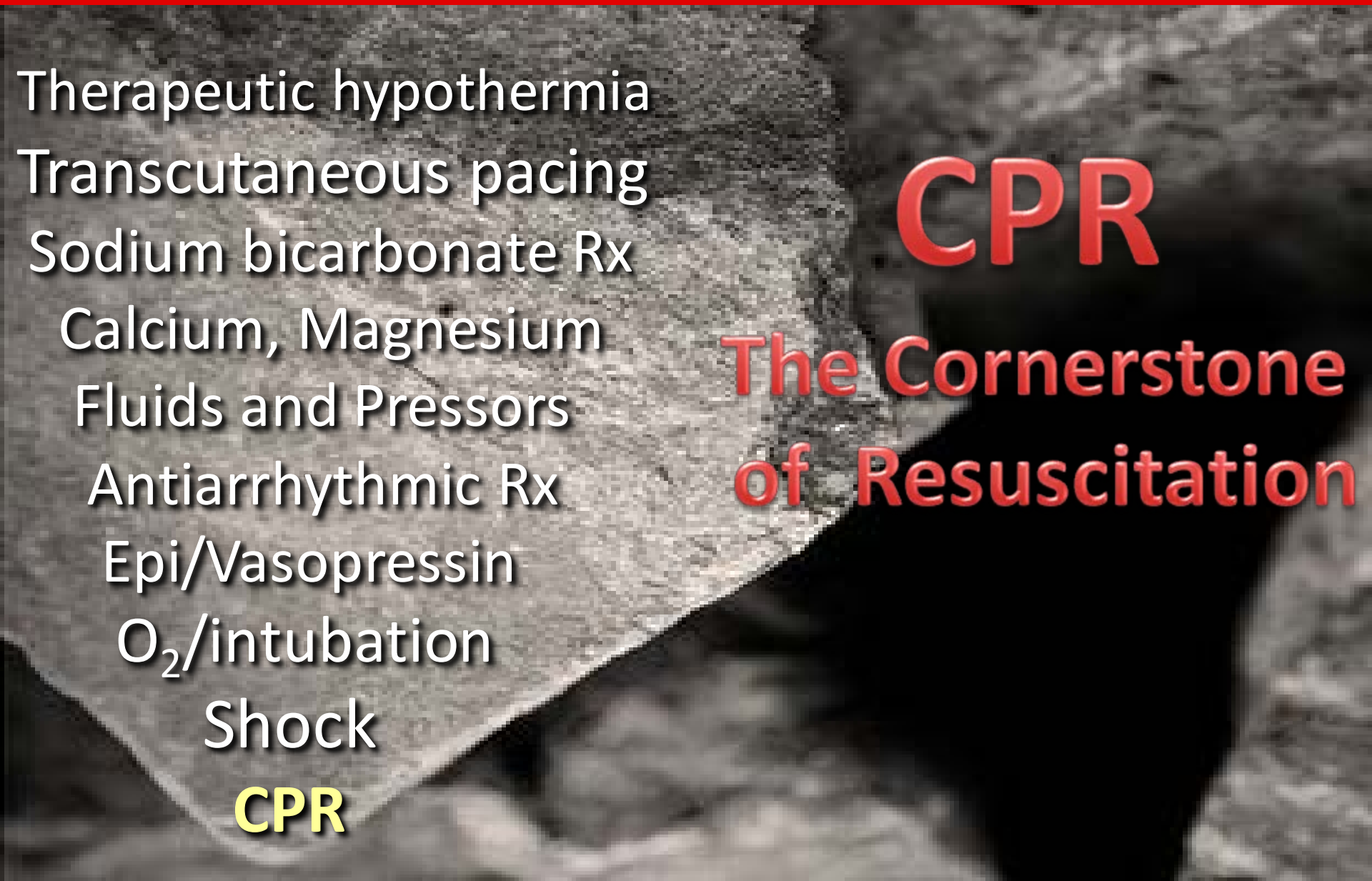
Medic One Foundation

King County Medic One

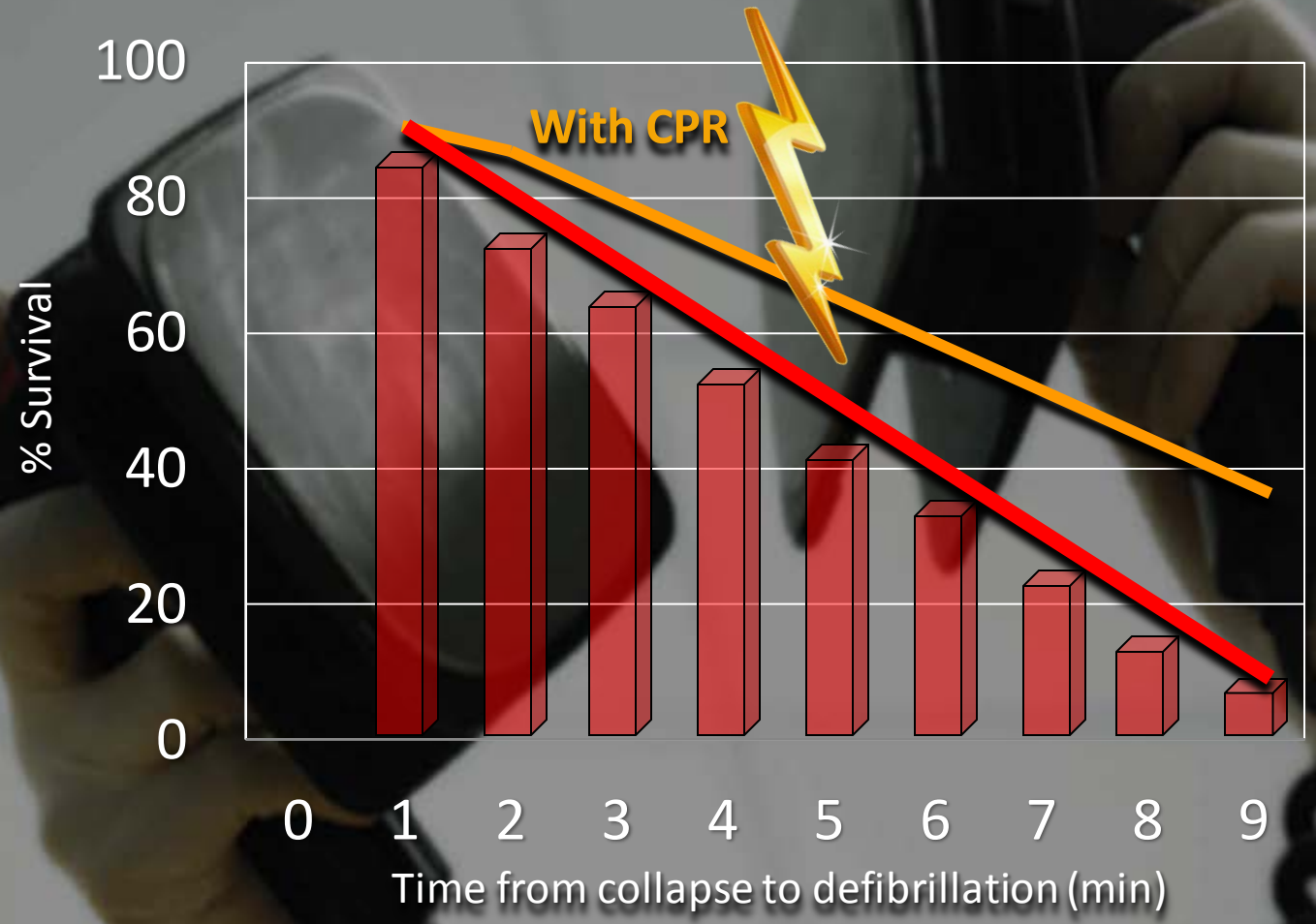
King County Training

UW Medicine

Resuscitation Arsenal



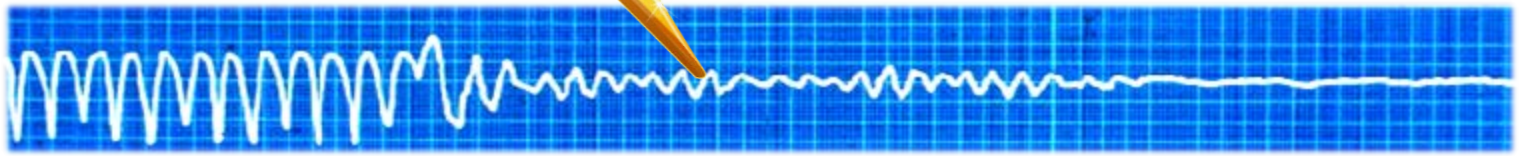
Estimated Survival to Hospital Discharge After Witnessed VF Cardiac Arrest

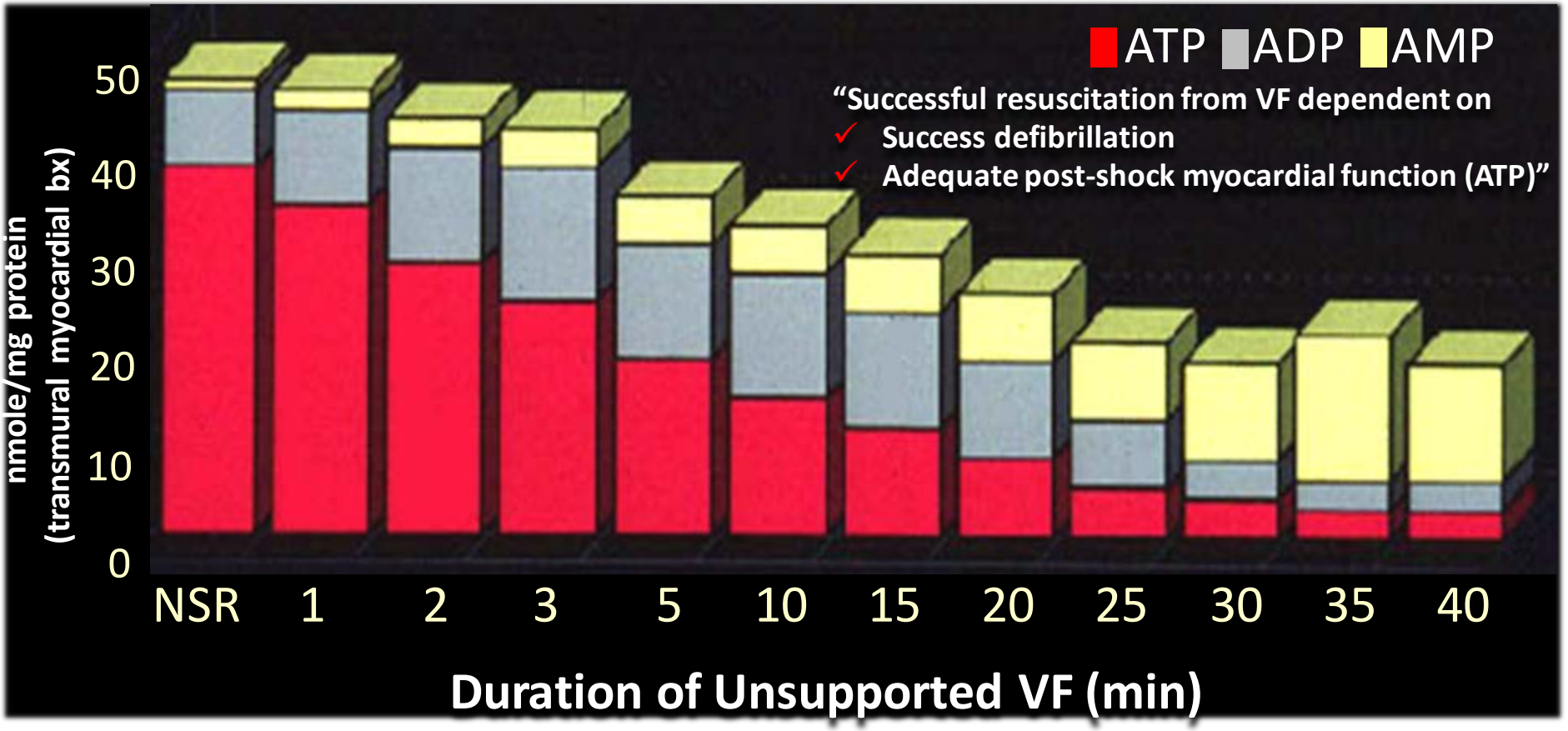


Link MS. CPR Guidelines Circulation 2010;122:S706-19
Christenson J Chest Compression Fraction Determines Survival Circulation 2009;120:1241-7
Stiell IG Chest Compression Depth during Resuscitation Crit Care Med 2012;40:1-7
Idris AH Chest Compression Rates and Outcomes Circulation 2012;125:3004-12

Adenosine Nucleotide Concentrations During VF

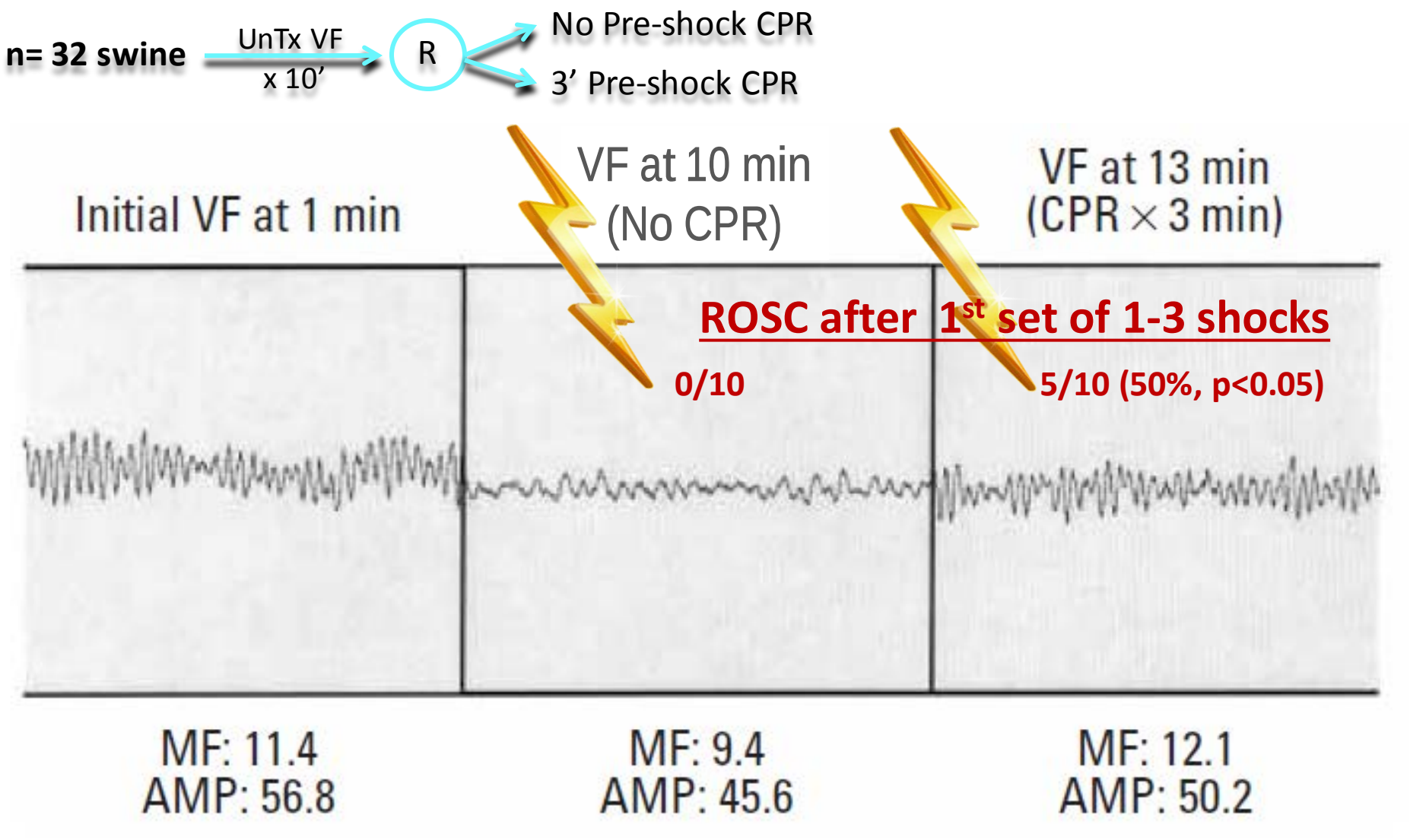
n = 10 swine (~10 samples/time period)





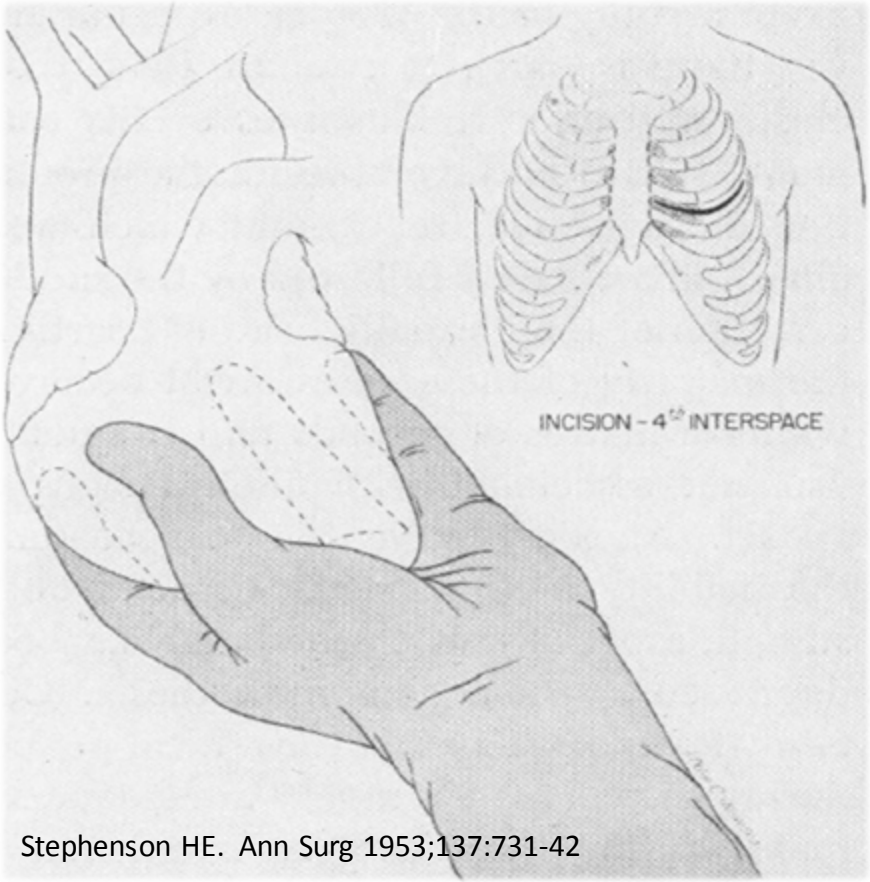
Neumar RW. Ann Emerg Med 1991;20:222-9

Changes in VF Waveform With and Without 3 Minutes of Pre-shock CPR



MF = VF median frequency in Hz; AMP = VF amplitude in mV

Berg RA. Ann Emerg Med 2002;40:563-70



Stephenson HE. Ann Surg 1953;137:731-42

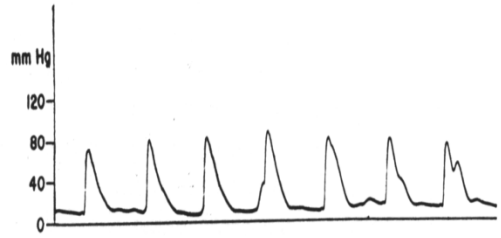
Cardiac resuscitation after cardiac arrest or ventricular fibrillation has been limited by the need for open thoracotomy and direct cardiac massage. As a result of exhaustive animal experimentation a method of external transthoracic cardiac massage has been developed. Immediate resuscitative measures can now be initiated to give not only mouth-to-nose artificial respiration but also adequate cardiac massage without thoracotomy. The use of this technique on 20 patients has given an over-all permanent survival rate of 70%. Anyone, anywhere, can now initiate cardiac resuscitative procedures. All that is needed are two hands.

Kouwenhoven WB. JAMA 1960;173:1064-7

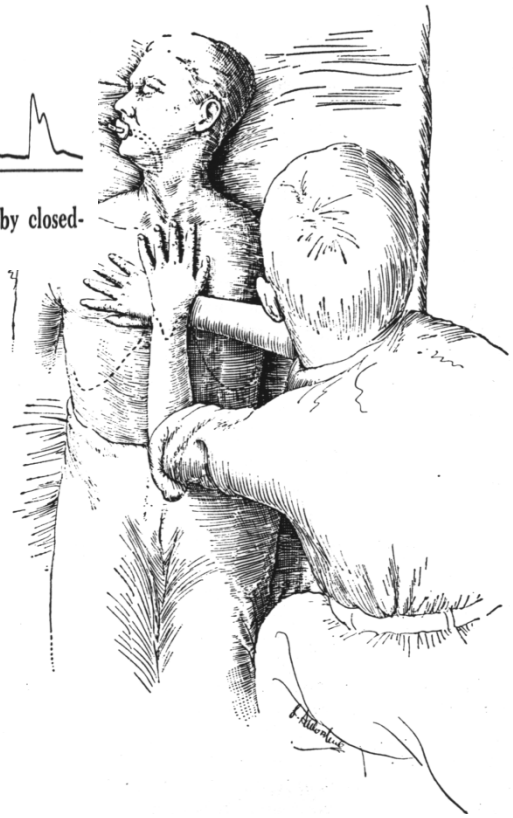
J.A.M.A., July 9, 1960

CLOSED-CHEST CARDIAC MASSAGE

W. B. Kouwenhoven, Dr. Ing., James R. Jude, M.D.
and
G. Guy Knickerbocker, M.S.E., Baltimore



Blood pressure produced in an adult by closed-chest cardiac massage.



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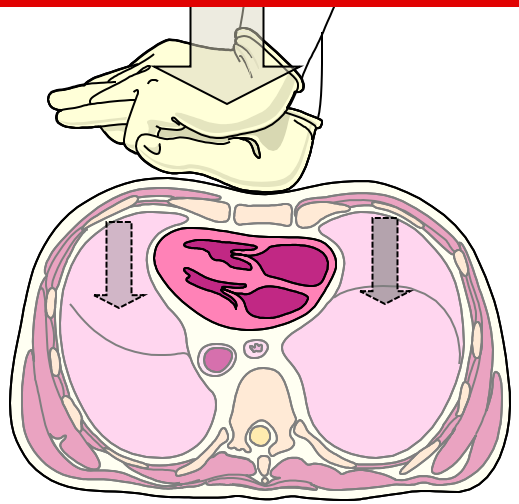
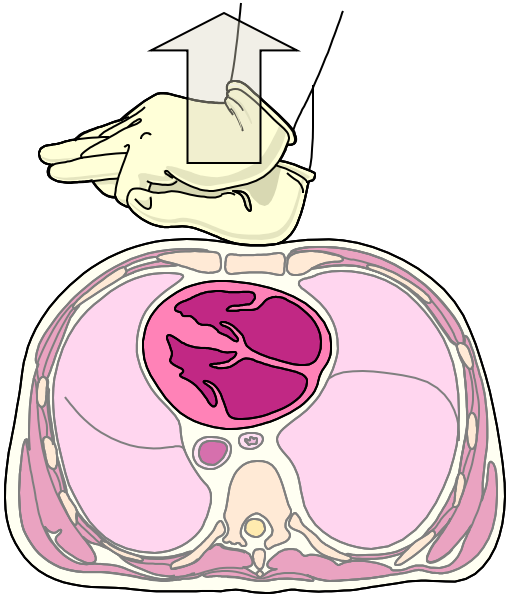
Components of CPR



Compression

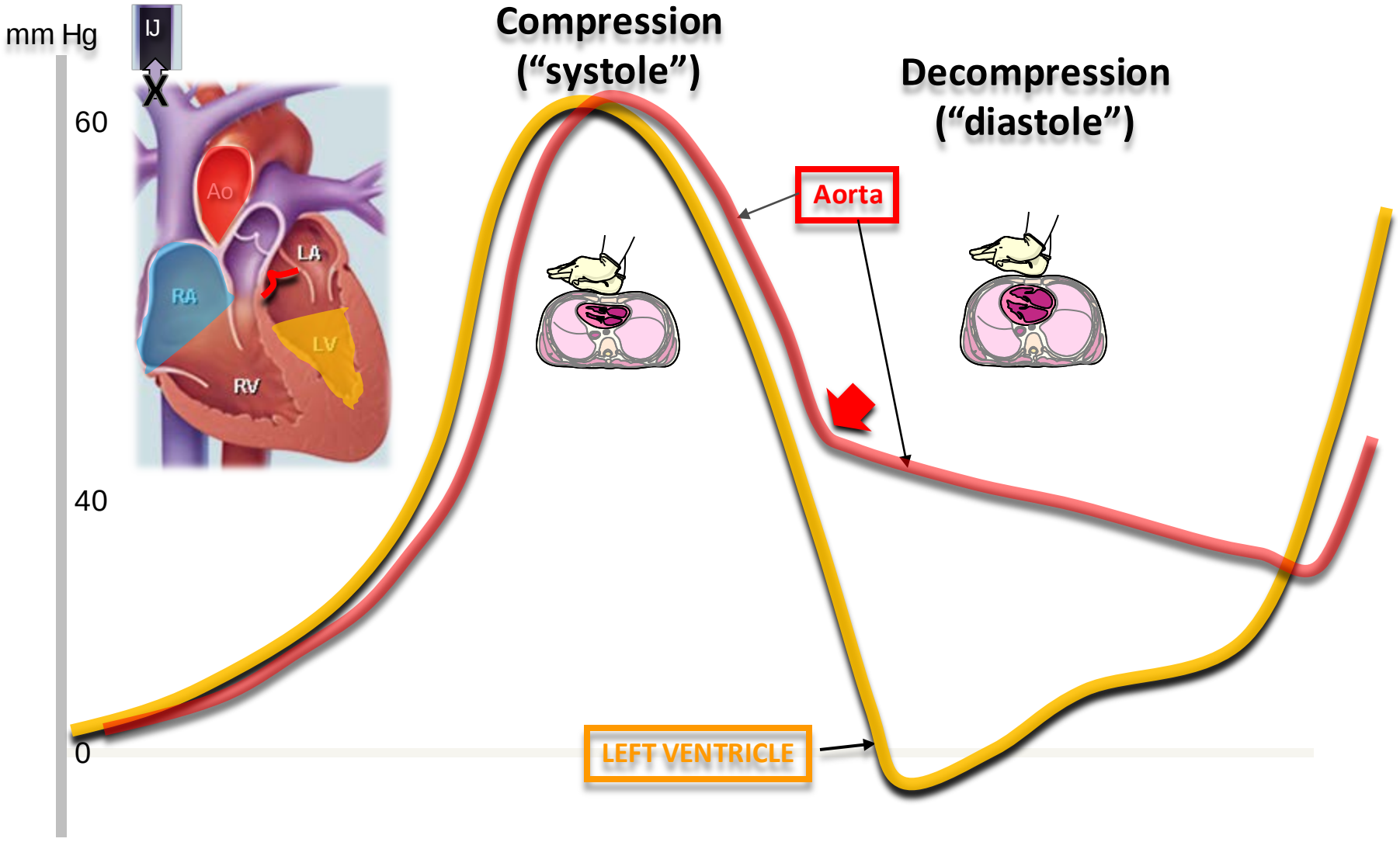
- Increased intrathoracic pressure
- Ejects blood from heart and lungs
- "Good" compression increases forward output and BP



Decompression (recoil)

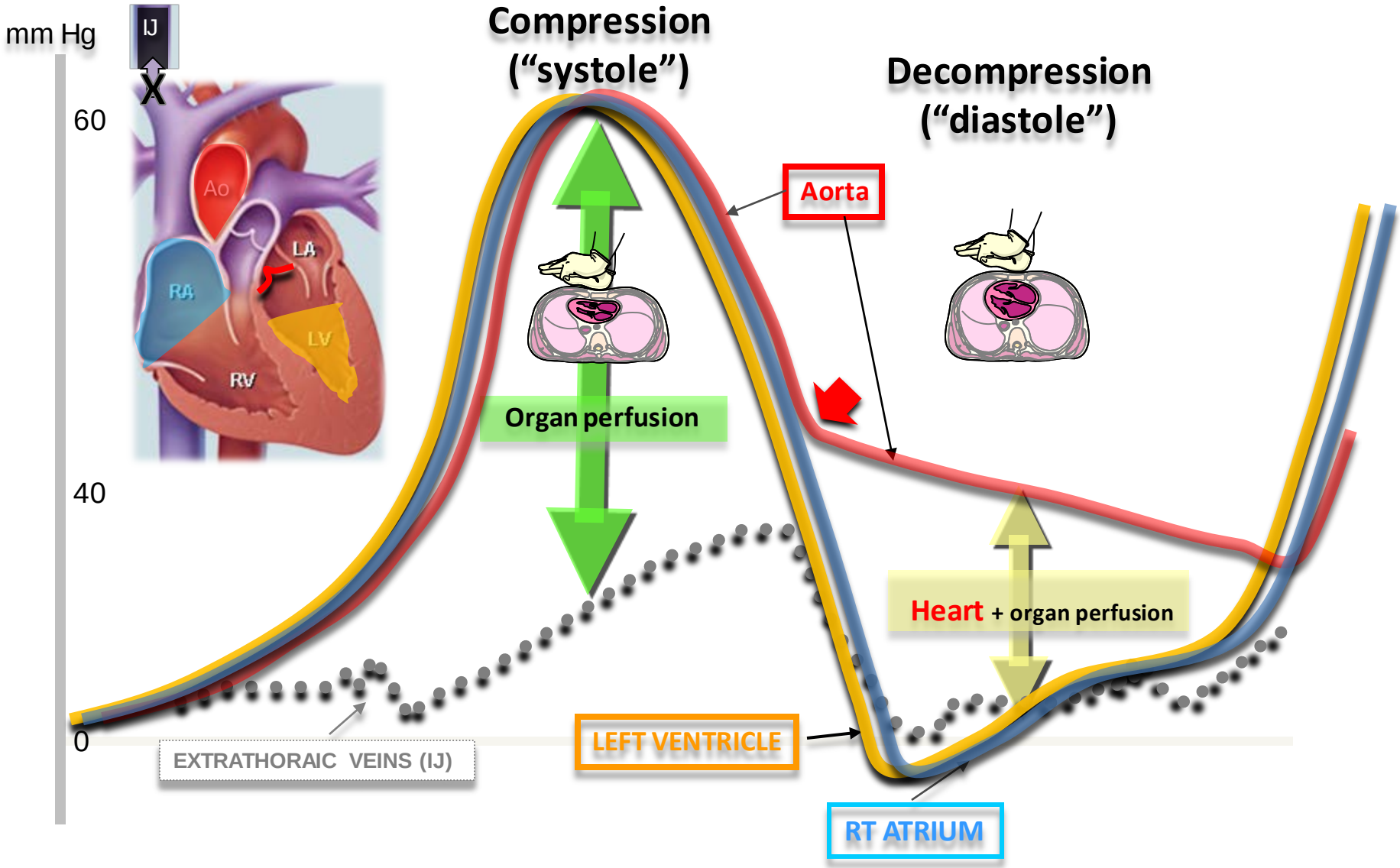
- Decreased intrathoracic pressure
- Refilling of heart and lungs
- "Good" recoil → ↑vacuum → ↑refilling → ↑forward output

Hemodynamics of CPR



Criley JM et al. Circulation 1986;74(IV):42-50 (modified).

Hemodynamics of CPR



Criley JM et al. Circulation 1986;74(IV):42-50 (modified).

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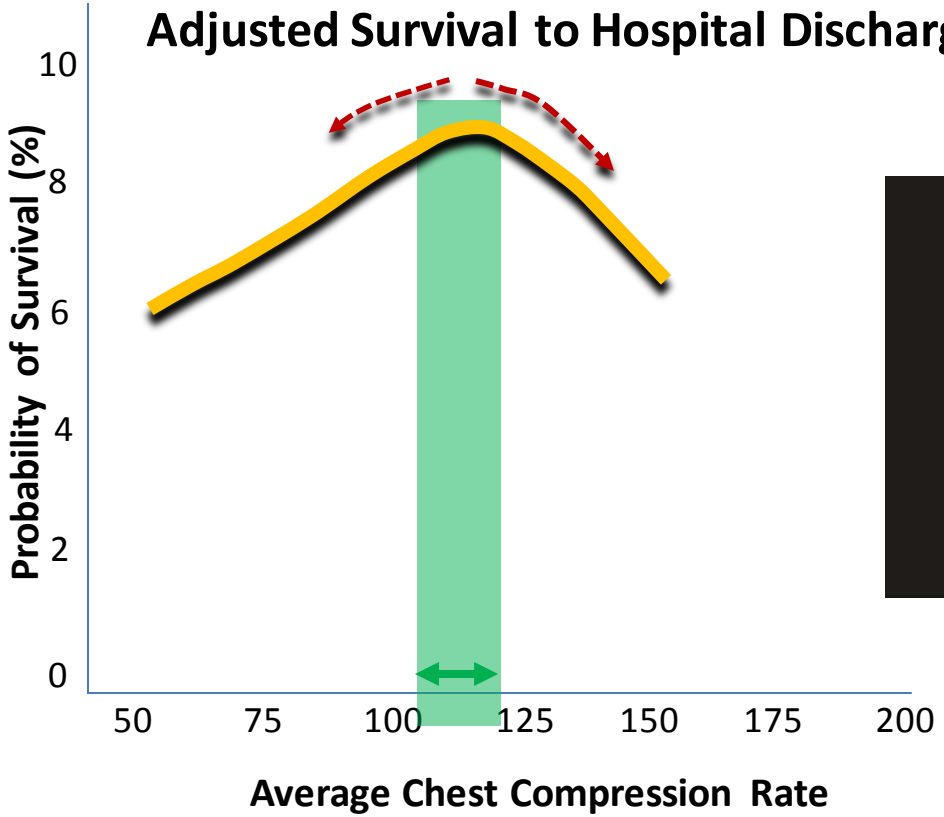
- **Sufficient compression depth:** ***≥ 50 mm (2”)***
- **Minimize interruptions:** ***chest compression fraction >80%***
- **Promote full chest recoil:** ***no leaning***

Meaney PA. Circulation 2013;128:417-35

Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest

Ahamed H. Idris, MD[1]; Danielle Guffey, MS[2]; Paul P. Pepe, MD[3]; Siobhan P. Brown, PhD[2]; Steven C. Brooks, MD[4]; Clifton W. Callaway, MD, PhD[5]; Jim Christenson, MD[6]; Daniel P. Davis, MD[7]; Mohamud R. Daya, MD[8]; Randal Gray, BS, MA Ed, NREMT-P[9]; Peter J. Kudenchuk, MD[10]; Jonathan Larsen, EMT-P[11]; Steve Lin, MD[12]; James J. Menegazzi, PhD[5]; Kellie Sheehan, BSN[2]; George Sopko, MD, MPH[13]; Ian Stiell, MD, MSc[14]; Graham Nichol, MD[15]; Tom P. Aufderheide, MD[16]; for The Resuscitation Outcomes Consortium Investigators

- **6399 adults out-of-hospital cardiac arrest**
- **≥5 min electronic chest compression rate recordings**



*Adj for chest compression fx, depth

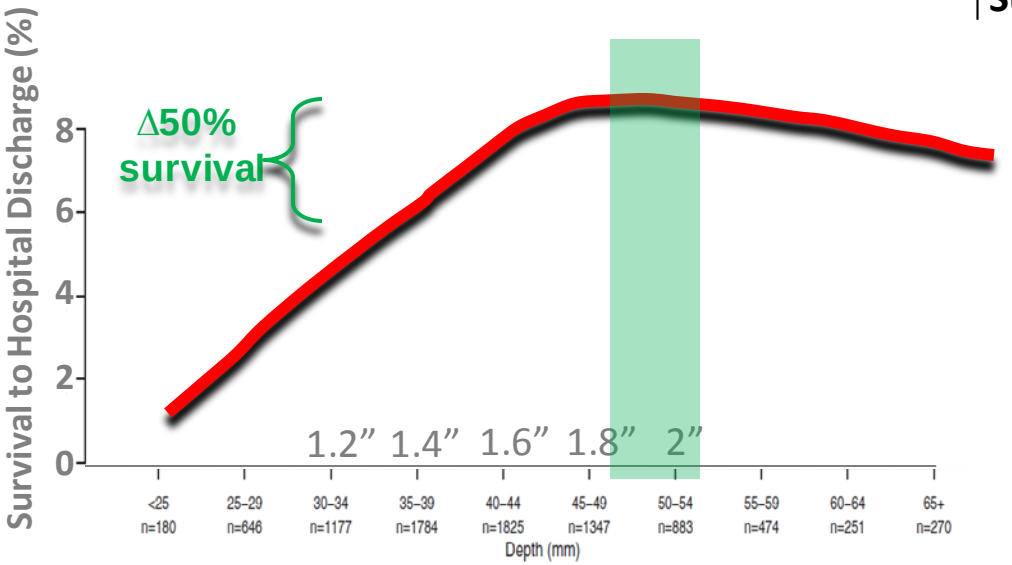
Idris AH. Circulation 2012;125:3004-12 (n=3098) ROC Epistry †Idris AH. Crit Care Med 2014 DOI: 10.1097/CCM.0000000000000824 (n=6399) ROC PRIMED

What Is the Optimal Chest Compression Depth During Out-of-Hospital Cardiac Arrest Resuscitation of Adult Patients?

Ian G. Stiell, MD; Siobhan P. Brown, PhD; Graham Nichol, MD; Sheldon Cheskes, MD; Christian Vaillancourt, MD; Clifton W. Callaway, MD; Laurie J. Morrison, MD; James Christenson, MD; Tom P. Aufderheide, MD; Daniel P. Davis, MD; Cliff Free, EMT-P; Dave Hostler, PhD; John A. Stouffer, EMT-P; Ahamed H. Idris, MD; and the Resuscitation Outcomes Consortium Investigators

- **9136 adults out-of-hospital cardiac arrest (all rhythms)**
- **≥10 min electronic chest compression depth recordings**

Per ↑5 mm depth → ~5% ↑outcome
↑ROSC ~6% (OR 1.06 (1.04,1.08) p<0.001)
↑Survival ~4% (OR 1.04 (1.0, 1.08) p=0.045)



Stiell IG et al. Circulation 2014;130:1962-70

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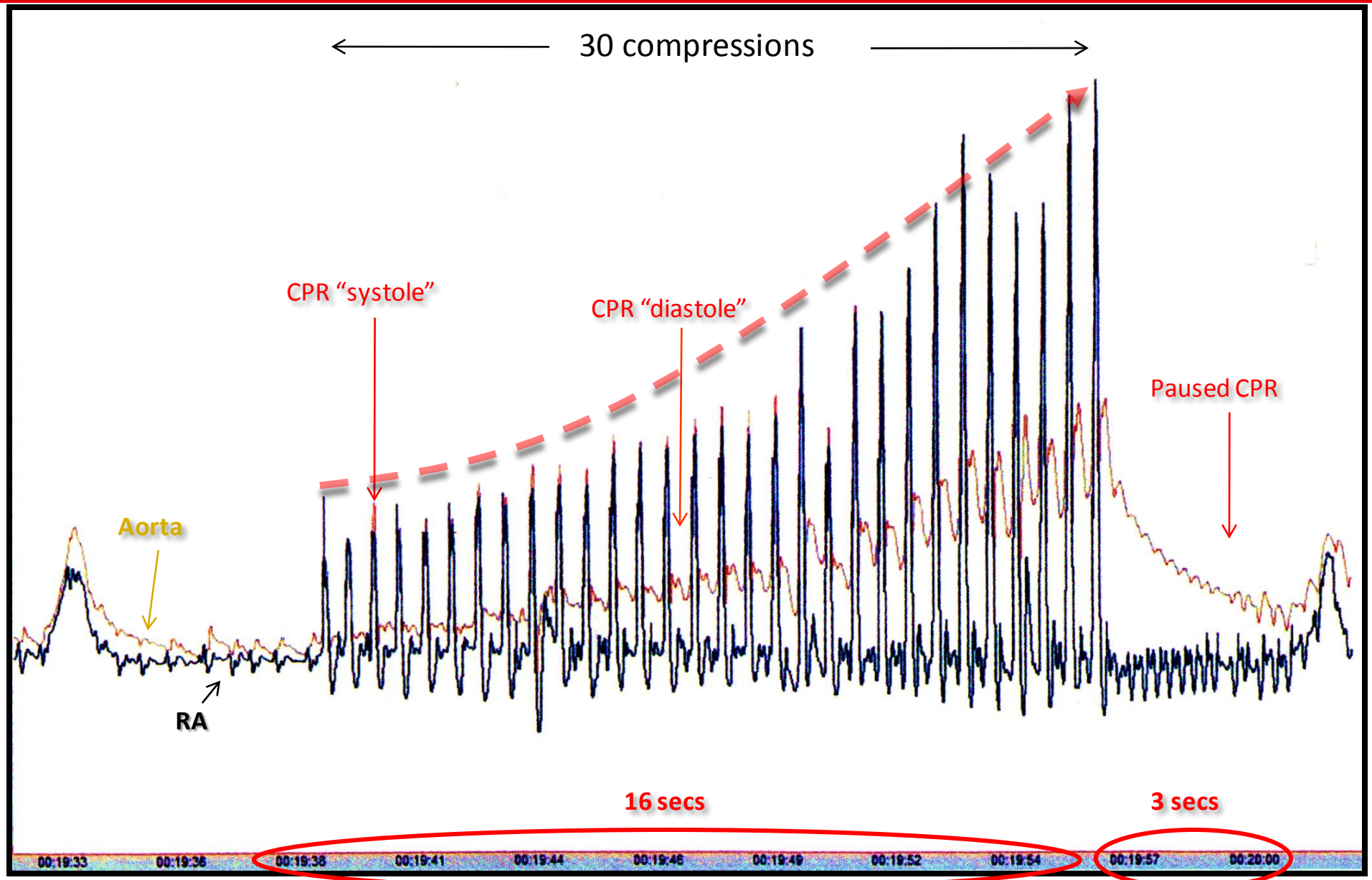
The Price of CPR Pauses

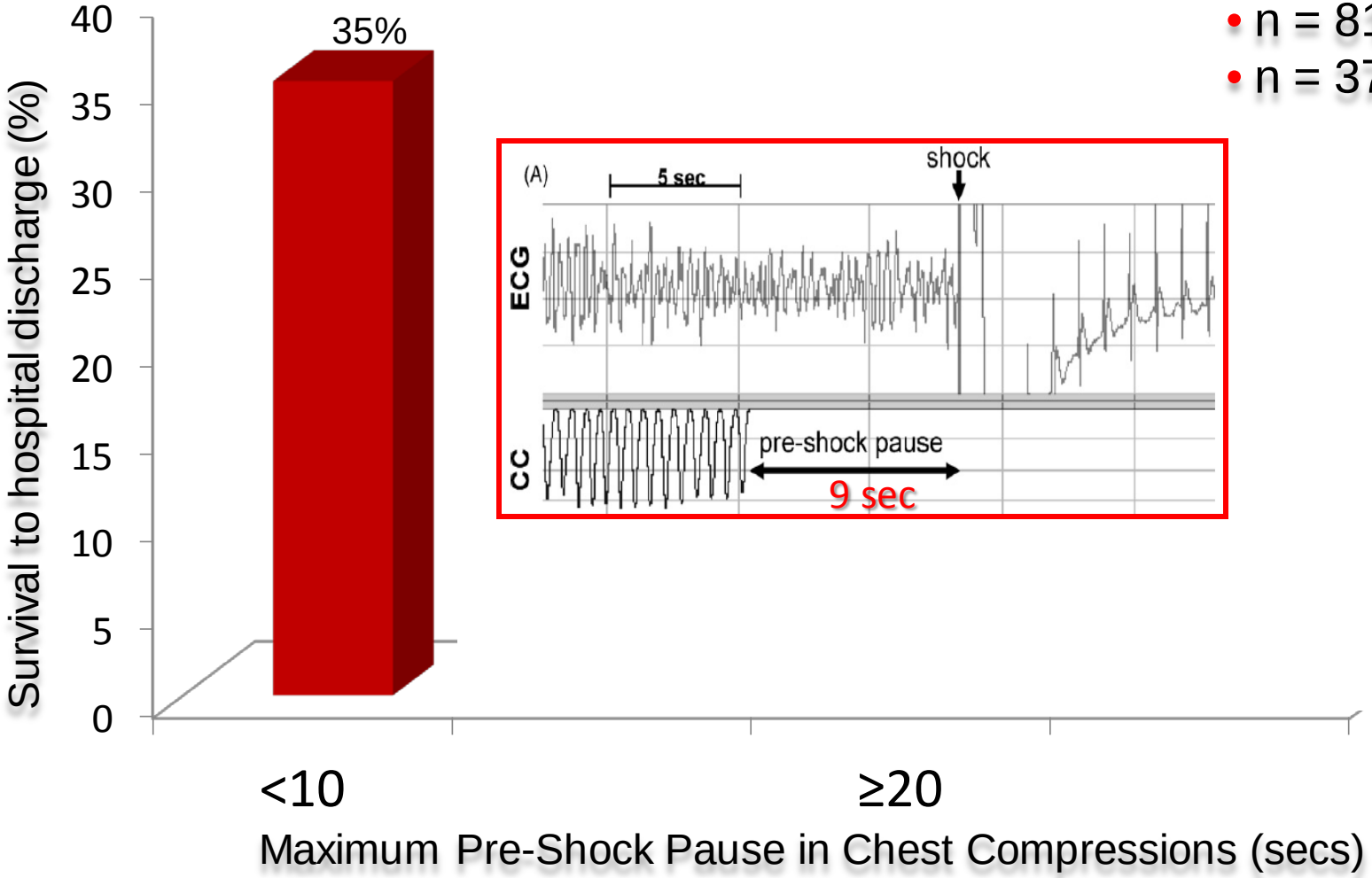


CPR Pauses and Survival

Perishock Pause

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

- n = 815 VF arrests
- n = 3756 shocks



Cheskes S et al. Circulation 2011;124:58-66

*Adjusted multivariable logistic regression model for age, sex, public location, witness status, bystander CPR, time from 911 dispatch to 1st vehicle arrival

Perishock Pause

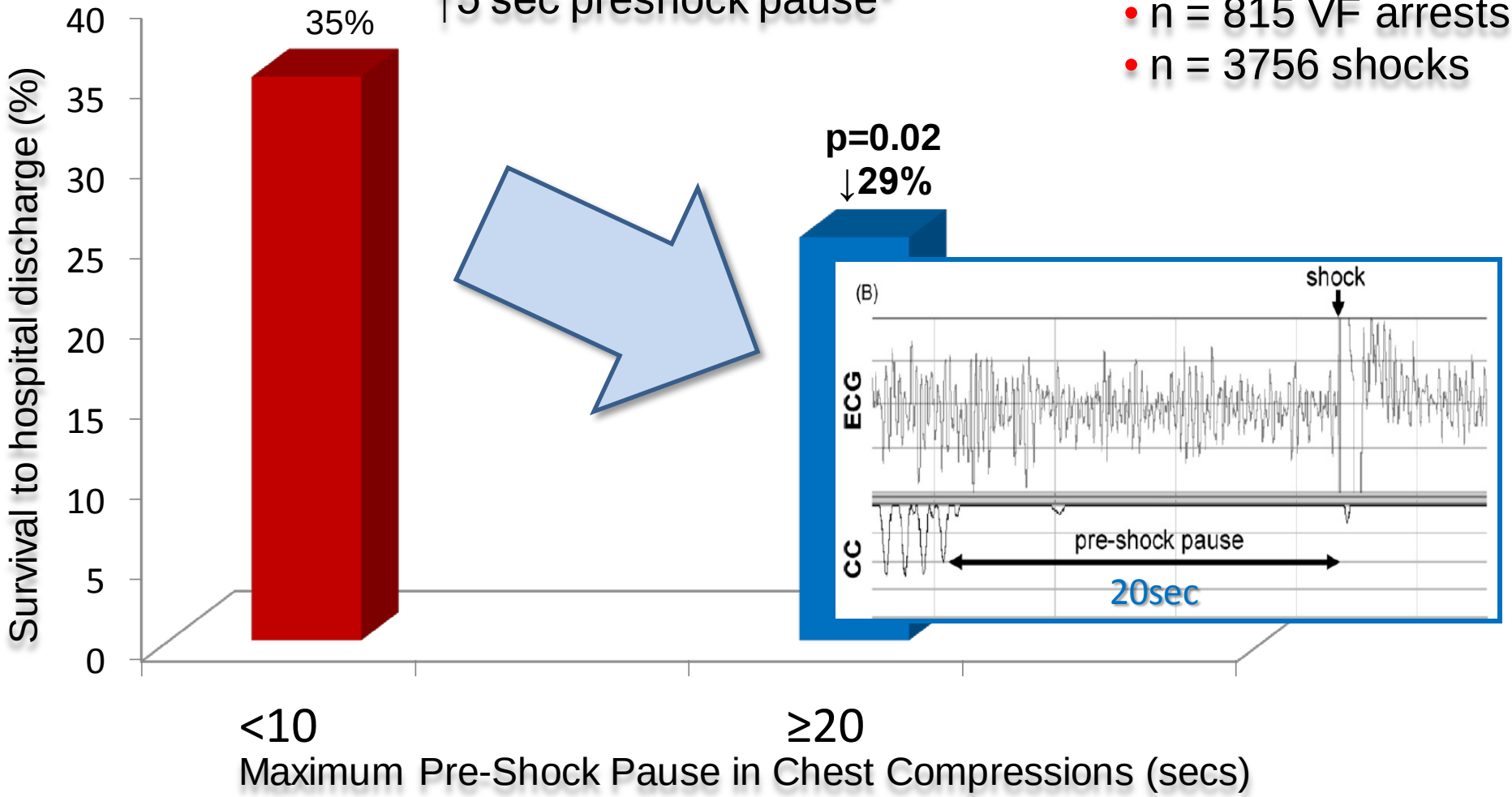
An Independent Predictor of Survival From Out-of-Hospital Shockable Cardiac Arrest

OR 0.82 (0.73, 0.93)/↑5 sec

↓18% survival per

↑5 sec preshock pause*

- n = 815 VF arrests
- n = 3756 shocks



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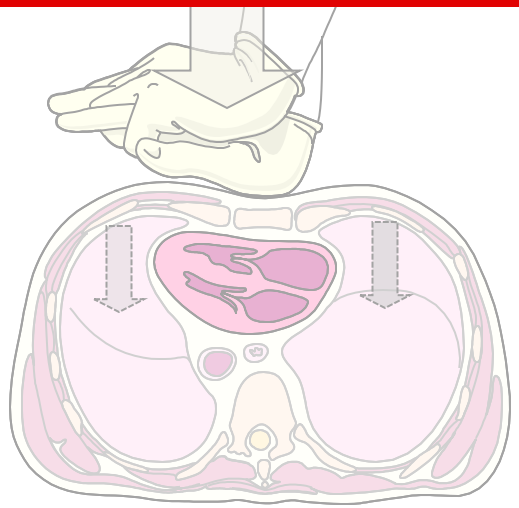

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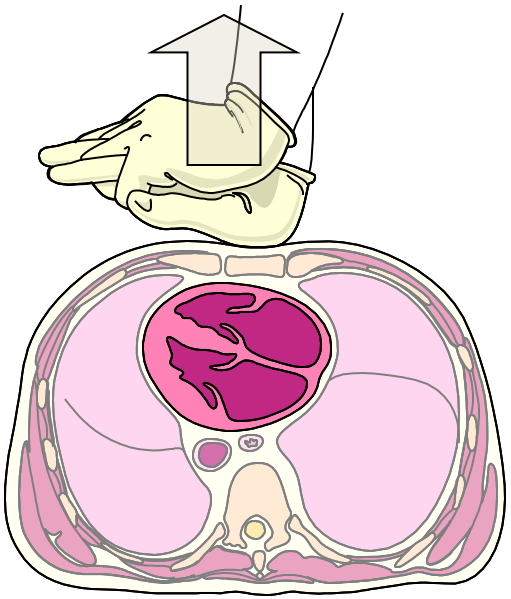

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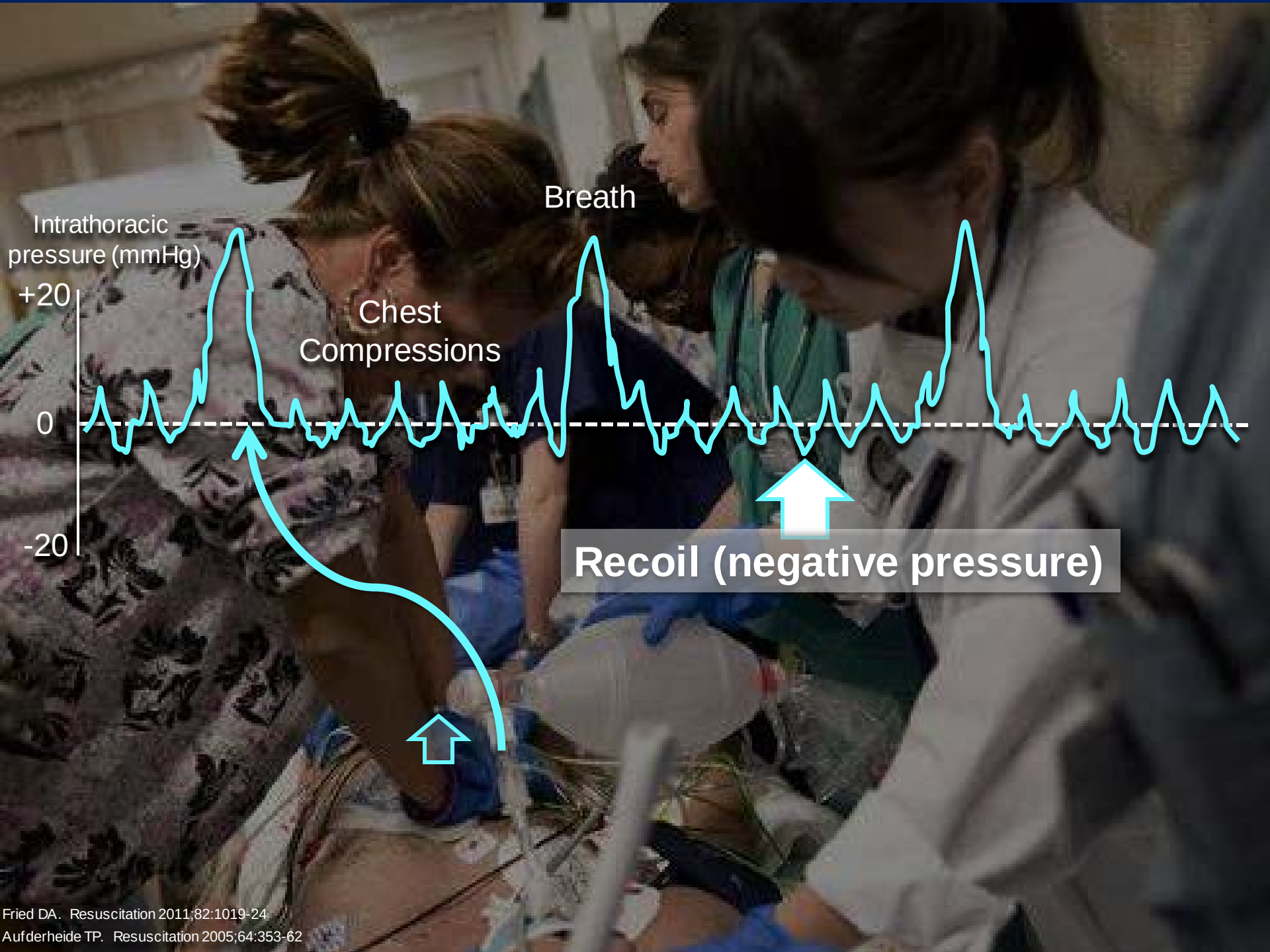
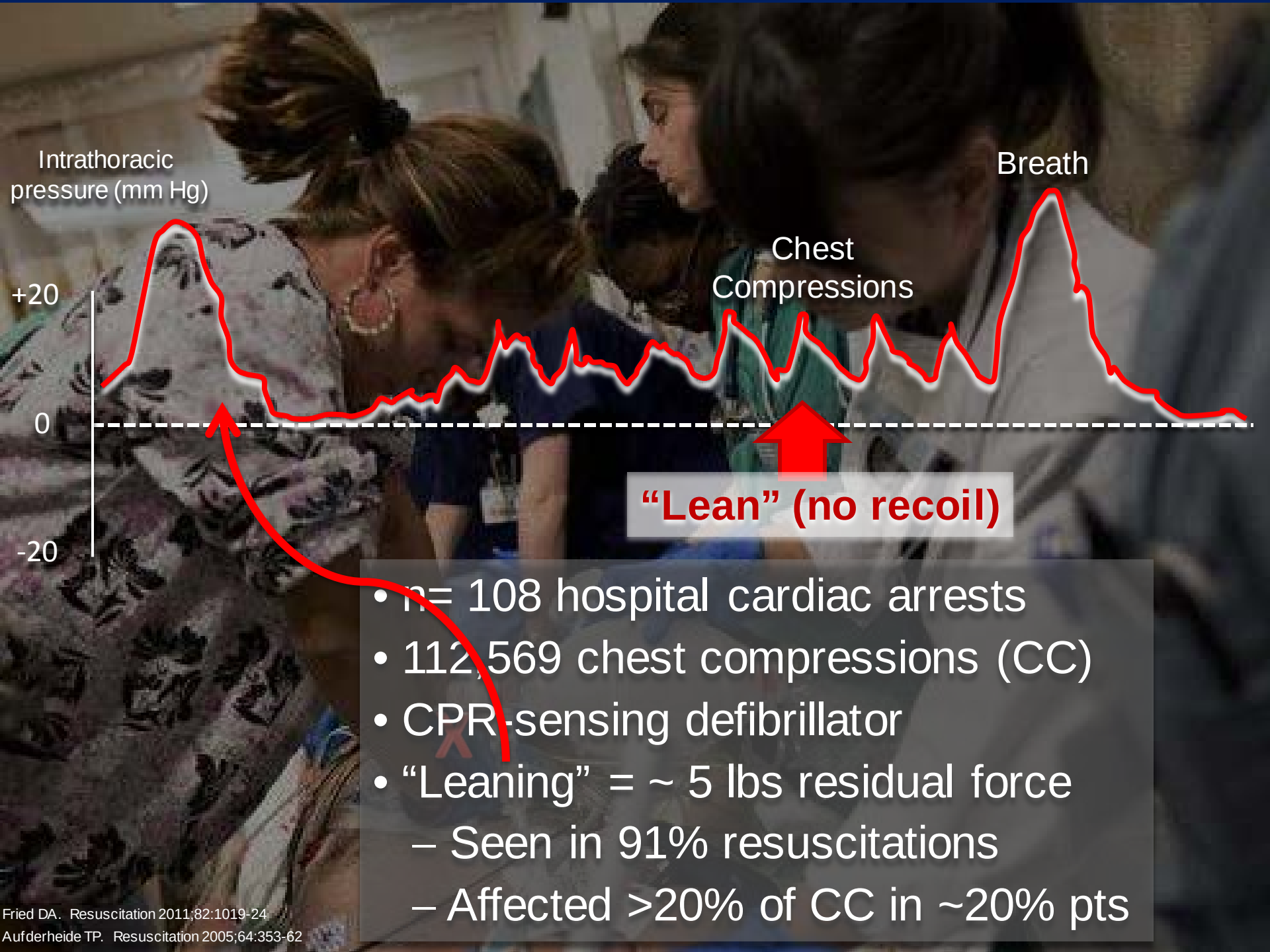


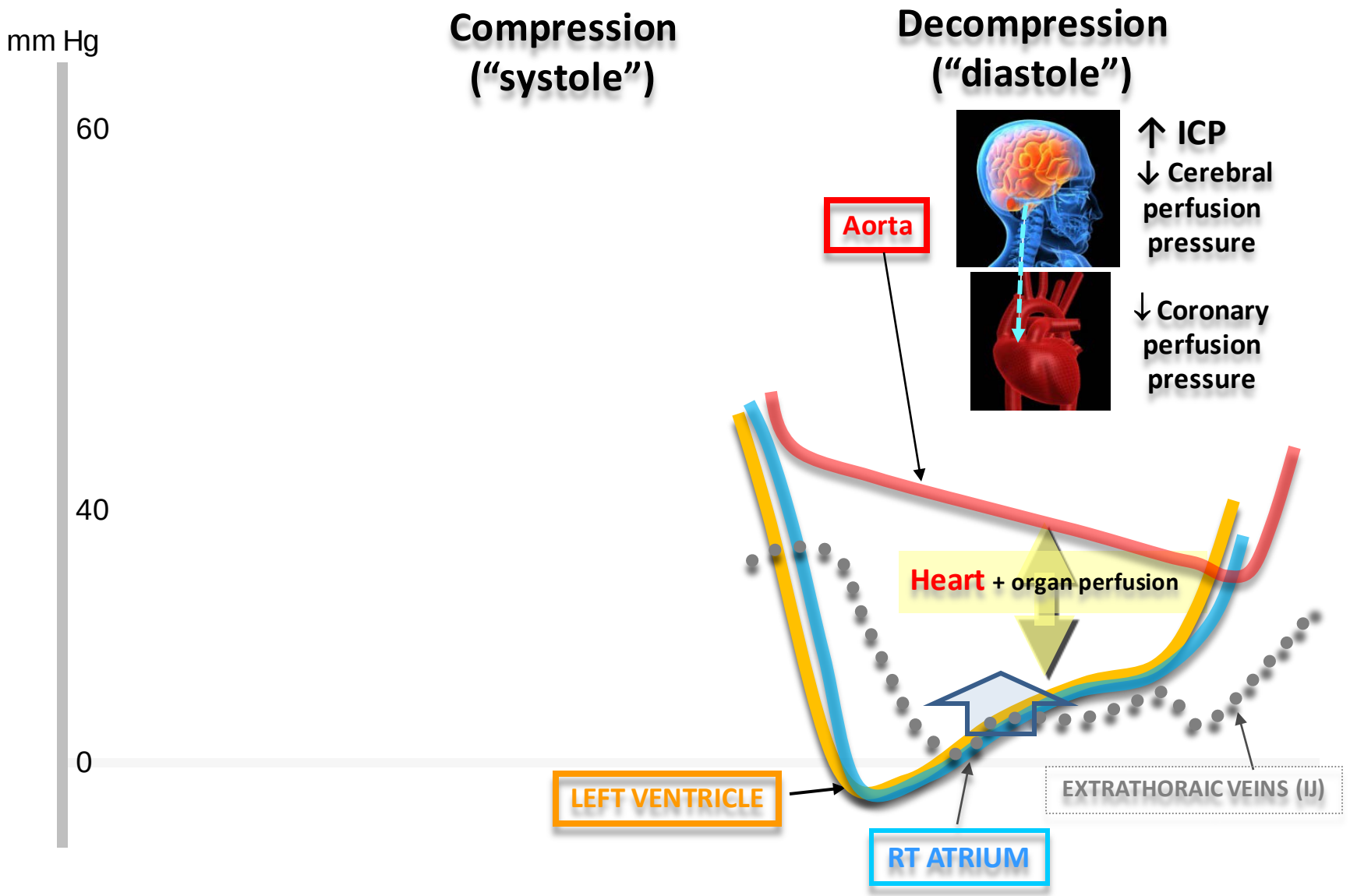
Fried DA. Resuscitation 2011;82:1019-24
Aufderheide TP. Resuscitation 2005;64:353-62



- n= 108 hospital cardiac arrests
- 112,569 chest compressions (CC)
- CPR-sensing defibrillator
- "Leaning" = ~ 5 lbs residual force
  - Seen in 91% resuscitations
  - Affected >20% of CC in ~20% pts

Fried DA. Resuscitation 2011;82:1019-24
Aufderheide TP. Resuscitation 2005;64:353-62

Hemodynamics of CPR



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Effects of incomplete chest wall decompression during cardiopulmonary resuscitation on coronary and cerebral perfusion pressures in a porcine model of cardiac arrest☆

Demetris Yannopoulos[a,b], Scott McKnite[a,c], Tom P. Aufderheide[d], Gardar Sigurdsson[a], Ronald G. Pirrallo[d], David Benditt[b], Keith G. Lurie[a,b,c,*]

n=9 instrumented swine

- 6 minutes untreated VF → Standard CPR* x 3 min

→ CPR with 75% recoil x 1 min (residual 1.2 cm sternal compression @ end decompression)

→ Standard CPR* x 1 min → Defib x 3 → ACLS

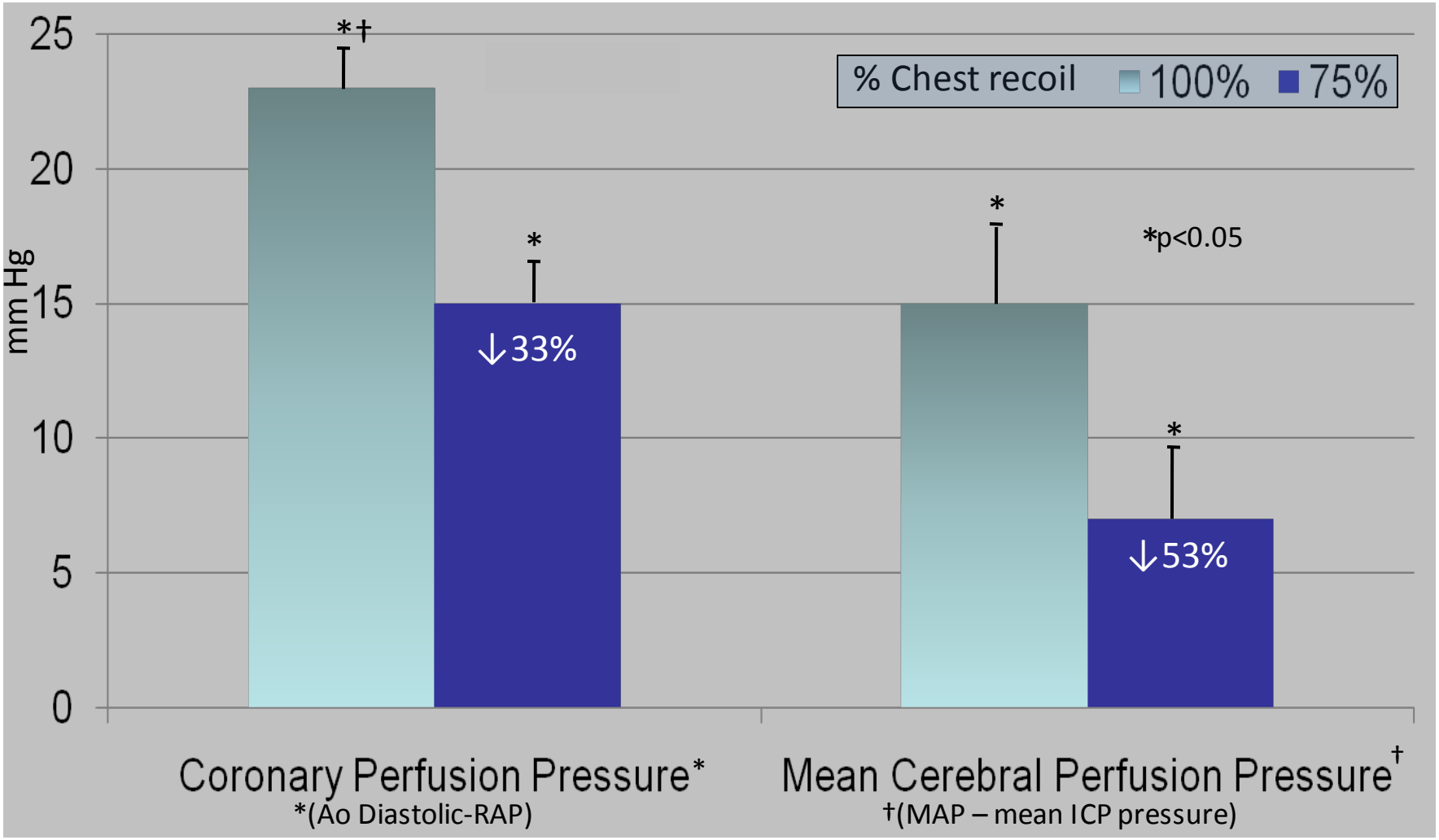
- Measure coronary, cerebral perfusion pressures

*Standard CPR = CC @100/min, 50% duty cycle, 5 cm depth, full (100%) recoil, 15:2 ratio

Yannopoulos D et al. Resuscitation 2005;64:363-72

Effect of Incomplete Chest Decompression On Coronary and Cerebral Perfusion Pressures

n=9 instrumented swine → std CPR (100% recoil) x 3' → CPR (75% recoil) x 1'



Yannopoulos D et al. Resuscitation 2005;64:363-72; Paradis et al JAMA 1990;263:3257-8

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RESUSCITATION
ACADEMY