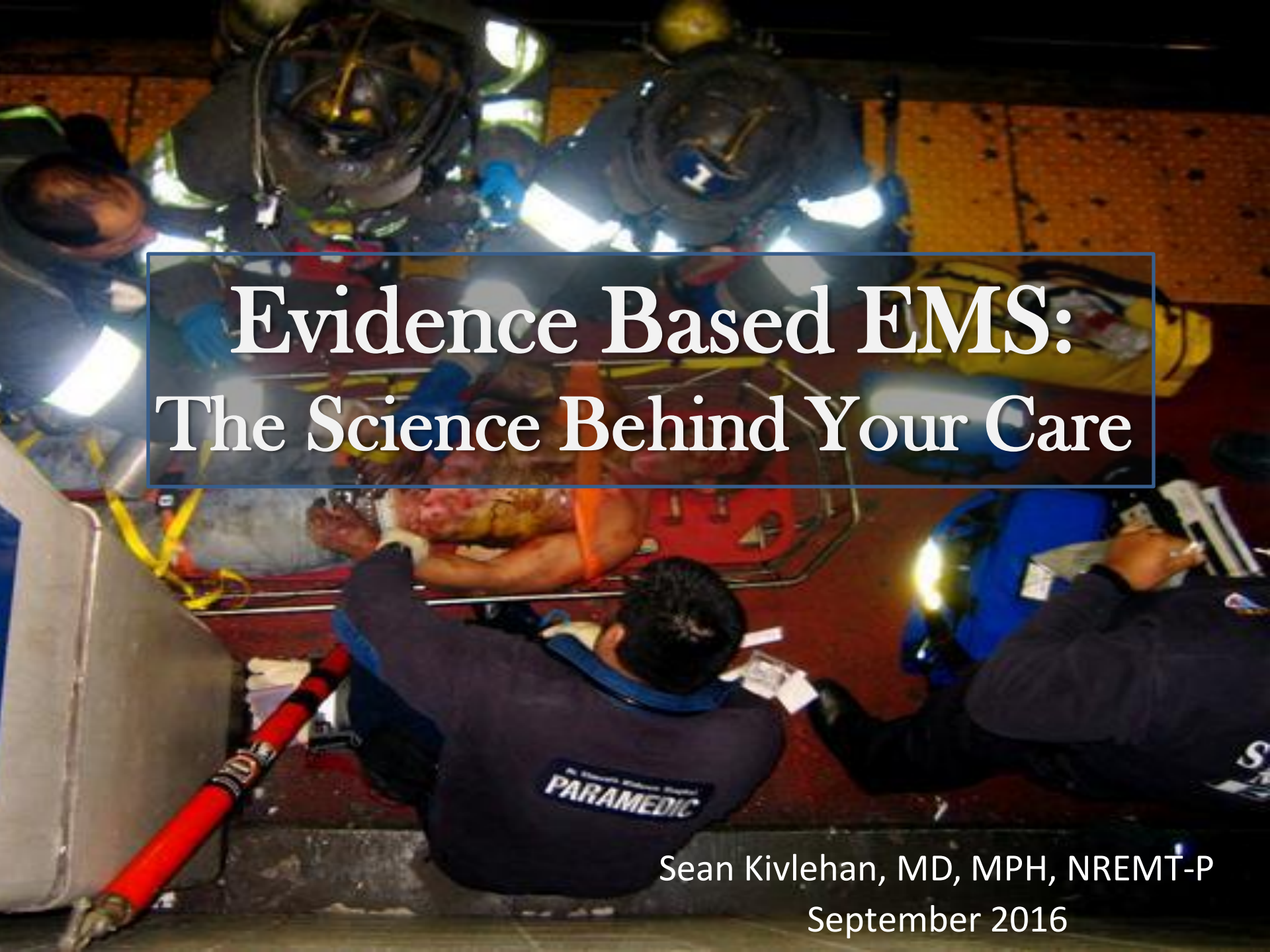
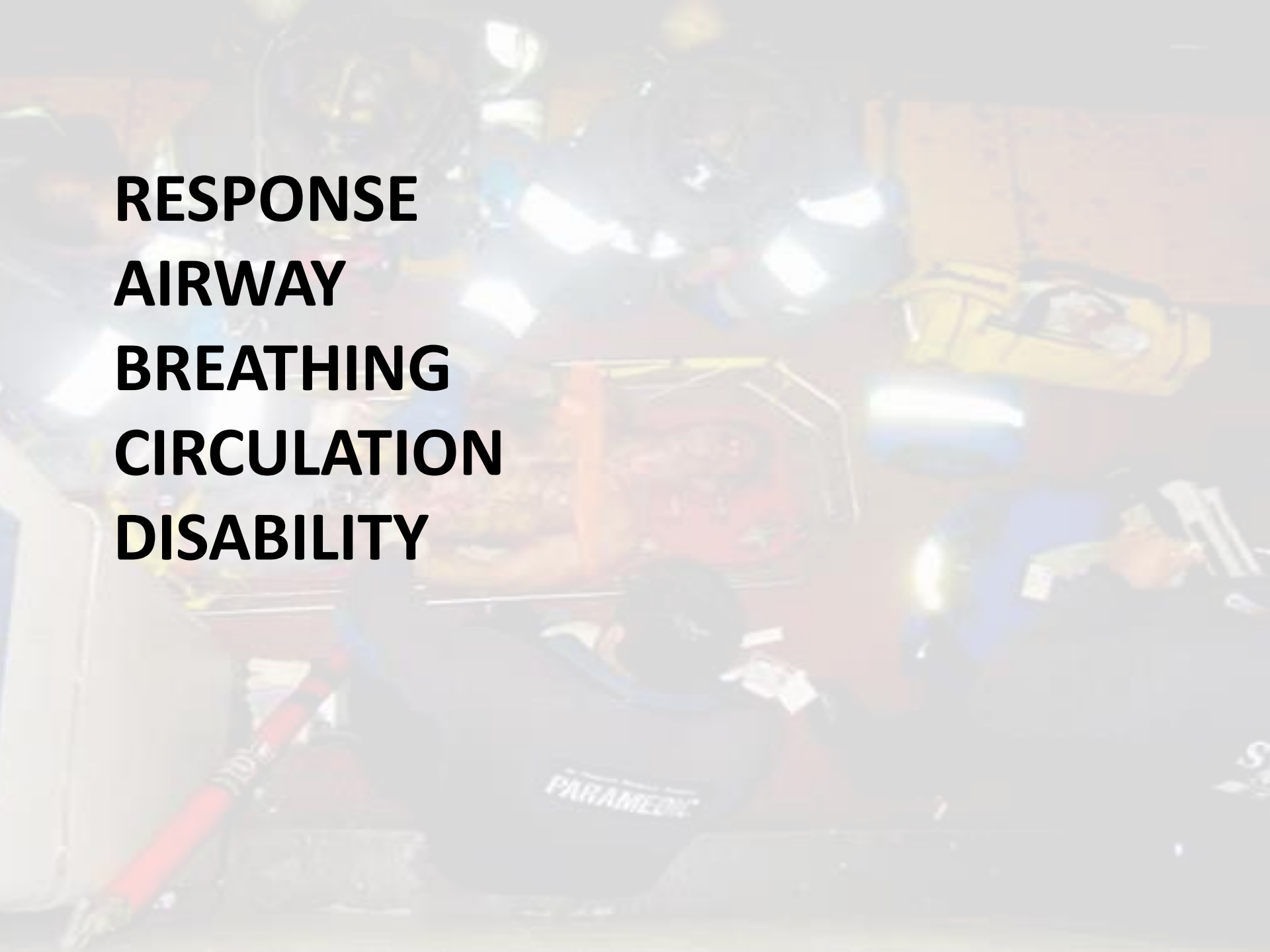


Evidence Based EMS:
The Science Behind Your Care

Sean Kivlehan, MD, MPH, NREMT-P

September 2016



RESPONSE
AIRWAY
BREATHING
CIRCULATION
DISABILITY

RESPONSE

AIRWAY

BREATHING

CIRCULATION

DISABILITY

“Less than or equal to 8 minutes at least 90% of the time”

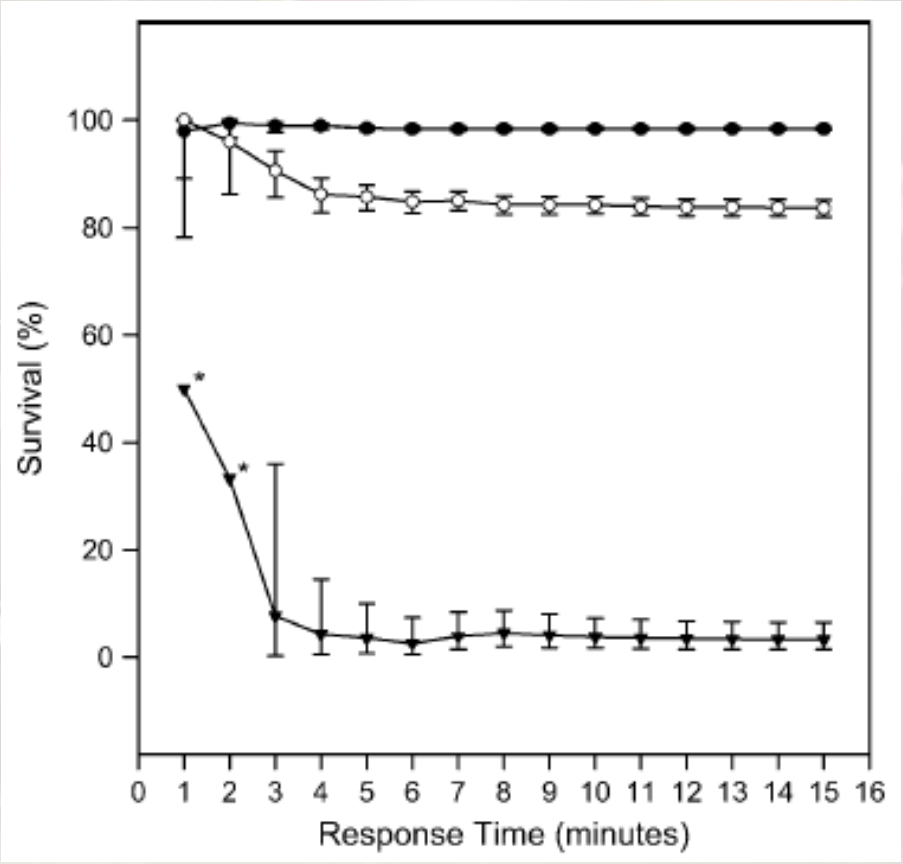
- 1979 study only looking at cardiac arrest
- Somehow generalized to everything
- Likely irrelevant even for arrests now with PAD programs (to their credit)

Eisenberg, *JAMA* 1979

Paramedic Response Time: Does It Affect Patient Survival?

Denver EMS, 1998 – all calls (49,851)

- Survival benefit for < 4min, but not 8
- High risk – arrests
- Medium risk:
  - Suicide
  - Exposures
  - Uncon
  - Diff breather
  - Hypotension



Pons, *Acad Emerg Med* 2005

The Golden Hour

3,656 trauma patients in 146 agencies

- SBP <90
- RR <10 or >29
- GCS <13
- Advanced airway intervention

Newgard, *Ann Emerg Med* 2010

Adjusted ORs for mortality, using EMS intervals (in minutes) among injury subgroups*

Subgroup/Strata	n	Total EMS Interval	Activation Interval	Response Interval	On-Scene Interval	Transport Interval
Ground	3,498	1.00 (0.99-1.01)	1.00 (0.95-1.05)	1.00 (0.96-1.04)	1.00 (0.98-1.01)	1.00 (0.99-1.01)
Air	158	0.97 (0.91-1.02)	0.67 (0.25-1.79)	1.00 (0.87-1.16)	1.03 (0.97-1.09)	0.93 (0.86-1.02)
Blunt	2,716	1.00 (0.99-1.005)	1.00 (0.95-1.05)	1.01 (0.97-1.06)	0.99 (0.98-1.01)	0.99 (0.98-1.01)
Penetrating	807	1.01 (0.99-1.04)	1.01 (0.73-1.39)	1.03 (0.94-1.13)	1.02 (0.99-1.05)	1.01 (0.96-1.06)
TBI (GCS score ≤8)	1,145	0.99 (0.98-1.003)	0.92 (0.82-1.03)	0.98 (0.93-1.04)	0.99 (0.98-1.01)	0.99 (0.97-1.01)
Shock (SBP ≤70, or SBP 71-90 with pulse rate ≥108 beats/min)	1,483	0.99 (0.98-1.01)	0.86 (0.68-1.10)	1.02 (0.95-1.09)	1.00 (0.98-1.03)	0.97 (0.94-1.001)
Advanced airway management	945	0.99 (0.98-1.01)	1.05 (0.95-1.16)	0.97 (0.89-1.05)	1.00 (0.98-1.02)	0.98 (0.96-1.01)
Revised Trauma Score ≤2	79	1.01 (0.94-1.09)	1.79 (0.49-6.50)	1.32 (0.51-3.44)	1.00 (0.93-1.08)	1.09 (0.87-1.36)
BLS first arriving	1,803	1.01 (0.99-1.02)	1.03 (0.97-1.10)	0.99 (0.94-1.05)	1.01 (0.99-1.03)	1.00 (0.997-1.003)
ALS first arriving	1,853	0.99 (0.98-1.002)	0.76 (0.60-0.96)	1.01 (0.96-1.06)	0.99 (0.97-1.01)	0.99 (0.97-1.001)
Elders (≥65 y)	472	1.00 (0.99-1.02)	1.02 (0.96-1.07)	0.98 (0.89-1.07)	1.00 (0.97-1.03)	1.03 (0.996-1.06)
United States	2,610	0.99 (0.98-1.004)†‡	1.04 (0.97-1.11)	1.04 (0.98-1.09)	0.99 (0.97-1.01)	0.99 (0.97-1.01)
Canada	1,046	1.00 (0.99-1.01)	0.94 (0.85-1.04)	0.97 (0.91-1.03)	1.00 (0.98-1.02)	1.00 (0.98-1.02)
Overall	3,656	1.00 (0.99-1.01)	1.00 (0.95-1.05)	1.00 (0.97-1.04)	1.00 (0.99-1.01)	1.00 (0.98-1.01)

No association btw time & mortality for any EMS intervention (OR 1.00, 95% CI 0.95-1.05)

Response, On-Scene, Transport, total EMS time

Not so fast (or slow…)

- Orange County 1996-2009
  - 19,167 patients; 84% blunt, 16% penetrating

Covariates	OR (95% CI)	
Scene time, min	Blunt	Penetrating
0–9	Reference	Reference
≥10–19	0.88 (0.65–1.18)	1.19 (0.66–2.16)
≥20	0.88 (0.57–1.37)	2.90 (1.09–7.74)
Transport time, min	Blunt	Penetrating
0–9	Reference	Reference
≥10–19	1.04 (0.78–1.40)	0.64 (0.35–1.15)
≥20	1.16 (0.76–1.78)	0.40 (0.14–1.19)

McCoy, *Ann Emerg Med* 2013

How Many Ambulance Accidents per Year?

A. 1,000
B. 5,000
C. 10,000
D. 20,000
E. 30,000

Risk vs Benefit

- Only condition in which rapid EMS response shown to improve survival:

Nontraumatic Cardiac Arrest

- Risk of Lights & Sirens to public
  - 12,000 ambulance accidents/year
  - 75,000 “wake effect accidents”

Clawson, *JEMS* 1991; Waldran, *Analysis of Red Lights & Sirens* 2008

CDC Report, 1991-2000

- 300 fatal ambulance accidents
  - 816 ambulance occupants involved, 82 died.
  - 275 occupants of other vehicles or pedestrians killed
- Injury rate for EMS personnel in the United States is 12.7 per 100,000 workers
  - “more than twice the national average.”

MMWR, 2003

L&S time difference

Responding ambulance followed by chase car (<u>urban</u>):

- 64 runs: 38.5% (3.02 minutes) time savings utilizing red lights and sirens

  [Ho & Casey, *Ann Emerg Med* 1998]

Responding ambulance followed by chase car (<u>rural</u>):

- 67 runs: 30.9% (3.63 minute) time savings

  [Ho & Lindquist *Prehosp Emerg Care* 2001]

Likely inflated numbers

  – disrupted traffic patterns from initial ambulance response.

Removing Confounders

- Off-duty paramedic drives identical ambulance:
  - Same route, same time of day

Study #1: 43.5 seconds saved

Study #2: 1 minute and 46 seconds saved

"While statistically significant, this time saving is likely to be clinically relevant in only a very few cases."

Hunt, Brown, Cabinum, et al, *Ann Emerg Med* 1995
Brown, Whitney, Hunt, Addario, and Hogue, *Prehosp Emerg Care,* 2000

Helicopters

- Advantages:
  - Faster transport
  - Expert care both enroute & on arrival
- Disadvantages:
  - Cost
  - Safety

Cochrane Review, 2013

- 25 studies
- Overall the quality of the included studies was low

"Helicopter transport for some trauma patients may be beneficial for a variety of reasons and more research is required to determine what elements of helicopter transport help improve outcomes."

Sampling of Studies

Stewart (AEM 2011): Decreased mortality for critical patients but extensive overtriage w/no benefit (Oklahoma)

de Jongh (Injury 2012): Increased mortality for TBI patients due to transport time, no sig outcome change for all others (Netherlands)

Taylor (BMC EM 2013): Overtriage, majority of patients have minor injuries (Australia)

What percentage are discharged from the ER?

1. 10%
2. 15%
3. 20%
4. 25%
5. 30%

Bledsoe, *J Trauma* 2006

What percentage are discharged from the ER?

1. 10%
2. 15%
3. 20%
4. **25%**
5. 30%

Bledsoe, *J Trauma* 2006

Flight Paramedic Dies from Injuries in Medical Helicopter Crash

10/23/2014 09:51 AM 10/23/2014 11:21 AM

Pro Argument

Galvagno (JAMA 2012): Reduced mortality in major trauma (Maryland)

- *65 transports to save 1 life*
- *Cost per flight $5,000*
- *Cost per life $325,000*

What should be done in the field

(and what shouldn't be)


RESPONSE
AIRWAY
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DISABILITY

AIRWAY

INTUBATION

ETI vs SGA

Witnessed nontraumatic OHCA x4 years in Japan

5,377 patients

Favorable neuro outcome **3.6% vs 3.6%**

Longer time to placement for ETI: 17.2 vs 15.8 min ($p<0.001$)

Kajino, *Crit Care* 2011

“Out of Hospital Airway Management in the United States”

NEMSIS data from 16 states in 2008

4.3 million EMS calls

10,356 ETI: success 77%

(Hubble, 2010 showed 86.3% in meta-analysis of 30 studies)

1,794 alternate airways: success 87%

[Combitube, EOA, LMA, King LT]

Wang, *Resuscitation* 2011

"Out of Hospital Airway Management in the United States"

UPDATE

NEMSIS data from 40 states in 2012

19.8 million EMS calls

74,993 ETI: success 85%

(Hubble, 2010 showed 86.3% in meta-analysis of 30 studies)

21,990 alternate airways: success 79%

[King LT 89%, EOA 38%]

Diggs, *Resuscitation* 2014

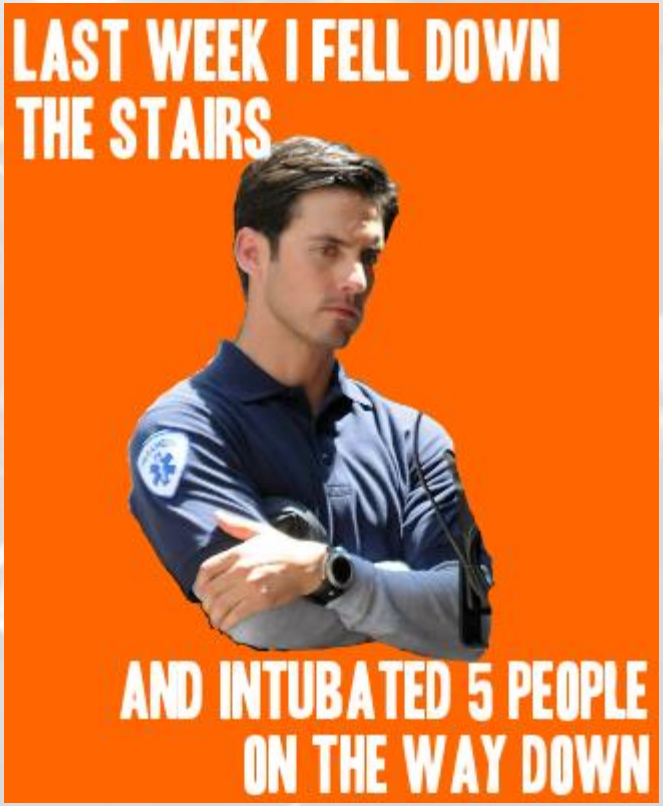
Japan Again

- 5 year observational study
- 649,359 patients
- 43% with airway
- WORSE neuro outcome
  - 1.1% vs 2.9% (OR 0.38)

Hasegawa, JAMA, 2013

Do It Right

- Need four providers
  - Team leader/intubator
  - Supplies & meds
  - Removing c-collar & holding cricoid
  - Holding in line stabilization
- SGA should be first line
- Capnography
- Effect of scene time



C-MAC Video Laryngoscope

- Higher first-pass rate
- Increased speed to intubation
- Reduced c-spine movement when compared with DL

Healy, *BMC Anest* 2012


RESPONSE
AIRWAY
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CIRCULATION
DISABILITY

BREATHING

OXYGEN

PNEUMOTHORAX

ACS Workup

1. Morphine
2. Oxygen
3. Nitro
4. Aspirin

Oxygen = Harm?

EMS providers administer oxygen during the initial assessment of patients with suspected ACS. However, there is insufficient evidence to support its routine use in uncomplicated ACS. If the patient is dyspneic, hypoxemic, or has obvious signs of heart failure, providers should titrate therapy, based on monitoring of oxyhemoglobin saturation, to ≥94% (Class I, LOE C).[36]

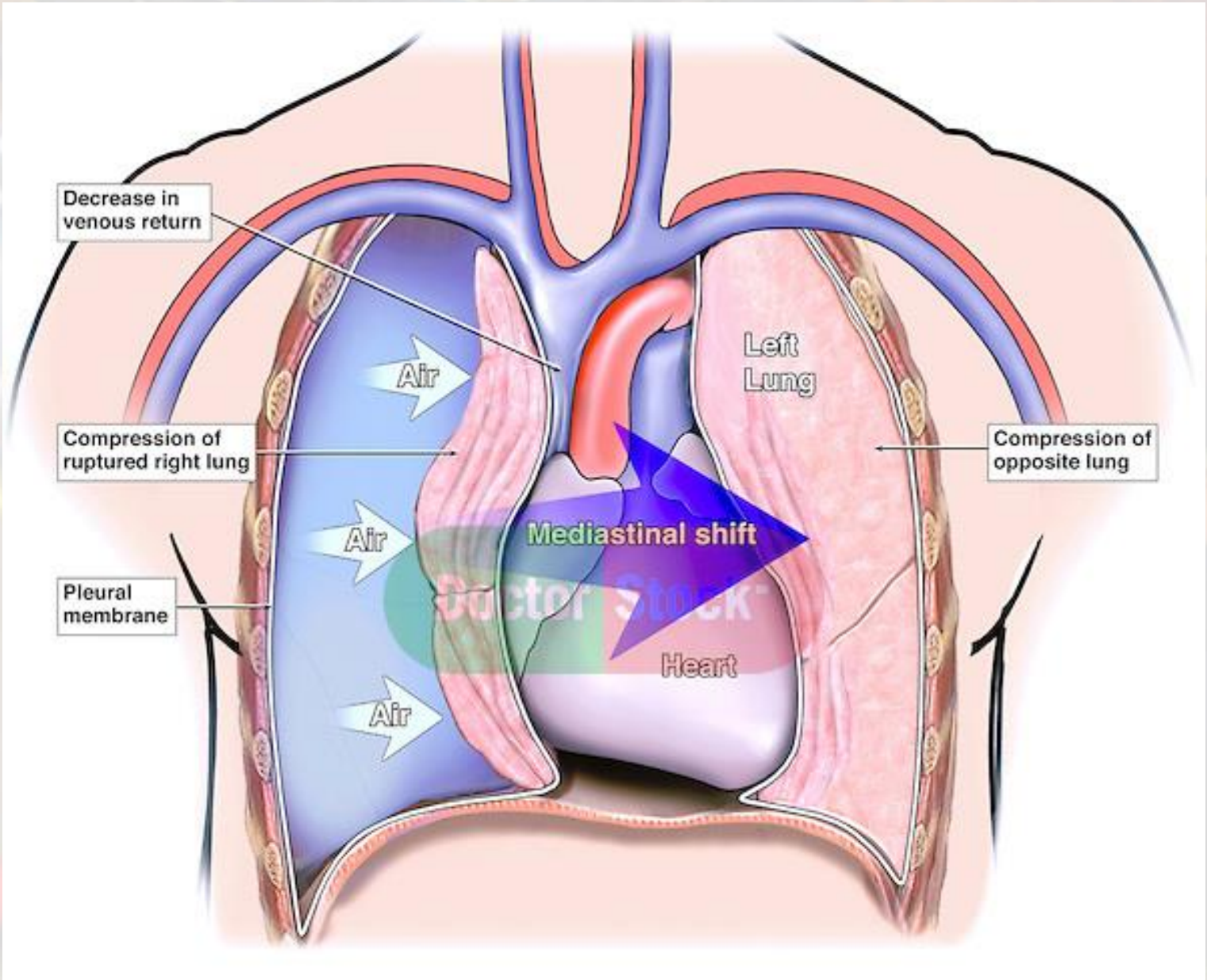
O'Conner, *Resuscitation* 2010; Cochrane Review 2013

BREATHING

OXYGEN

PNEUMOTHORAX

Tension Pneumothorax



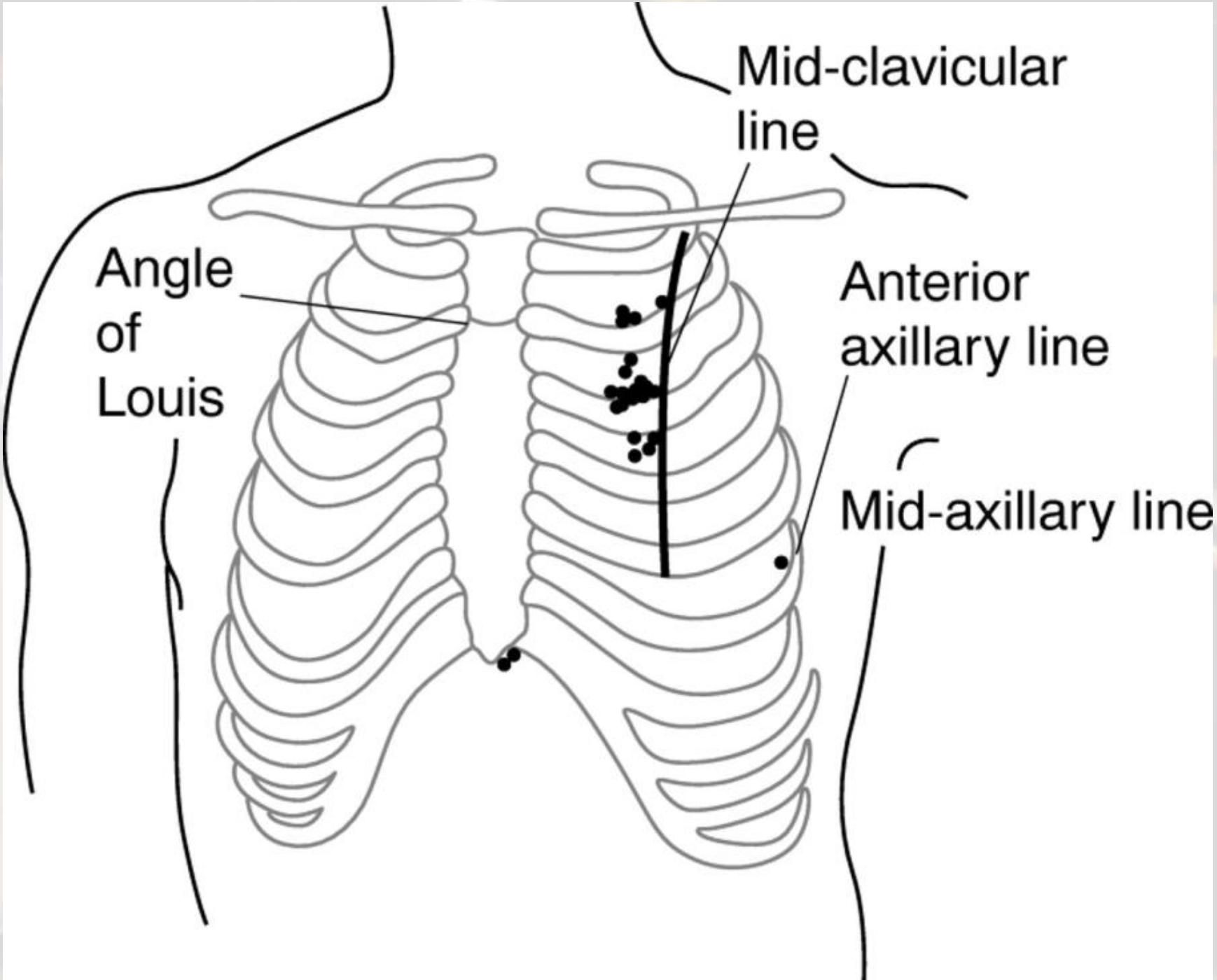
Length!

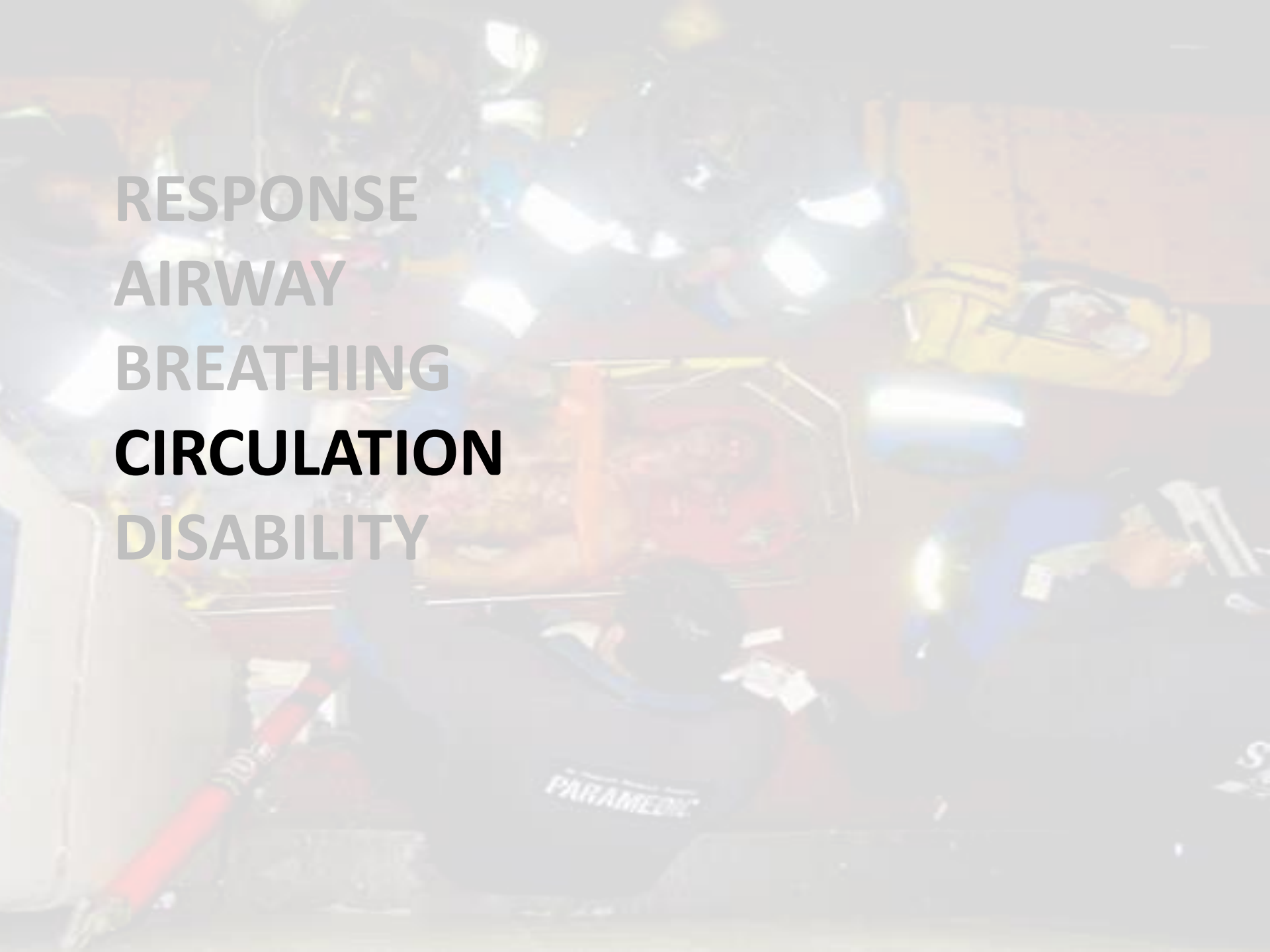
- Need AT LEAST 14 gauge,
- 3.25 inch long

Table 1 Mean Chest Wall Thickness (cm) in the Second Intercostal Space Midclavicular Line

	Right	Left
Female	3.84 ± 1.17	3.92 ± 1.42
Male	3.41 ± 1.04	3.37 ± 0.99
p value	<0.0001	<0.0001

Source: Academic Life in EM


Mid-clavicular line
Angle of Louis
Anterior axillary line
Mid-axillary line


RESPONSE
AIRWAY
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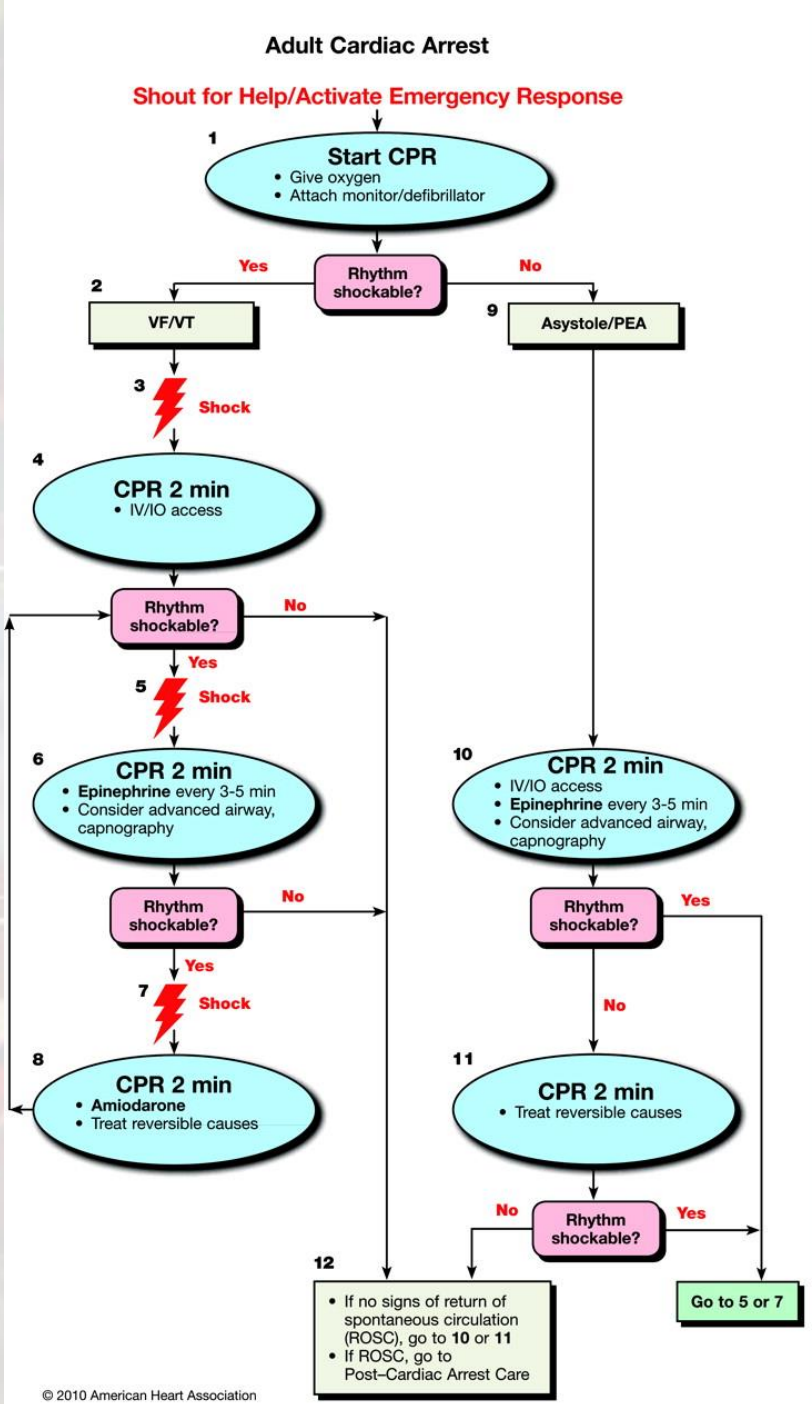
Adult Cardiac Arrest



CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy
- **Epinephrine IV/IO Dose:** 1 mg every 3-5 minutes
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- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.

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- Supraglottic advanced airway or endotracheal intubation
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- 8-10 breaths per minute with continuous chest compressions

Reversible Causes
- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
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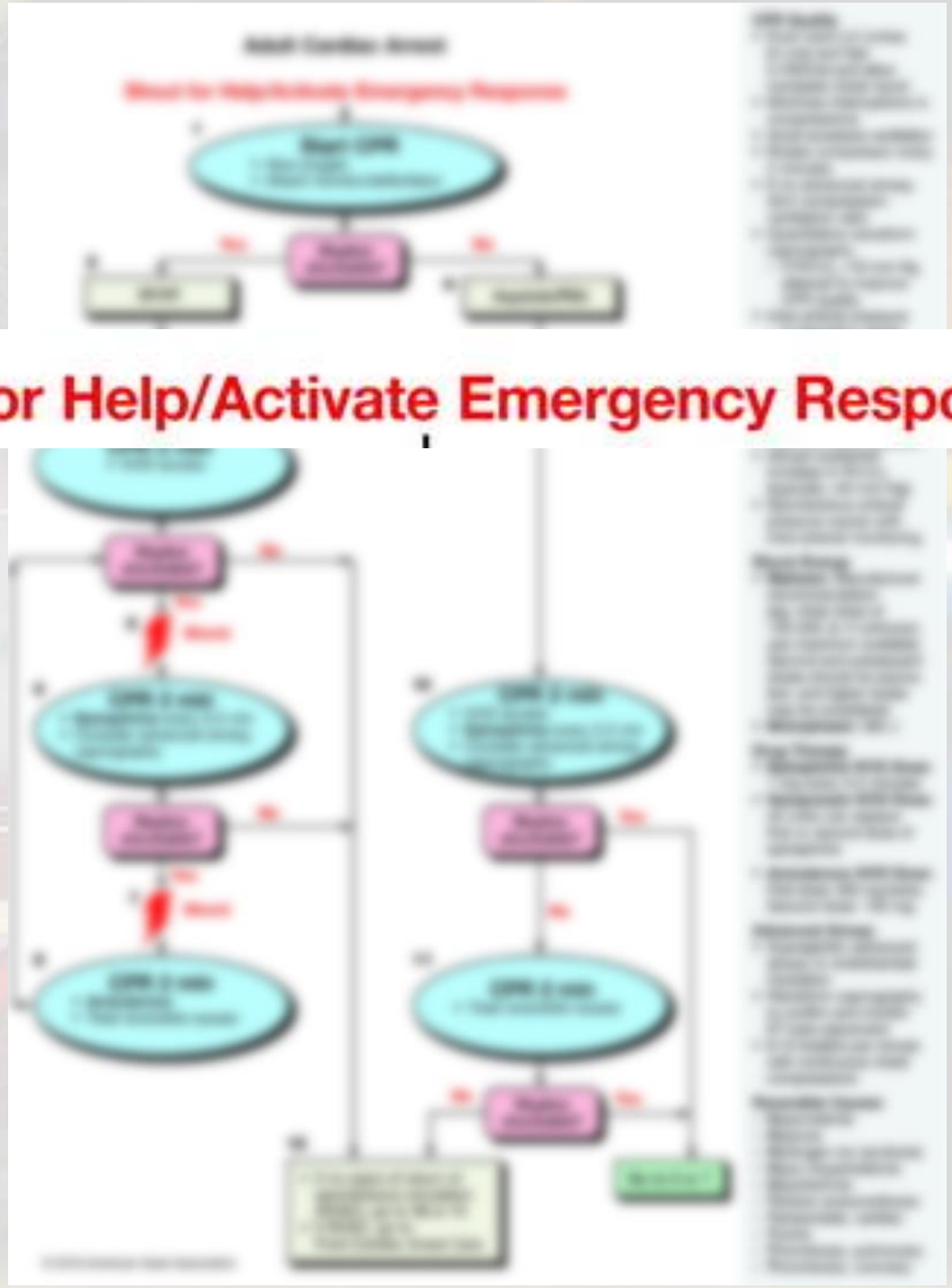
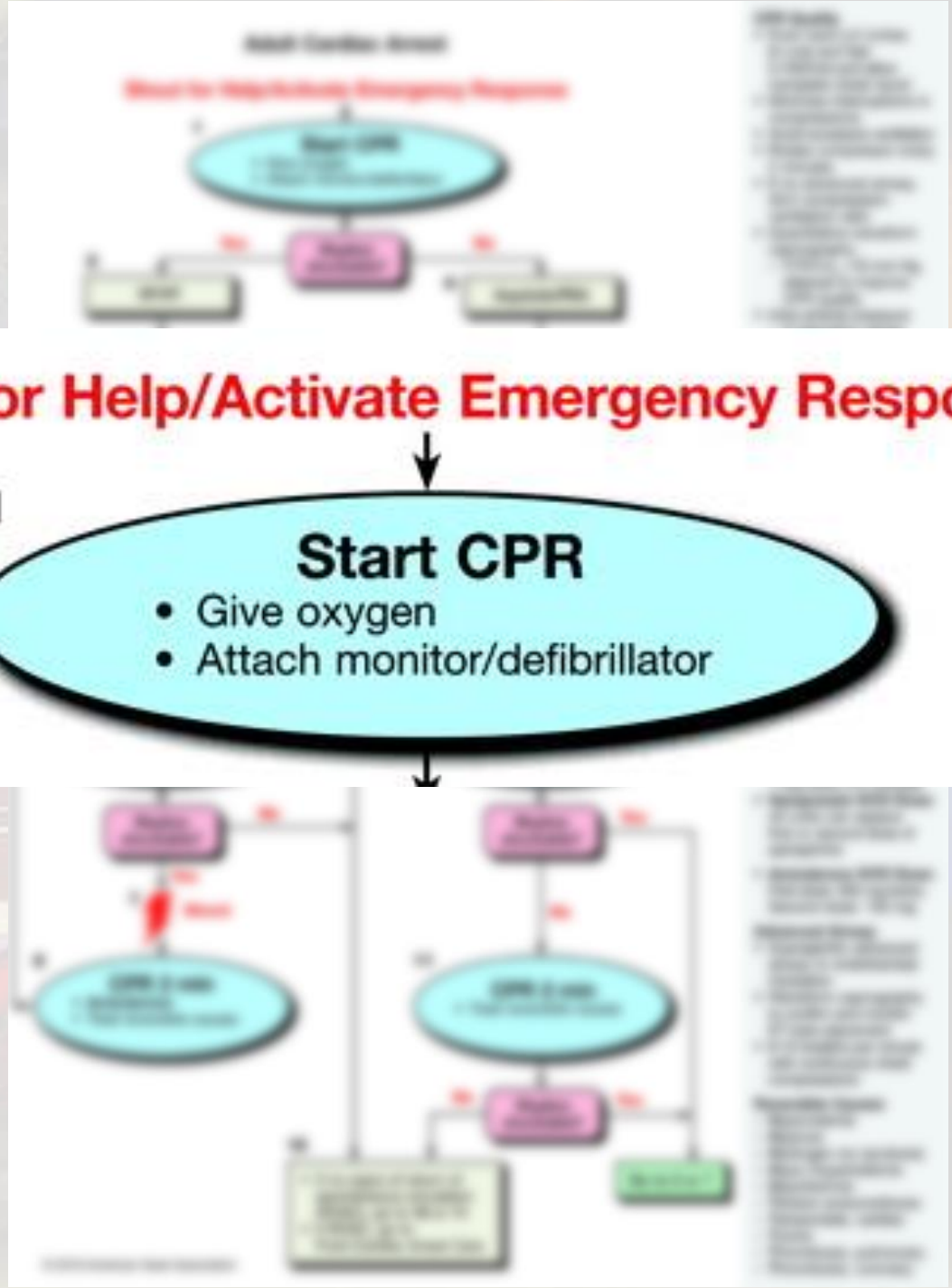
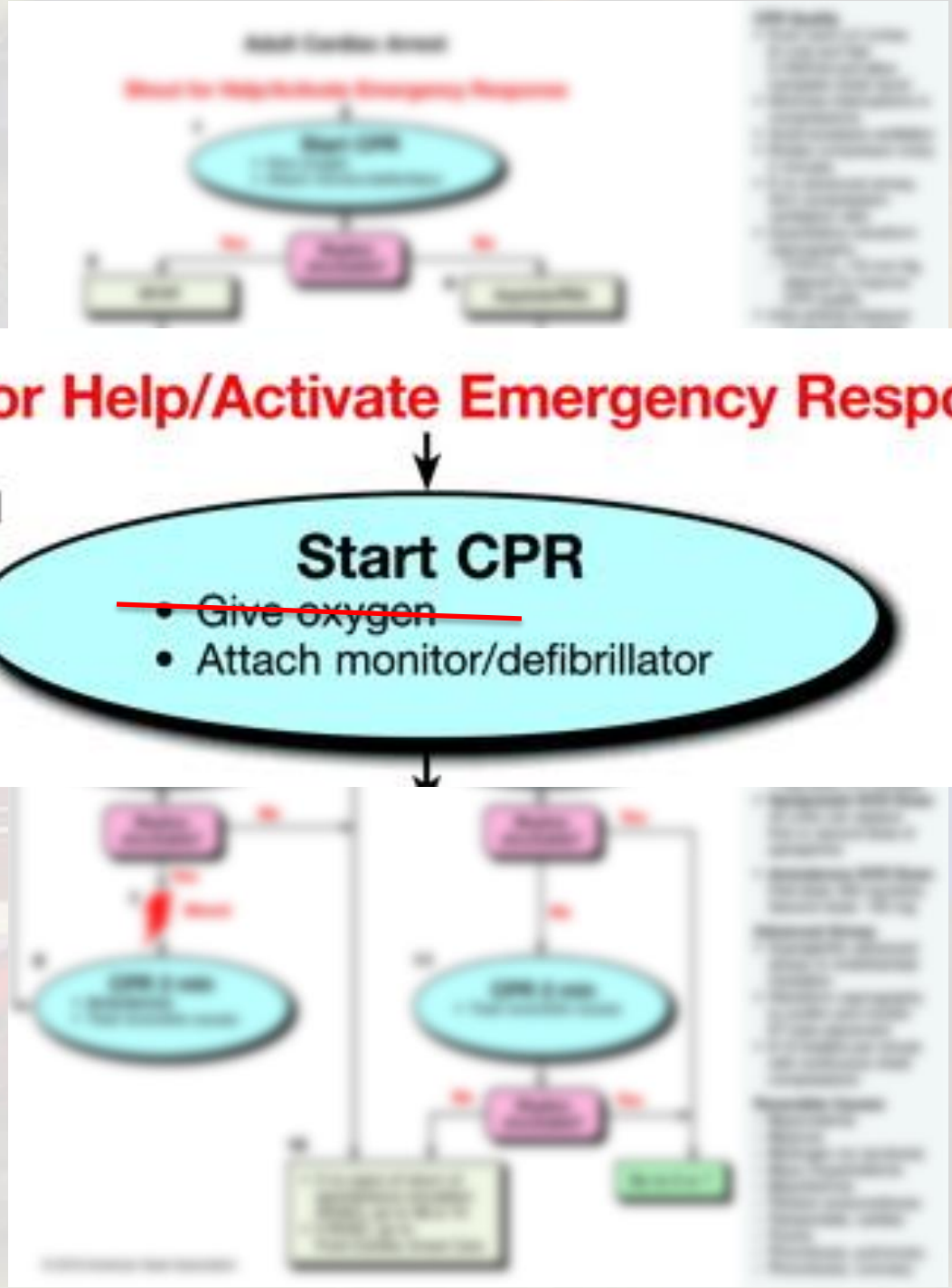


Shout for Help/Activate Emergency Response


Shout for Help/Activate Emergency Response
1
Start CPR
• Give oxygen
• Attach monitor/defibrillator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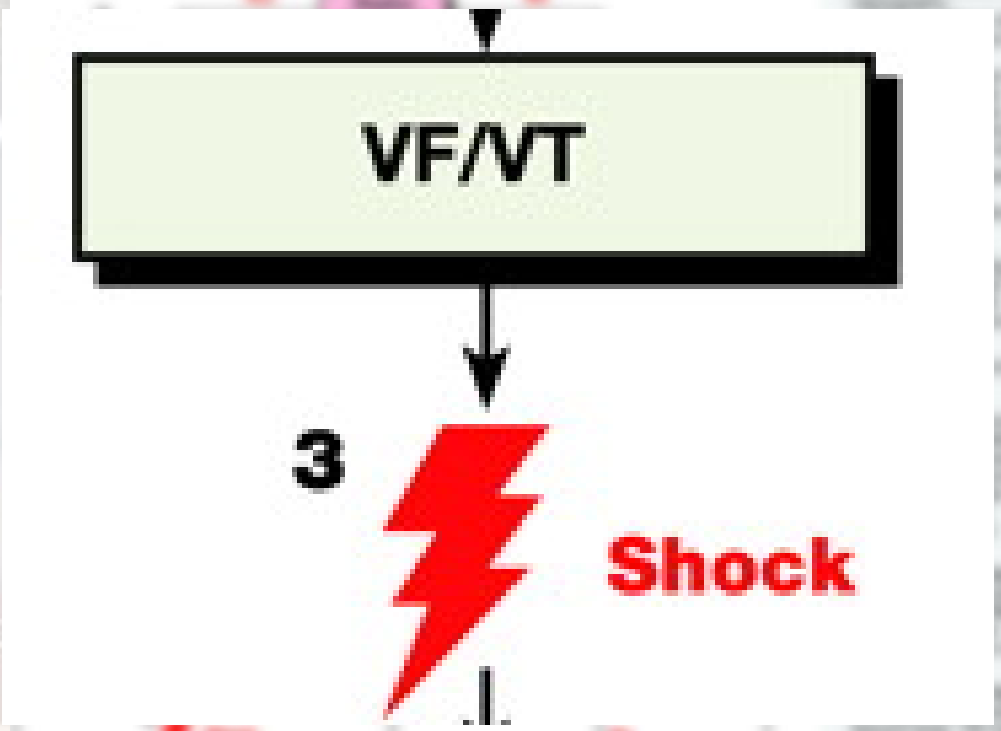
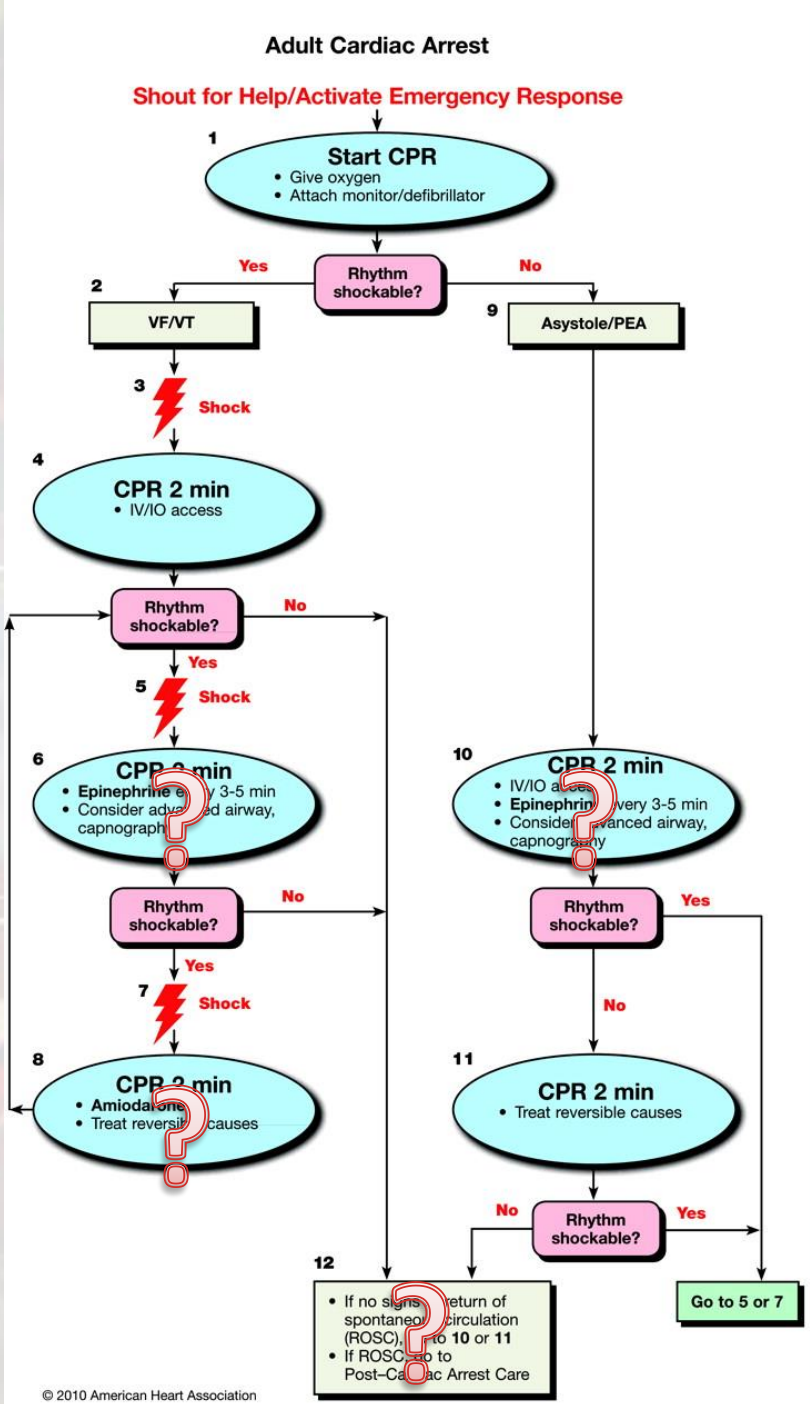

VF/VT
3
Shock

Adult Cardiac Arrest



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- **T**hrombosis, coronary

CIRCULATION

CAPNOGRAPHY

COMPRESSIONS

HYPOTHERMIA

ACCESS

MEDICATIONS

Question

What is the stronger predictor of ROSC?

A: Witnessed Arrest

B: Initial ETCO2 of 13

Termination & Capnography

Associated with ROSC:

- Witnessed Arrest (OR = 1.51)
- Initial EtCO2 >10 (OR = 4.79)

No ROSC:

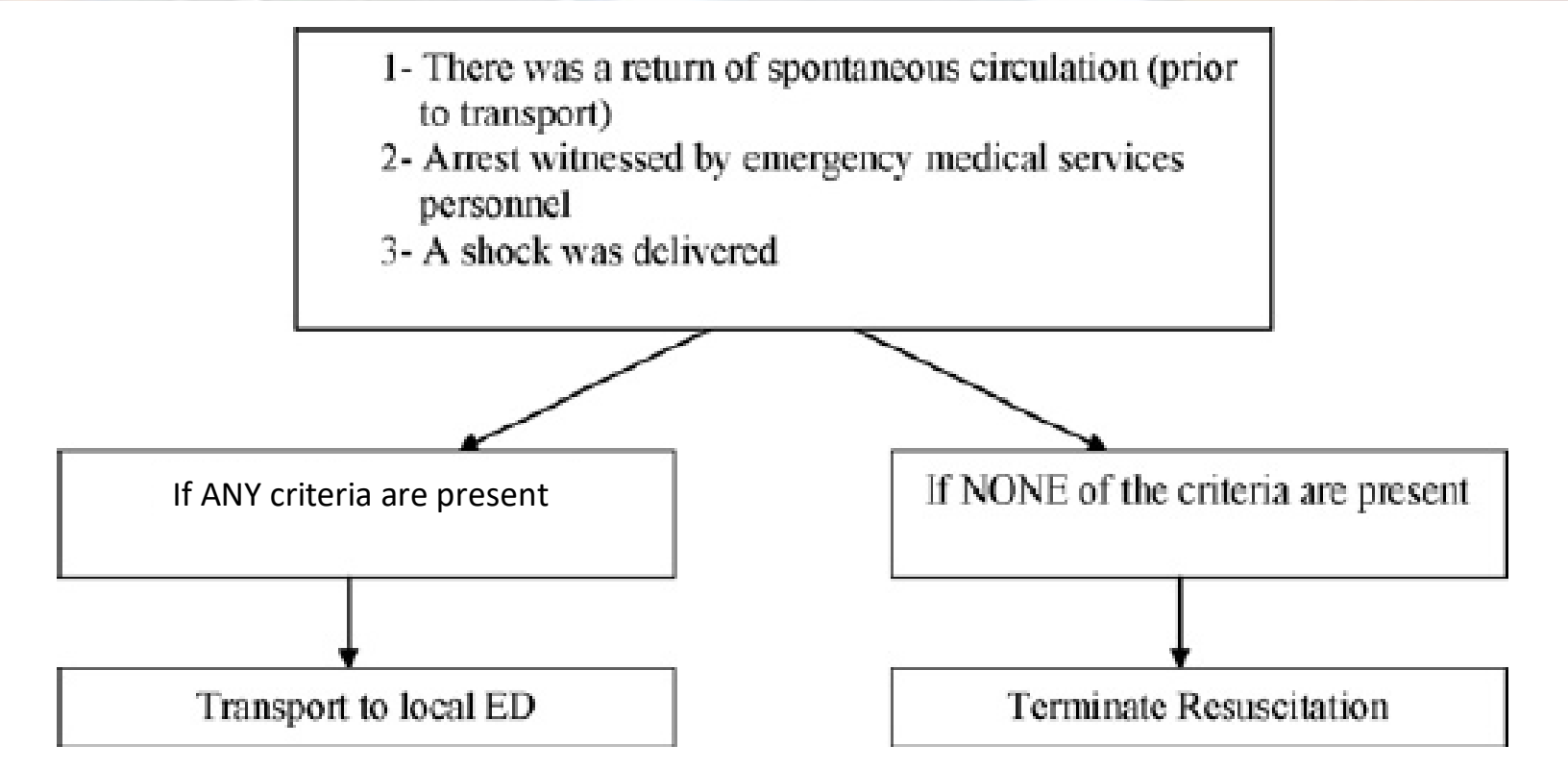
- No bystander CPR, unwitnessed collapse, non-VF/VT arrest, initial EtCO2 <10
- 97% predictive of no ROSC

Eckstein, *Prehosp Dis Med* 2011

Who Would Call It?

- 65F in cardiac arrest
- Witnessed
- Immediate bystander CPR
- VF earlier, shocked x1, asystole since
- ACLS per protocol
- Intubated, PIV
- 24 minutes down time
- EtCO2 8

Termination Rules



But, How Long?

Morrison, *Resuscitation* 2009

20 minutes?

150 patients in Washington in the 90's

EtCO2 @ 20 minutes

Survivors: **32.8**

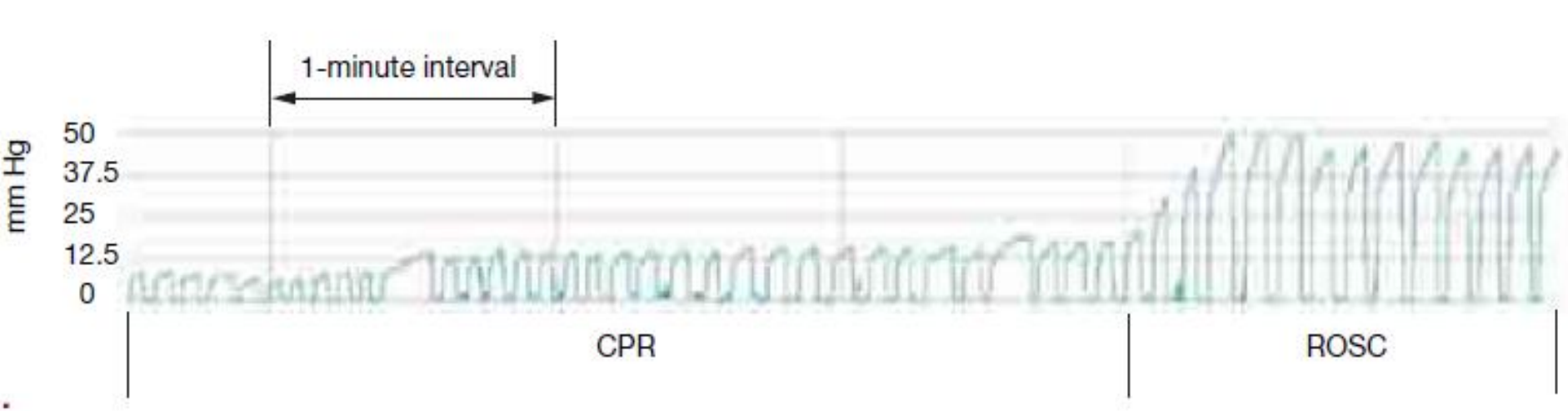
Non-survivors: **4.4**

Levine, *NEJM* 1997

Capnography

A guide to:

1. Likelihood of ROSC
   - GOOD: Abrupt & sustained increased to 35-40
   - BAD: <10 is a poor predict
2. Airway confirmation
3. CPR quality (Goal >20)



CIRCULATION

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CLOSED-CHEST CARDIAC MASSAGE

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

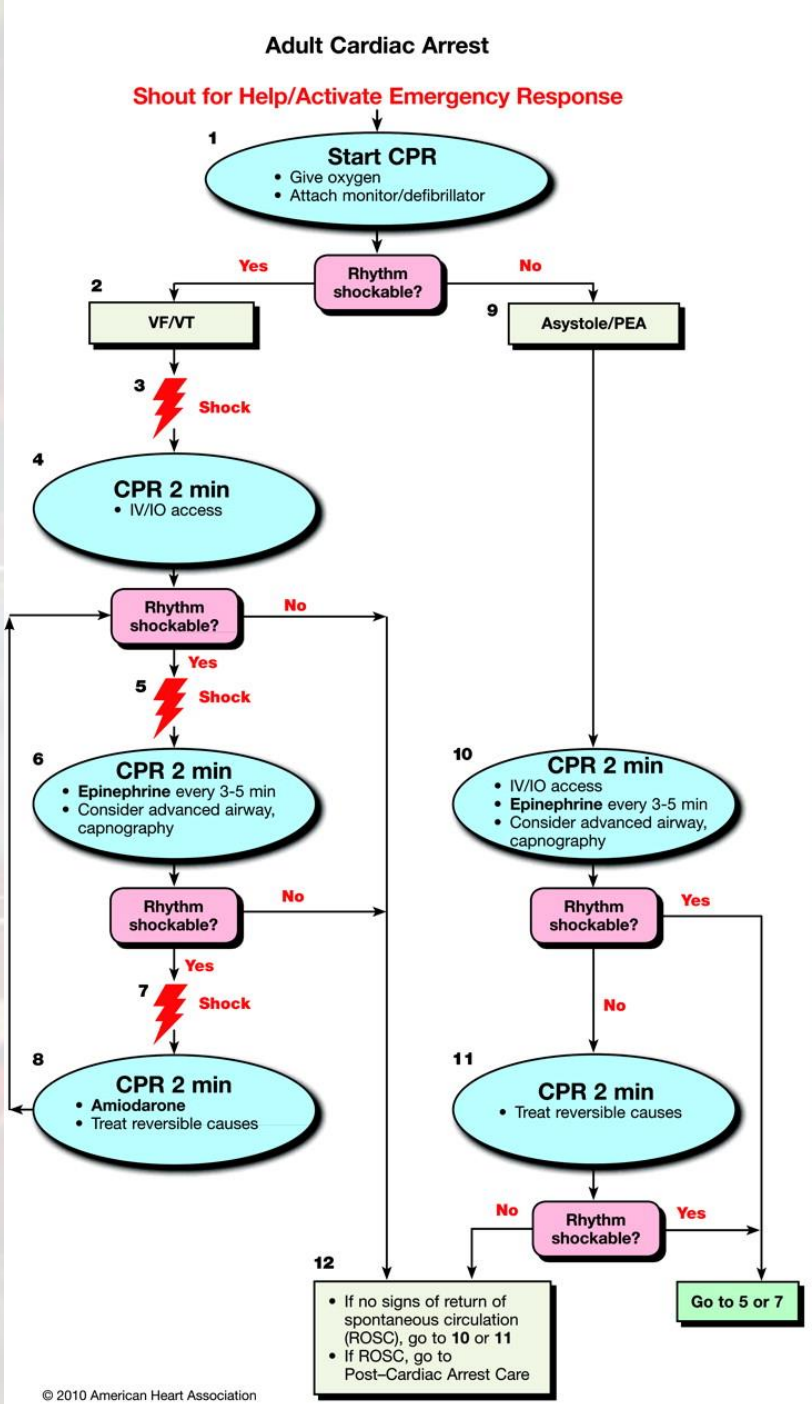
What they already knew:

Compressions affected ventilation

If alone, only do compressions

"Only the human hand is required"

Adult Cardiac Arrest



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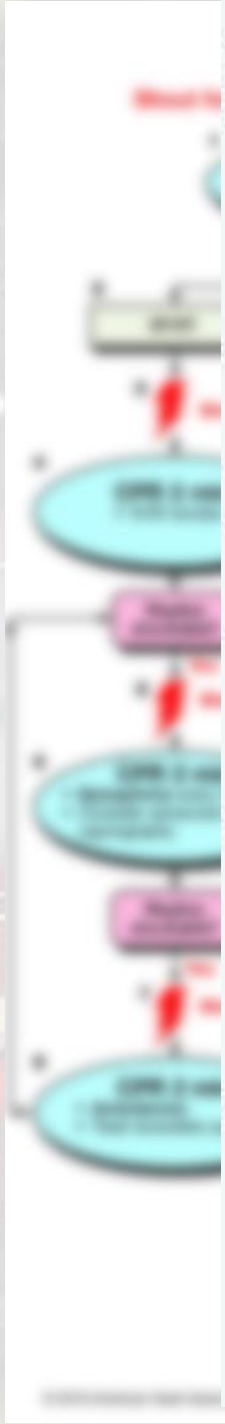

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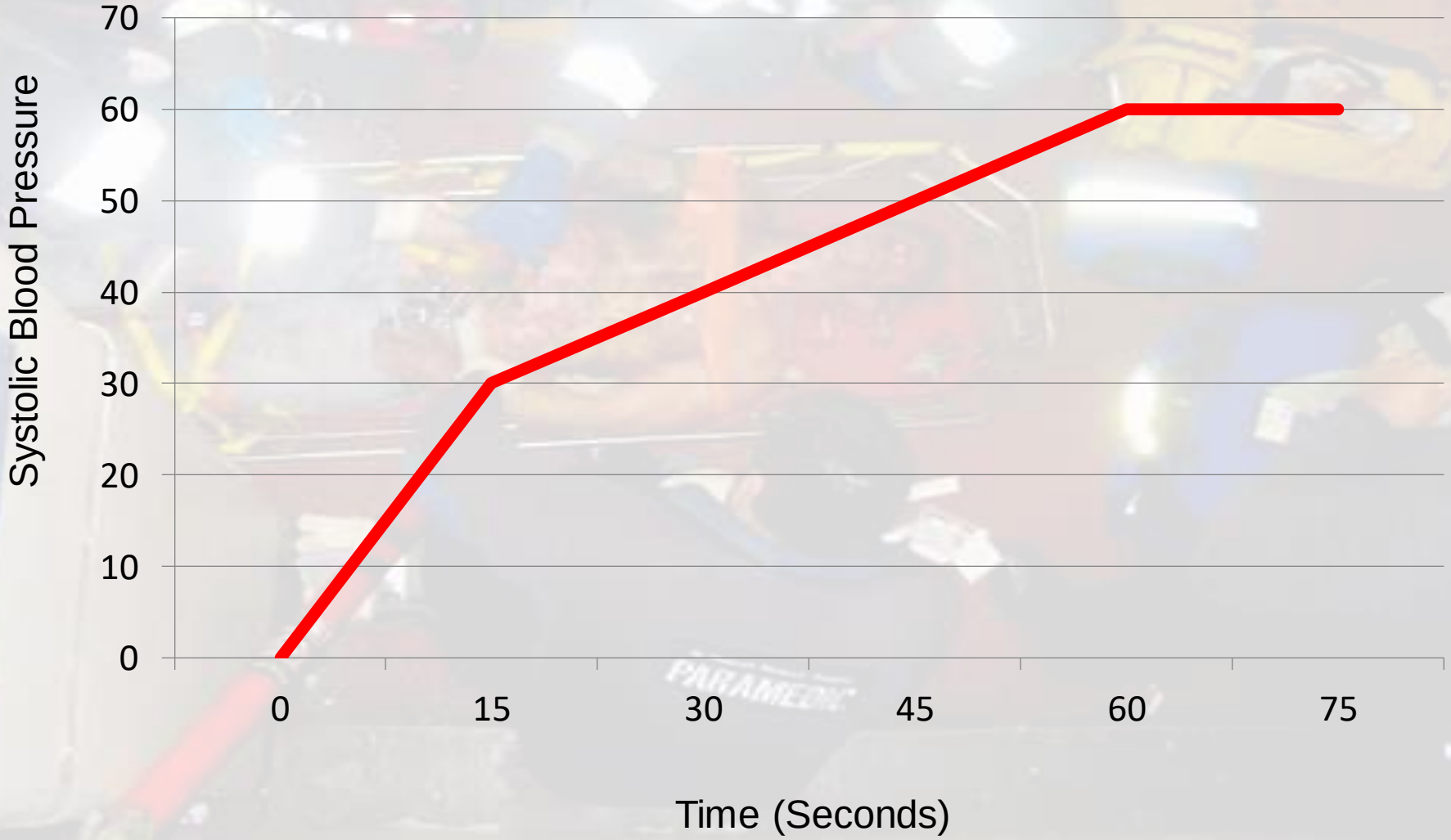
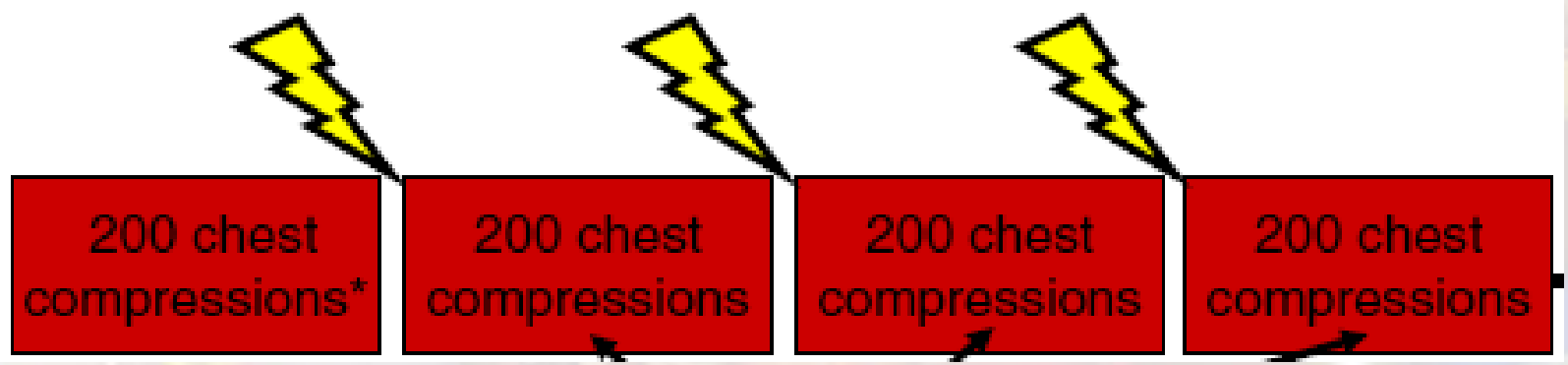
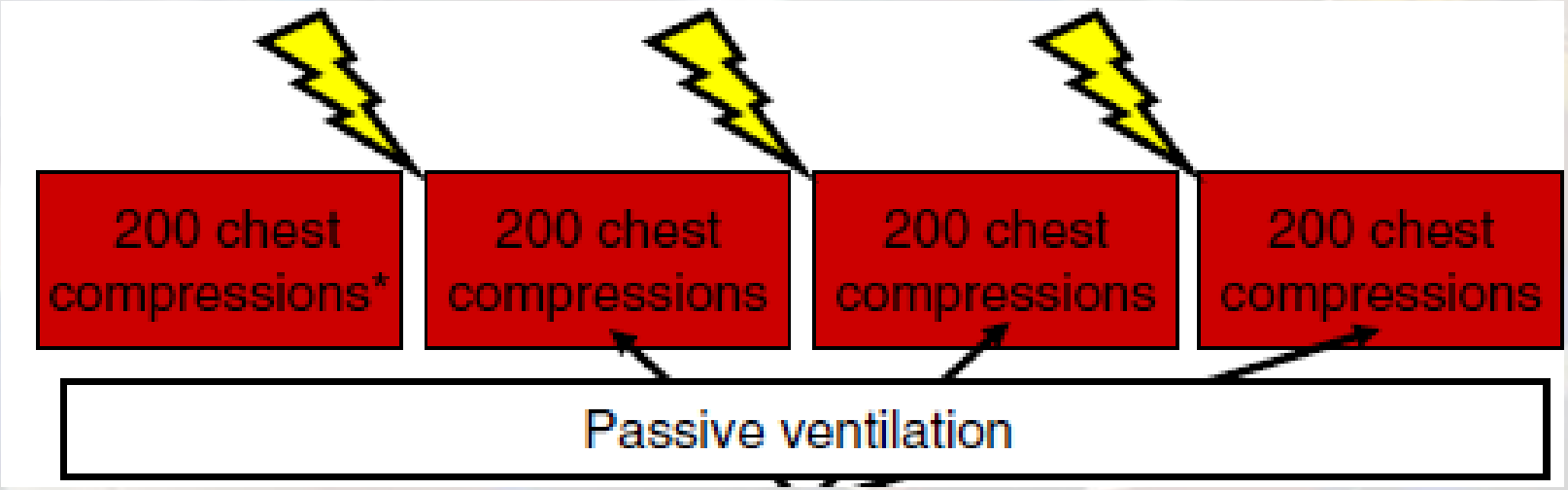
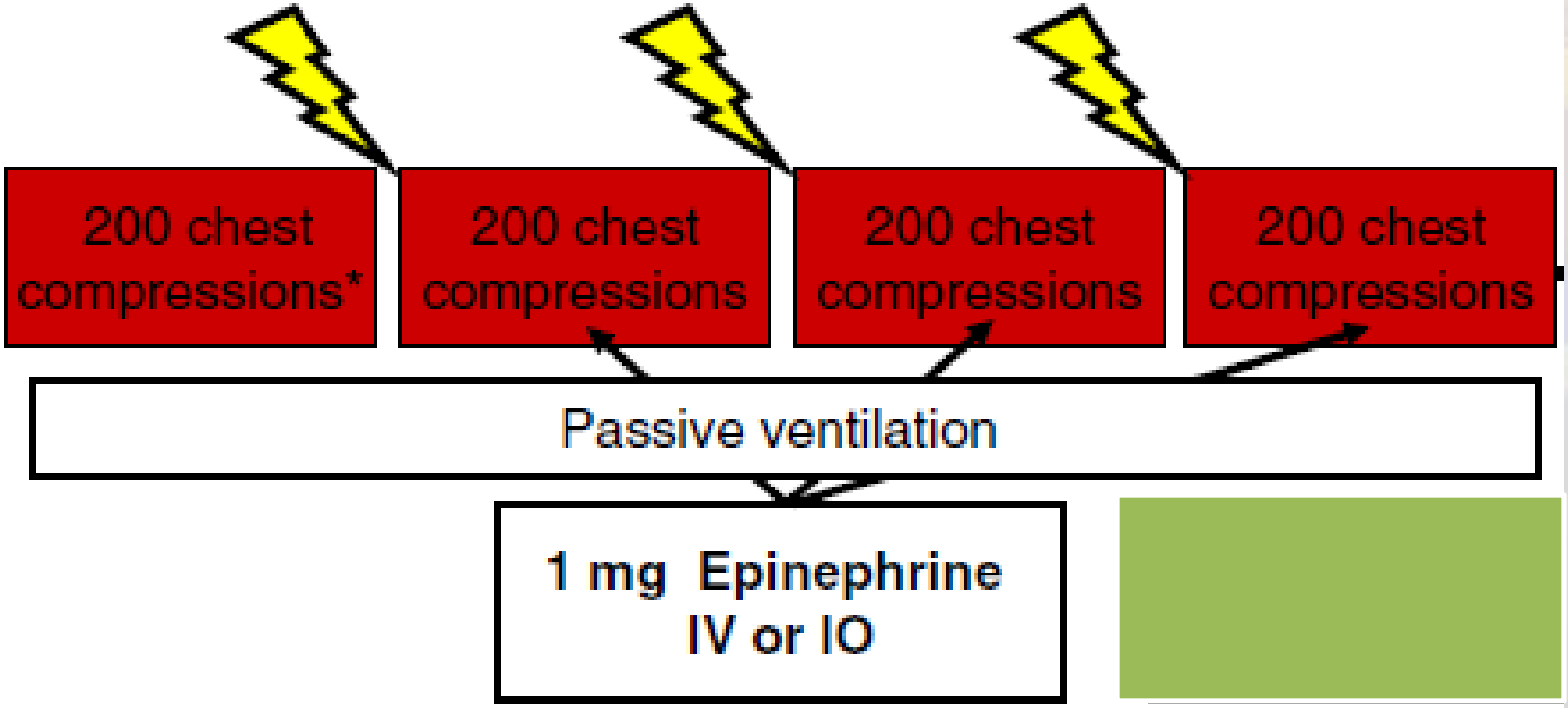
Compressions

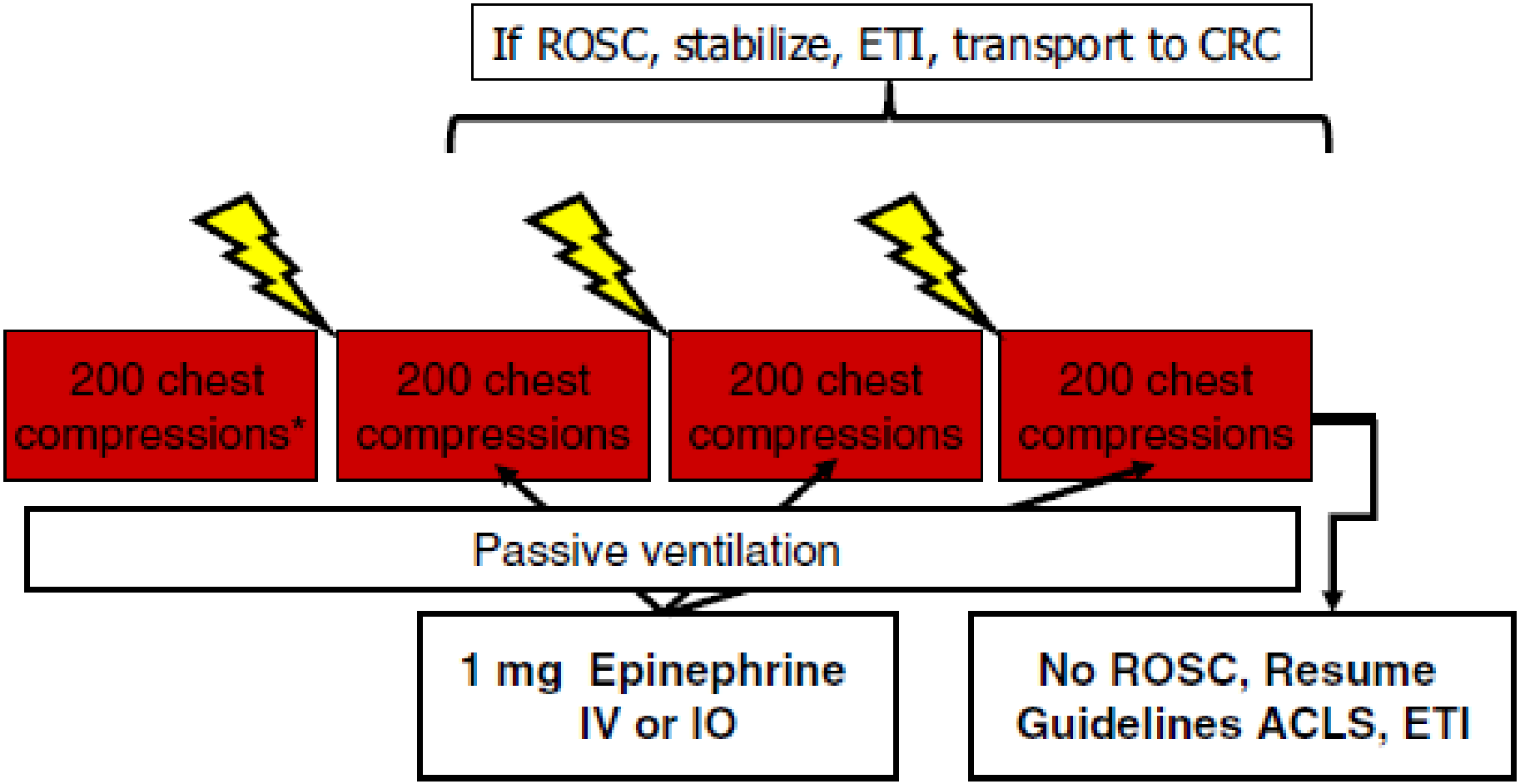



200 chest compressions*


200 chest compressions*
200 chest compressions
200 chest compressions
200 chest compressions


200 chest compressions*
200 chest compressions
200 chest compressions
200 chest compressions
Passive ventilation


200 chest compressions*
200 chest compressions
200 chest compressions
200 chest compressions
Passive ventilation
1 mg Epinephrine IV or IO



Ewy, *JACC* 2013

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 DECEMBER 3, 2015 VOL. 373 NO. 23

Trial of Continuous or Interrupted Chest Compressions during CPR

Graham Nichol, M.D., M.P.H., Brian Leroux, Ph.D., Henry Wang, M.D., Clifton W. Callaway, M.D., Ph.D., George Sopko, M.D., Myron Weisfeldt, M.D., Ian Stiell, M.D., Laurie J. Morrison, M.D., Tom P. Aufderheide, M.D., Sheldon Cheskes, M.D., Jim Christenson, M.D., Peter Kudenchuk, M.D., Christian Vaillancourt, M.D., Thomas D. Rea, M.D., Ahamed H. Idris, M.D., Riccardo Colella, D.O., M.P.H., Marshal Isaacs, M.D., Ron Straight, Shannon Stephens, Joe Richardson, Joe Condle, Robert H. Schmicker, M.S., Debra Egan, M.P.H., B.S.N., Susanne May, Ph.D., and Joseph P. Ornato, M.D., for the ROC Investigators*

114 EMS Agencies
23,711 patients
7.0% vs 7.7% fav. Neuro survival

CIRCULATION

CAPNOGRAPHY
COMPRESSIONS
HYPOTHERMIA
ACCESS
MEDICATIONS

In Hospital – 2002

Study #1: 77 patients randomized to 33°C x12 hours

Favorable neuro outcome:
49% (chilled) vs 26% (not)

Study #2: 136 patients randomized to 32-34°C x24 hours

Favorable neuro outcome:
55% (chilled) vs 39% (not)

Bernard, *NEJM* 2002; Hypothermia Study Group, *NEJM* 2002

Is Colder Better?

- 33 vs 36 targeted temperature
- 939 patients
- No difference in survival
- Overall survival better vs 2002

Nielsen, *NEJM* 2013

Is Faster Better?

- PreHospital Cooling vs In-hospital
- 1359 patients in VT/VF
- No difference in survival
- Slightly worse outcomes

Kim, *JAMA* 2013

Targeted Temperature Management

- All comatose patients for 24 hours
- 32-36 degrees Celsius
- Not recommended in field

AHA Guidelines 2015

CIRCULATION

CAPNOGRAPHY
COMPRESSIONS
HYPOTHERMIA
ACCESS
MEDICATIONS

Question

What is your first line?

A. PIV
B. IO

IO as first line in arrest?

[182 arrest patients]

1st attempt success:

Tibial IO: 91%

Humeral IO: 51%

PIV: 43%

Time to initial success:

Tibial IO: 4.6 min

Humeral IO: 7.0 min

PIV: 5.8 min

Reades, *Ann Emerg Med* 2011

2nd IV Line?

- No change in mortality, GCS, SBP, or anything
- No evidence to support
- Not risk-free:
  - Needle stick
  - Infection
  - Vascular Injury
  - Nerve injury

Merlin, *Prehosp Emerg Care* 2011

CIRCULATION

CAPNOGRAPHY
COMPRESSIONS
HYPOTHERMIA
ACCESS
MEDICATIONS

Question

What Medications Work in ACLS?

A. Epinephrine
B. Atropine
C. Bicarbonate
D. Amiodarone
E. Lidocaine
F. None of the Above

Norway 2003-2008

IV drugs *vs* no IV drugs

6 years, 851 patients

ROSC: 32% vs 21%: **BETTER**

Survival to discharge: **NO CHANGE**

Favorable Neuro Outcome: **NO CHANGE**

Olasveengen, *JAMA* 2009

Western Australia 2006-2009

Epi *vs* Placebo

4 years, 534 patients

ROSC 23.5% vs 8.4%: **BETTER**

Survival to discharge: **NO CHANGE**

Jacobs, *Resuscitation* 2011

Japan 2005-2008

Epi *vs* Nothing

4 years, 417,188 patients
ROSC: 18% vs 5%: **BETTER**
1 month survival: **NO CHANGE**

Good functional status: 1.4% vs 2.2%
WORSE

Hagihara, *JAMA* 2012

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 5, 2016 VOL. 374 NO. 18

Amiodarone, Lidocaine, or Placebo in Out-of-Hospital Cardiac Arrest

P.J. Kudenchuk, S.P. Brown, M. Daya, T. Rea, G. Nichol, L.J. Morrison, B. Leroux, C. Vaillancourt, L. Wittwer, C.W. Callaway, J. Christenson, D. Egan, J.P. Ornato, M.L. Weisfeldt, I.G. Stiell, A.H. Idris, T.P. Aufderheide, J.V. Dunford, M.R. Colella, G.M. Vilke, A.M. Brienza, P. Desvigne-Nickens, P.C. Gray, R. Gray, N. Seals, R. Straight, and P. Dorian, for the Resuscitation Outcomes Consortium Investigators*

Bottom Line

"…there is no placebo-controlled study that shows that the routine use of any vasopressor during human cardiac arrest increases survival to hospital discharge."

"There is no convincing evidence that the routine use of other drugs (atropine, amiodarone, lidocaine, procainamide, bretylium, magnesium, buffers, calcium, hormones, or fibrinolytics) during human CPR increases survival to hospital discharge."

"There was no clear advantage of epinephrine…the efficacy of vasopressor use in OHCA remains unanswered."

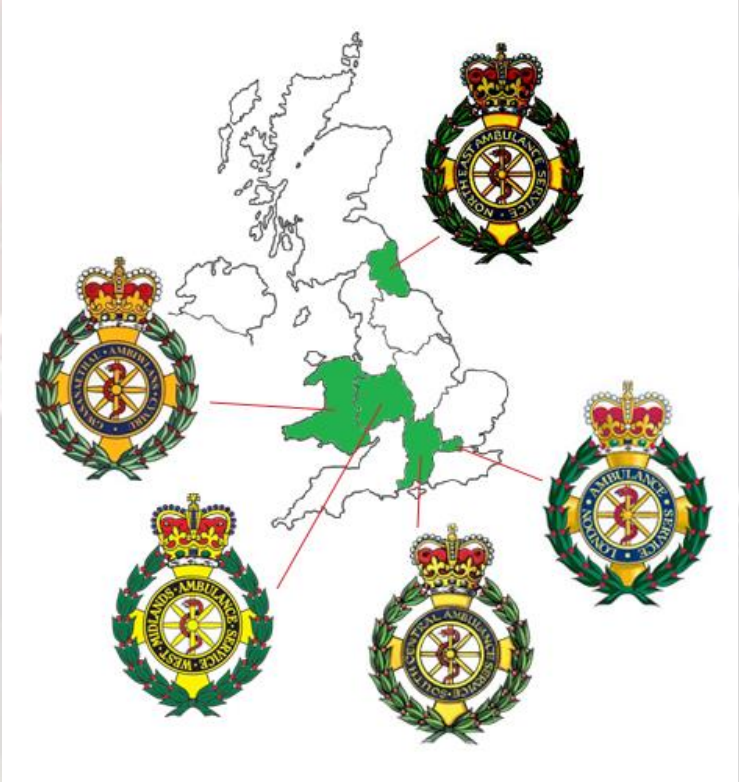
Morrison, *Circulation* 2010; Lin, *Resuscitation* 2014

PARAMEDIC 2: The Adrenaline Trial

- RCT in UK
- Started December 2014
- Results expected in 2018

PARAMEDIC 2

The Adrenaline Trial



Heart patients to be given placebo by paramedics in controversial trial

Patients whose hearts stop will be given a placebo instead of adrenalin by paramedics during attempts to save their lives in a study branded 'ethically questionable'

Concerns have been raised that injecting cardiac arrest sufferers with adrenalin may cause severe brain damage and may not help overall survival at all Photo: Alamy

Ontario PreHospital Advanced Life Support (OPALS) Study

Survival to Discharge Odds Ratios

1. Bystander CPR: 3.7
2. Rapid Defibrillation: 3.4
3. Paramedics with ACLS: 1.1

Stiell, *NEJM* 2004

TWO STEPS TO SAVE A LIFE:

RESPONSE

AIRWAY

BREATHING

CIRCULATION

DISABILITY

DISABILITY

HEAD INJURIES

BLS CARE

FIELD REPORTS

Head Injury

Hypotension:

- 1 episode: OR 2.1 for death
- 2 or more: OR 8.1 for death

Manley, *Arch Surg* 2001

Question

- 75F fell out of bed
- Lift Assist
- No visible Trauma
- On Coumadin

Does she need to go to the ER?

Head Injury

Head Bleed in GCS 15 patient:

- Plavix: 12%
- Coumadin: 5%

Nishijima, *Ann Emerg Med* 2012

DISABILITY

HEAD INJURIES

BLS CARE

FIELD REPORTS

ALS vs BLS for Trauma

- Ontario Prehospital Advanced Life Support (OPALS) Major Trauma Study
- Before-After Study
  - No Change in Survival
  - Survival worse for GCS <9
    - 60% vs 50% w/ ALS

Stiell, *CMAJ* 2008

DISABILITY

HEAD INJURIES

BLS CARE

FIELD REPORTS

Field Reports

- Normotensive patient in the ED with reported field hypotension
  - 37% had emergent surgery, 6% died
- If no report of hypotension
  - 11% had emergent surgery, 3% died

Lipsky, *J Trauma* 2006

SUMMARY 1 of 3

1. Scene Times – penetrating trauma
2. Lights & Sirens – risk > benefit
3. Helicopters – risk = benefit?
4. Intubation – SGA's & video
5. Oxygen – harm > help?
6. Tension PTX – longer needle

SUMMARY 2 of 3

1. Capnography - helpful
2. Compressions - work
3. Hypothermia – questionable
4. Access – IO first
5. Medications - dogma

SUMMARY 3 of 3

1. Head Injury – avoid low BP
2. Blood Thinners – need a CT
3. Trauma – BLS > ALS
4. Field Reports - matter

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