Evidence Based EMS: The Science Behind Your Care

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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
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

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

- 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.”
L&S time difference

Responding ambulance followed by chase car (urban):
• 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 (rural):
• 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.”

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
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)
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
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
BREATHING
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
BREATHING

OXYGEN

PNEUMOTHORAX
Tension Pneumothorax
Length!

- Need AT LEAST 14 gauge,
- 3.25 inch long

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Source: Academic Life in EM
RESPONSE
AIRWAY
BREATHING
CIRCULATION
DISABILITY
Shout for Help/Activate Emergency Response

1.

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

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator
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

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

1. There was a return of spontaneous circulation (prior to transport)
2. Arrest witnessed by emergency medical services personnel
3. A shock was delivered

If ANY criteria are present
- Transport to local ED

If NONE of the criteria are present
- Terminate Resuscitation

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

CAPNOGRAPHY

COMPRESSIONS

HYPOTHERMIA

ACCESS

MEDICATIONS
What they already knew:
Compressions affected ventilation
If alone, only do compression
“Only the human hand is required”
Adult Cardiac Arrest

Shout for Help/Activate Emergency Response

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator

2. Rhythm shockable?
   - Yes
   - VF/VT
   - Shock
   - CPR 2 min
     - IV/IO access
   - Rhythm shockable?
     - Yes
     - Shock
     - CPR 2 min
       - IV/IO access
       - Epinephrine every 3-5 min
       - Consider advanced airway, capnography
   - CPR 2 min
     - IV/IO access
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography

3. Asystole/PEA
   - CPR 2 min
     - IV/IO access
     - Treat reversible causes

4. Return of Spontaneous Circulation (ROSC)
   - Pulse and blood pressure
   - Abrupt sustained increase in PetCO2 (typically >40 mm Hg)
   - Spontaneous arterial pressure waves with intra-arterial monitoring

5. Shock Energy
   - Biphasic: Manufacturer recommendation (eg, initial dose of 100-200 J; if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
   - Monophasic: 360 J

6. Drug Therapy
   - Epinephrine IV/IO Dose: 1 mg every 3-5 minutes
   - Vasopressin IV/IO Dose: 40 units can replace first or second dose of epinephrine
   - Amiodarone IV/IO Dose: First dose: 300 mg bolus. Second dose: 150 mg.

7. Advanced Airway
   - Supraglottic advanced airway or endotracheal intubation
   - Waveform capnography to confirm and monitor ET tube placement
   - 8-10 breaths per minute with continuous chest compressions

8. Reversible Causes
   - Hypovolemia
   - Hypoxia
   - Hyperkalemia
   - Hypothermia
   - Tension pneumothorax
   - Tamponade, cardiac
   - Toxins
   - Thrombosis, pulmonary
   - Thrombosis, coronary

9. If no signs of return of spontaneous circulation (ROSC), go to 10 or 11
10. CPR 2 min
    - IV/IO access
    - Treat reversible causes

11. CPR 2 min
    - IV/IO access
    - Treat reversible causes

12. 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 PetCO2 <10 mm Hg, attempt to improve CPR quality
    - Intra-arterial pressure
      - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

© 2010 American Heart Association
CPR Quality

- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
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  - If $\text{PETCO}_2 < 10$ mm Hg, attempt to improve CPR quality
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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
If ROSC, stabilize, ETI, transport to CRC

200 chest compressions
200 chest compressions
200 chest compressions
200 chest compressions

Passive ventilation

1 mg Epinephrine IV or IO

No ROSC, Resume Guidelines ACLS, ETI

Ewy, JACC 2013
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)

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
CIRCULATION

CAPNOGRAPHY
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MEDICATIONS
Question

What is your first line?

A. PIV
B. IO
IO as first line in arrest?

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

“...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.”

PARAMEDIC 2: The Adrenaline Trial

- RCT in UK
- Started December 2014
- Results expected in 2018
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'.
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:

1. [Cell phone icon]
2. [Hand icon]
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%

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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