Cardiac Arrest: Special Topics

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I have no conflicts or financial interests to disclose.

This presentation and the recommendations provided within are not intended to replace protocols or supersede local medical direction.

False dichotomies:

- ACLS:
  - Good for entry-level providers
  - Protocol-driven yes or no
  - Prevents critical-thinking

What can I actually do to help my patients in cardiac arrest?

Roadmap:

- Traumatic arrest
- Refractory VF/VT
- Thrombolytics
- Toxicological arrest
- Airway management
- Termination guidelines
- Therapeutic hypothermia

Traumatic Arrest:

- Important:
  - Injury 4th leading cause of mortality
  - 1st in children and young adults
- Management is inconsistent
  - No good guidelines
  - Paramedic-preference
  - Majority of large services are not following guidelines available

Traumatic Arrest:

- Survivability studies are mixed:
  - 1% - 7% - 20% - 50%
- Applicability of these numbers?
  - Prehospital physicians
  - Urban vs. suburban vs. rural
  - Proximity to trauma centers
- Aggressive management?
- Transport?

Case 1:

- 44 y/o male motorcyclist
  - Struck by car and thrown
  - Found unresponsive to pain (GCS 3)
  - Agonal respirations
- Loses pulse as soon as you arrive

What might actually help???

Epinephrine:

- Medical arrest literature:
  - Equivocal at best
- In trauma:
  - Increased catecholamines already
  - Epi decreases tissue perfusion
  - One study in children – ↑ ROSC
- Recommendation:
  - *Probably not helpful*

Chest Compressions:

- CPR
  - Improves perfusion
  - Could ↓ perfusion in tamponade
  - In the NAEMSP/ASCOT guidelines
- Recommendation:
  - *May be useful and should be done*
  - *Should not delay interventions*

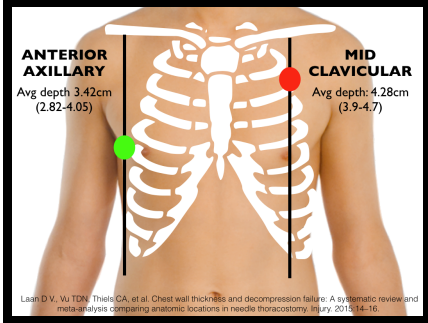
Pericardiocentesis:

- Pros:
  - Possible temporizing measure
  - Can't kill a dead guy
- Cons:
  - Can't remove clotted blood
  - High risk of iatrogenic injury
- Ultrasound is replacing empiric use
- Recommendation:
  - *May be useful in some situations*

Pleural Decompression:

- 5-10% of trauma deaths have a pneumothorax
- Easy and possibly life-saving
- Fairly low risk of iatrogenic injury

Needle Decompression:



Needle Decompression:

- Needle Length and Site:
  - 2nd ICS midclavicular:
    - 4.4 cm only 50% successful
    - 5.0 cm only 58% successful
  - 5th ICS midaxillary:
    - 5.0 cm 100% successful
    - 0.6-0.7 cm less tissue

Finger/Open Thoracostomy:

- Needle method not very sensitive
- First described by Deakin et al. 1995
- A few case reports and protocols
- No extensive research/literature
- Massarutti et al. 2006 published a report of 55 pts

Finger/Open Thoracostomy:

- Pros
  - Confirmation of correct space
  - Allows for revalidation of "lung up"
  - Limited supplies/prep/hassle
  - Quick to perform?
- Cons
  - Fairly invasive for prehospital providers
  - Perhaps recurrent pneumo?
  - Have to be fairly comfortable for speed

Pleural Decompression:

- Recommendation:
  - *Bilateral pleural decompression in all traumatic (peri-) arrests ASAP*
  - *5th ICS MAL > 2nd ICS MCL*
  - *Finger > Large Needle > Normal IV*

Transport:

- Transport
  - Many risks
  - Some benefit, for rapid intervention
- Recommendation:
  - *May be useful for:*
    - *Penetrating thoracic trauma*
    - *Witnessed arrest*
    - *Proximity of trauma center (<10-15 min)*

Traumatic Arrest:

- Survivability
  - Etiology:
    - Penetrating > Blunt
    - Hypoxia
    - Tension Pneumothorax
    - Cardiac Tamponade
  - Rhythm:
    - Asystole < 1-2.7%
    - PEA < 40bpm very low (similar?)

Traumatic Arrest:

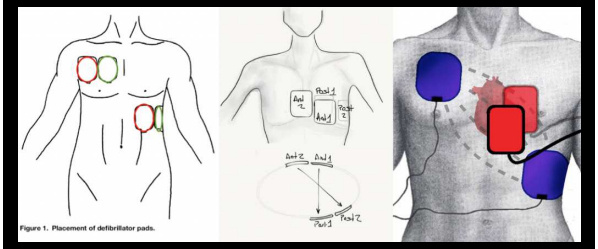
- *Algorithm:*
  - Immediate transport if indicated and trauma center is close
  - CPR if it doesn't delay other things
  - Needle decompression
  - BLS airway interventions
  - Fluid/blood resuscitation
  - Maybe pericardiocentesis
  - Termination of resuscitation

Case 2:

- 48 y/o healthy female
  - Witnessed cardiac arrest
  - Immediate, high-quality CPR
  - EtCO2 38
- Still in VF despite:
  - 5 shocks at 360 J biphasic
  - 3 mg epinephrine
  - 450 mg amiodarone

Refractory VF/VT:

Double-sequential external defibrillation



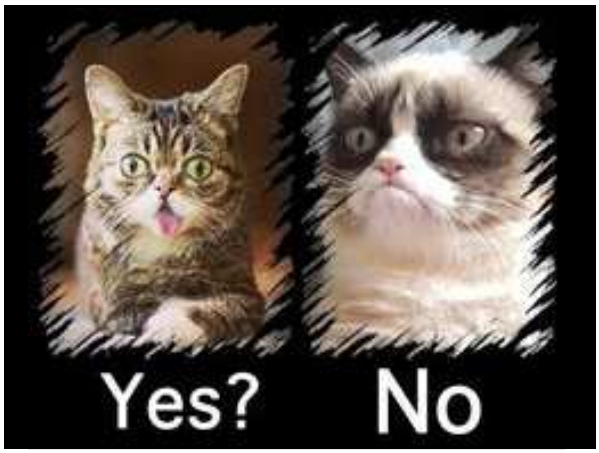
DSED:

- Has been around since 1994
  - 5 EP patients with rVF, 7-20 shocks
- Theory:
  - Broader energy vector (95%?)
  - 1st shock decreases threshold
  - Increasing time of energy exposure
  - Increasing dose of energy

Refractory VF/VT:

- Extremely rare (<0.1% of VF arrests)
- Usually RECURRENT, not refractory.

- Causes of Failed Shocks
  (i.e. why DSED may work):
  - Vector (Optimal positioning of pads)
  - Resistance (Pad adherence, Pressure)
  - Causes (CCL or ECMO?)
  - Constantly changing energy vectors



Problems with DSED:

- Timing:
  - Shocks must be given within <0.01 seconds apart to improve efficacy
  - Human reaction time ~0.2 seconds
  - If 0.01-0.75 sec apart, second shock can actually induce VF
  - Shocks can cancel each other out
- Damage to defibs can result if 2nd shock given at the same time.

DSED:

- Recommendation:
  - *Rarely needed, but something to keep in the toolbox (have a plan)*
- Fix resistance, placement issues
- Identify refractory vs. recurrent VF
- Any defib used for DSED should be evaluated by the manufacturer

Refractory VF/VT and Meds:

- Catecholamine storm (β1)
  - Endogenous or Exogenous
  - Increases myocardial O2 demand
  - Worsens ischemia
  - Lowers VF threshold
  - Worsens post-ROSC myocardial fx

Refractory VF/VT and Meds:

- Animal Studies
  - Propranolol and Esmolol
    - Reduced myocardial oxygen demand
    - Decreased number of defib attempts
    - Improved post-ROSC myocardial fx
    - Reduced arrhythmia reoccurrence
    - Prolonged survival

Esmolol:

Esmolol:

- Ideal due to pharmacokinetics
- Bolus dose of 500 mcg/kg
  - ± infusion of 50-100 mcg/kg/min
- Human case series: More likely to:
  - Have temporary ROSC
  - Have sustained ROSC
  - Survive to ICU admission
  - Survive to discharge, neuro intact

Esmolol:

- Recommendation:
  - *Use esmolol bolus ± infusion for recurrent and refractory VF/VT*
- Transport of refractory VF?
  - *Only if other therapies available:*
    - *ECMO/ECPR, and/or PCI*
    - *Esmolol, Stellate ganglion block*

Case 3:

- 32 year old female
  - Overweight, smokes 1 ppd
  - Rx: Birth control
  - Recent hx of international air travel
- Severe shortness of breath
- Then arrests…

What do you have to offer her?

Intra-Arrest Thrombolytics:

- Not supported for undifferentiated arrests
- TRIOCA:
  - Wide inclusion criteria
  - No difference in ROSC or survival
  - 2.7% vs. 0.4% ICH

Intra-Arrest Thrombolytics:

- Supported for known/suspected PE
  - Up to 13% of OHCA
  - Reduction in death (9% vs. 19%)
  - Good ROSC (96%) and survival (87%)
- May be useful in clear OMI
- CPR not an absolute contraindication

Intra-Arrest Thrombolytics:

- Dose:
  - tPA 50 (to 100) mg bolus ± infusion
  - TNKase 0.5 mg/kg or 50 mg bolus
- 15-60 minutes of CPR after
- Anticoagulants also indicated

Intra-Arrest Cardiac Cath:

- Intra-arrest PCI (IAPCI) is indicated if:
  - Suspected or known cardiac cause
  - Quickly implemented
  - Need a protocol and mCPR or ECPR
- ECPR + IAPCI:
  - ROSC 88%
  - 30-day survival 29%
  - Neuro-intact survival 24%

Intra-Arrest Thrombolytics/PCI:

- Recommendation:
  - *Provide pre-hospital thrombolysis in suspected massive PE.*
  - *Consider pre-hospital thrombolysis in OMI with short down-time when access to PCI is delayed or not available.*
  - *Consider urgent transport for patients with OMI when IAPCI is available.*

Case 4:

- 21 year old female
  - History of severe depression
  - Recent emotional distress
  - Near-empty pill bottles next to her:
    - Propranolol, Fluoxetine
- Arrests as you arrive….
  - And stays in arrest….

What do you have to offer her?

Toxicological:

- High-dose Insulin Euglycemic Therapy (HIET)
- Indications:
  - Calcium-channel blocker overdose
  - Possibly beta-blocker and other ODs

HEIT:

- Action:
  - ↑ glucose/lactate uptake by myocardial cells
  - ↑ myocardial fx (doesn't increase DO2)
  - Improved calcium handling and waste clearance
  - ↑ contractility through glucose availability
- Concerns:
  - Must match with vasopressors
    - Insulin has no chronotropic effect
    - Insulin may cause vasodilation
  - Need to balance euglycemia

HEIT:

- Implementation:
  - 1 unit/kg insulin bolus
  - 0.5 units/kg/hour insulin infusion
    - Titrate up every 15-30 minutes
  - Blood glucose correction:
    - 25 grams/hour dextrose, titrated
    - Monitor BGL q20min for 1 hour
    - Then monitor BGL hourly

Lipid Rescue Therapy:

- Intralipids might:
  - Improve cardiac contractility:
    - Supply fatty acids for metabolism
    - Improve calcium handling
  - Raise tonicity (volume booster?)
  - Provide a "sink" for lipophilic drugs:

Medication	Bupivicaine	Amitriptyline	Bupropion	Verapamil	Propranolol
Partitioning coefficient (logP)	3.9	5.04	2.61	2.31	3.09

Lipid Rescue Therapy:

- 20% Intralipid Solution
  - 1.5 mL/kg bolus
    - May repeat x2
  - 0.25 mL/kg/min infusion
    - May double

Case 5:

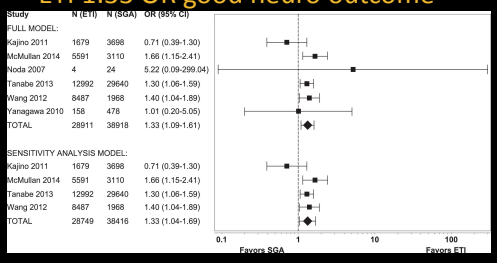
- 65 y/o M arrest:
  - ACLS in-progress
  - OPA in-place
  - BVM going well

"More medics than you can shake a stick at"

Should we insert an advanced airway?

Airway Management:

- Benoit 2015
  - 75,000 patient meta-analysis
  - ETI 1.33 OR good neuro outcome



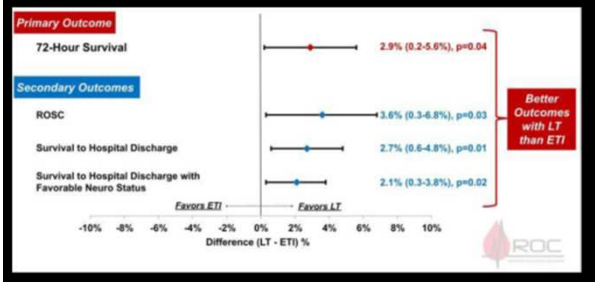
Airway Management:

- Hasegawa 2013
  - 357,000 patients (incl. trauma)
  - Good neurological outcome
    - 3.2% BVM
    - 1.1% SGA
    - 1.0% ETI

Airway Management:

- Jabre 2018
  - 2,000 patients – randomized
  - Good neurological outcomes:
    - 4.3% BVM
    - 4.2% ETI
  - More failures and complications in BVM group

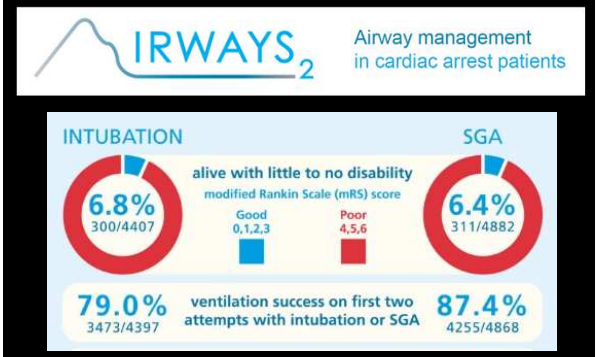
Airway Management:

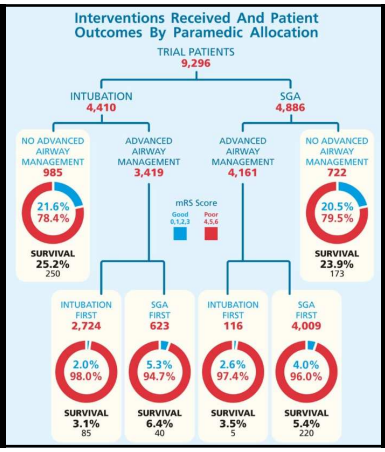


Airway Management:

Characteristic	LT N=1,505	ETI N=1,499
Compliance with Assigned Airway	95.5%	90.7%
Airway Insertion Success		
Initial airway	89.9%	51.3%
Overall airway	94.2%	91.5%
Elapsed Times, mean minutes (SD)		
Arrival to airway start	11.0 (6.5)	13.6 (6.8)
Arrival to airway success (or abandon)	11.7 (6.4)	14.4 (6.8)
Emergency Department Intubation	64.4%	33.1%

Airway Management:



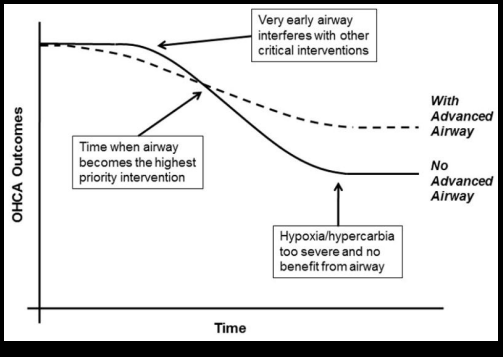


Airway Management:

- BVM>ETI>King ? iGel ?

- Possible reasons:
  - Study design/confounders
  - Interruptions in CPR
  - Distractions from CPR
  - SGA compression of carotids/IJ
  - Hyperventilation

Airway Management:



Case 6:

- Continuing our 65 y/o M arrest:
  - ACLS on-scene for 25 minutes
  - Fast PEA persists
  - EtCO2 14
  - Some slight motion on ultrasound

Should we terminate resuscitation?

Termination of Resuscitation:

- Multifactorial
  - Prognostic factors
  - Family concerns
  - Available resources – local facilities
    - Do they do more than ACLS?
      - IAPCI, ECPR, Esmolol, etc.

Termination of Resuscitation:

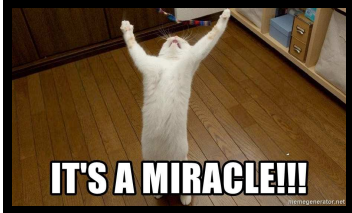
- EtCO2 < 10mmHg is pretty good
  - Small studies
  - Initial vs. initial, average/5min, final
  - Some survivors
- No cardiac motion on sonogram is pretty good
  - Small studies
  - Some survivors

Termination of Resuscitation:

- 100% specificity and sensitivity:
  - Not witnessed by EMS
  - Non-shockable initial rhythm
  - No ROSC prior to 3rd epi

Case 7:

- Continuing our 65 y/o M arrest:
  - ROSC achieved
  - Vitals miraculously stable



Should we cool him?

Therapeutic Hypothermia:

- Overall post-ROSC TH:
  - Likely some neurological benefit
  - Likely no difference 32-34-36 deg C
- Pre-hospital TH:
  - No proven improvement in:
    - Survival to admission
    - Survival to discharge
    - Good neurological recovery

Therapeutic Hypothermia:

- Pre-hospital TH:
  - Complications:
    - More recurrent arrest
    - Decreases admission pH
    - Chilled IVF → pulmonary edema
- Recommendation:
  - *Do not provide pre-hospital TH.*


Questions?
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