Resuscitation Outcomes Consortium

Impact of Out-of-Hospital Advanced Airway Management on Outcomes after Traumatic Brain Injury and Hemorrhagic Shock

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- None
Background

- Out-of-hospital advanced airway management (AAM) prominent in major trauma care
  - Endotracheal intubation (ETI)
  - Supraglottic airways
  - Cricothyroidotomy

- Out-of-hospital AAM associated with harm compared with Emergency Department (ED) AAM
  - Retrospective single region data
  - Selection/classification/other bias
  - Incomplete risk adjustment
  - Absence of long-term outcomes
  - Aggregated TBI and hemorrhagic shock

Objective

- Determine effect of out-of-hospital AAM after severe TBI
- Determine effect of out-of-hospital AAM after hemorrhagic shock

Methods
- Resuscitation Outcomes Consortium
  - North American multicenter research consortium
  - 35,000 square miles
  - 24 million people
  - 268 EMS and fire agencies
  - 3,500 EMS vehicles
  - 30,000 EMS personnel
  - 289 Hospitals
  - 100 IRBs
Secondary Analysis of ROC Hypertonic Saline Trial Data

• RCTs of hypertonic saline
  – 1) Severe TBI and 2) hemorrhagic shock
  – 1) [7.5% HS] vs. 2) [7.5% HS + 6% dextran] vs. 3) [normal saline]

• 85 participating EMS agencies

• Trials ended early for futility
  – Second interim analysis
  – No differences in survival

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HS Trial Inclusion/Exclusion Criteria

• Inclusion Criteria
  – Adult, injured patients
  – Severe TBI
  – Blunt injury + GCS ≤ 8
  – Hemorrhagic shock
    • [initial SBP ≤ 70 mm Hg] or
    • [initial SBP 71-90 mm Hg + HR ≥ 108 bpm]

• Exclusion Criteria
  – Prisoner status
  – Known or suspected pregnancy
  – Age ≤ 15 years
  – CPR
  – >2000 ml IVF or blood before enrollment
  – Severe hypothermia (<28°C)
  – Drowning, hanging, burns >20%, isolated penetrating head injury
  – No IV access
  – Intra-facility transfer
  – >4 hours elapsed time

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Inclusion Criteria for Airway Analysis

• Included
  – Successful out-of-hospital or ED AAM
    • Endotracheal intubation
    • Supraglottic airways
    • Surgical airways

• Excluded
  – No out-of-hospital or ED AAM
    • e.g. intubated in OR
  – Dead in field
  – Dead on ED arrival
  – Missing key data
Key Exposure

– Location of Advanced Airway Management

• Successful out-of-hospital vs. ED AAM
  – Exclude other AAM in other places (e.g. operating room)
• Per EMS/ED reports
  – No independent confirmation protocols
• If both successful out-of-hospital ETI and ED AAM
  → classified as out-of-hospital ETI

Outcomes

• Primary Outcome
  – 28-day mortality
    • TBI and shock
• Secondary Outcomes
  – Poor 6-month Glasgow Outcome Score Extended (GOSE ≤4)
    • TBI only
  – Poor 6-month Disability Rating Score (DRS ≥4)
    • TBI only
  – Elevated initial ED serum lactic acid (≥4 mmol/L)
    • TBI and shock

Analysis

• Multivariable logistic regression
• Adjustment for:
  – Age
  – Sex
  – Head or neck abbreviated injury score (AIS - TBI only)
  – Injury severity score (ISS)
  – Mechanism of injury (blunt vs. penetrating)
  – Initial systolic blood pressure
  – Highest field heart rate
  – Initial Glasgow Coma Scale
  – Out-of-hospital neuromuscular blockade use
  – Mode of transportation (air medical vs. ground)
  – Trial arm
Analysis

- **Hot deck imputation**
  - Missing 6-month GOSE (12%) and DRS (13%)

- **Sensitivity Analysis**
  - Any attempted out-of-hospital AAM
    - Successful or failed
  - Only out-of-hospital ETI vs. ED-AAM
    - No out-of-hospital SGA

- Could not evaluate individual SGAs

Results

- **2,132 enrolled in HS trials**

- **1,637 received AAM (included in analysis)**
  - **TBI:** 1,112
    - Out-of-Hospital: 760
    - ED: 352
  - **Shock:** 525
    - Out-of-Hospital: 293
    - ED: 232

- **495 excluded from analysis**
  - Dead in field
  - No AAM in field or ED
  - Missing key data

Patient Characteristics

- **ETI most common AAM**
  - 96.1-99.7%

- **Out-of-hospital AAM:**
  - More severely injured
  - Air medical transport more common
  - Paralytics more common

- **Lower GCS in shock out-of-hospital AAM**
  - Other characteristics similar

- **Mortality**
  - TBI: 26.8%
  - Shock: 34.3%

- **Neuro/Functional Outcome**
  - TBI 6-month GOSE: 4.0
  - TBI 6-month DRS: 12.2
Adjusted Associations with Outcomes
- Out-of-Hospital vs. ED AAM

Adjusted Associations with Initial ED Lactate
- Out-of-Hospital vs. ED AAM

Sensitivity Analysis

• Absence of association with 28-day TBI death
• Persistence of association with 28-day shock death
Significance

- Strong association between out-of-hospital AAM and 28-day shock mortality
  - Prior studies point to hyperventilation as culprit
  - Prospectively collected data from narrow inclusion criteria - large and persistent associations

Significance

- Less dramatic associations with TBI
  - Likely from ability to separate out shock cases
  - Small (but worrisome) adverse association with 6-month GOSE
  - ETI errors, desaturation, hyperventilation

- No associations with serum lactate

Clinical Implications

- Study shows association – not causality
- Consider alternative airway management strategies
  - Shock – need better understanding of physiology
  - TBI – “Rapid sequence airway”
Limitations

• Clinical trial data – not intended for airway evaluation
• Incomplete risk adjustment
• Limited airway management data
  – Limited adverse event data
  – Could not analyze individual SGAs
  – No airway times
  – No hyperventilation data

Conclusions

• Out-of-hospital AAM associated with increased 28-day shock mortality
• Out-of-hospital AAM associated with worsened 6-month TBI neurologic outcome

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Questions?

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