Red Flags in Prehospital (Out-of-Hospital) Airway Management

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The Current Standard

- Out-of-hospital endotracheal intubation (OOH-ETI) has been practiced by paramedics for a long time
  - “Standard of care” for over 25 years
  - Procedure that “defines” paramedic level care

- Science has raised numerous “red flags”
Does OOH-ETI Save Lives?

- >14 studies of OOH-ETI and outcome (survival)

- Recurrent theme:
  - OOH-ETI associated with *increased* risk of death
  - OOH-ETI associated with *poorer* neurological outcome
OOH-ETI and Outcome - Highlights

- Gausche, et al., JAMA 1999
  - RCT Pediatric ETI vs BVM, n=830
  - “No difference in survival”
  - “No difference in neurological outcome”

- Davis, et al., J Trauma 2003
  - San Diego RSI Trial
  - Large-scale implementation of prehospital RSI for TBI
  - 209 pts matched with 627 historical non-intubated controls
  - “Prehospital RSI $\rightarrow$ increased odds of death”
  - “Prehospital RSI $\rightarrow$ no effect on neuro outcome”
OOH-ETI and Outcome - Highlights

  - Retrospective, statewide trauma registry
  - 4,098 TBI patients – compared OOH-ETI vs ED-ETI
    - Excluded non-intubated cases
  - “OOH-ETI → 4x greater odds of death”
  - “OOH-ETI → 1.6x greater odds of poor neuro outcome”
Is Poor Outcome Due to Adverse Events and Errors?

- OOH-ETI is complex
- Emerging evidence of unrecognized errors
Misplaced Endotracheal Tubes by Paramedics in an Urban Emergency Medical Services System

Steven H. Katz, MD  
Jay L. Falk, MD

Study objective: To determine the incidence of unrecognized, misplaced endotracheal tubes inserted by paramedics in a large urban, decentralized emergency medical services (EMS) system.

Methods: We conducted a prospective, observational study of patients intubated in the field by paramedics before emergency department arrival. During an 8-month period, emergency physicians assessed tube position at ED arrival using a combination of auscultation, end-tidal carbon dioxide (ETCO₂) monitoring, and direct laryngoscopy.

Results: A total of 108 intubated patients were studied. On arrival in the ED, 25% (27/108) of patients were found to have improperly placed endotracheal tubes. Of the misplaced tubes, 67% (18/27) were found to be in the esophagus, whereas in 33% (9/27), the tip of the tube was found to be in the hypopharynx, above the vocal cords. Of the patients with misplaced
Katz and Falk
(Annals of Emergency Medicine, January 2001)

- Prospective, observational study of 108 field intubations arriving at an urban ED
- “25% Misplaced”
  - 2/3 esophageal
  - 1/3 above vocal cords

- Themes echoed by similar studies
Dunford, Ann Emerg Med 2004 (San Diego RSI Trial)

- Subset of 152 RSI patients
  - Out of 462 from total trial
- Continuously recorded waveforms:
  - Heart Rate
  - Oxygen Saturation
  - End-Tidal Capnography

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Emerg Med Clin North Am

Incidence of Transient Hypoxia and Pulse Rate Reactivity During Paramedic Rapid Sequence Intubation

Introduction

On trauma patients, severe closed head injuries are related to inflammatory and oxidative injury processes. Changes in neurologic outcomes are complicated by a cascade of events resulting in depressed consciousness. The management of severe head injuries and the time before secondary injury are critical determinants of neurologic and oxidative injury processes. Hypoxia and hyperoxia have been linked to oxygen radicals and reperfusion injury at the cellular level. Detoxification of free radicals and reperfusion injury is essential.
Dunford, et al. (con’t)

- 31 (57%) of 54 patients experienced desaturation
  - Median duration: 160 seconds (IQR 48 to 272)
  - Median desaturation (SpO2): 22%
- 6 (19%) patients experienced bradycardia
  - Pulse rate <50 beats/min
- Paramedics described intubation as "easy" in 26 (84%) of 31 patients
Prehospital Airway Collaborative Evaluation (PACE I and PACE II)

- Prospective, multi-center observational trial
- Over 40 Pennsylvania EMS services
- Self-reported airway management data
- Sample Size:
  - PACE I: n = 743 ETI
  - PACE II: n = 1,963 ETI

Acad Emerg Med 2003 Jul;10(7):717-24
Overall ETI Error Rate

1 in 4.5 Exposed to an ETI Error

- Tube Misplacement or Dislodgement: 3.1%
- ≥4 Attempts: 3.2%
- ETI Failure: 18.5%
- Any ETI Error: 22.7%

Overall ETI Error Rate: 3.1%
**Intubation → Hyperventilation → BAD**

- **Known to be “bad” in TBI**
  - ↑ Vent → ↓ pCO2 → ↓ Cerebral Perfusion

- **May be “bad” during CPR**
  - ↑ Vent → ↑ Intrathoracic Pressure → ↓ Coronary Perfusion
“Does Skill Play a Role?”
(“Are We as Good as We Think?”)
ETI Success Rates - Cardiac Arrests

Wang HE, et al., AEM 2006
ETI Success Rates - RSI

Wang HE, et al., AEM 2006
How Many Tubes Do You Need to Graduate?

- EM Residents 35
- Anesthesia Residents 20-57
- CRNA Students 200
- Paramedic Students 5
Wang, et al., Prehosp Emerg Care 2005

Magic Number: 15-20 ETI
OR Training Hours per Student

Median 17-32 hours

Johnston, et al., AEM 2006
Program Director Frustration…

- “We are seeing ORs completely shut out paramedic students.”
- “Our local hospital [anesthesia] group refuses to have students in the OR Students must drive two hours each way for OR experiences.”
- “We had a hospital for intubations until they said we would be required to pay.”
- “Securing OR time for ETI is the single most difficult aspect of my job as program director.”
Mannequins and Simulators?

- Few studies
- Plastic ≠ Flesh
  - Levitan: “Does not recreate the ‘mush’ of live structures”
  - Sim-man cannot recreate Jabba’s airway
- Sim-man cannot recreate *heterogeneity* of airways
"Skill" ("Proficiency") = Baseline Training + Regular Application
Per-Rescuer ETI Frequency for Pennsylvania Rescuers (2003)

Median ETI: 1 (IQR 0-3)
39% performed no ETI
67% performed 2 or fewer ETI

Intubations Across Pennsylvania

# of Procedures

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“Houston, We Have a Problem . . .”

- OOH-ETI is a (very) complex and difficult skill
- Not proven to have clinical benefit
- Prone to significant error (some unrecognized)
- Interacts with other interventions
- Performed under worst possible conditions
- Performed by rescuers with limited training
  - Inadequate baseline training
  - Inadequate clinical experience

“Should paramedics intubate at all?”
“An Unspeakable Idea…”
Alternate (Rescue) Airway Devices

- First Generation
  - EOA
  - PTL

- Second Generation
  - Combitube
  - LMA

- Third Generation
  - King LT

- Fourth Generation
  - ???
Weighing the Options

- **ETI**
  - Difficult to Use
  - Difficult to Learn
  - Difficult to Maintain Skill
  - Error-Prone

- **Alternate Airways**
  - Easy to Use
  - Easy to Learn
  - Easy to Maintain Skill
  - Fewer Potential Errors
  - Ventilate as Well as ET Tube (we think)

“Not perfect solutions, but have many appealing qualities…”
Combitube vs. ETI: Faster Airway, More Chest Compressions

30 sec Airway Savings

10-30 sec CPR Savings
It’s Already Happening in the USA…

- Kalamazoo, MI
- Chesterfield County, VA
- Collier County, FL

- Paramedics substituting ETI with Combitube/King for Cardiac Arrests
  - Decreased CPR hand-off time
  - Increased ROSC/survival – best figures in 15 years
“Some Final Thoughts on Drug-Facilitated Intubation”
Do You Need OR Time for RSI?

- “There are no data to support this, so I’m not requiring it for my RSI medics”

- Strongest RSI programs have incorporated OR time
  - Wayne, PEC 2001
  - OR for baseline training
  - Requirement: 12 ETI/year – or else to OR
  - >2000 RSI over 20 years – very few complications
  - “We know this works”
Sedation-Facilitated Intubation

- Many theoretical fears (of all agents)
- None formally studied
- “It (etomidate-only) seems to work for me…”
- “Jury still out…”

- However…Strong consensus …
  - Sedation-facilitated intubation requires *same* system and patient safeguards as for RSI
  - “Formulary availability ≠ qualification to perform technique”
How About Etomidate?

- Theoretically safer? Theoretically more effective?

- Two descriptive pilot series
  - Reed, PEC 2002
  - Bozeman, Air Med J 2002

- One RCT
  - Irony – no difference in success rates vs. versed
Take-Home Messages

◆ ETI is far more complex than we imagine
  ❖ Previously unrecognized adverse events
  ❖ Cannot overestimate prevalence and significance of adverse events

◆ Airway training is mandatory
  ❖ Significant questions about training effectiveness vs. availability

◆ Airway QA is mandatory
  ❖ If you don’t look for the problems, you won’t find them

◆ Need to keep an open mind to new (unpopular) ideas
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Other Outcome Studies of RSI

- Sloane, J Emerg Med 2000
- Davis, J Trauma 2003
- Bulger, J Trauma 2005

- These studies ask different questions.