

Paramedic Endotracheal Intubation and Health Services Research

Henry E. Wang, MD, MS

Associate Professor and Vice Chair for Research

Department of Emergency Medicine

University of Alabama at Birmingham



Overview

- Scrutiny of clinical question led to broader perspectives of EMS health services system

What is Endotracheal Intubation (ETI)?



Controlled OR vs. Chaotic Field



***“Does Paramedic ETI
Improve Outcomes?”***

Does Paramedic ETI Save Lives?

- >14 studies of paramedic ETI and outcomes
- Paramedic ETI:
 - Is not associated with improved survival
 - Is not associated with improved neurological outcome
- In select cases, associated with:
 - Increased risk of death
 - Worsened neurological outcome

Gausche, et al. (JAMA, February 2000)

- Controlled trial
- 830 pediatric patients
- Alternated ETI/BVM with BVM-only
- No difference in survival
- No difference in neurological outcome

Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome

A Controlled Clinical Trial

Marianne Gausche, MD

Roger J. Lewis, MD, PhD

Samuel J. Stratton, MD, MPH

Bruce E. Haynes, MD

Carol S. Gunter, BSN, MPA

Suzanne M. Goodrich, RN, MSN

Pamela D. Poore, RN

Maureen D. McCollough, MD, MPH

Deborah P. Henderson, PhD, RN

Franklin D. Pratt, MD

James S. Seidel, MD, PhD

ALTHOUGH BAG-VALVE-MASK ventilation (BVM) and endotracheal intubation (ETI) are both widely used in the out-of-hospital setting in caring for critically ill or injured children, there has been no controlled study comparing the outcomes of pediatric or adult patients treated with these 2 procedures. In 1 out-of-hospital study, BVM did compare favorably to non-ETI advanced airway management techniques (pharyngeal tracheal lumen, laryngeal mask, and esophageal tracheal combination esophageal-tracheal tube) among adults and children, as measured by PO_2 and PCO_2 values on arrival in the emergency department (ED), frequency of vomiting, and patient outcome.¹

There have been a number of descriptive studies of ETI in the out-of-hospital

For editorial comment see p 797.

Context Endotracheal intubation (ETI) is widely used for airway management of children in the out-of-hospital setting, despite a lack of controlled trials demonstrating a positive effect on survival or neurological outcome.

Objective To compare the survival and neurological outcomes of pediatric patients treated with bag-valve-mask ventilation (BVM) with those of patients treated with BVM followed by ETI.

Design Controlled clinical trial, in which patients were assigned to interventions by calendar day from March 15, 1994, through January 1, 1997.

Setting Two large, urban, rapid-transport emergency medical services (EMS) systems.

Participants A total of 830 consecutive patients aged 12 years or younger or estimated to weigh less than 40 kg who required airway management; 820 were available for follow-up.

Interventions Patients were assigned to receive either BVM (odd days; $n = 410$) or BVM followed by ETI (even days; $n = 420$).

Main Outcome Measures Survival to hospital discharge and neurological status at discharge from an acute care hospital compared by treatment group.

Results There was no significant difference in survival between the BVM group (123/404 [30%]) and the ETI group (110/416 [26%]) (odds ratio [OR], 0.82; 95% confidence interval [CI], 0.61-1.11) or in the rate of achieving a good neurological outcome (BVM, 92/404 [23%] vs ETI, 85/416 [20%]) (OR, 0.87; 95% CI, 0.62-1.22).

Conclusion These results indicate that the addition of out-of-hospital ETI to a paramedic scope of practice that already includes BVM did not improve survival or neurological outcome of pediatric patients treated in an urban EMS system.

JAMA. 2000;283:783-790

www.jama.com

setting. Reported success rates of pediatric ETI vary from 50% to 100%, depending on the patient's presenting illness or injury, the age of the patient, education level of the health care provider, and use of neuromuscular blocking agents to facilitate intubation.²⁻¹⁰ Major complications of ETI, such as esophageal intubation, have been reported in as little as 1.8% and as many as 17% of pediatric patients in the out-of-hospital setting.^{7,10} One study reported an overall complication rate of 22.6%, using succinylcholine to facilitate

intubation.¹⁰ Despite the fact that retrospective studies comparing the survival of patients treated with BVM and ETI have generally found no difference, some investigators have suggested that ETI may

Author Affiliations are listed at the end of this article. **Corresponding Author and Reprints:** Marianne Gausche, MD, Harbor-UCLA Medical Center, Department of Emergency Medicine, 1000 W Carson St, Box 21, Torrance, CA 90509 (e-mail: mgausche@emedharbor.edu).

Caring for the Critically Ill Patient Section Editor: Deborah J. Cook, MD, Consulting Editor, JAMA.

Advisory Board: David Bihari, MD; Christian Brun-Buisson, MD; Timothy Evans, MD; John Heffner, MD; Norman Paradis, MD.

Wang, et al. (Annals EM 2004)

- PA State 2000-2002
- Severe TBI
- Paramedic ETI vs. Emergency Dept ETI
 - Excluded all others
- Multivariate, propensity score adjustment

Out-of-Hospital Endotracheal Intubation and Outcome After Traumatic Brain Injury

See editorial, p. 451.

Henry E. Wang, MD, MPH
Andrew B. Peitzman, MD
Laura D. Cassidy, PhD
P. David Adelson, MD
Donald M. Yealy, MD

From the Department of Emergency Medicine (Wang, Yealy), Department of Surgery (Peitzman), and Department of Neurosurgery (Adelson), University of Pittsburgh School of Medicine; and the Department of Biostatistics, University of Pittsburgh (Cassidy), Pittsburgh, PA.

Study objective: Previous studies disagree about the effect of out-of-hospital endotracheal intubation on traumatic brain injury. This study compares the effects of out-of-hospital endotracheal intubation versus emergency department (ED) endotracheal intubation on mortality and neurologic and functional outcome after severe traumatic brain injury.

Methods: From the 2000 to 2002 Pennsylvania Trauma Outcome Study (a registry of all patients treated at trauma centers in the Commonwealth of Pennsylvania), adult patients with head/neck Abbreviated Injury Scale score of 3 or greater and undergoing out-of-hospital endotracheal intubation or ED endotracheal intubation were included. Transferred patients were excluded. The primary outcome was death (on hospital discharge). The secondary outcomes were neurologic (good versus poor, inferred from discharge to home versus long-term care facility) and functional outcome (determined from a Functional Impairment Score). The key exposure was endotracheal intubation (out-of-hospital endotracheal intubation versus ED endotracheal intubation). Using multivariate logistic regression, odds estimates for out-of-hospital endotracheal intubation were adjusted using age, sex, head/neck Abbreviated Injury Scale score, Injury Severity Score, mechanism of injury (penetrating versus blunt), admission systolic blood pressure, mode of transport (ground only versus helicopter or helicopter + ground), and the use of out-of-hospital neuromuscular blocking agents. A propensity score adjustment accounted for the potential effects of preexisting conditions, in-hospital complications, and social factors (drug and alcohol use, race, and insurance coverage).

Results: There were 4,098 patients with head/neck Abbreviated Injury Scale score of 3 or greater who received either out-of-hospital endotracheal intubation (n=1,797, 43.9%) or ED endotracheal intubation (n=2,301, 56.1%). Adjusted odds of death were higher for out-of-hospital endotracheal intubation than ED endotracheal intubation (odds ratio [OR] 3.99; 95% confidence interval [CI] 3.21 to 4.93). Out-of-hospital endotracheal intubation was associated with an increased adjusted odds of poor neurologic outcome (OR 1.61; 95% CI 1.15 to 2.26), moderate or severe functional impairment (Functional Impairment Score 6 to 15; OR 1.92; 95% CI 1.40 to 2.64), and severe functional impairment (Functional Impairment Score 11 to 15; OR 1.80; 95% CI 1.29 to 2.52).

Conclusion: Out-of-hospital endotracheal intubation was associated with adverse outcomes after severe traumatic brain injury. The implications for current clinical care remain undefined.

[Ann Emerg Med. 2004;44:439-450.]

0196-0644/04/0000

Copyright © 2004 by the American College of Emergency Physicians.

doi:10.1016/

j.annemergmed.2004.04.008

Paramedic ETI Associated with Worsened Outcomes

- Increased odds of death
 - Adjusted OR 3.99 (3.21 – 4.93)
- Increased odds of poor neurological outcome
 - Adjusted OR 1.61 (1.15 – 2.26)
- Increased odds of functional impairment
 - Adjusted OR 1.92 [1.27 – 2.93] (Moderate-or-Severe)
 - Adjusted OR 1.59 [1.11 – 2.26] (Severe)

***“Do Paramedics Make
ETI Mistakes?”***



Paramedics Often Misplace the Tube

- 108 paramedic ETI
- Orlando Emergency Department
- **25% Misplaced**
 - 2/3 esophageal
 - 1/3 above vocal cords

EMS/ORIGINAL CONTRIBUTION

Misplaced Endotracheal Tubes by Paramedics in an Urban Emergency Medical Services System

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

See editorial, p. 62.

From the Department of Emergency Medicine, JFK Medical Center, Atlantis, FL,* and Department of Emergency Medicine, Orlando Regional Medical Center, Orlando, FL, and University of Florida College of Medicine, Gainesville, FL.†

Received for publication May 27, 1999. Revisions received July 24, 2000, and September 22, 2000. Accepted for publication October 3, 2000.

Presented in part at the Society for Academic Emergency Medicine annual meeting, Boston, MA, May 1999.

Address for reprints: Jay L. Falk, MD, Department of Emergency Medicine, Orlando Regional Medical Center, 86 West Underwood, Suite 200, Orlando, FL 32806; 407-237-6324, fax 407-649-3083; E-mail: JayFalk@orh.org.

Copyright © 2001 by the American College of Emergency Physicians.

0196-0644/2001/\$35.00 + 0

4711/112098

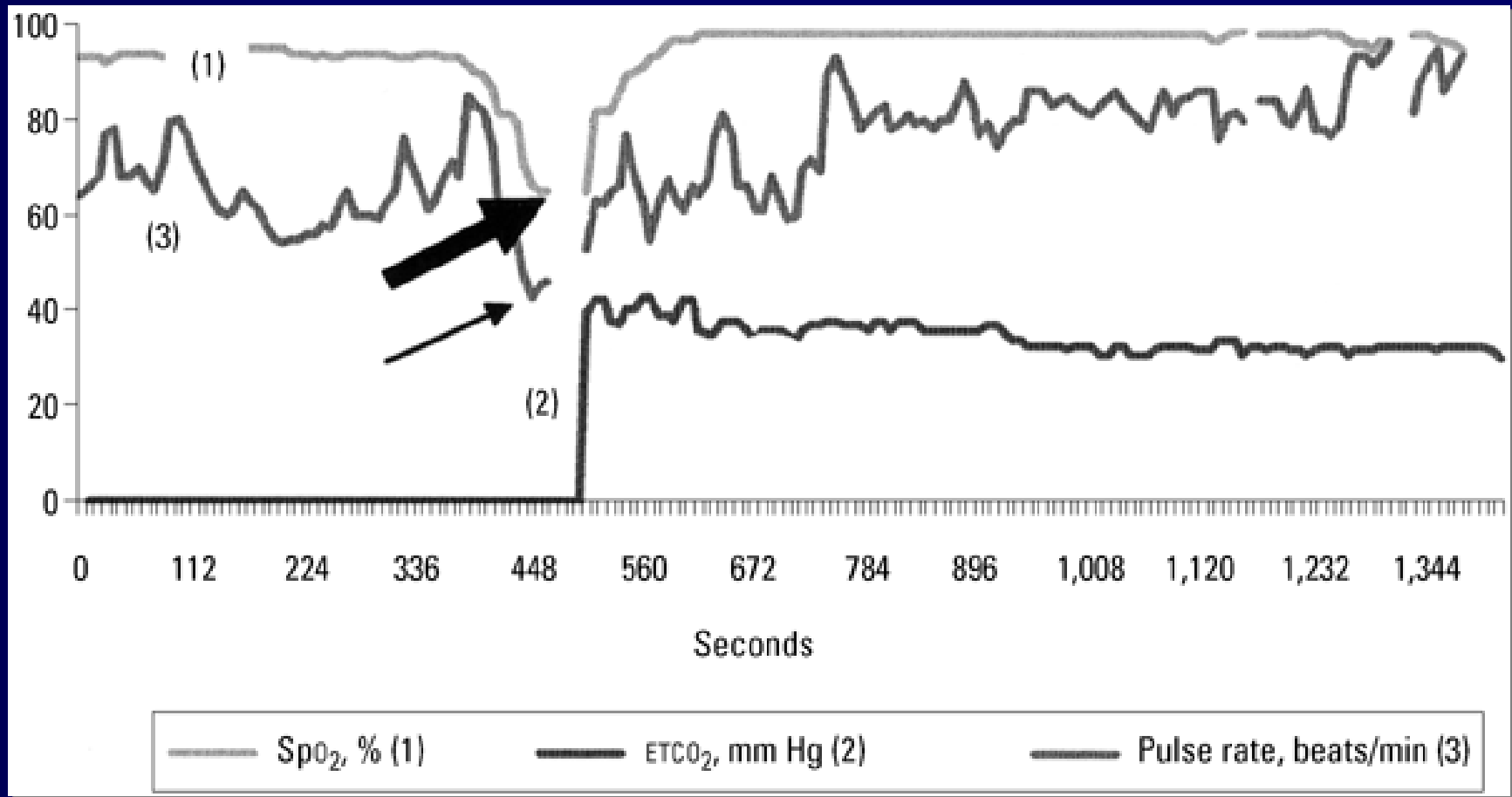
doi:10.1067/em.2001.112098

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 tubes noted in the hypopharynx, 33% (3/9) died while in the ED. For the patients found to have tubes in the hypopharynx, 56% (5/9) had evidence of ETCO₂ on ED arrival. For the patients found to have esophageal tube placement on ED arrival, 56% (10/18) died in the ED. Esophageal intubation was associated with an absence of expired CO₂ (17/18, 94%) on ED arrival. The single patient in this subset with a recordable ETCO₂ had been nasotracheally intubated with the tip of the endotracheal tube noted in the esophagus while spontaneous respirations were present. On patient arrival to the ED, 63% (68/108) of the patients had direct laryngoscopy in addition to ETCO₂ determination. All patients had ETCO₂ evaluation performed on arrival. All patients in whom an absence of ETCO₂ was demonstrated on patient arrival underwent direct laryngoscopy. In cases in which direct laryngoscopy was not performed, the attending physician documented the ETCO₂ in conjunction with the presence of bilateral breath sounds.

“Just Because the Tube is in the Right Place Doesn't Mean Everything is OK”



Dunford, et al. Ann Emerg Med 2003 Dec;42(6):721-8



Dunford, et al. (con't)

- Oxygen desaturation in over half
 - 31 of 54 (57%) desaturated
 - Median duration: 160 seconds (IQR 48 to 272)
 - Median desaturation (SpO2): 22%
- Bradycardia in one-fifth
 - 19% bradycardia
- Paramedic described “easy intubation” in 84%

ETI Errors Across Systems

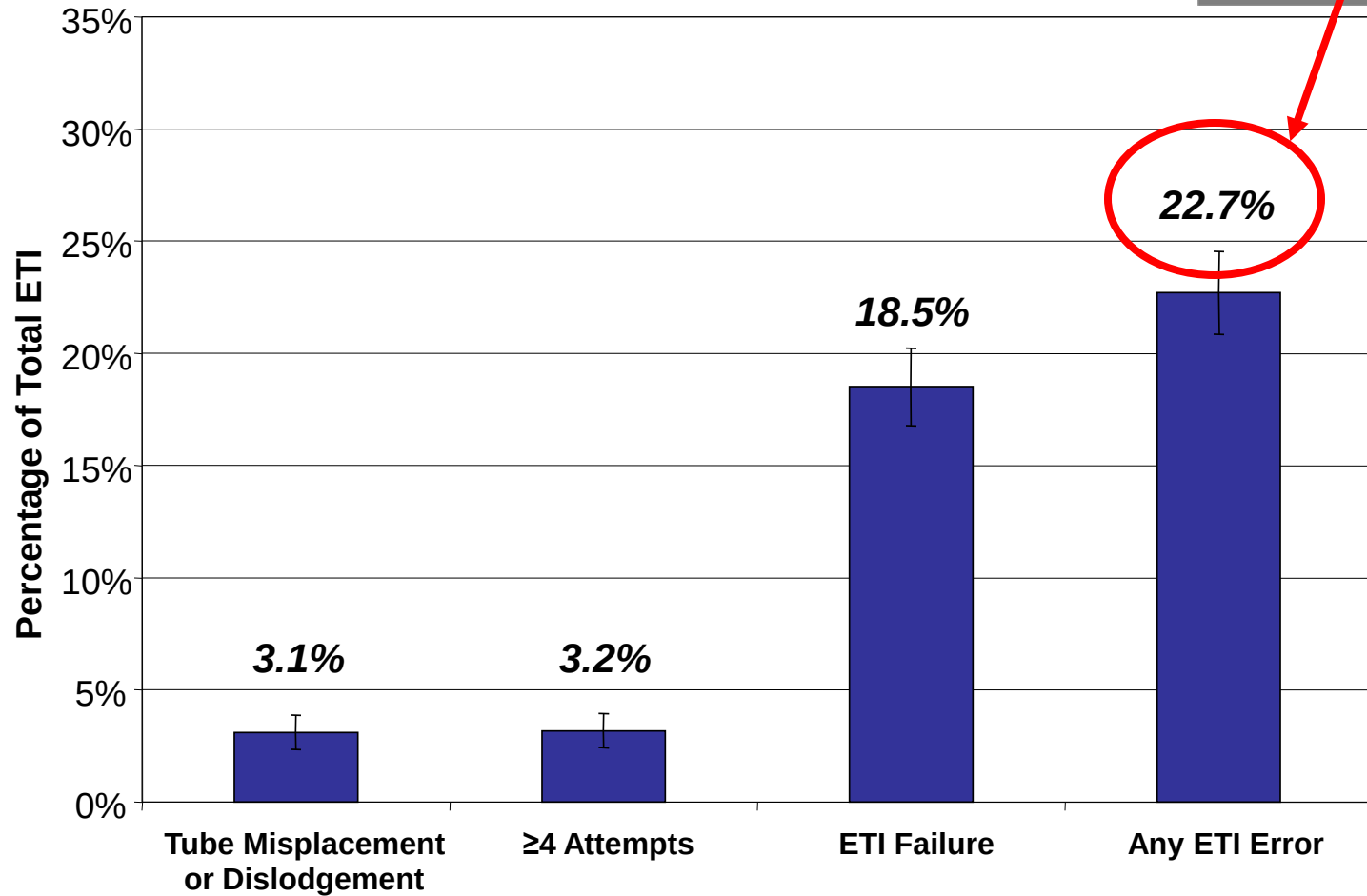
- Prospective, multicenter observational study
- Over 40 Pennsylvania EMS services
- Self-reported ETI data
 - PACE I: n = 743 ETI
 - PACE II: n = 1,953 ETI

Resuscitation 2003 Jul;58(1):49-58
Acad Emerg Med 2003 Jul;10(7):717-24
Prehosp Emerg Care 2004 Jan-Mar;8(1):1-9
Health Affairs 2006;25:501-509

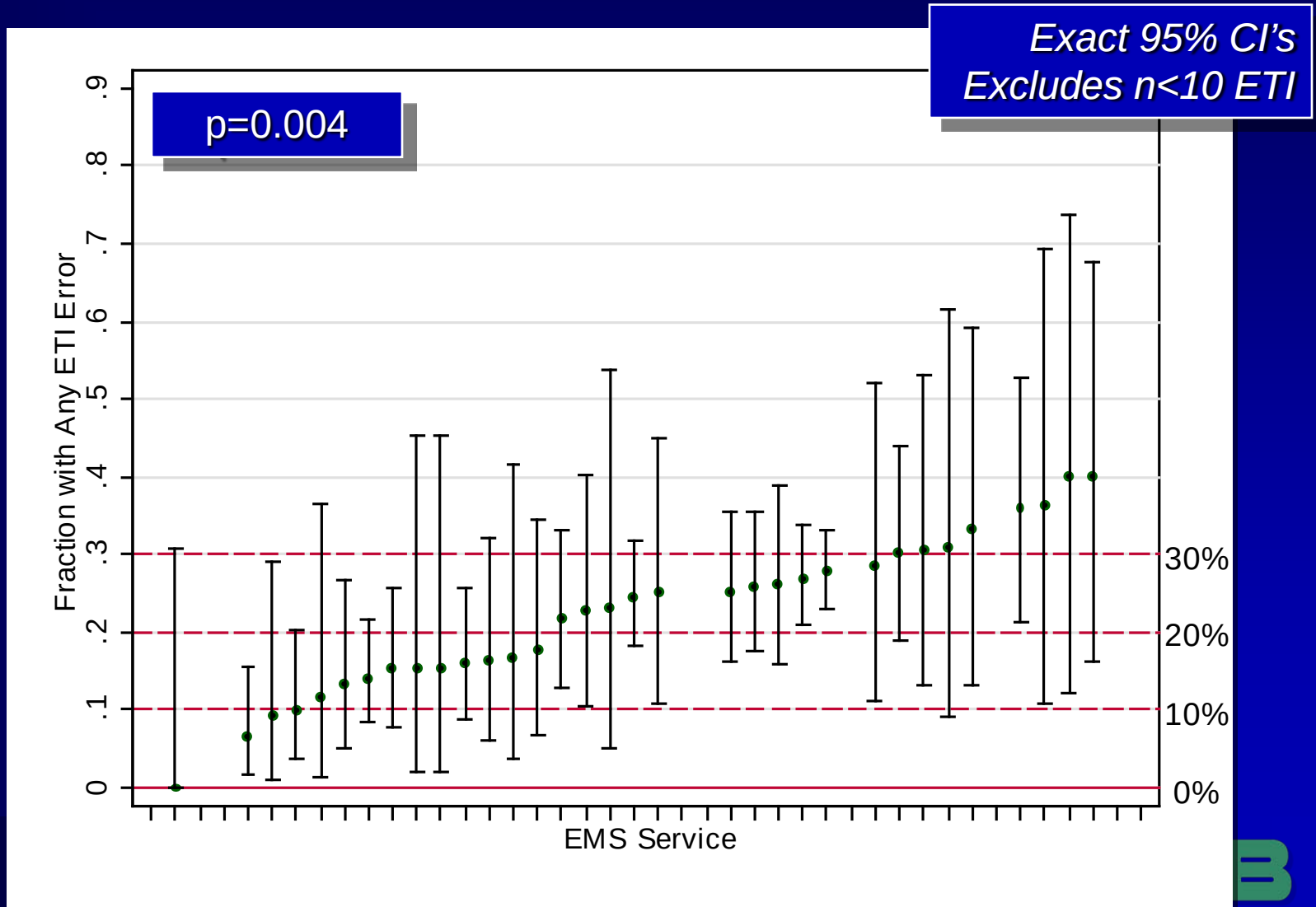


Overall ETI Error Rate

**1 in 4.5
Exposed to
an ETI Error**



Variation in Agency ETI Error Rates

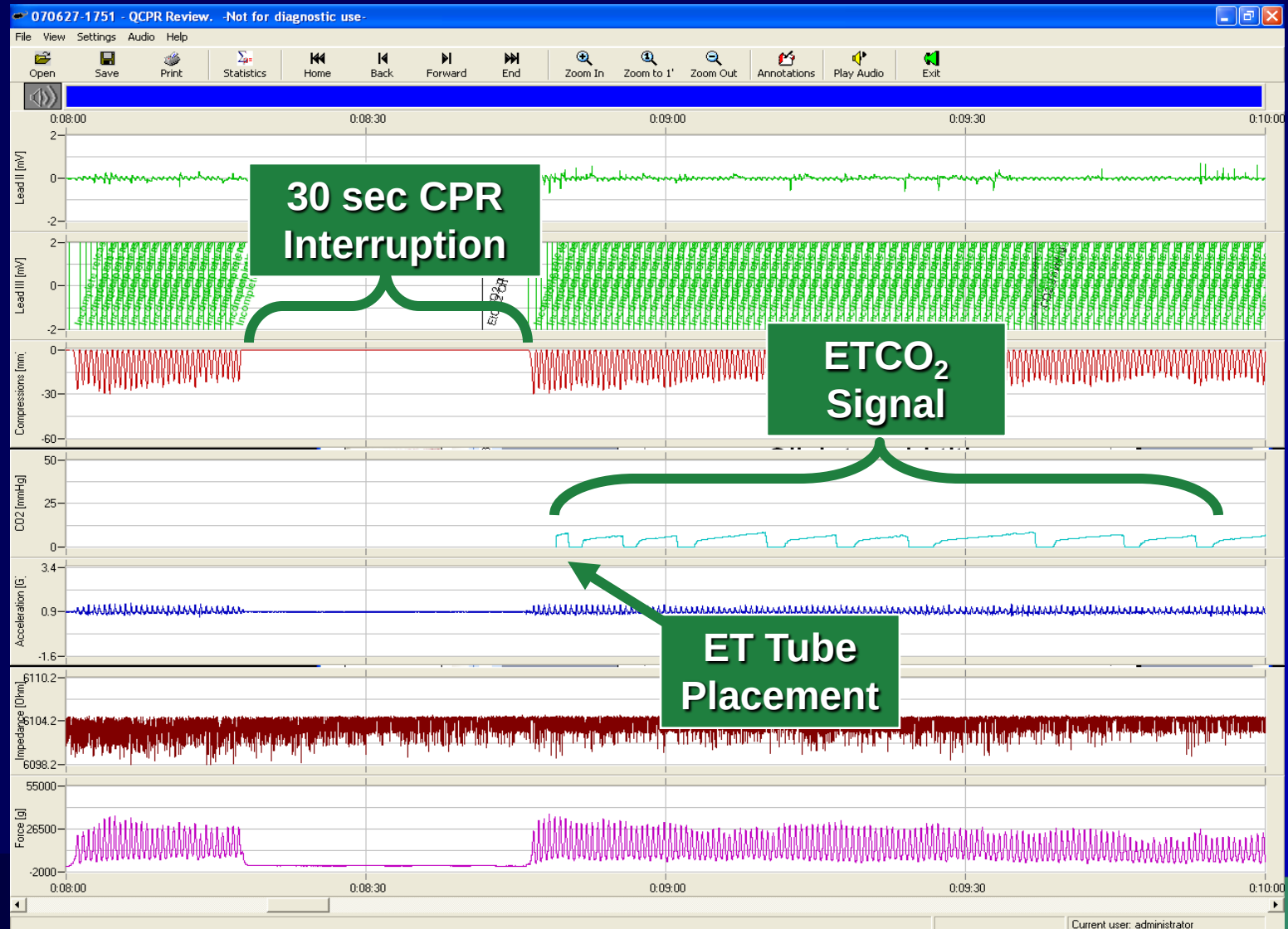


“Intubate quickly...”

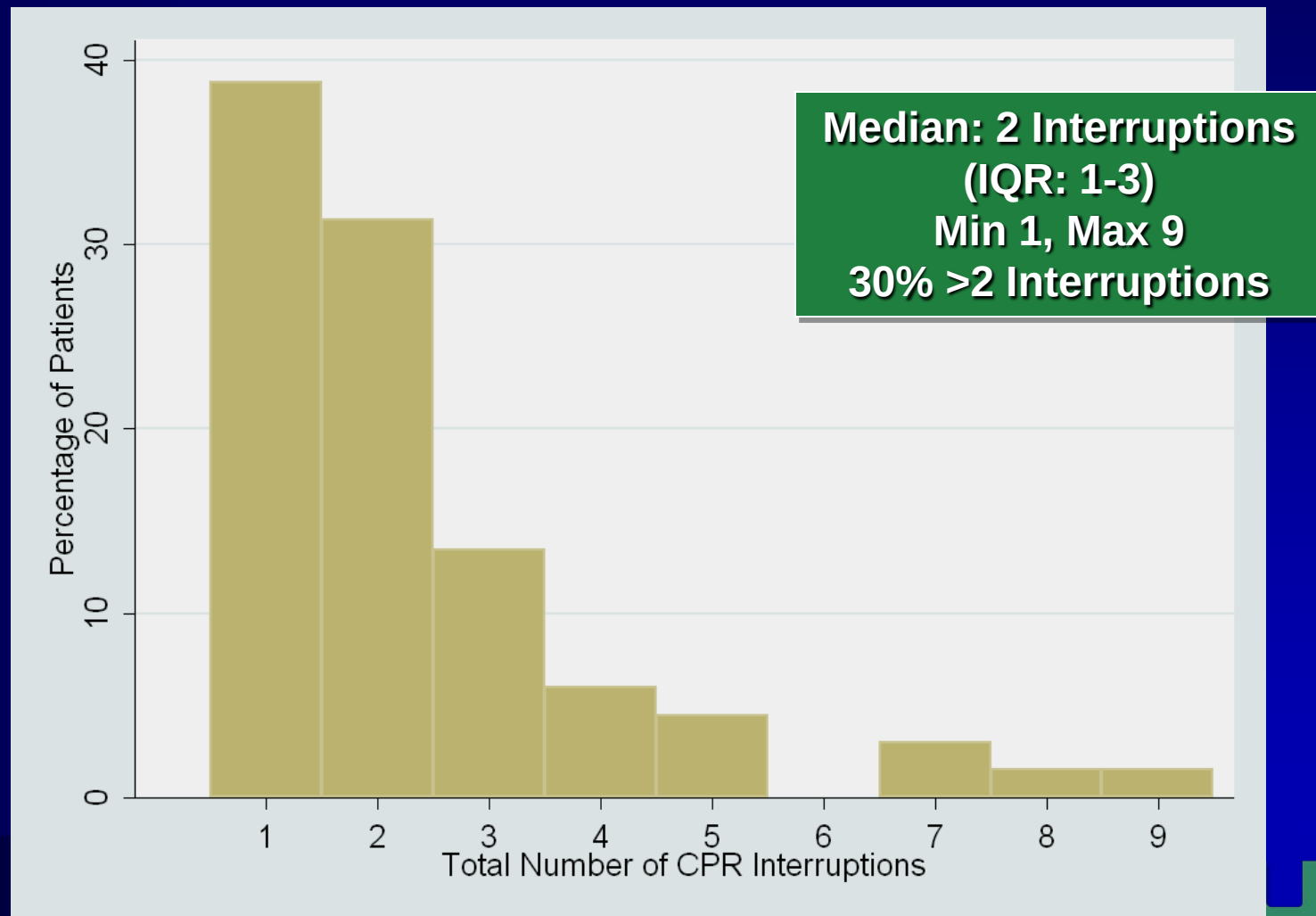
***“Don’t stop other tasks to
intubate ...”***



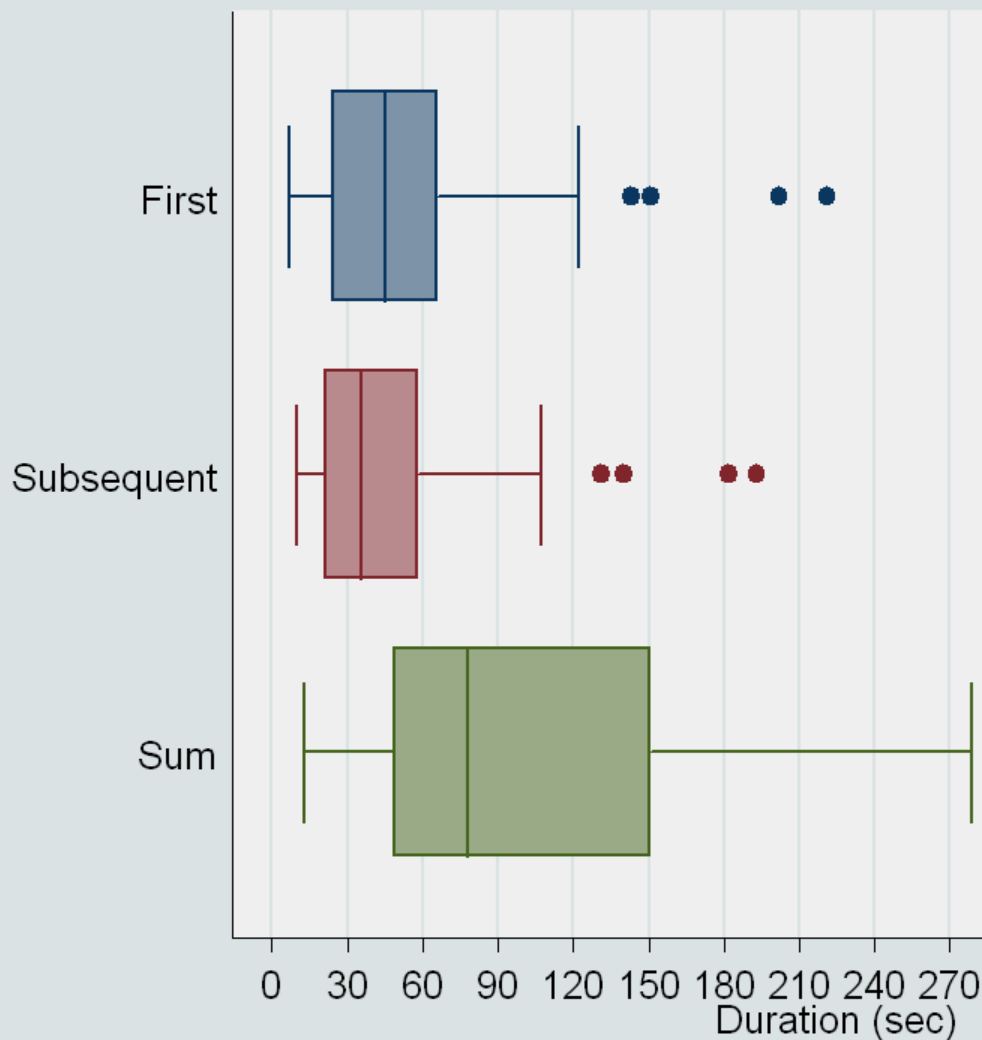
“Don’t Stop CPR to Intubate”



Number of ETI-Associated CPR Interruptions



Duration of ETI-Associated CPR Interruptions



First CPR Interruption

Median: 46.5 sec (IQR: 23.5-73)

Min 7, Max 221

~30% >60 sec

Subsequent CPR Interruptions

Median: 35 sec (IQR: 21-58)

Min 7, Max 199

~20% >60 sec

Sum of All CPR Interruptions

Median: 109.5 sec (IQR: 54-198)

Min 13, Max 446

~25% >180 sec

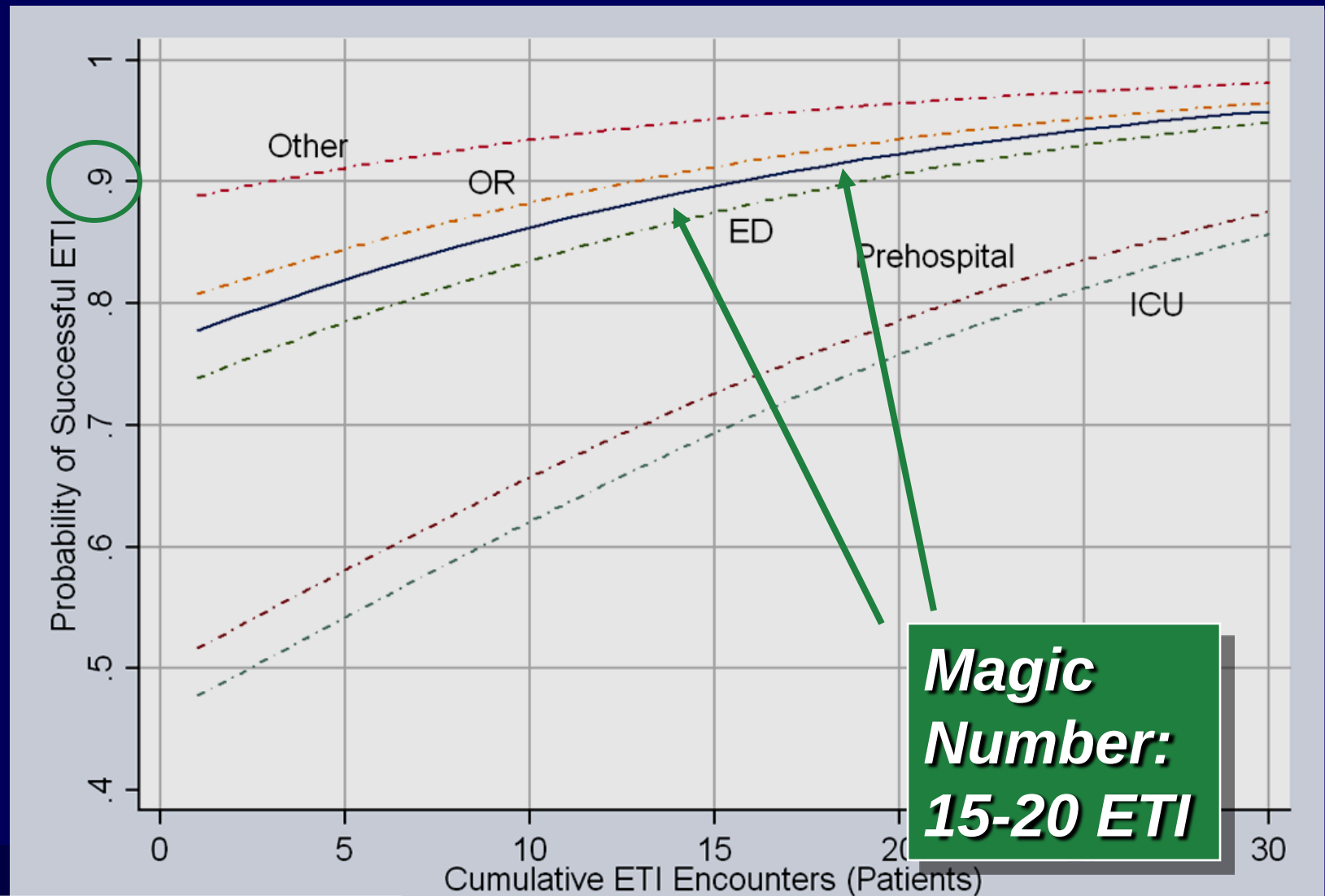
“Does Skill Play a Role?”



How Many ETI Do You Need to Graduate?

- EM Residents 35
- Anesthesia Residents 20-57
- CRNA Students 200
- Paramedic Students 5

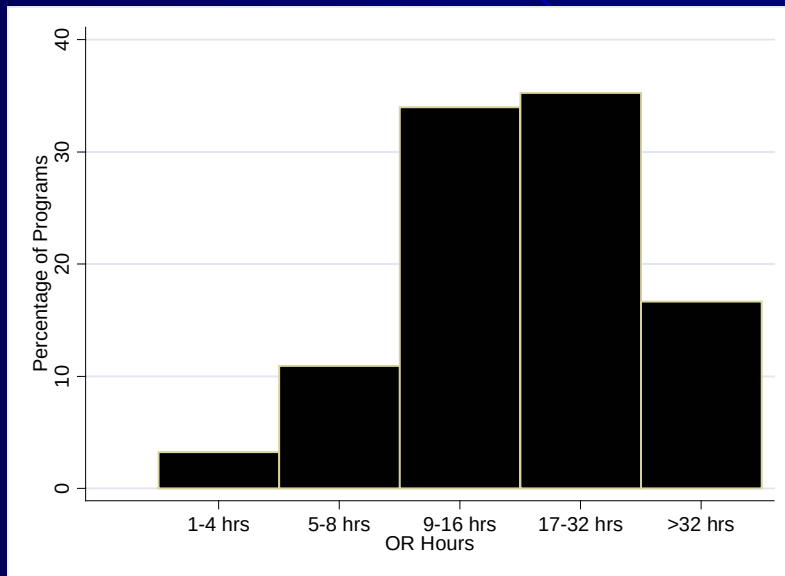
Learning Curve for Paramedic Student ETI



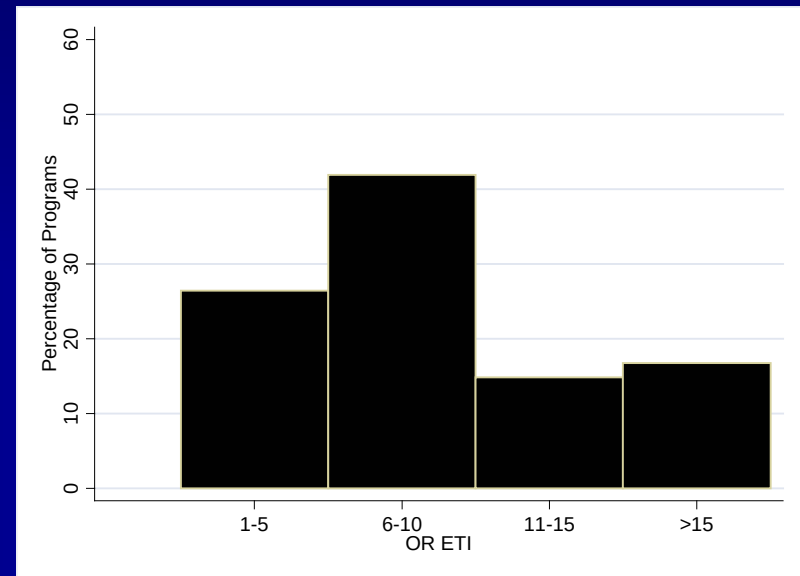
Wang, et al., PEC 2005

OR Training Hours per Student

Median 17-32 hours



Median 6-10 ETI



Johnston, et al., AEM 2006



Barriers

- Competition from other students
- Widespread Laryngeal Mask Airway use
- Anesthesiologists' medicolegal concerns



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.”

***“Skill”
 (“Proficiency”)***

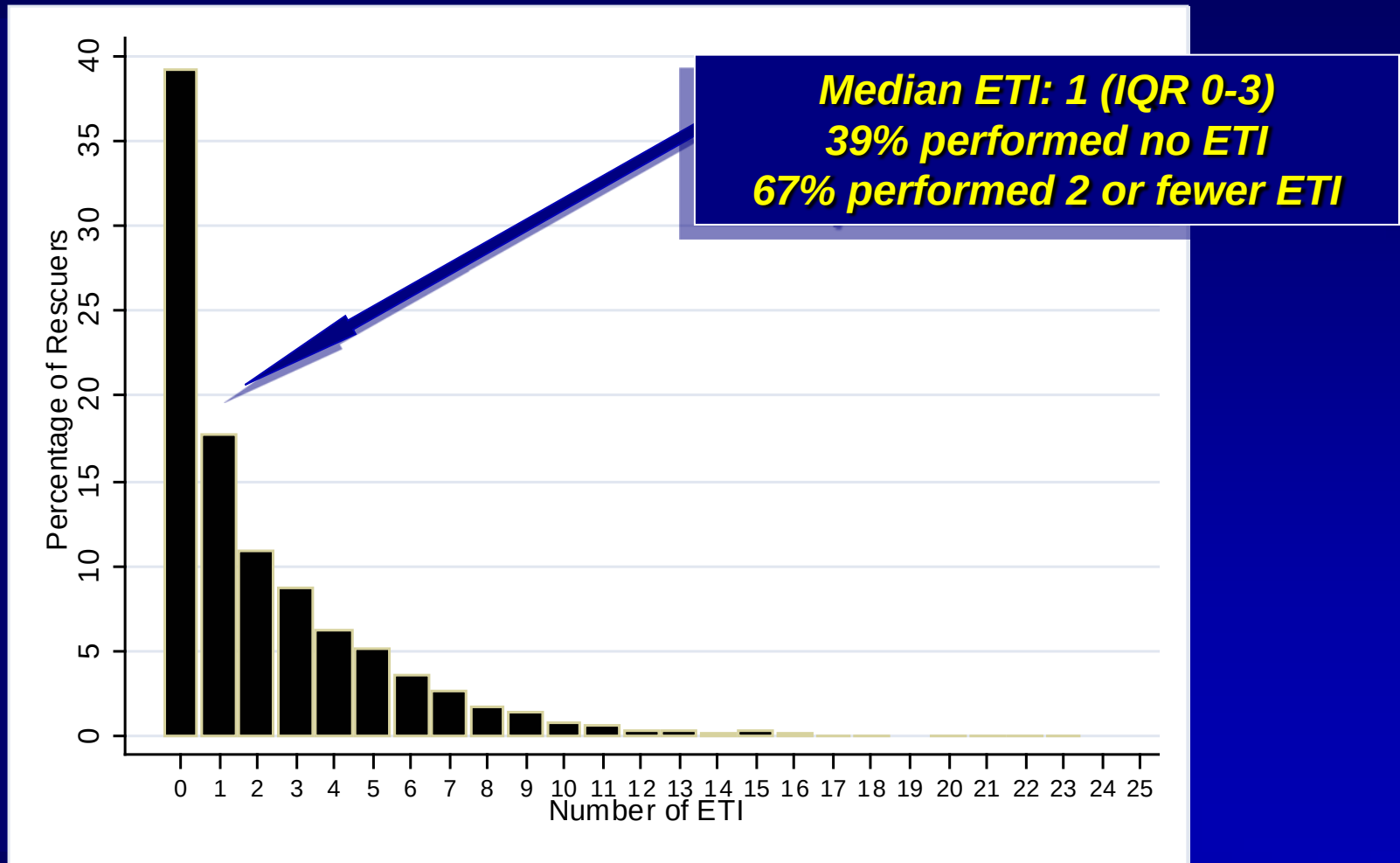
=

***Baseline
 Training***

+

***Regular
 Application***

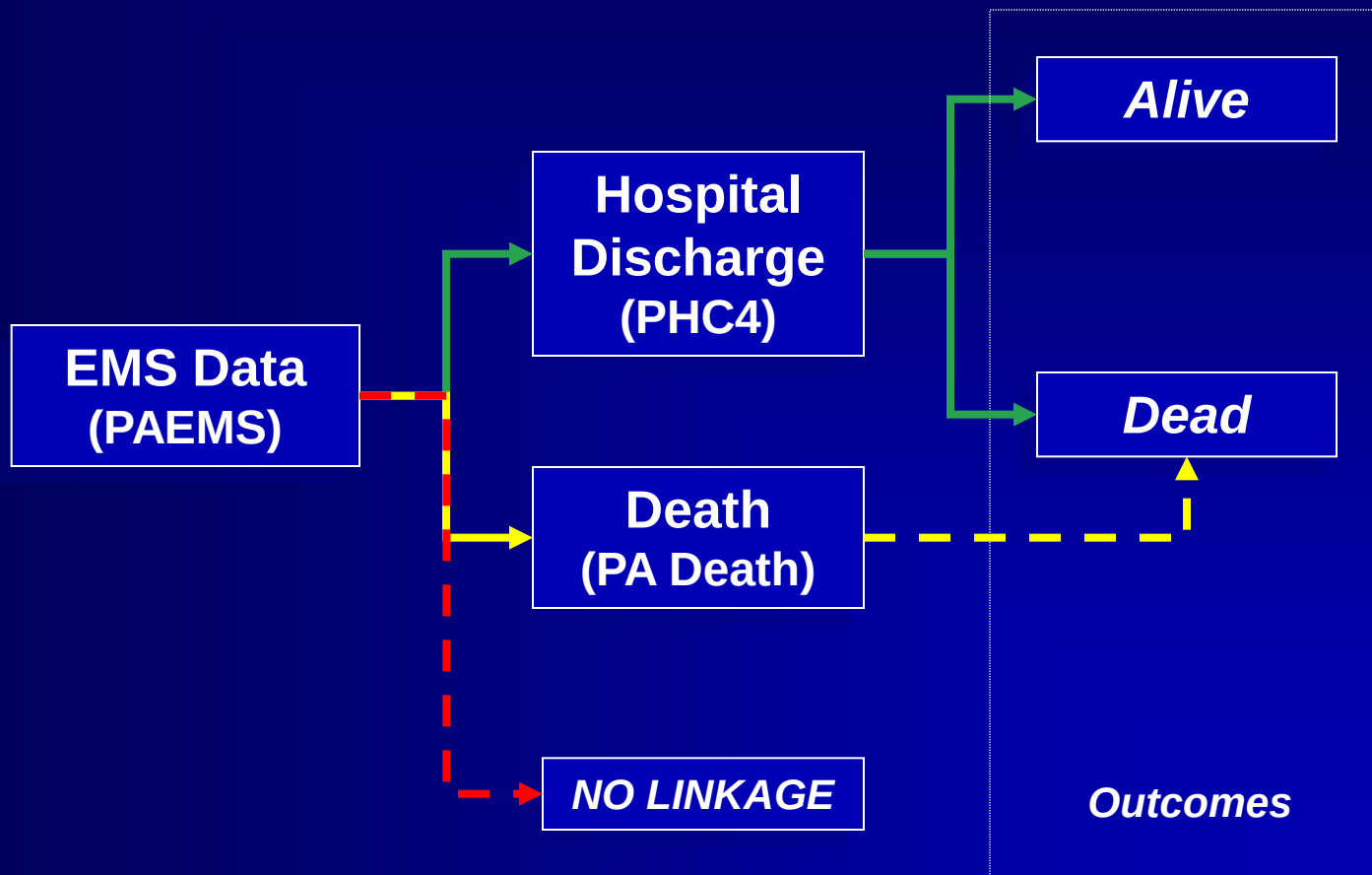
Per-Rescuer ETI Frequency



Wang HE, et al., Critical Care Med 2005; 33:1718-21

“Does ETI Experience Improve Outcomes?”

Probabilistic Linkage of Statewide Data Sets



Cumulative Paramedic ETI Experience and Patient Survival

Cardiac Arrests

Paramedic ETI
Experience
Cardiac Arrests

"Very High" >50	1.44 (1.10 - 1.89)
"High" 26-50	1.14 (0.98 - 1.33)
"Medium" 11-25	1.04 (0.91 - 1.19)
"Low" 1-10	Referent

Increased
Experience

Non-Arrests

Paramedic ETI
Experience
Non-Arrests

"Very High" >50	1.60 (1.16 - 2.20)
"High" 26-50	1.28 (1.06 - 1.54)
"Medium" 11-25	1.10 (0.94 - 1.28)
"Low" 1-10	Referent

Increased
Experience

0.1

1

10

Adjusted Odds Ratio (Survival)

Adjusted OR

Cumulative Paramedic ETI Experience and Patient Survival

Cardiac Arrests

Paramedic ETI
Experience
Cardiac Arrests

"Very High" >50		1.44 (1.10 - 1.89)
"High" 26-50		1.14 (0.98 - 1.33)
"Medium" 11-25		1.04 (0.91 - 1.19)
"Low" 1-10		Referent

Non-Arrests

Paramedic ETI
Experience
Non-Arrests

"Very High" >50		1.60 (1.16 - 2.20)
"High" 26-50		1.28 (1.06 - 1.54)
"Medium" 11-25		1.10 (0.94 - 1.28)
"Low" 1-10		Referent

0.1

1

10

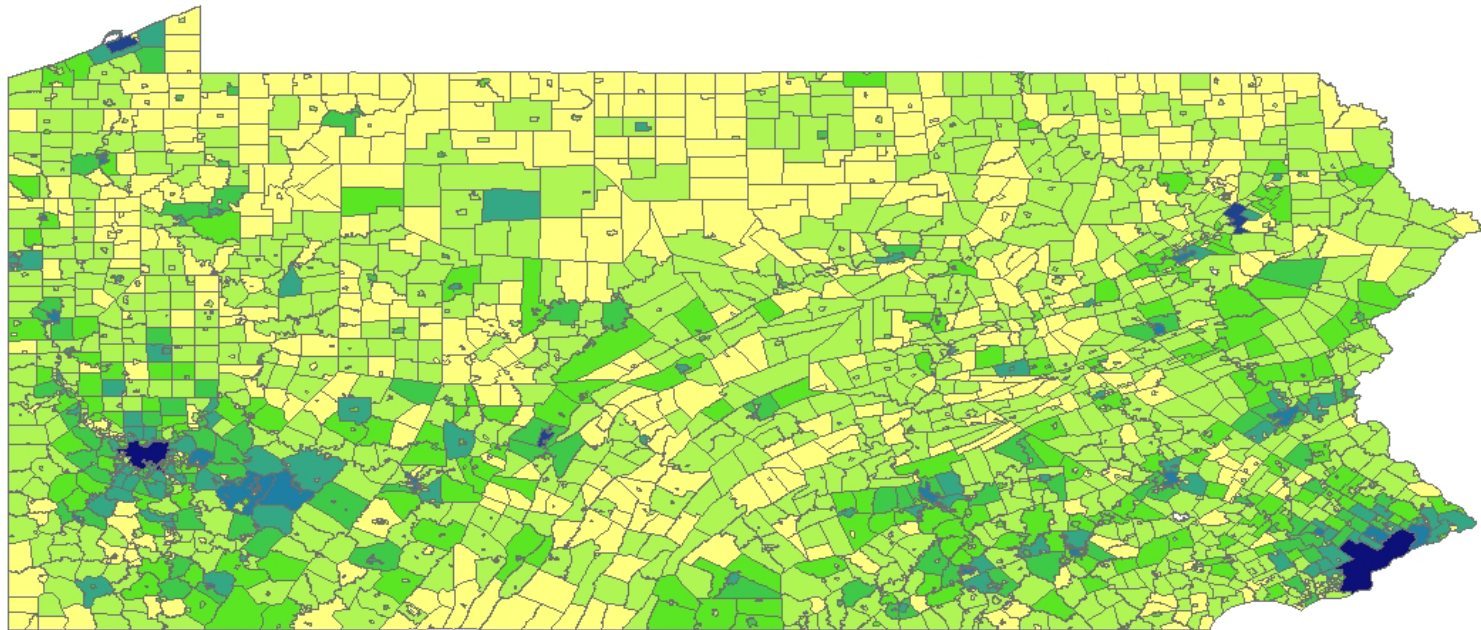
Adjusted Odds Ratio (Survival)

Adjusted OR

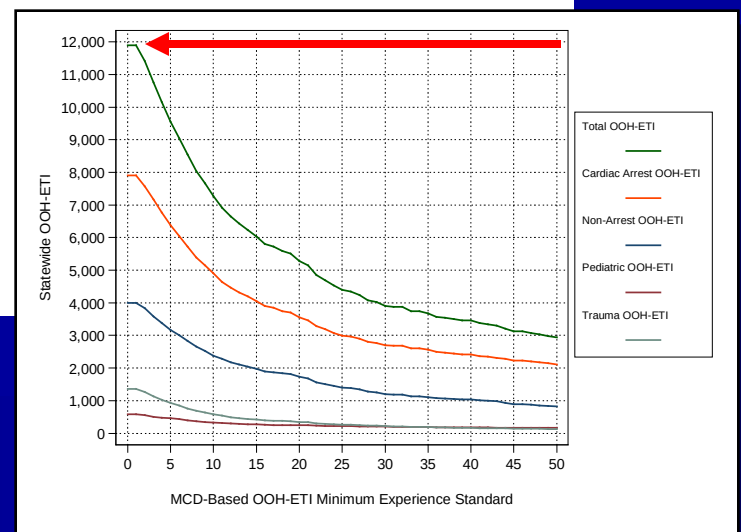
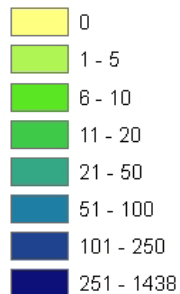
*Cumulative ETI
experience
associated with
improved
survival*

“What if We Limited ETI?”

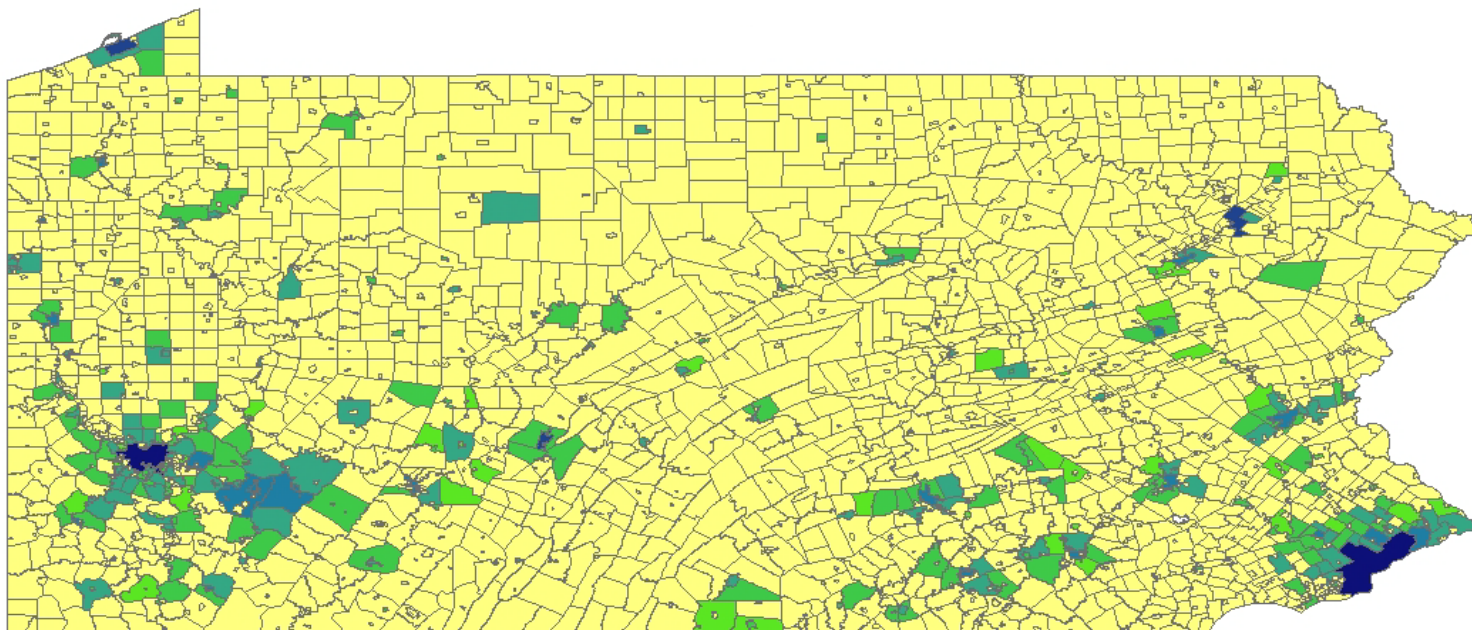
Minimum Standard = 1 ETI/MCD



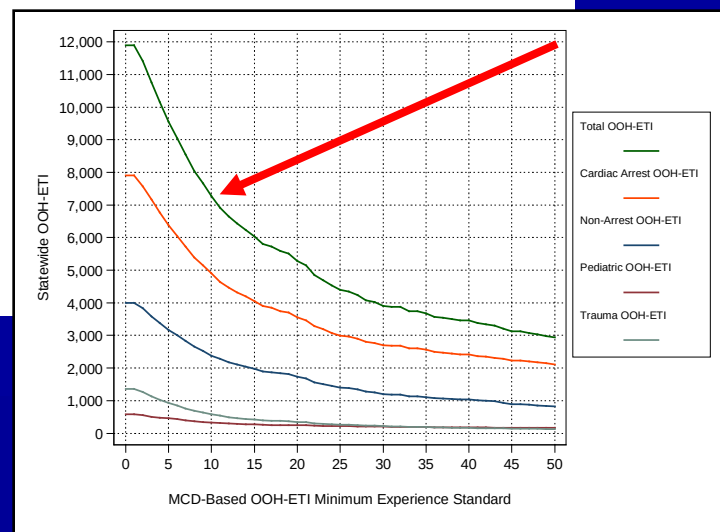
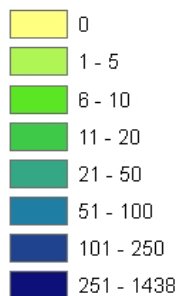
PROCTHRE.MCDETI1



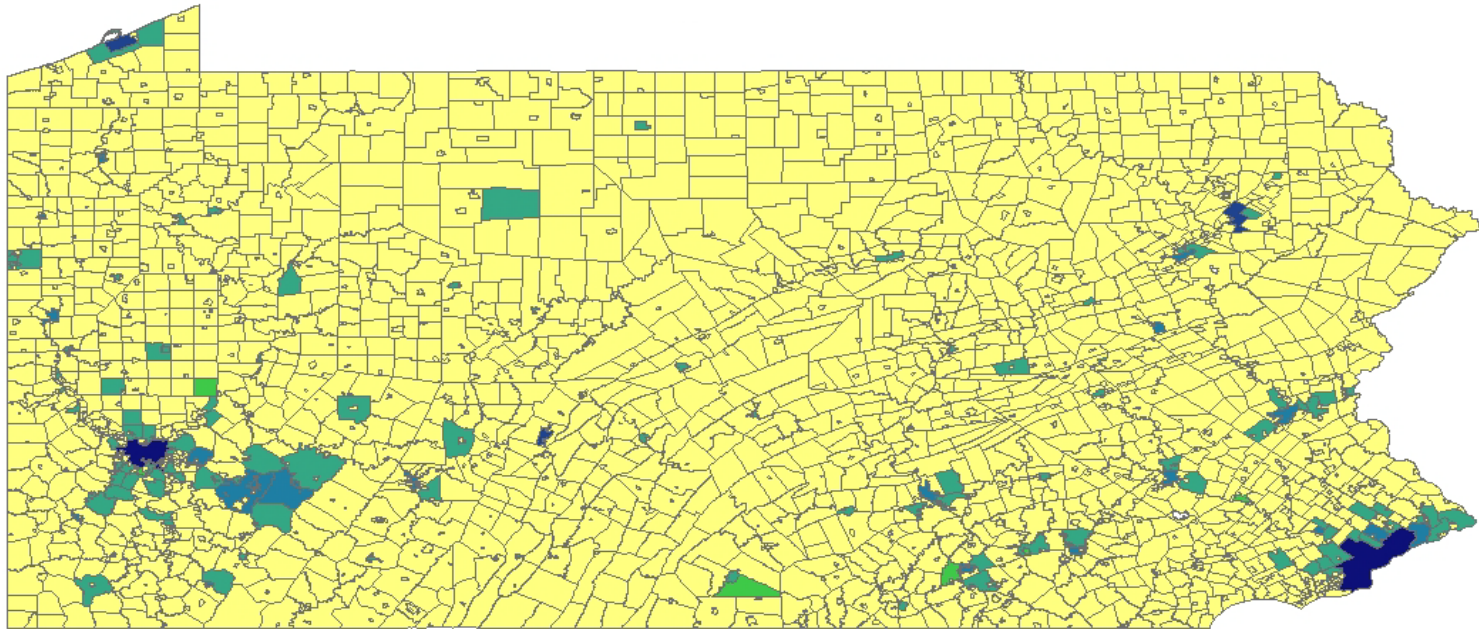
Minimum Standard = 10 ETI/MCD



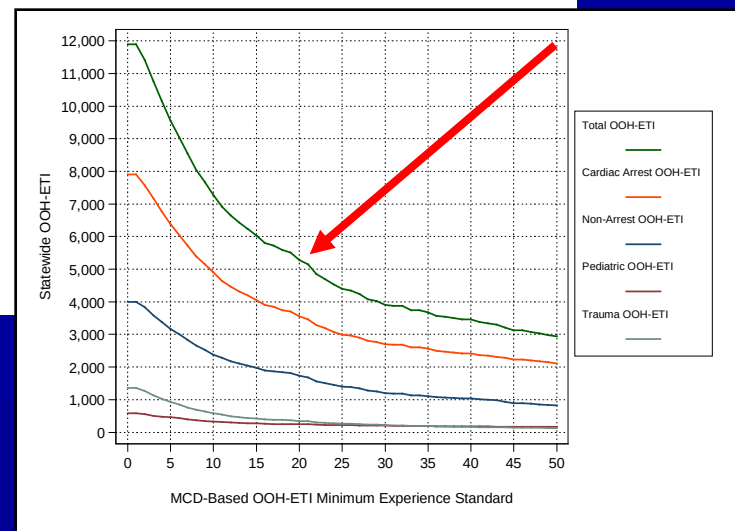
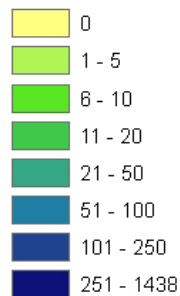
PROCTHRE.MCDETI11



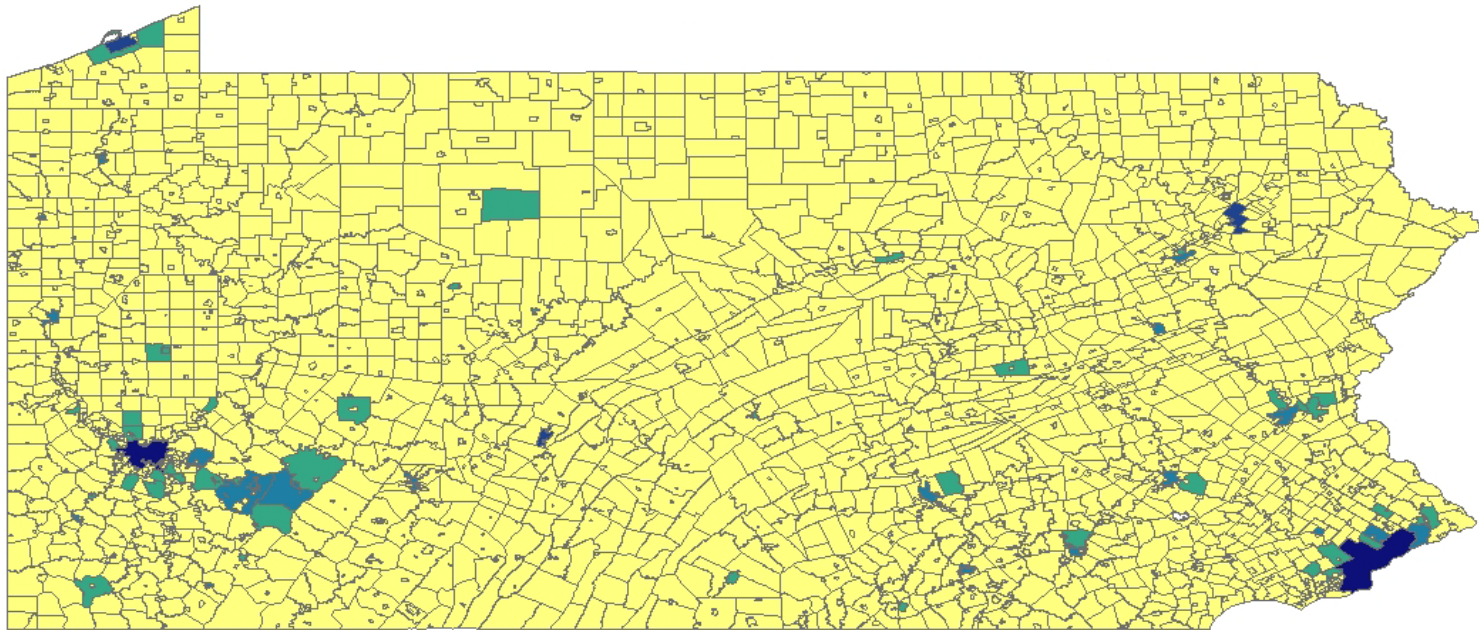
Minimum Standard = 20 ETI/MCD



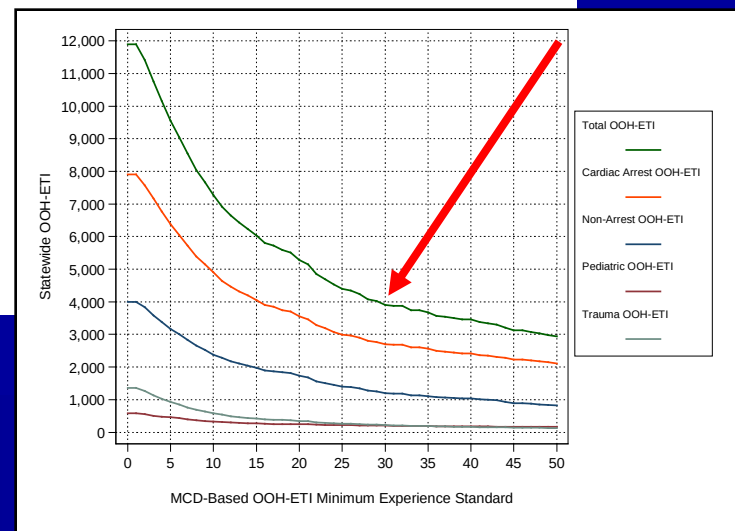
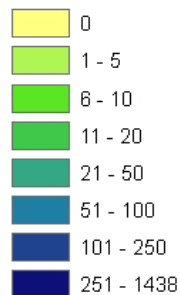
PROCTHRE.MCDETI21



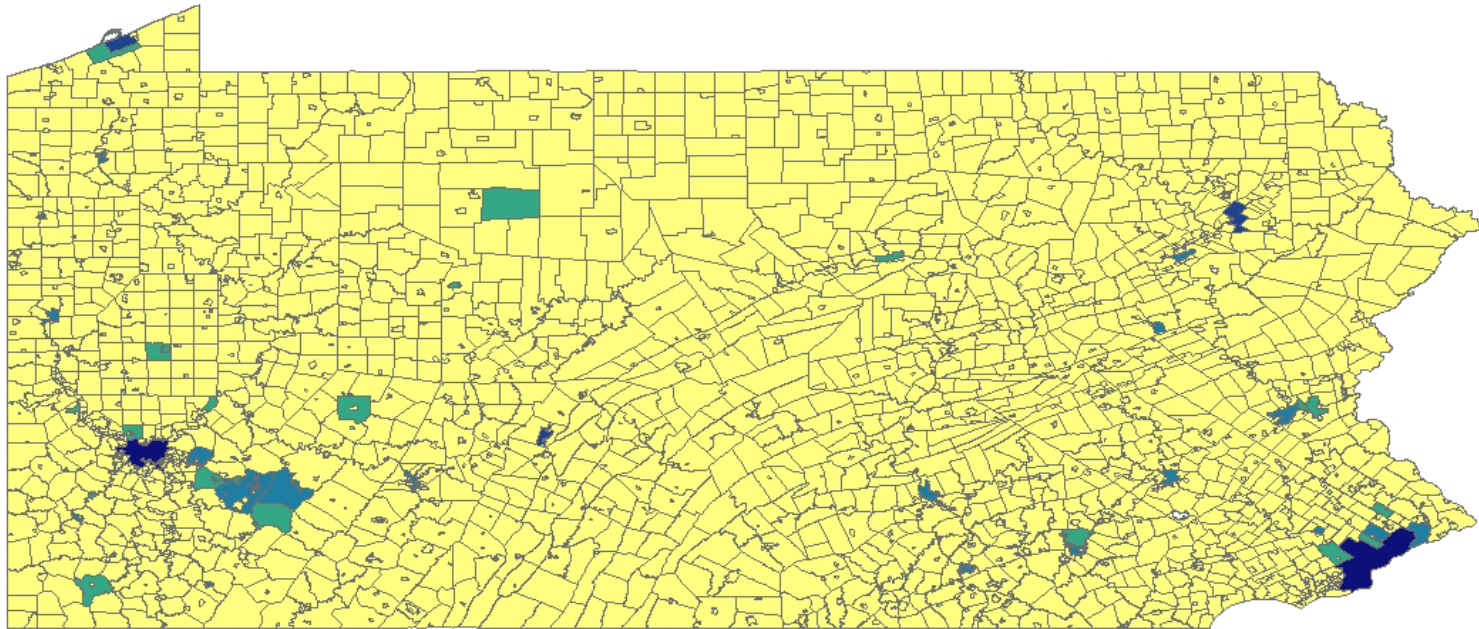
Minimum Standard = 30 ETI/MCD



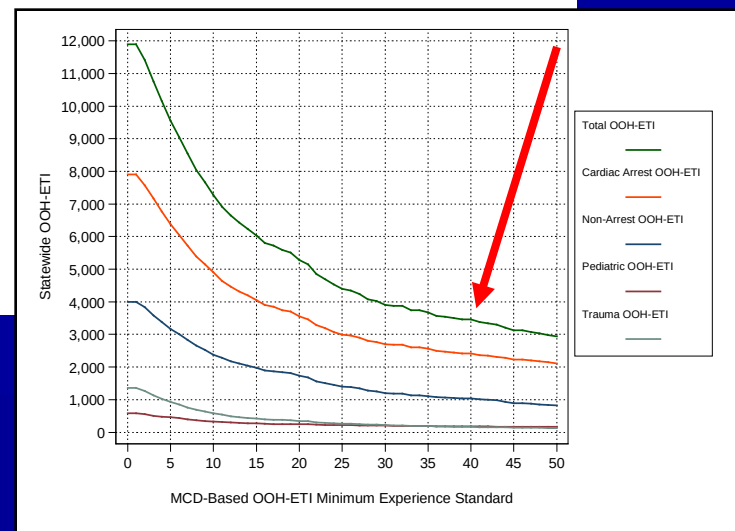
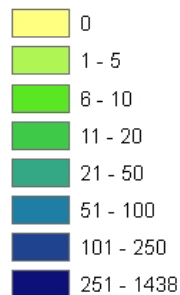
PROCTHRE.MCDETI31



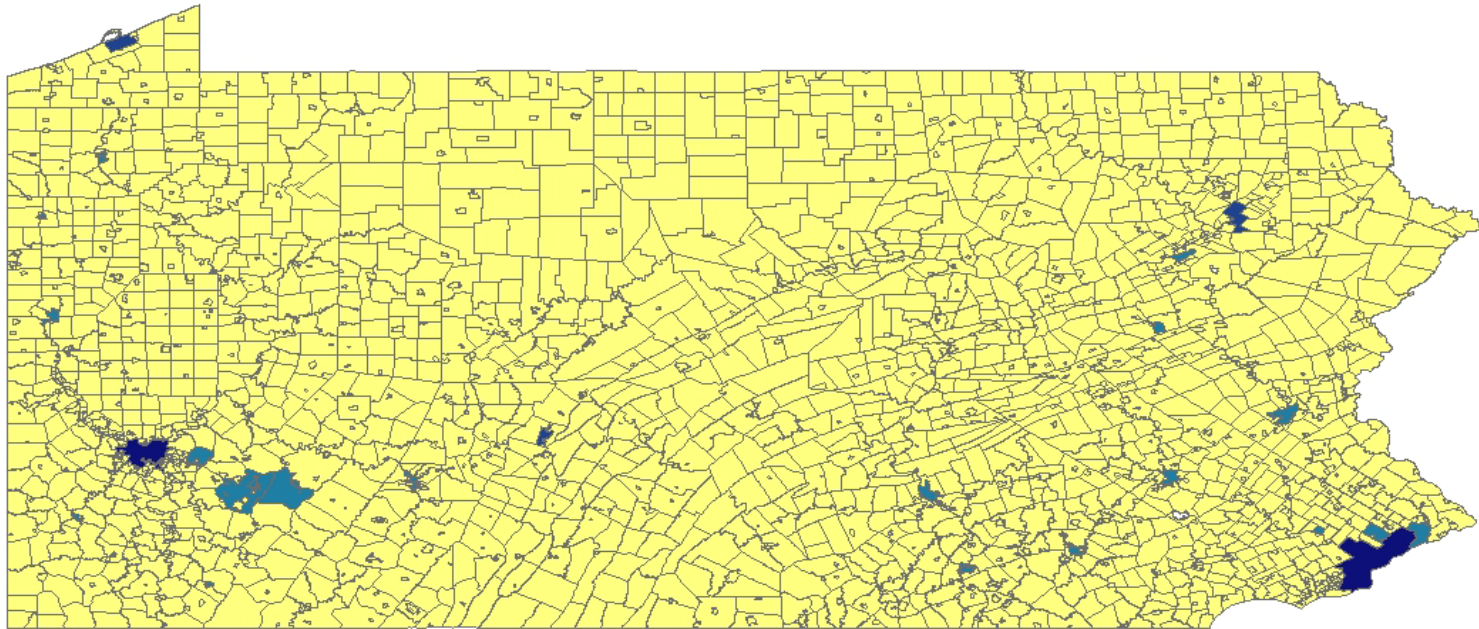
Minimum Standard = 40 ETI/MCD



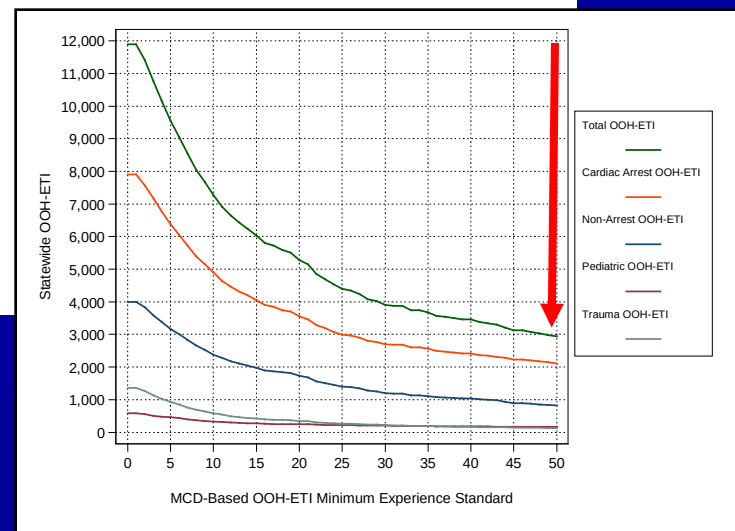
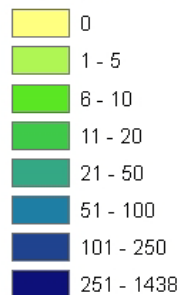
PROCTHRE.MCDETI41



Minimum Standard = 50 ETI/MCD



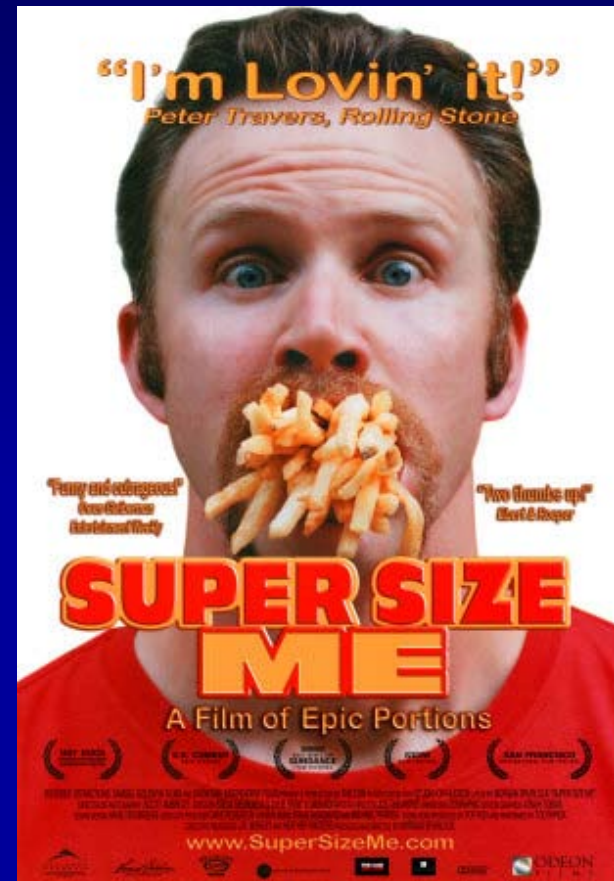
PROCTHRE.MCDETI51



Policy Implications

Super-Sized EMS

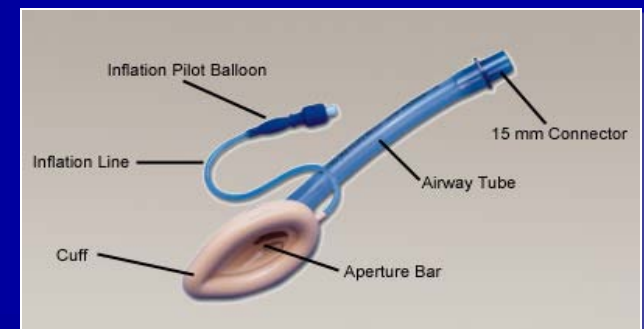
- A paramedic on every fire truck?
- More medics $\neq$ Better care
 - Procedural dilution
 - Harder to assure quality and training
 - Better care with tiered systems



“EMS Often Ignores the Simplest Solutions”

- e.g., Alternate Airways

- King LT
- Combitube
- LMA
- Easy to use, learn and retain skill
- ***Would solve many systemwide problems***



Questions?



Contact

Henry E. Wang, MD, MS
Associate Professor
Department of Emergency Medicine
University of Alabama at Birmingham
619 19th St. South
JTN 265
Birmingham, AL 35249
(205)-996-6526
hwang@uabmc.edu