"GAG ME"
Current Trends in Airway Management

2012 Virginia

EMS Symposium

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Introduction

- Why an airway lecture?
- Airway management is a key skill for EMS providers at all levels.
- Inherently challenging due to the relative infrequency of performance.
- Out-of-hospital airway management has been the topic of recent research.

Introduction

- **Questions regarding:**
  - **Safety**
  - **Efficacy**
  - **Competencies**
  - **Outcome data**
- **New options available**
  - **Greater emphasis placed on assessment of the airway**
  - **Decision making on how to manage the airway**
- **Changes in the fundamental approach to airway management.**

Introduction

- **Objectives for today:**
  - **Review some of the current practices in advanced airway management.**
  - **Identify research trends related to airway management.**
  - **Discuss several adjuncts to “traditional” airway techniques.**
  - **Identify advantages and disadvantages for various adjuncts.**
  - **Stimulate your appetite for more information…..**

Fundamentals of Airway Decision Making

- **Rapid patient assessment**
  - Need for advanced airway management
  - Urgency of the need
- **Consideration of the options available**
  - Basic vs. advanced techniques
  - Invasive vs. surgical
  - Medication assisted
- **Practitioner biasness**
  - Knowledge, skills, attitude
  - Preferences, competencies

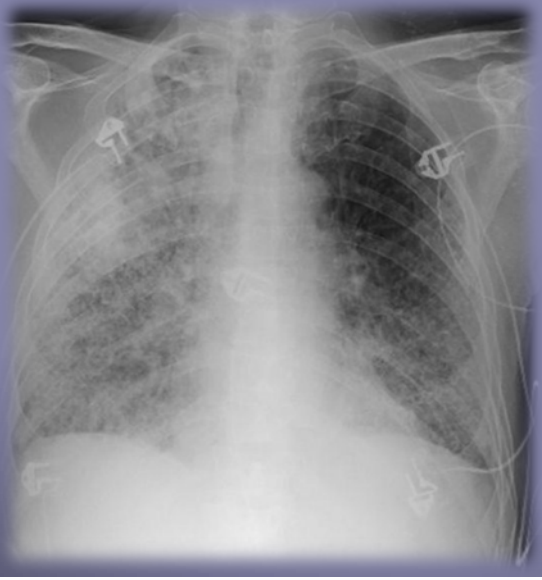
Requirements for Airway Management

- **Failure to maintain or protect the airway**
  - Patent airway is fundamental
  - Protect against aspiration
- **Gag vs. swallowing (secretions, blood, vomit)**
  - The gag reflex is a poor indication for intubation. Up to 30% of patients may lack a gag reflex in light of a relatively normal mental status.
  - Spontaneous swallowing is a better measure of the patient's ability to protect their airway.

Moultan, et. al. 1991; Bleach, 1993; Davis, et. al 1995; Chan et. al 1993.

Requirements for Airway Management

- **Failure of ventilation or oxygenation**
  - **Respiratory fatigue/failure – not easily reversible**
  - **Increasing hypoxemia/hypercapnea (COPD/asthma)**



Requirements for Airway Management

- **Condition present or a therapy is required that mandates intubation**
  - Controlled ventilation-head injuries
  - Potential for airway deterioration-penetrating or blunt neck injuries
  - Upper airway swelling-edema, infection
  - Active core re-warming

“LEMON”

“When life hands you lemons……
make lemonade

When your patient hands you a bad airway…….

think *LEMON*

LEMON * mnemonic useful guide to help identify quickly, risks and complications and predictors of difficult airway management.

* Difficult Airway Course ™, ATLS

"LEMON"

- ***LOOK for:***
  - **Obesity**
  - **Micrognathia (small jaw)**
  - **Poor dentition, prominent anterior upper teeth, dentures**

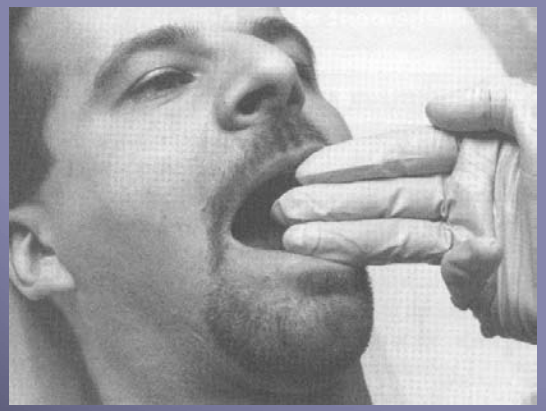
"LEMON"

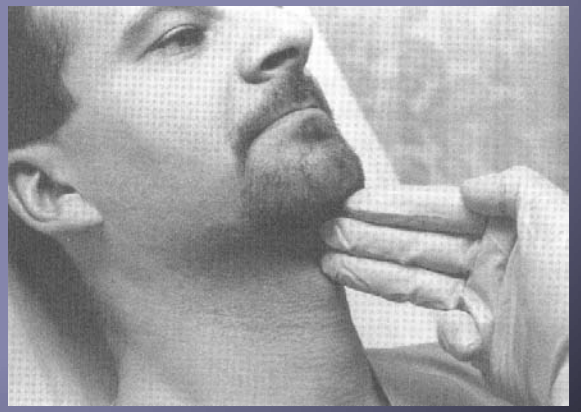
Anatomic Indicators of Difficult Airway

- Limited hinge movement of jaw (e.g. rheumatoid arthritis, muscle spasm from deep space infection, or mandibular fx)
- Protruding maxillary incisors or maxillofacial trauma
- Upper airway obstruction or bleeding (trauma, infection, burn, inhalation injury)

"LEMON"

- ***Evaluate the 3-3-2 rule:***
  - **Patients with normal anatomy should have the following:**
    - **3 fingerbreadths of mouth opening**
    - **3 fingerbreadths between the front of the chin and the hyoid**
    - **2 fingerbreadths from the floor of the mouth to the thyroid cartilage**





"LEMON"

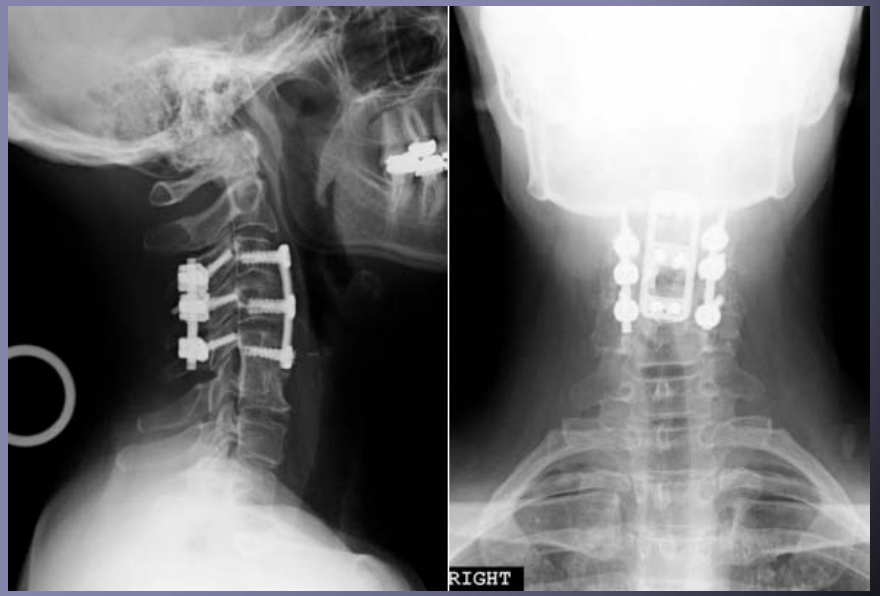
- ***Mallampati score** (if time/patient permits):*
  - With the patient sitting with neck extended
  - Open mouth as wide as possible
  - Protrude the tongue as much as possible
- **A good airway will allow visualization of the entire oropharynx to the bases of the tonsillar pillars or at least to the tip of the uvula.**

"LEMON"

- ***Obstruction / Obesity:***
  - Look and listen for evidence of upper airway obstruction
  - Muffled voice, stridor, difficulty swallowing
    - Teeth wired shut
    - Foreign body
    - Dentures
    - Swelling of the soft tissues

“LEMON”

- ***Neck mobility:***
  - C-spine immobilization
  - Neck surgery
  - Arthritis



Is intubation still the *gold* standard?

- In certain situations, maybe yes?
- In other situations, maybe no?
- Many paramedics have the idea that failure to intubate a patient is ***substandard*** care.

- ***In reality, failure to ventilate a patient is substandard care—not failure to place an endotracheal tube.***

8 “Ps” of Advanced Airway Management

Plan B

Preparation

Preoxygenation

Pretreatment

Put down / **P**osition

Paralysis (with induction)

Pass the tube

Prove tube placement

8 “Ps” of Advanced Airway Management

Plan B

- **Murphy’s Law - *Always best to anticipate the worst !***
- **Current intubation studies ask the questions….**
  - Can paramedics intubate quickly?
  - How well do paramedics intubate in various situations?
  - What are the success/failure rates?
  - How many intubation attempts are acceptable, before going to

Plan B ?

Intubation Studies

Colwell, 2005

Objectives:

Determine the success and complication rates associated with ETI in an urban EMS system.

Methods:

3 month study. Patients were identified and enrolled prospectively with the identification of all patients for whom intubation was attempted.

Retrospective chart review of the emergency department (ED), intensive care unit, other hospital records, and the coroner's records was then conducted with the intent of identifying all complications related to attempted intubation, including the placement of each endotracheal tube.

Intubation Studies

Colwell, 2005

Results:

278 patients were included in this study.

- 154 (55%) had an initial nasal intubation attempt
- 124 (45%) had an initial oral intubation attempt
- 234 (84%) r b P to be successfully intubated
  - 114 (74%) nasal intubations r b P as successful
    - 2 were found to be misplaced
  - 120 (97%) oral intubations r b P as successful
    - 1 was found to be misplaced

278 patients

- 22 (8%) had complications
  - 3 had endotracheal tubes incorrectly positioned
    - 2 were undetected esophageal intubations
    - 1 was in the posterior pharynx

Intubation Studies

Colwell, 2005

Conclusions:

Reasonable success and complication rates of endotracheal intubation in the out-of-hospital setting can be achieved in a busy, urban EMS system without the assistance of medications.

Implications for additional research:

- **Intubated vs. not intubated**
  - **Scene time**
  - **Length of stay**
  - **Complications**
  - **Clinical outcomes**

Colwell, C.B., McVaney, K.E., Houkoos, J.S., Wiebe, D.P., Gravitz, C.S., Dunn, W.W., et. al. (2005) An Evaluation of Out-of-Hospital Advanced Airway Management in an Urban Setting. *Acad Emerg Med,* 12(5), 417-422.

Intubation Studies

Davis, 2006

Objectives:

- Explore the relationship between intubation success and perfusion status, GCS score, and $EtCO_2$.
- Describe the incidence of unrecognized esophageal intubations with use of continuous $EtCO_2$.
- Document the incremental benefit of invasive vs. noninvasive airway management techniques in correcting hypoxemia.

Methods:

- This was a prospective, observational study conducted in a large urban EMS system.
- Paramedics completed a telephone debriefing interview following delivery of all patients in whom invasive airway management had been attempted.
- $EtCO_2$ was used for confirmation of tube position.
- Descriptive statistics were used to document airway management performance (1^{st} , overall attempt ETI/CTI success, unrecognized esophageal intubation).
- SpO_2 values were compared .

Intubation Studies

Davis, 2006-

Results:

A total of 703 patients were enrolled over 12 months.

(512-cardiac arrest, 37-AMS, 66-traums, 24-resp distress, 24-other)

- First-attempt ETI success = 425 - 61%
- Combitube insertion = 55 – 7.8%
- Overall ETI success = 81% (up to 4 attempts)
- Invasive airway management (ETI or CTI) was unsuccessful = 11% of patients
- A single unrecognized esophageal intubation was observed (0.1%)

Intubation Studies

Davis, 2006

Conclusions:

- **Relationship between intubation success and perfusion status, GCS score, and initial $EtCO_2$ value was observed.**
- **Capnometry was effective in eliminating unrecognized esophageal intubations.**
- **Both noninvasive and invasive airway management strategies were effective in increasing SpO_2 values and decreasing the incidence of hypoxemia, with additional benefit observed with invasive airway maneuvers in some patients.**

- **Some degree of self-reporting biasness.**
- **Did not include outcome analysis.**

Davis, D.P., Fisher, R., Buono, C., Brainard, C., Smith, S., Ochs, G., et. al. (2006). Predictors of Intubation Success and Therapeutic Value of Paramedic Airway Management in a Large, Urban EMS System. *Prehosp Emerg Care*, 10(3), 356-362.

Intubation Studies

Davis, 2011

Objectives:

Explore the relationship between out-of-hospital intubation attempts and outcome among trauma patients with GCS scores ≤8 across sites participating in the Resuscitation Outcomes Consortium (ROC).

Methods :

The ROC Epistry–Trauma, an epidemiologic database of prehospital encounters with critically injured trauma victims, was used to identify EMS-treated patients with GCS scores ≤8.

Multiple logistic regression was used - association between intubation attempts and vital status at discharge.

Intubation Studies

Davis, 2011

Results:

1,555 patients included in the study (16 mo period)

758 intubation attempts

797 no intubation attempt

Patients in whom intubation was attempted had higher mortality.

However, sites with higher rates of attempted intubation had lower mortality across all trauma victims with GCS scores ≤8.

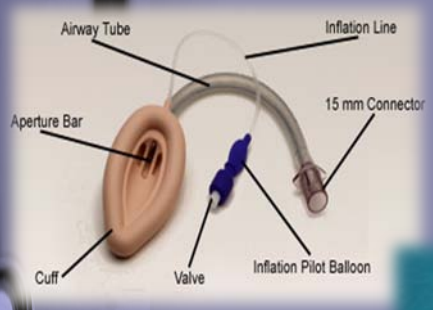
Randomized trials are needed to better define the role of prehospital intubation for patients with severe traumatic injuries.

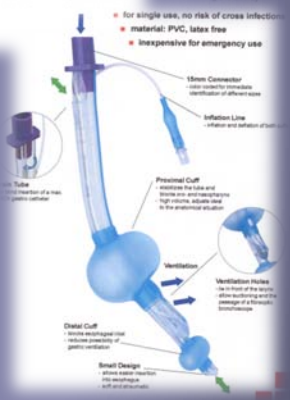
Davis, D.P., Koprowicz, K. M., Newgard, C.D., Daya, M., Bulger, E.M., Stiell, I., et.al. (2011). The Relationship Between Out-Of-Hospital Airway Management and Outcome Among Trauma Patients with Glascow Coma Scale Scores of 8 or Less. *Prehosp Emerg Care*, 15, 184-192.

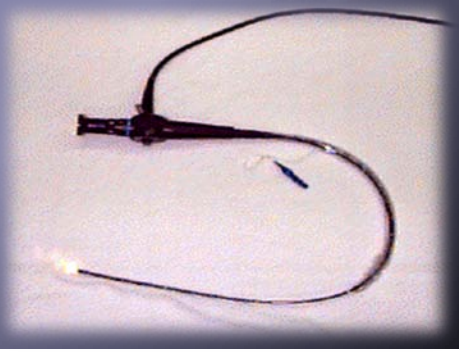
Make it stop !!!!

What does it all mean ???

Plan B

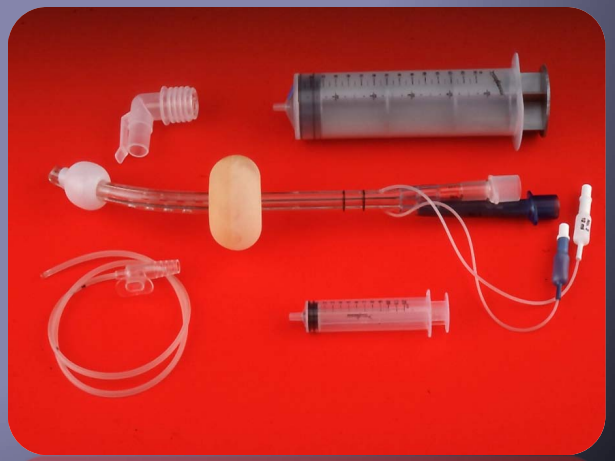

Airway Tube
Inflation Line
Aperture Bar
15 mm Connector
Cuff
Valve
Inflation Pilot Balloon


for single use, no risk of cross infection
material: PVC, latex free
inexpensive for emergency use
15mm Connector
Inflation Line
Proximal Cuff
Ventilation
Distal Cuff
Small Design

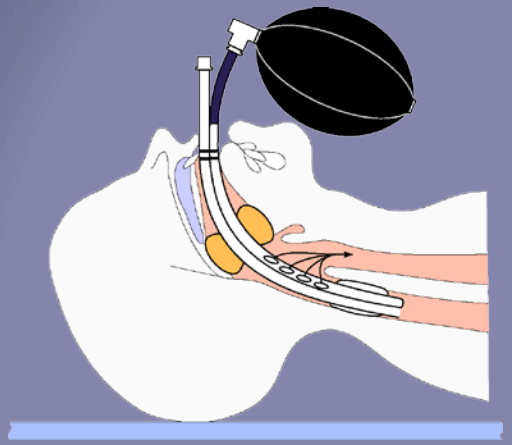


Plan B
Alternate Airways

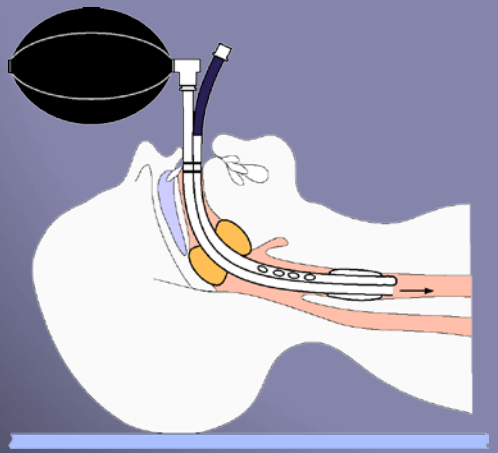
- **Esophageal-Tracheal Combitube**
  - Popular primary or rescue airway (Plan B)
  - 1987
  - Dual lumen and dual cuff
    - Creates a seal above and below the laryngeal inlet
    - High volume, low pressure cuffs
  - Allows for effective gas exchange



Esophageal Tracheal Combitube



Most likely esophageal intubation



Most likely tracheal intubation (5%)

- **Advantages**
  - Can be inserted blindly or with a laryngoscope
    - Esophagus or into the trachea
  - Requires little training time
  - Relatively inexpensive
  - Once inserted (tracheal) can replace with a definitive airway (gum-elastic)
  - Neutral cervical position
  - 2 sizes (based on height)
  - Single use

Esophageal Tracheal Combitube

- **Disadvantages**
  - Not designed for patients < 4ft tall (pediatric)
  - Once inserted (esophageal) cannot utilize any other definitive airway
  - Single use

Complications:

- Does not provide optimal prevention of aspiration.
- Increased cuff pressure
  - Hematomas (upper airway and esophageal)
  - Mucosal lacerations
  - Mucosal ischemia

Esophageal Tracheal Combitube

Ochs, 2000

Methods:

18 month study

22 EMT-D provider agencies = ~ 500 EMT-D

- 195 prehospital patients in cardiorespiratory arrest
- 79% overall successful insertion rate
- Identical success rates for medical and trauma patients were noted
- 91% device was placed in the esophagus
- No complications were reported (conservative training)

Conclusion:

EMT-Ds can be trained to use the Combitube as a means of establishing an airway in the pre-hospital setting. **Future studies will need to further evaluate its effect on patient outcome.**

Ochs, M., Vilke, G.M., Chan, T.C., Moats, T., & Buchanan, J. (2000). Successful Prehospital Airway Management of EMT-Ds Using the Combitube. *Prehosp Emerg Care*, 4(4), 333-337.

Esophageal Tracheal Combitube

Davis, 2003

METHODS:

RSI study -If the RSI attempts were unsuccessful, combitube insertion was mandated. The primary outcome measure for this analysis was the success rate for combitube insertion after unsuccessful orotracheal intubation.

RESULTS:

A total of 420

355 (84.5%) successful orotracheal intubation

58 (95.1%) successful insertion of the combitube

Patients undergoing combitube insertion were more likely to have oropharyngeal blood or vomitus.

Arrival PCO_2 values were higher, and arrival PO_2 values were lower but still supranormal in patients undergoing combitube insertion.

There were no mortality differences between patients undergoing combitube insertion and those undergoing orotracheal intubation.

Esophageal Tracheal Combitube

Davis, 2003

CONCLUSION:

- Effective rescue airway for paramedic rapid sequence intubation in an urban/suburban high-volume system
- Safe when used by experienced paramedics with stringent protocols.
- RSI patients may not yield the same data as non-RSI patients.
- This study was not designed to look for complications, so this data is incomplete.

Davis, D.P., Valentine, C., Vilke, G.M. & Ochs, M. (2003). The Combitube as a Salvage Airway Device for Paramedic Rapid Sequence Intubation. *Ann Emerg Med*, 42(5), 697-704..

Esophageal Tracheal Combitube

Calkins, 2006

Objective:

To observe success and complication rates of paramedic placement of an ETC as a rescue airway.

Compare success rates with endotracheal tube (ETT) intubation.

Methods:

Retrospective review of pt. records who had ETC attempts by EMS (3 yr period)

The ETC used primarily as rescue airway for a failed attempt at an endotracheal tube (ETT) intubation.

A control group for ETT placements was drawn from the EMS quality assurance (QA) database for the same period.

Calkins, T.R., Miller, K., & Langdorf , M.I. (2006). Success and Complication Rates with Prehospital Placement of an Esophageal-tracheal Combitube as a Rescue Airway. *Prehospital and Disaster Medicine*, 21, 97-100.

Esophageal Tracheal Combitube

Calkins, 2006

Results:

ETC – attempted in 162 patients

The primary outcome indicator was placement with successful ventilation.

113 (70%) were successful

46 (28%) failed

3 (2%) was not recorded

29 (18%) unable to place the ETC

76 (84%) were esophageal

14 (16%) were tracheal

ETT - attempted in 128 control patients

107 (84%) were successful

21 (16%) failed

Esophageal Tracheal Combitube

Calkins, 2006

Complications

- Dental trauma = 1 patient
- Subcutaneous emphysema = 1 patient
- Active upper gastrointestinal bleeding = 9 (6%) patients
- Dislodged enroute = 4 tubes (3%)
- Inability to determine placement due to emesis from both ports = 21 patients

Conclusion:

- The complication and success rates of ETC are acceptable for a rescue airway device.
- Tracheal placement of the Combitube is uncommon, but requires fail-safe discrimination.
- The success ratio for ETT > the ETC.

Calkins, T.R., Miller, K., & Langdorf , M.I. (2006). Success and Complication Rates with Prehospital Placement of an Esophageal-tracheal Combitube as a Rescue Airway. *Prehospital and Disaster Medicine*, 21, 97-100.

Just when you thought it was safe . . . . . .

Esophageal Tracheal Combitube

Vezina, 2007

Objectives:

To determine the incidence and the nature of complications associated to the Combitube in the pre-hospital setting.

Methods:

BLS treatment algorithm for EMTs included the use of a Combitube as the primary airway device for management for patients in cardiac or respiratory arrest.

Retrospective review of the EMS data bases 1993 and 2003 (2,981 patients).

Medical records of these patients were reviewed to identify complications related to the use of the Combitube.

Esophageal Tracheal Combitube

Vezina, 2007

Results:

280 patients were identified

58 patients (20.7%) presented 69 complications:

Aspiration pneumonitis (*n = 31)*	*Esophageal perforation and mediastinitis (n = 2)*
Pulmonary aspiration (n = 16)	*Tongue edema (n = 2)*
Pneumothorax (n = 6)	*Vocal cord injury (n = 1)*
Upper airway bleeding (n = 4)	*Tracheal injury (n = 1)*
Esophageal laceration (n = 3)	*Peumomediastinum (n = 1*
SC emphysema (n = 2)	

13 of these complications (12 patients, 4.3%) were judged as most likely resulting from trauma associated with insertion of the Combitube.

Esophageal Tracheal Combitube

Vezina, 2007

Conclusion:

The use of the Combitube in the pre-hospital setting is associated with a notable incidence of serious complications.

Vezina, M.C., Trepanier, C.A., Nicole, P,C., & Lessare, M.R. (2007) .Complications Associated with the Esophageal-Tracheal Combitube® in the Pre-hospital Setting. *Can J Anesth*, 54(2), 124-128.

My Cousin Vinny

Oh..but wait there's more….

Complications

Decreased Carotid Blood Flow

Segal, 2012

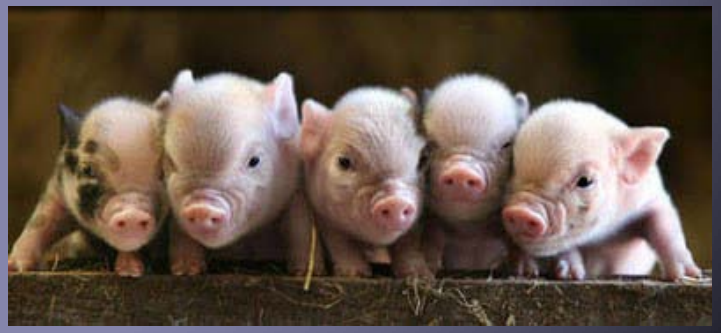
Objective:

The use of a supraglottic airway device (SGD) will compress the carotid artery and decrease carotid blood flow (CBF) during CPR in pigs.

Methods:

VF was induced in 9 female pigs followed by 4 min without compressions. CPR was then performed. During each interval, an ETT was used for the first 3 min, followed by 3 min of each SGD (King LTS-D™, LMA Flexible™, Combitube™) in a random order.

The primary endpoint was mean CBF (ml/min).



Complications

Decreased Carotid Blood Flow

Segal, 2012

Results:

CBF was significantly lower with each SGD (compared with ETT).
Arteriograms showed that with each SGD there was compression of the internal and external carotid vessels.

Conclusion:

The use of 3 different SGDs during CPR significantly decreased CBF in a porcine model of cardiac arrest.

While the current study is limited to pigs, the findings suggest that further research on the effects of SGD use in humans and the effects on carotid artery blood flow is warranted.

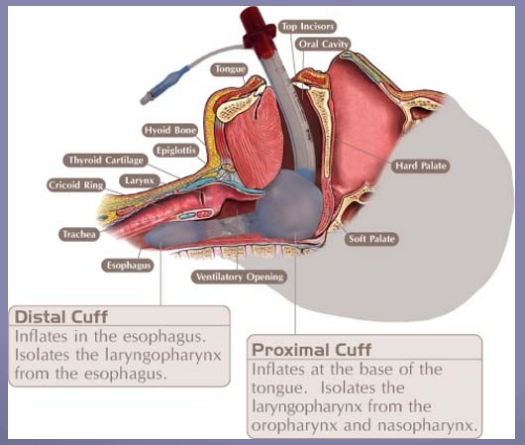
Segal, N., Yannopoulos, D., Mahoney, B.D., Frasone, R., Matsuura, T., Cowles, C.G., et. a. (2012). Impairment of Carotid Artery Blood Flow by Supraglottic Airway Use in a Swine Model of Cardiac Arrest. *Resus,* 83(8), 1025-1030.

Laryngeal Tube Airway

- Latex free- single lumen silicon laryngeal tube
- 2003
- Oropharyngeal and esophageal low-pressure cuffs
- Ventilation ports between two cuffs
- Blunt/blunt tip or open distal tip (gastric decompression)
- Single balloon port for simultaneous inflations

Laryngeal Tube Airway

- **Advantages**
  - Single balloon port for easier inflation
  - Easy to insert, minimum resistance
  - Designed to only enter the esophagus
  - Pediatric and adult sizes



- **Disadvantages**
  - Single port may lead to seal to be lost and repositioning required
  - Replacement of the LTA utilizing a gum-bougie can lead to perforation of glottic structures
  - Not a protected airway

Laryngeal Tube Airway

Ulrich-Pur, 2006

BACKGROUND:

High pressures exerted by balloons and cuffs of conventional …tubes may traumatize the pharyngeal mucosa.

METHODS:

Nineteen fresh cadavers were included.

RESULTS:

Tracheal mucosal pressures were significantly higher…

CONCLUSIONS:

Although some devices exhibit a somewhat higher mucosal pressure …the authors believe that the observed differences of the cuff pressures do not suggest a clinically relevant danger, because the investigated devices,… are not intended for prolonged use.

Ulrich-Pur, H., Hrska, F., Kraffi, P., Friehs, H., Wulkersdorfer, B., Kostler, W.J., et.al. (2006). Comparison of Mucosal Pressures Induced by Cuffs of Different Airway Devices. *Anesth.* 104(5), 933-938.

Laryngeal Tube Airway

Genzwuerker, 2000

OBJECTIVE:

To examine the reliability of the laryngeal tube for airway management in a mannequin.

METHODS:

50 MDs and RNs inserted the laryngeal tube blindly during 10 consecutive attempts in an ALS. (1st time users)

RESULTS:

500 insertions of the tube

- 478 (95.6%) correct placement and sufficient ventilation were achieved on 1st attempt
- 4 attempts (0.8%) sufficient ventilation was not possible due to the tube's not being placed deep enough.
- 27.15 sec average time for positioning the laryngeal tube

CONCLUSION:

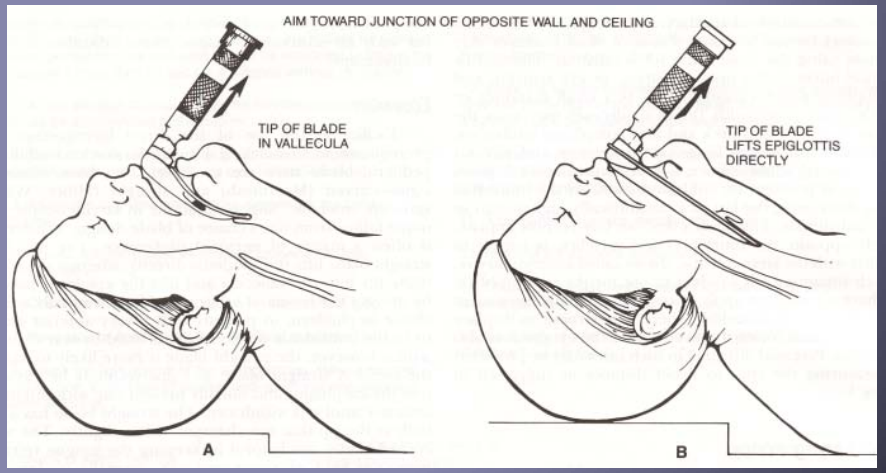
The laryngeal tube may be a fast, reliable, and easy device for airway management. Further research is necessary.

Genzwuerker, H. V., Hilker, T., Hohner, E., & Kuhnert-Frey, B. (2000). The Laryngeal Tube: A New Adjunct for Airway Management. *Prehosp Emerg Care* ,4(2),168-72.

8 “Ps” of Advanced Airway Management

Pass the tube

- Visual confirmation of correct placement of the airway



Video Laryngoscopy

- Traditional laryngoscopy (TL) requires direct visualization and “line of sight”
- High definition screens
- May be used for routine or difficult airway management.

Video Laryngoscopy

Wayne, 2010

Background:

Study comparing traditional laryngoscopy (TL) versus video laryngoscopy (VL) was performed. The study endpoint was the number of attempts to achieve intubation.

Methods:

300 consecutive patients, 6 years of age or older, weighing at least 20 kg, who were intubated using TL.

Compared with data on 315 patients who were intubated using VL.

All intubations were confirmed by visualization where possible, auscultation, misting, and capnography.

In addition, all were continuously monitored by capnography.

.

Video Laryngoscopy

Wayne, 2010

Results:

21 sec - average time to intubate in the VL group

42 sec – average time to intubate in the TL group

1.2 - average number of attempts in the VL group

2.3 – average number of attempts in the TL group

97% - successful intubations in the VL group

95% - successful intubations in the TL group.

37 sec - maximum non-ventilated time during any one intubation attempt in the VL group

55 sec - maximum non-ventilated time during 1 intubation attempt in the in the TL group.

Conclusions:

The numbers of attempts were significantly reduced in the VL group. This suggests that the use of VL has a positive effect on the number of attempts to achieve tracheal intubation.

Wayne, M.A., & McDonnell, M. (2010).Comparison of Traditional versus Video Laryngoscopy in Out-Of-Hospital Tracheal Intubation. *Prehosp Emerg Care*, 14(2), 1-5.

Video Laryngoscopy

Je, 2012

Background:

Fatal chocking due to food is the 4th leading cause of death in the U.S.

Video laryngoscopy provides greater visualization and may be used for the removal o foreign bodies in the hypopharynx.

To evaluate whether the Glidescope ® is an effective method for FB removal

Method:

1st year EM residents used both VL and traditional Macintosh blade with Magill forceps or Sponge forceps for the removal of FB.

Relatively little or not airway management experience.

Received training in the morning.

“Lightly” embalmed cadaver with a sausage FB placed in the hypopharynx.

Video Laryngoscopy

Je, 2012

Results:

# Atmpts	Using Magill Forceps		Using Sponge Forceps	
	Glide VL	MacI	Glide VL	MacI
1	11	25	11	25
2	4	3	2	3
3	2	0	5	0
Cumulative Success	60.7%	100%	64.3%	100.0%
Failed	39.3%	0.0%	35.7%	0.0%
Medium Time	79.0	23	45.5	21

Conclusion:

MacI superior for the extraction of FBs.

Je, S.M., Kim, M.J., Chung, S.P., Chung, H.S. (2012) Comparison of GlideScope® versus Macintosh laryngoscope for the removal of a hypopharyngeal foreign body; A randomized cross-cadaver study. *Resusci*, 83, 1277-1280.


AMBULANCE
PRESS
HORRIBLY TRAGIC... CROWD OF PEOPLE WATCHING A MIME... TURNS OUT THE GUY REALLY WAS CHOKING

8 “Ps” of Advanced Airway Management

Prove tube placement

- Auscultation of abdomen and chest
- End-tidal CO_2
- Bulb and syringe device
- Reassess patient
- Pulse oximetry

Prove the Tube Placement

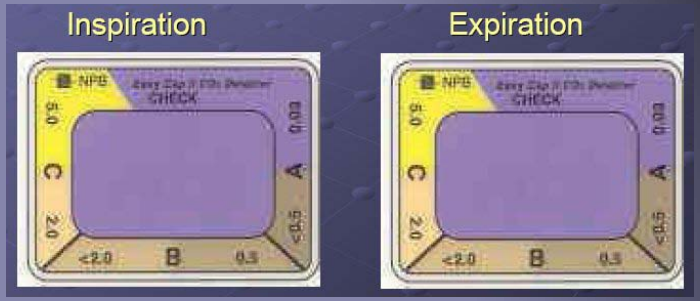
- **The usual clinical methods:**
  - **Bilateral breath sound auscultation, auscultation over the stomach**
- **Chest movement**
- **Visualization**
- **Clouding of the ETT**
- **End-tidal CO_2**
  - Colorimetric
  - Quantitative wave form capnometry

Colorimetric End-Tidal (CO_2) Monitors

- Colorimetric $ETCO_2$ monitors are highly sensitive and specific for detecting the presence of carbon dioxide.
- In the presence of carbon dioxide, filter paper (metacresol purple) changes to yellow if the [carbon dioxide] >2%

Colorimetric End-Tidal (CO_2) Monitors

- **Advantages-**
  - Inexpensive
  - Small, easy to carry
  - Simple to apply
  - Rapid interpretation
  - Easy to read/interpret
  - Accurate



Purple = 0.03% -< 0.5% CO2 (< 4 mm Hg)

Tan= 0.5% - 2% CO2 (4- 14 mm Hg)

Yellow = 2%-5% (15-38 mm Hg)

Colorimetric End-Tidal (CO_2) Monitors

- **Disadvantages**
  - 25% false-negative rate (prolonged cardiac arrest /hypoperfusion states)
  - Avoid exposure to adverse environments (gastric contents)
  - Not affected by temperature, affected by humidity (ET medications)
  - Well lit environment (Incandescent lighting?)
  - Colorblind providers
  - Non-quantitative (no change w/ < 0.05% and little change w/0.05% -2%

Colorimetric End-Tidal (CO_2) Monitors

Myth or fact?

Colorimetric End-Tidal (CO_2) Monitors

Oureshi, 2000

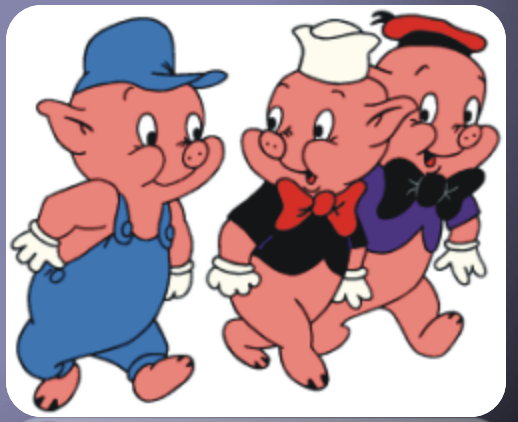
Reports of false-positive readings from esophageal intubations in patients who had ingested carbonated beverages

Study Objective:

Determine whether carbonated gastric contents can affect colorimetric $EtCO_2$ readings.

Methods:

$EtCO_2$ was measured in piglets after instillation of 5-, 10-, 15-, and 20-mL Diet Coke were placed into the empty



Colorimetric End-Tidal (CO_2) Monitors

Oureshi, 2000

Results:

Compiled data from 3 piglets . Not ventilated or moved and measurements taken @ 20 degrees supine. All data collected within 2 hours post mortem.

Conclusion:

The colorimetric end-tidal CO_2 turned "yellow" and did not change to blue with extended insufflations.

The CO_2 of a small quantity of carbonated beverage in the stomach could be "blown off" by multiple insufflations.

Esophageal intubation in the setting of recent ingestion of a carbonated beverage may result in a false-positive end-tidal CO_2.

Oureshi, S., Park, K., Sturmann, K., & Hsu, C. (2000). The Effect of Carbonated Beverages on Colorimetric End-tidal CO(2) Determination. *Acad Emerg Med*, 7(10), 1169.

Continuous $ETCO_2$ Monitoring

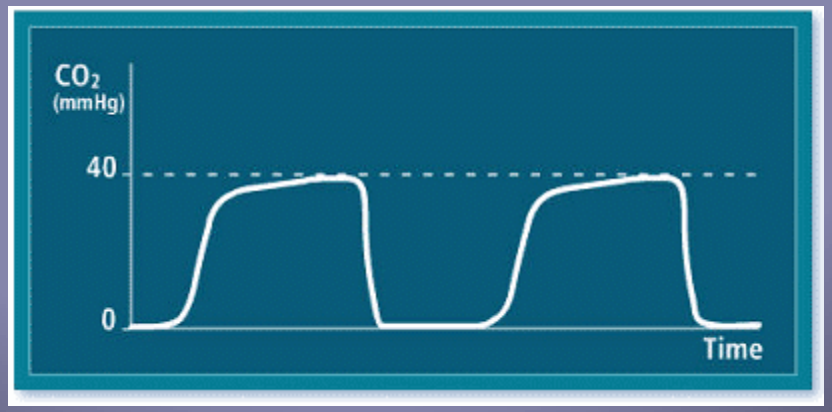
American Heart Association recommendation that continuous waveform capnography should be the standard of care

Advantages

- Accurate and real time
- Continuous monitoring
- Quantify carbon dioxide levels
- Qualify resuscitation efforts

Disadvantages

- Cost
- Absent in prolonged cardiac arrest
- Monitor dysfunction



Continuous $ETCO_2$ Monitoring

Silvestri, 2005

Study objective:

Association between out-of-hospital use of continuous end-tidal carbon dioxide ($ETCO_2$) monitoring and unrecognized misplaced intubations within a regional (EMS) system.

Methods:

Prospective, observational study, conducted during a 10-month period, on all patients arriving at a Level I trauma center ED who underwent out-of hospital ET intubation. The regional EMS system is composed of multiple numerous EMS agencies.

The main outcome measure was the unrecognized misplaced intubation rate with and without use of continuous $ETCO_2$ monitoring.

Continuous $ETCO_2$ Monitoring

Silvestri, 2005

Results:

248 patients received out-of-hospital airway management, 153 -received intubation.

- 93 (61%) had continuous ETCO2 monitoring
- 60 (39%) did not
  - 49 (32%) medical patients
  - 104 (68%) trauma patients
  - 51 (33%) cardiac arrest

Overall incidence of unrecognized misplaced intubations was 9%

- Rate of unrecognized misplaced intubations WITH continuous $ETCO_2$ monitoring was = 0
- Rate of unrecognized misplaced intubations WITHOUT continuous $ETCO_2$ monitoring was = 23.3%

Silvestri, S., Ralls, G.A., Krauss, B., Thundyll, J., Rothrock, S.G., Senn, A., et. al. (2005). The Effectiveness of Out-of-Hospital Use of Continuous End-Tidal Carbon Dioxide Monitoring on the Rate of Unrecognized Misplaced Intubation Within a Regional Emergency Medical Services System. *Ann Emerg Med*, 45(5), 497-503.

Placement Assessment

Conclusion;

- No one method of confirmation is perfect:
  - Colorimetric monitors are nearly 100% accurate for confirming ETT placement
    - False positive readings may occur with colorimetric (“cola complication”)
    - Should resolve after 6 breaths
    - But may not be useful in cardiac arrest situations
  - Continuous wave form is most reliable for confirming and monitoring ETT placement (AHA)
  - May be absent in prolonged resuscitations or monitor malfunction

Placement Assessment

- **Use a combination:**
  - Clinical assessment
    - Direct visualization
    - Auscultation of lung sounds
    - Absence of sounds over the epigastrium
    - Chest rise and fall
    - Observed clinical improvement
  - Oxygen saturation
  - Esophageal detection devices

Conclusion
What does it all mean ?

- There is a reason it is called an **ART** and not a **SCIENCE**.
- There are few answers but many questions.
- There is no **ONE RIGHT ABSOLUTE** answer to any question.

- ***Understand why our clinical practice changes frequently.***
- ***Avoid "band wagons" and fads.***
- ***Read the research.***
- ***Make data driven decisions.***
- ***Become part of the research.***

Thank you for your kind attention.

Have a great conference
and a safe travels home.

Marilyn Bourn
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God bless our women and men serving this country.