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Emergence Pearls  
This ain't no rodeo

# Emergence Pearls - Objectives

- Identify factors associated with and potential causes of airway irritability on emergence.
- Discuss interventions to decrease airway reactivity during emergence and extubation.
- Review causes of emergence and post-emergence delirium/agitation.
- Evaluate pharmacologic methods of emergence management specific in potentially difficult patient populations.



# Emergence Pearls: Part 1

Prevention of  
Bucking and Coughing

# Airway Irritability - Factors

- Reactive Airway Dysfunction (Not “Disease”)
- Asthma (5 – 15% of children and increasing)
- Vocal Cord (Glottic) Dysfunction (10% asthma)
- Iatrogenic: Anesthesia (Mechanical or drug)
- Iatrogenic: Surgical (ENT surgery, Parathyroid)
- Excessive secretions (FB, Pharm, Ethnic, age)

# RAD - Factors

- Occupational (15-23% of asthma: Am Thorac society)
  - Painters / Chemical workers / Miners
  - Farmers (fungus, chemical, H<sup>+</sup> sulfide,)
  - Swimmers / Lifeguards (Lifeguard lung)
  - Welders (especially stainless steel)
  - Carpenters / (especially walnut and oak)
- Family History: heritability of asthma
  - 7% if neither parent has asthma
  - 20% if one parent has asthma
  - 64% if both parents have asthma

# RAD – Factors (cont)

- Smoking
- 2<sup>nd</sup> hand smoke
- Quit smoking within the past 48 – 72 hrs
- Current or Recent URI
- GERD-uncontrolled
- Hx pulmonary aspiration / dysphasia

# Airway Irritability - Factors

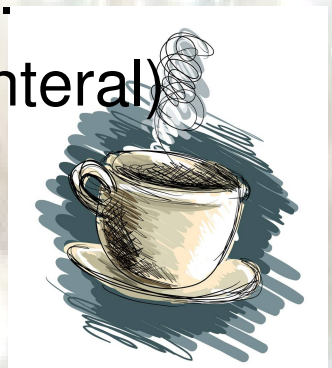
- Reactive Airway Dysfunction (Not “Disease”)
- Asthma (5 – 15% of peds and increasing)
- Vocal Cord (Glottic) Dysfunction (10% asthma)
- Desflurane (on induction or emergence only)
- Iatrogenic: Anesthesia (Mechanical or drug)
- Iatrogenic: Surgical (ENT surgery, etc...)
- Excessive secretions (FB, Pharm, Ethnic, age)

# Prevention

- Best Prevention is good interview / assessment
  - Family History
  - Occupation
  - Inhaler: (frequency, last use, efficacy, spacer use)
  - Recent URI
  - Allergies (even food allergies are relevant)
  - Raspy voice with Hx of anxiety and Hx of difficult to treat or vague asthma attacks.

# Prevention - Bronchodilators

- Bronchoconstriction: Muscarinic mechanisms
  - Large and small airways lined with parasympathetic afferent nerve endings
  - Vagal stimulation causes bronchoconstriction.
  - Tx is most effective in COPD / smoker's lung with anticholinergic agents such as Ipratropium
- Bronchoconstriction: Adrenergic mechanisms
  - Not causative but AW smooth muscle innervated with  $\beta_2$  receptors that oppose muscarinic effects.
  - $\beta_2$  fast/short acting agents (Inhaled or parenteral)
  - Methylxanthines: effective only in infants



# Prevention - Bronchodilators

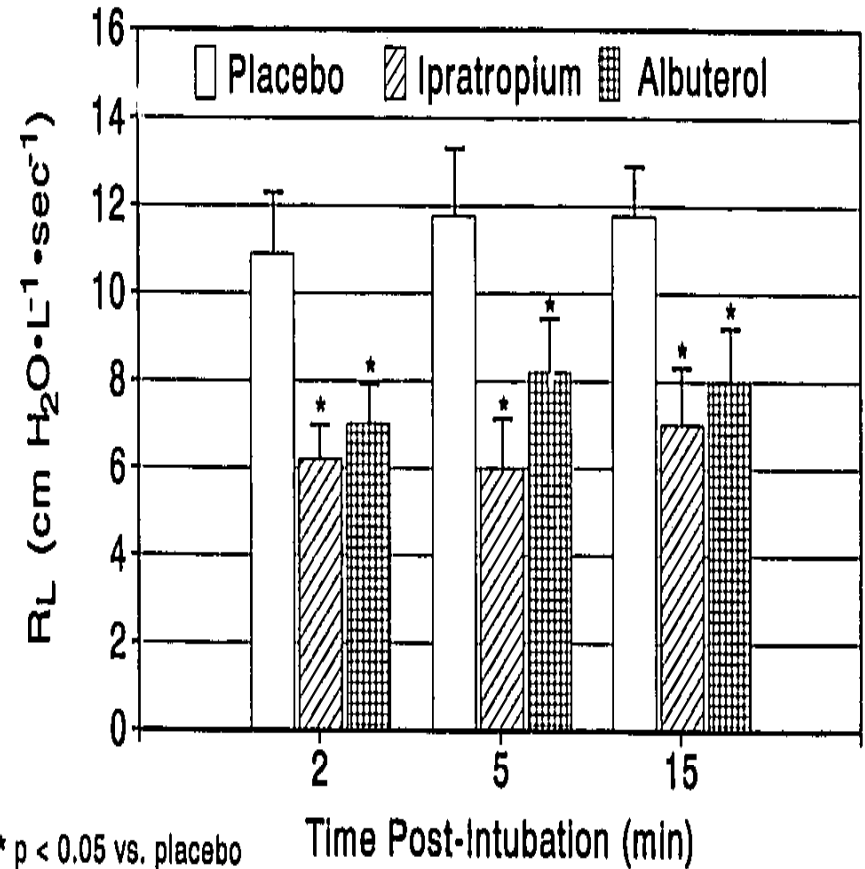
- DuoNeb combines Ipratropium and Albuterol
  - 500mcg ipratropium : 2.5 mg albuterol
  - Antagonist muscarinic and agonist on  $\beta_2$  receptors
  - Especially effective in smokers & chronic cough
- Nebulized dose in age 12+ is one aliquot
- Administer 30 minutes before Induction
- Effects last 3 to 4 hours
- Equivalent MDI dose is 4-8 puffs (17mcg/puff)

# Preop Bronchodilators & Intubation

Hae-Keum (1994)

- Studied airway resistance increases following intub.
- Airway resistance is decreased ~ 45% by preop Ipratropium vs placebo
- Decreased about 30% by preop Albuterol

Hae-Keum, K et al. Effect of Prophylactic Bronchodilator Treatment on Lung resistance after Tracheal Intubation. *Anesthesiology*. 1994; 81:43-48

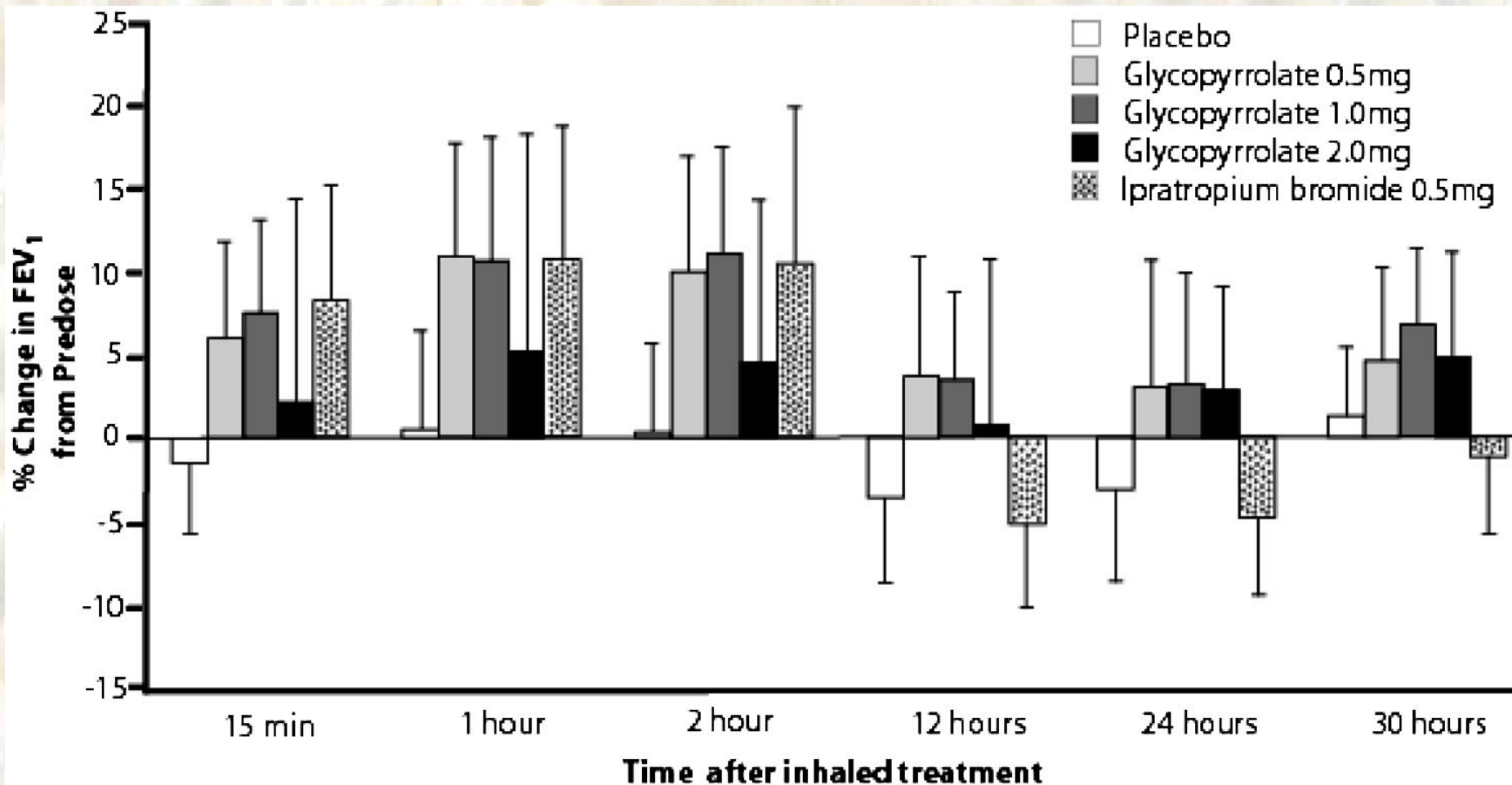


\* p < 0.05 vs. placebo

Fig. 1. Lung resistance (mean  $\pm$  SEM) after intubation in albuterol- and ipratropium-treated groups compared with placebo. \*P < 0.05 versus placebo by analysis of variance.

# Glycopyrrolate nebulization

- 0.5 mg nebulized Robinul as effective as Ipratropium



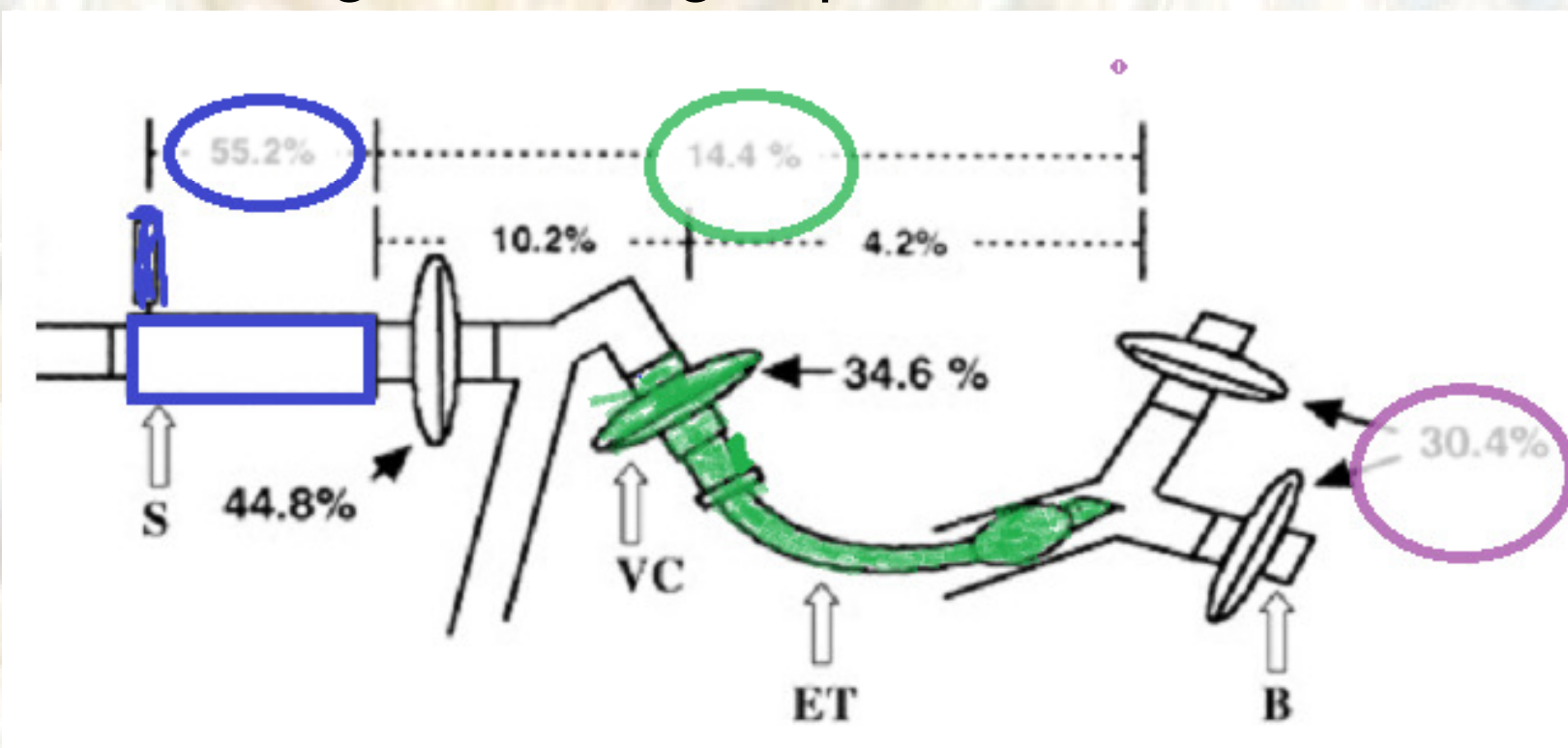
Hansel, T. et al. Glycopyrrolate Causes Prolonged Bronchoprotection and Bronchodilatation in Patients With Asthma *Chest*. 2005; 128(4); 1974-1979

# Intraop Bronchodilator:MDI vs Neb

- Nebulization on Anesth ventilators disadvantages:
  - Increases Tidal Volume due to unrestricted inspiratory flow; thus potential for barotrauma.
  - Dilutes inhalational agent; thus decrease in anesth depth.
  - Must be used distal to HME filter but still high “rain-out”.
- MDI with spacer chamber more effective than nebulization in intubated patient.
- Do not use MDI without Spacer as deposition in airways is decreased by factor of 4 to 6.
- Consider use of anticholinergic with  $\beta_2$  agonist.

# MDI Drug Deposition:Spacer Use

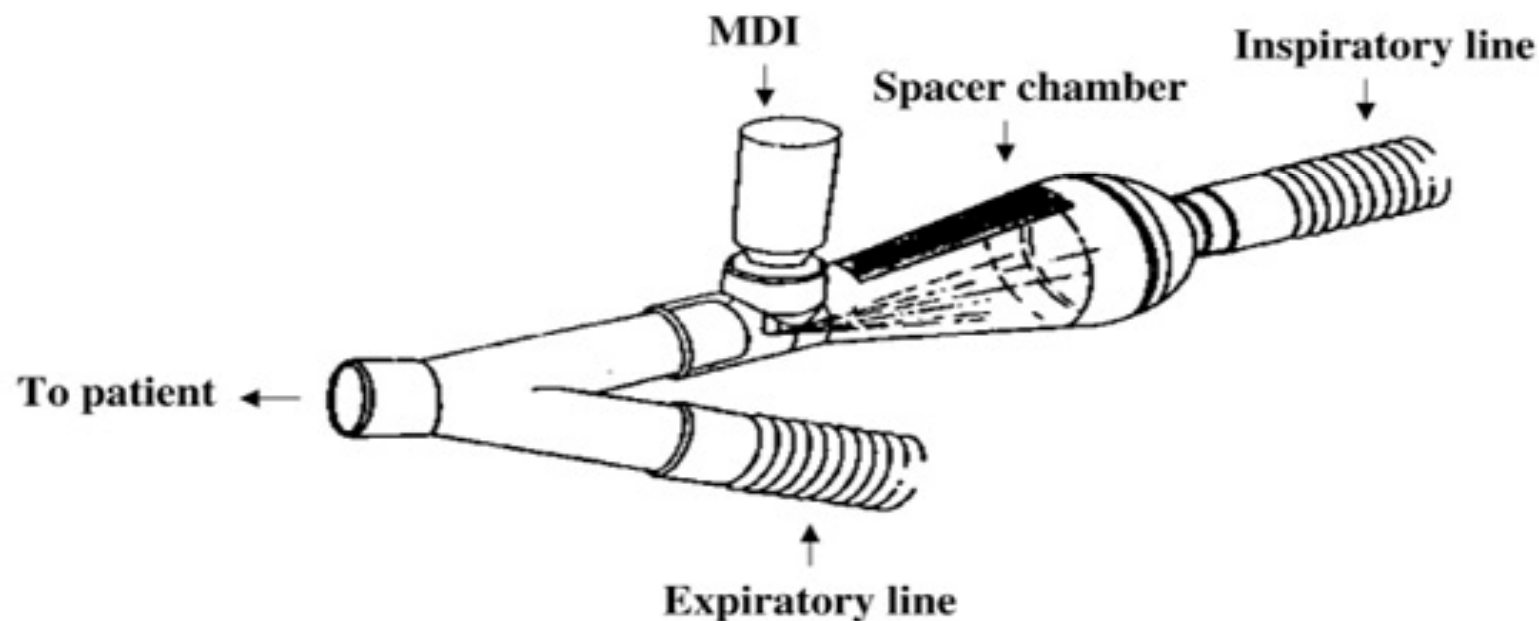
- MDI use with intubated patient: drug deposition in lung vs. circuit rainout **with spacer chamber**.
- 4-6 times greater lung deposition than MDI alone



Georgopoulos, D et al. Bronchodilator Delivery with Metered-Dose Inhaler During Mechanical Ventilation. *Critical Care*. 2000;4:227-234

# Correct use of MDI Spacer

- Proper use of MDI with spacer
- MDI flume faces away from patient



Mouloudi E, Katsanoulas K, Anastasaki M, Hoing S, Georgopoulos D. Bronchodilator delivery by metered-dose inhaler in mechanically ventilated COPD patients: influence of tidal volume. *Intensive Care Med.* 1999;25:1215–1221.

# IV Magnesium in tonsillectomy

- Mg<sup>++</sup> (Neb & IV) used extensively in ER and ICU as bronchodilator in refractory asthma and status asthmaticus. Acts as a potent bronchodilator.
- Prevents laryngospasm/coughing on extubation  
Usual Incidence of laryngospasm after T&A is ~25%
- Gulhas (2003) study of 40 patients for T&A
  - IV infusion of 15mg/kg Mg<sup>++</sup> or NS placebo over 20 minutes after sevo induction and intubation.
  - Rectal paracetamol (acetaminophen)
  - IV Vecuronium 0.1 mg/kg, Alfenta 10mcg/kg, Lido 1mg/kg
  - Extubated deep after spont respiration and serum Mg<sup>++</sup>
  - Results: No laryngospasm in study group

# IV magnesium in tonsillectomy

**Table 2**  
Incidence of laryngospasm

	n (%)
Group I	0/20
Group II	5/20 (25)*

\* $P < 0.05$  between groups.

**Table 3**  
Plasma magnesium concentrations

	Magnesium concentration ( $\text{mmol}\cdot\text{l}^{-1}$ )
Group I	$0.89 \pm 0.16^*$
Group II	$0.72 \pm 0.18$

Values are mean  $\pm$  SD. \* $P = 0.007$  between groups.

# Dexmedetomidine (Precedex)

- IV selective alpha<sub>2</sub> agonist (similar to clonidine)
- T<sub>1/2</sub> α half-life is 6 minutes and T<sub>1/2</sub> β is 2 hours
- Provides “cooperative sedation” / anxiolysis
- Minimal effect on ventilation
- Hemodynamic stability (occasional bradycardia)
- Analgesic effect potentiates opioids up to 50%
- Decreases anesthesia requirements
- Provides “drying” of the airway
- Decreased coughing on extubation/emergence
- Quiet/calm patient in PACU

Candiotti, K.A. et.al., Monitored Anesthesia Care with Dexmedetomidine: A Prospective, Randomized, Double-Blind, Multicenter Trial. *Anesthesia and Analgesia* 2010; 110:47-56

# Precedex Preop Dosing

- Preoperative administration: Intravenous
  - IV bolus over 10 minutes at 0.5 – 1  $\mu\text{g}/\text{kg}$
  - Infusion titrated 0.2 - 1  $\mu\text{g}/\text{kg}/\text{hr}$  (if >45 min case)
- Preoperative administration : Intranasal
  - Ages 4mon- 5 years with 20- 45 min. onset time
  - Used in over 30 studies with 80% success rate.
  - Undiluted in TB syringe with atomizer: 2  $\mu\text{g}/\text{kg}$
  - OK to coadminister with preop midazolam
  - May repeat dose after 20 minutes if poor results

# Precedex and Cough prevention

- Pre-emergence for rhinoplasty: Aksu (2009)
  - Two groups: Treated 5 minutes before extubation
    - IV bolus Precedex 0.5  $\mu\text{g}/\text{kg}$  versus
    - IV bolus fentanyl 1  $\mu\text{g}/\text{kg}$
  - Precedex more effective than fentanyl
    - Precedex incidence of cough post-extub: 30%
    - Fentanyl incidence of cough post-extub: 85%
  - Extubation and Recovery times similar

Aksu, R. et al. Comparison of the effects of dexmedetomidine versus fentanyl on airway reflexes and hemodynamic responses to tracheal extubation during rhinoplasty: A double-blind, randomized, controlled study, *Current Therapeutic Research*. 2009; 70(3): 209-220

# Lidocaine filled cuff- advantages

- Significant decrease in coughing on emergence and up to 15 minutes post extubation
- Supraglottic airway reflexes preserved
- Less CNS depression compared to IV Lidocaine
- Anesthetizes cuff site better than LITA tubes

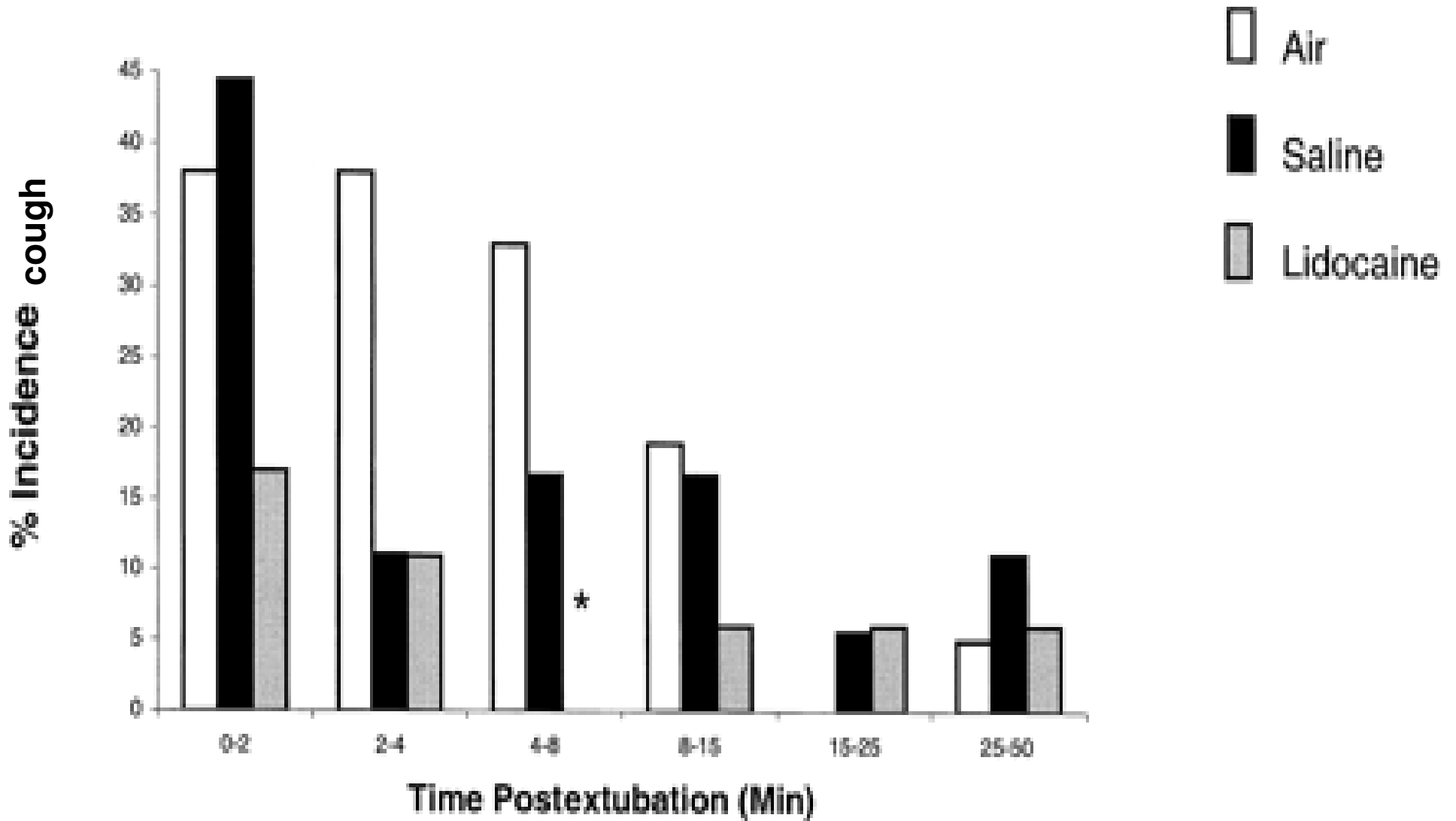


# Lidocaine filled cuff- Fagan (2000)

- 63 pts: prospective, dbl blinded, randomized.
- Three groups: ETT cuff sealed to 20 cm H<sub>2</sub>O with either 4% lido or saline or air.
- ASA I & II patients in surgeries > 1 hour.
- Post extub cough rated by blinded observer.
- Significant decrease in coughing up to 15 minutes post extubation

Fagan,C. et al.The Effects of Intracuff Lidocaine on Endotracheal-Tube-Induced Emergence Phenomena After General Anesthesia. Anesthesia & Analgesia 2000;91:201-5

# Lidocaine filled cuff- Fagan (2000)



# Lidocaine filled cuff- How to

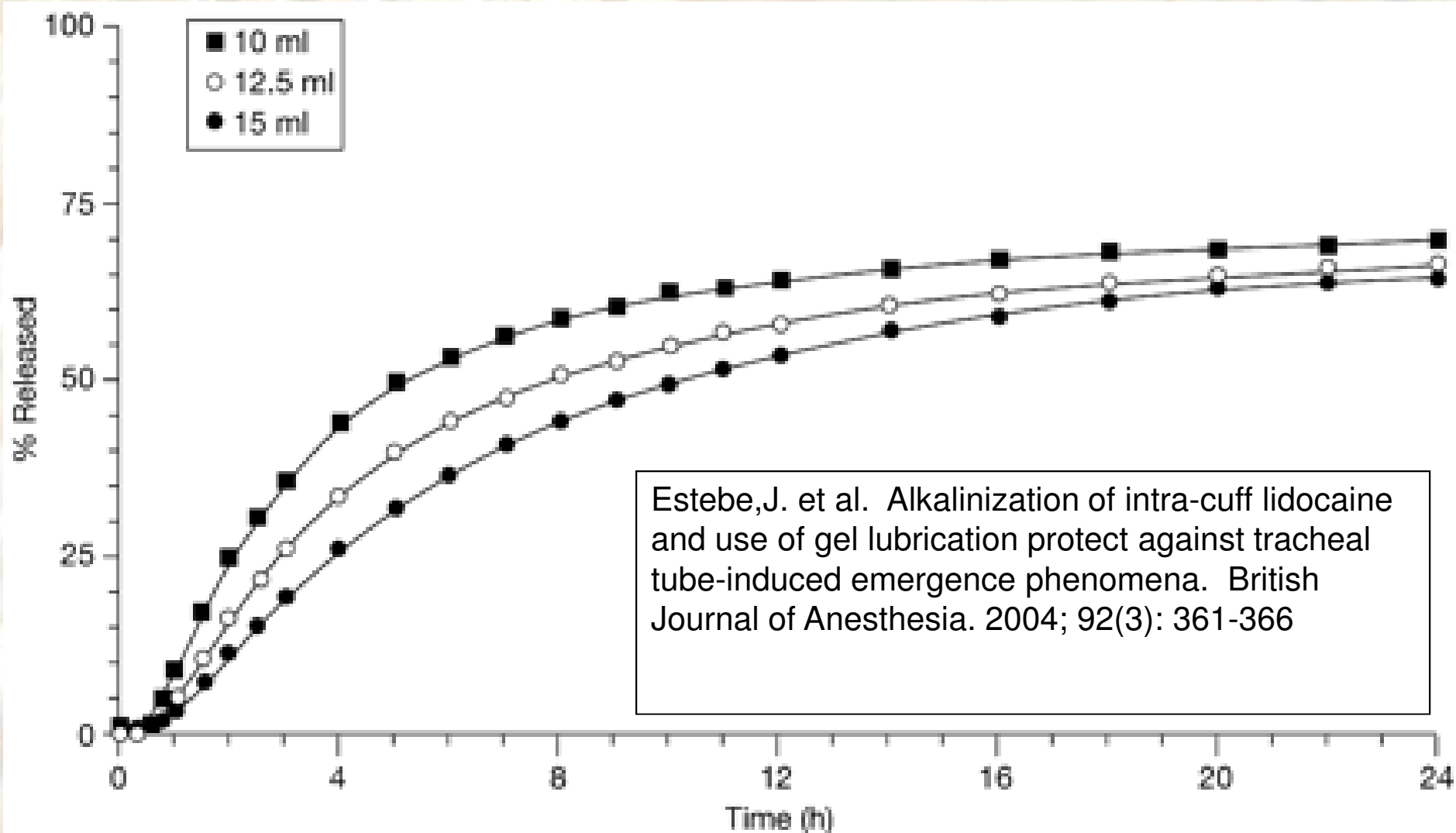
- 4% solution Preservative-free Lidocaine.  
*Diffuses faster if alkalinized with Bicarb.*
- Instill in ETT cuff for 45-60 minutes pre-induction to allow diffusion across cuff – or- use LTA to provide tracheal anesthesia during the latent diffusion period.
- Instill volume after intubation that seals airway to 20 cm H<sub>2</sub>O (6-9 ml)
- *Note:* Takes about 5-10 seconds to deflate lidocaine from cuff before extubation.

# Lidocaine filled cuff-Wetzel (2008)

- Apr. 2008 study by Wetzel, L. et al. in **AANA Journal**, The effectiveness of 4% intracuff *lidocaine* in reducing coughing during emergence from general anesthesia in smokers in surgeries lasting less than 1.5 hours
- Found no difference in coughing, however:
- Study lacking in technique:
  - Cuffs not preloaded with lidocaine
  - Did not test intracuff cuff pressures .
  - Procedures too short for adequate diffusion.
  - Did not alkalize lidocaine nor use neutral pH
  - Poor interrater reliability in assessing cough

# Rate of lidocaine cuff diffusion

- Alkalinized Lidocaine cuff diffusion curves.



# Coughing & Bucking Prevention Review

- Bronchodilation: Nebulize or MDI w/spacer
  - $\beta_2$  Agonists
  - Anticholinergics: Ipratropium or glycopyrrolate
- IV magnesium
- Precedex
- Lidocaine filled ETT cuff

# Instrumentation / Mechanical Miscellaneous Methods

- Prewarm ET tubes
- Use glidescope or other fiberoptic device
- Use LMA where possible

The background of the slide is a reproduction of the painting 'The Scream' by Edvard Munch. It depicts a figure in the center with a pale, yellowish face and an open mouth, surrounded by other figures in a dark, turbulent sea under a stormy, orange and red sky. The text is overlaid on this image.

# Emergence Pearls: Part 2

Prevention of  
Emergence Delerium

# Emergence Delerium ( ED)

- In 1961 Eckenhoff et al. in *Anesthesiology* were the first to report the signs of hyper-excitation in patients emerging from ether, cyclopropane, or ketamine anesthesia.
- Described with different terms; excitation, delerium, agitation, combativeness...
- Negative effects:
  - Injury of patient or staff
  - Loss of IV, dressings or catheters etc...
  - Disruption of PACU environment & staff

# Emergence Delirium Factors

Difficult to pinpoint or predict:

- **Rapid Emergence:** Propofol is the exception
- **Inhalational agent:** Sevoflurane: 40% rate of ED versus 10% rate associated with halothane in preschool age. Halothane EEG changes different.
- **Pain:** use of intraop analgesics (Ketorolac and/or opioids) decreases incidence of ED by 400% in both halothane and sevoflurane anesthetics
- **Wakeup Location:** No difference whether pts emerge in Surgery or PACU

Vlajkovic, G. et al. Emergence Delirium in Children: Many Questions, Few Answers. *Anesthesia & Analgesia*. 2007; 104(1); 84-91

# Emergence Delerium Factors

- Other factors that we can't change are: surgical site, age, and temperament **BUT** we do have drugs that can make a difference:
  - Propofol
  - Precedex
  - Pain control

# Propofol and ED

- Uezono (2000) demonstrated that after a sevoflurane induction changing to a propofol infusion reduced ED from 38% to 0%.
  - Used nonpainful procedures
  - Agitation period with Sevo averaged 8 min length
  - Slightly faster recovery with sevoflurane  
*(Statistically, but not clinically significant)*

Uezono, S. Emergence Agitation After Sevoflurane Versus Propofol in Pediatric Patients. *Anesthesia and Analgesia*, 2000;91:563–6

# Propofol and ED

- MetaAnalysis by Dahmani (2010) revealed:
  - Neither preop Midazolam nor induction Midazolam have a preventative effect on ED.
  - Boluses doses of Propofol after induction also have no effect; however,
  - Infusion with Propofol **and/or** Propofol boluses before emergence yield a significant decrease in ED

Dahmani,S. Pharmacological prevention of sevoflurane- and desflurane-related emergence agitation in children: a meta-analysis of published studies . British Journal of Anaesthesia, 2010; 104(2):216-223

# Precedex - How to

- Administer as discussed earlier in cough prevention section
  - Numerous studies using 0.3 – 1  $\mu\text{g}/\text{kg}$  IV administered towards end of surgery.
  - ED rates reduced from 40-50% in control grps to <10% in treatment groups consistently
  - Minimal effect on Recovery/Discharge times although patients more quiet / still in PACU similar to natural sleep.

The background of the slide is a close-up, high-resolution image of a large quantity of pearls. The pearls are arranged in neat, overlapping rows, creating a dense, textured pattern. They vary slightly in color, ranging from a soft, creamy white to a pale, warm yellow. Each pearl has a smooth, lustrous surface that reflects light, giving them a shimmering appearance. The lighting is soft and even, highlighting the individual facets and curves of the pearls.

**Pain Control – Intranasal Fentanyl**

**No IV....No Problem**

# Pain Control-Intranasal Fentanyl

- Intranasal Fentanyl useful when IV is not present: (eg. EUA & BMT procedures)
- Intranasal Fentanyl is non-irritating and well accepted even in awake patients.
- Onset, potency and duration similar to IV administration

# Pain Control-Intranasal Fentanyl

- **Concentration:** Full strength
- **Route:** dripped in nares with blunt tip syringe (eg. Tb syringe), angiocath tipped syringe or atomizer syringe
- **Timing:** after exiting stage II during mask induction

# Intranasal Fentanyl -Finkel (2001)

- 150 peds for BMT ages 5 mos to 5 yr in 3 groups with either two differing doses of fentanyl or saline
- Postop agitation/pain incidence:
  - 7% of 2 mcg/kg group,
  - 12% of 1 mcg/kg group
  - 46% of placebo saline group
- 2 mcg/kg almost twice as effective than 1 mcg/kg for controlling post op agitation/pain

# Intranasal Fentanyl -Finkel (2001)

- No difference in emergence time or PACU stays compared to placebo group.
- 67% of Ped BMT patients experience ED with unsupplemented sevoflurane while Finkel's 2 mcg/kg group experienced only a 7% rate.

Finkel, J. et al. The Effect of Intranasal Fentanyl on the Emergence Characteristics After Sevoflurane Anesthesia in Children Undergoing Surgery for Bilateral Myringotomy Tube Placement.

# Small Dose Fentanyl & ED

Fentanyl prevents ED even in the absence of surgical/painful interventions when emerging from general anesthesia.

- Cravero (2003) compared 32 patients ages 1 ½ to 10 years for MRI under general anesthesia.
- Either Fent 1 mcg/kg or NS Placebo IV were given 10 minutes before end of MRI scan. RESULT:
- 56% agitation with placebo in PACU
- 12% agitation with fentanyl in PACU
- No pruritus or N/V in either group
- Discharge times similar

Cravero, J. et al. The Effect of Intranasal Small Dose Fentanyl on the Emergence Characteristics of Pediatric Patients After Sevoflurane Anesthesia Without Surgery. *Anesthesia & Analgesia*. 2003; 97:364-67

# Get Rid of the Gas

- Low concentrations of inhalational anesthetic are antianalgesic (hyperalgesic)
  - 0.1 MAC enhances C-fiber activity
  - 0.1 MAC potentiates pain response in DHG
- Recommendations to reduce emergence pain
  - Use BIS monitoring: Results in less use of agent
  - Use anesthetic agents with lower blood solubility
  - Reduce endtidal volume% to  $< 0.1$  MAC before emergence. (Substitute with Propofol, Precedex, nitrous, narcotic titration etc... )

Zhang Y, Eger EI II, Dutton RC, Sonner JM. Inhaled anesthetics have hyperalgesic effects at 0.1 minimum alveolar anesthetic concentration. *Anesthesia and Analgesia* .2000;91:462–6



# ED Prevention Review

**Propofol**

**Precedex**

**Pain Control**



Questions?

This ain't no rodeo

Emergence Pearls