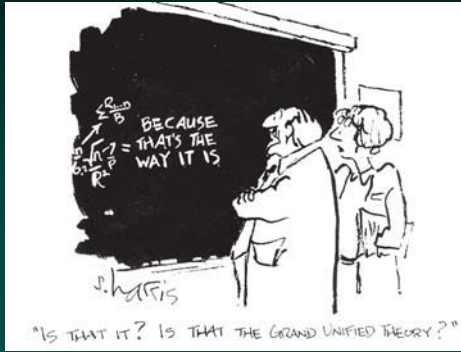


Top 10 Respiratory Anesthesia Practices That Drive Me Crazy

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The Top 10 (in no particular order...)

1. Wimpy preoxygenation
2. "Routine" ventilatory settings
3. "Routine" mechanical ventilation/paralysis
4. "Assisted" ventilation
5. PEEPed out
6. Mode madness
7. Why is my vaporizer broken?
8. What, no pediatric circuit?
9. Two puffs is enough
10. Don't stop smoking!

Learning Objectives

- Identify common practices related to perioperative respiratory management that have no basis in physiology and no clinical evidence to support them
- Compare the risks and benefits of spontaneous breathing and new modes of mechanical ventilation during anesthesia
- Formulate rational plans for ventilatory management based on scientific principles and evidence rather than dogma

1. "Wimpy Preoxygenation"

- 74 Kg, 55 y/o male for urethroplasty
 - Endotracheal intubation planned
 - O₂ mask placed lightly on face for 30 s prior to induction, O₂ flow at 6 l/min
- What is the approximate FIO₂ under these conditions?
- A. 100%
 - B. 80%
 - C. 60%
 - D. 40%
 - E. 30%



Commercialization, Technology Transfer...

Evans and Co, London, 1774

In Anesthesia, Empiricism is Alive and Well...



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 - D. 40%
 - E. 30%

Calculation of approximate $F_I O_2$ if adequate mask fit not achieved

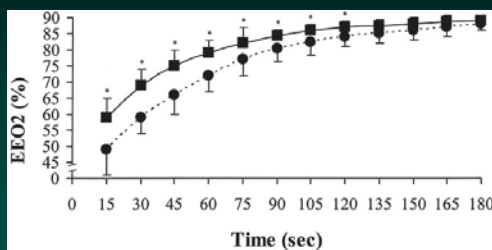
- Average inspiratory flow?
 - ♦ $0.5 \text{ L } V_T$ over $1 \text{ s} = 30 \text{ L/min}$
- Peak inspiratory flow?
 - ♦ May approach 60 L/min
- Assume average inspiratory flow...
 - ♦ $6 \text{ L/min } 100\% \text{ O}_2 + 24 \text{ L/min } 21\% \text{ O}_2$ leads to....
approximate $F_I O_2 = 38\% \text{ O}_2$

2. "Routine" Ventilator Settings

- Patient is now anesthetized and mechanically ventilated with the following settings:
 - ♦ Tidal volume = 750 ml ($\sim 11 \text{ ml/kg}$)
 - ♦ Frequency = 12 breaths/min
 - ♦ I:E ratio = $1:2$
- What is the approximate arterial CO_2 under these conditions?
- A. 45 mmHg
 - B. 40 mmHg
 - C. 35 mmHg
 - D. 30 mmHg
 - E. 25 mmHg

Use of End-tidal O_2 to Monitor Preoxygenation

Tidal breathing, with (squares) or without (circles) max. exhalation



Baraka et al, Anes Analg, 2002

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Bottom line for preoxygenation....

- Do it right, every time, every case!
- Monitor what you are doing...

Justifications for "Routine" Ventilator Settings

- Higher tidal volumes will prevent atelectasis and improve oxygenation
- Respiratory rates of $10\text{-}12$ approach physiologic frequencies of breathing
- Hypocarbica is good, hypercarbica is bad

Problems With These Justifications....

- High tidal volumes do not prevent atelectasis and do not consistently improve gas exchange
 - Visick et al, Anesthesiology 39:285, 1973
- High tidal volumes may injure the lungs
 - Futier et al, Anesthesiology 121:400, 2014
- Hypocapnia may not be beneficial
 - delays during emergence
- Hypercarbia may be good
 - Increased tissue oxygenation, reduced wound infection?

3. "Routine" Use of Mechanical Ventilation / Paralysis...

- After adjusting the ventilator according to your sage advice...
- Patient begins "bucking"
- Receiving 2% isoflurane, 50% N₂O

What do you administer?

- A. Vecuronium
- B. Propofol
- C. More isoflurane
- D. I.V. lidocaine
- E. All of the above

So What About "Routine" Ventilator Settings?

"Traditional" ventilatory settings produce hyperventilation, which may not be a good thing...use lower tidal volumes...

Justifications for "Routine" Use of Mechanical Ventilation / Paralysis...

- Higher tidal volumes will improve oxygenation
- Hypercapnia is bad
- Tachypnea is bad
- Surgeons will be happier and I won't get yelled at
- I can use more opioids, less of volatile agents which is good for the blood pressure
- We always do it that way

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Problems with "Routine" Mechanical Ventilation

- May require endotracheal intubation
- You can learn a lot by watching patients breathe
 - Indicators of anesthetic depth
 - breathing frequency
 - end-tidal CO₂
 - Helpful to titrate opioids
- Awareness is rare in a patient who is not paralyzed

More Problems with “Routine” Mechanical Ventilation

- Mechanical ventilation has hemodynamic consequences
- Neuromuscular blocking drugs can be dangerous
 - ♦ Patient is now utterly dependent on you to survive
 - ♦ Adverse reactions to these drugs and reversal agents
 - ♦ Prolonged paralysis can be a bad thing
 - unnecessary postop ventilation
 - risk factor for postoperative respiratory complications

4. “Assisted” ventilation?

- 74 Kg, 55 y/o male for urethroplasty (remix)
- Induction with propofol, LMA inserted, leak at 24 cm H₂O
- With spontaneous breathing...
 - ♦ ETCO₂ = 58 mm Hg
 - ♦ Breathing frequency = 24 /min
 - ♦ Tidal volume = 240 ml
- Are these parameters acceptable? (yes/no)

So What About “Routine” Mechanical Ventilation/Paralysis?

Use mechanical ventilation/paralysis because it is indicated, not as a matter of routine...
or as a substitute for adequate anesthesia...

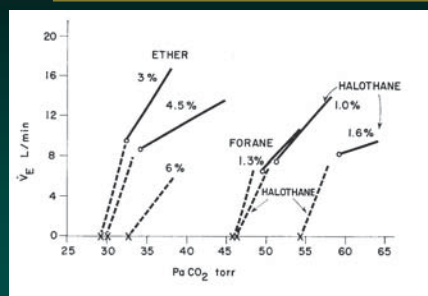
Rationale for “Assisted” ventilation

- Increase tidal volume (“sigh”)
 - ♦ Improves atelectasis (?), oxygenation (?)
- Decrease work of breathing (ETT, etc.)
 - ♦ Straus et al, AJRCCM 157:23 – work of breathing post extubation
- Augment minute ventilation (improve hypercapnia)
- *We now have fancy ventilators that can do this*

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Apneic threshold



Apneic threshold was a mean of 4.6 mmHg below PaCO₂ maintained during spontaneous breathing, largely independent of anesthetic or depth.

So What About “Assisted” Ventilation?

The rationale for “assisted” ventilation...questionable at best!

AP



Lat.

Atelectasis in Dependent Lung Regions

- Healthy subject breathing 1.2 MAC halothane
- Imaged with volumetric fast CT scanner

Warner et al, Anesthesiology, 1996

5. PEEPed Out

- 125 kg, 48 y/o male for lap. cholecystectomy
- Intubated, paralyzed, mech. ventilation
 - ♦ Tidal volume = 800 ml, f = 10, FiO₂ = 60%
 - ♦ ETCO₂ = 42 mmHg
 - ♦ SaO₂ = 87%

What do you do?

- A. Increase tidal volume
- B. Increase F_IO₂
- C. Apply PEEP
- D. Apply recruitment maneuver, then PEEP

Intraoperative effect of isolated PEEP in “normal” lungs

- Multiple studies have demonstrated that when applied in isolation, intraop. PEEP
 - ♦ Does *not* consistently affect atelectasis
 - ♦ Does *not* consistently affect oxygenation

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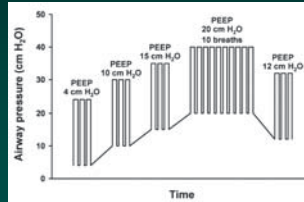
“Recruitment” Maneuvers

- Sustained high airway pressures
 - ♦ “Sustained” – 30 to 40 seconds
 - ♦ “High” – approximately 40 cm H₂O
- Apply PEEP after recruitment maneuver to maintain open lung
- High F_IO₂ accelerates the formation of atelectasis – so keep F_IO₂ below 80% if possible

Effect of recruitment maneuvers on intraoperative oxygenation



- 20 patients undergoing laparoscopic bariatric surgery, randomized to recruitment or not

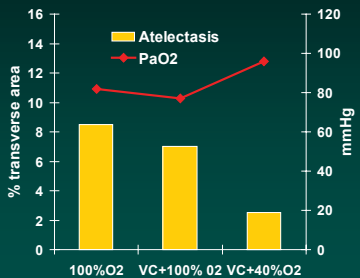


Whalen et al, Anesth Analg 2006;102:298

Remember that for Intraoperative Hypoxemia...

- Often caused by dependent lung atelectasis
- Often treated by recruitment maneuvers, followed by PEEP
- Avoid 100% inspired oxygen
 - ♦ Accelerates formation of atelectasis
 - ♦ May have little effect on PaO₂
 - ♦ Decrease to 80% may be beneficial
- DO NOT INCREASE TIDAL VOLUME

Effect of intraoperative maneuvers on postoperative atelectasis



- 30 anesthetized adults, randomized 10 min before extubation
- CT scans for atelectasis obtained 20 min after extubation (room air)
- Combination of vital capacity maneuver (40 cm H₂O for 15 min) and low FiO₂ optimal

Benoit et al, Anesth Analg 2002;95:1777-81

6. Mode Madness

- 125 kg, 48 y/o male for lap. cholecystectomy
- Now end of the case –breathing spontaneously with “PSV-Wonder”
 - ♦ Pressure support with SIMV-PC backup
- Resident extubates – but now apenic
- Chaos ensues
- What just happened?

Recent “lung protective” studies...

- Both studied “at risk” patients, open ab. procedures
- PROHILO (n=900)
 - ♦ V_T= 8 ml/kg
 - ♦ PEEP 12 cm H₂O + RM vs. PEEP < 2 cmH₂O
 - ♦ No differences in pulmonary outcomes
- IMPROVE (n=400)
 - ♦ V_T=10-12 ml/kg ZEEP vs. V_T=6-8 ml/kg, PEEP = 6 cmH₂O, RM
 - ♦ RR = 0.29 (95%CI 0.14 to 0.61) for acute respiratory failure

PROVE Invest., Lancet 2014; 384: 495
Futier et al, NEJM 2013;369:428

An embarrassment of riches...

- Volume Controlled Ventilation
- Pressure Controlled Ventilation
- SIMV/PSV
- SIMV/PC – “Good for LMA cases”
- PSV-“Wonder” – “Good for emerging cases”
- PCV-“Volume plus” – “Good for laparoscopic cases”



7. Why is my vaporizer broken?

- 26 y/o female for Le Fort osteotomy
- Otherwise healthy
- Propofol/fentanyl/succinylcholine induction
- 2% isoflurane in 50% O₂ commenced after confirmation of ETT placement

Complex things can fail.....

Wonder Medical has sent out Urgent Medical Device Correction Notice to all customers who are using the Wonder Anesthesia Machine with 6.0.1.q.4.&.3 software. The issue in has to do with the vent mode PCV-VG; when using this mode the Wonder machine may over-deliver tidal volume when given a unique sequence of user inputs and a collapsed bellows....recall.....

Disaster strikes!!

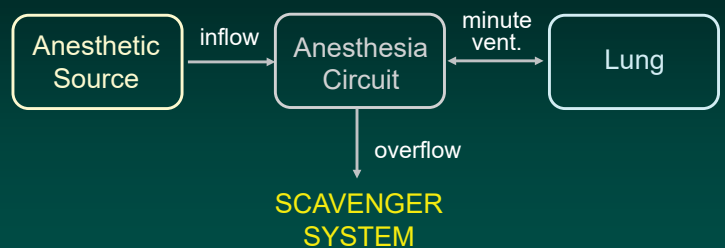
- 5 min after induction, patient starts coughing, surgeon starts yelling
- End-tidal isoflurane reads 1.0%, inspiratory isoflurane reads 1.6% on the monitor, vaporizer is set to 2.2%
- You call Jerry Rach to check the vaporizer
- What's going on?
- What one bit of information do you want to know?

~~Evidence That Intraoperative Ventilatory Mode Affects Outcome~~



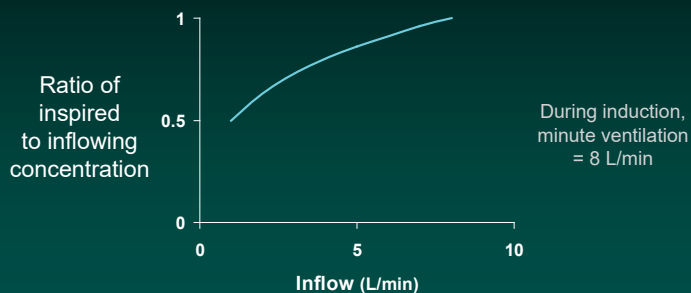
But high tidal volumes are bad....

Effects of anesthesia circuits...



Inflow < minute ventilation = rebreathing

Effect of flows on inspired concentration

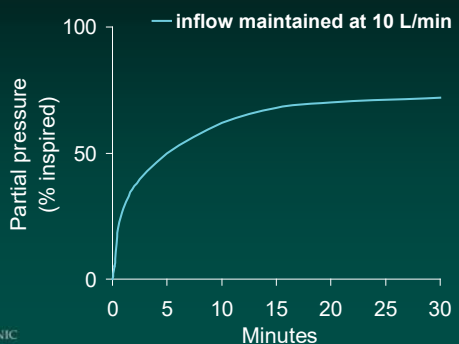


Is My Vaporizer Broken?

Flow rates can significantly affect actual inspired concentrations....

NO! The vaporizer is fine...

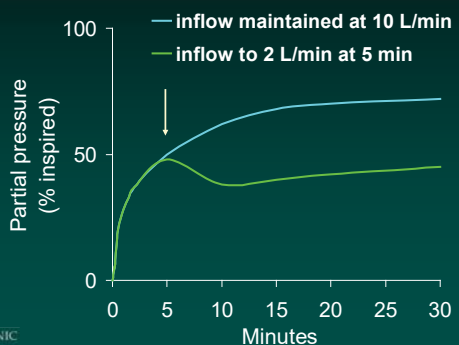
How inflow can affect induction...



8. What, no pediatric circuit?!?

- 3 m/o healthy infant for herniorraphy
- No more cute pink anesthesia bags with smaller tubing (teamsters on strike)
- Only large, ugly, "green bag" adult circle system available....
- Is it safe to proceed? (yes / no)

How inflow can affect induction...



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Why do we use pediatric circuits?

- Compression volume (mechanical ventilation)
 - ◆ Peak airway pressure of 20 cmH₂O
 - ◆ Fraction of volume compressed is 20/1000 = 2%
 - ◆ For 200 ml circuit volume, 4 ml of tidal volume “lost” to compression; for 100 ml volume, 2 ml “lost”
- Dead space
 - ◆ From the Y-junction....
- The “educated hand”

Trouble Brewing!!

- Now 10 min after induction, increased airway pressures and wheezing noted
- Your response:
 - ◆ Increase sevoflurane
 - ◆ Administer propofol
 - ◆ Give 2 puffs albuterol per ETT
- Still wheezing – now what?
 - ◆ Should you give more albuterol? (yes/ no)

What is your response?

Proceed!

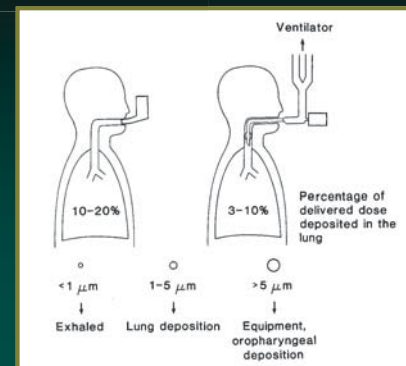
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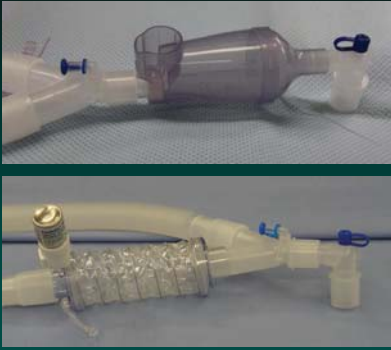
9. Two Puffs is Enough

- 34 y/o female for partial thyroidectomy
- Mild persistent asthma, symptoms under good control
- Propofol/fentanyl/succinylcholine induction with bronchospasm precautions
- 4% sevoflurane in 50% O₂ maintained after confirmation of ETT placement

Aerosol Delivery



Intraoperative Aerosol Delivery



- CFC-free inhalers
- Spacers for inspiratory limb increases efficiency of delivery

10. Don't Stop Smoking!

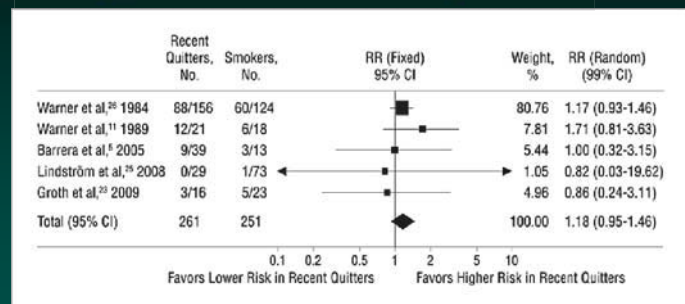
- 63 y/o male, currently smoking 1 pack/day
- Scheduled for open gastric resection for cancer
- Morning cough, mild obstructive disease on PFTs
- Seen in your preop clinic two days prior to surgery
- Should you recommend that he quit smoking preoperatively? (yes / no)

What is your response?

More puffs!

And consider iv epinephrine if no response....

Meta-analysis of pulmonary complications in recent quitters



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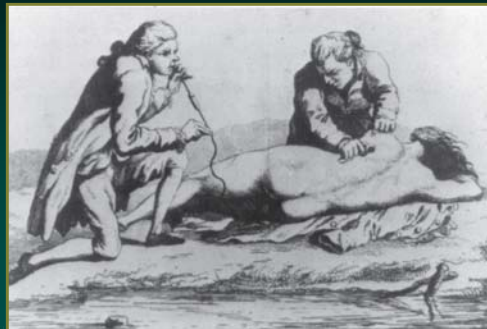
What should surgical providers do for smokers who need surgery?

- **ASK** - assess tobacco use at every visit
- **ADVISE** - strongly urge all tobacco users to quit
- **REFER** - To a tobacco quitline or other resources

“Quitcard”



“Top 10 Respiratory Anesthesia Practices that Drive Me Crazy”



MAYO CLINIC

Any time is a good time for surgical patients to quit smoking!

- Surgery is an excellent time to attempt abstinence, either “for a bit” or “for good”
- Interested in learning more? Contact me! warner.david@mayo.edu
- Use the ASA website as a resource

Patients - <http://www.lifelinetomodernmedicine.com/Anesthesia-Topics/Smokers-and-Surgery.aspx>

Providers - <http://www.asahq.org/stopsmoking> *Join the listserv!*

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