



*FLOW VENTILATION*  
*ACCELERATED RECRUITMENT FOR*  
*NEONATES TO ADULT ARDS AND BEYOND*

*By*

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# DISCLOSURES

- Clinical Consultant:
- Percussionaire Corporation
  
- Nothing else
  
- The opinions expressed during this presentation are those of the speaker, and not necessarily those of the organizing committee, association or sponsor.

# OBJECTIVES

- To describe flow ventilation.
- To explore how it is used in all ICU's and in the home setting.
- To ask ourself how does accelerated laminar flow and Newton's third law of physics come into Play?

# LEGACY HOSPITAL'S IN PORTLAND

- We have six hospitals in Oregon and Washington.
- We have all ICUs to include a burn center and a mobile ECMO team.
- We have both an Adult and pediatric rehab center for which patients are admitted and discharged home to.





Legacy Emanuel





Randall Children's Hospital

# Pulsatile flow ventilation for hospital and home



# WHAT IS A VENTILATOR

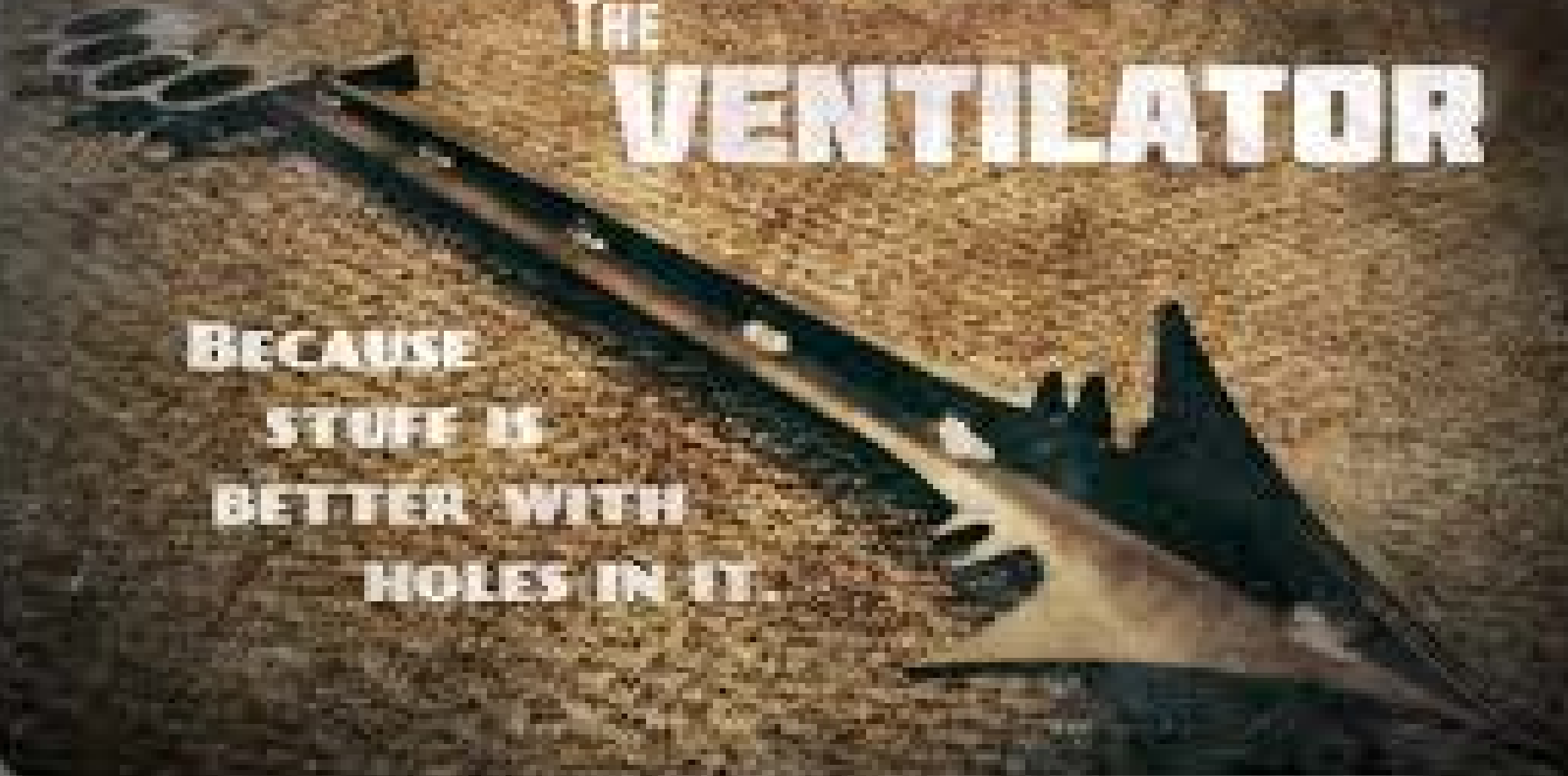




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# THE VENTILATOR

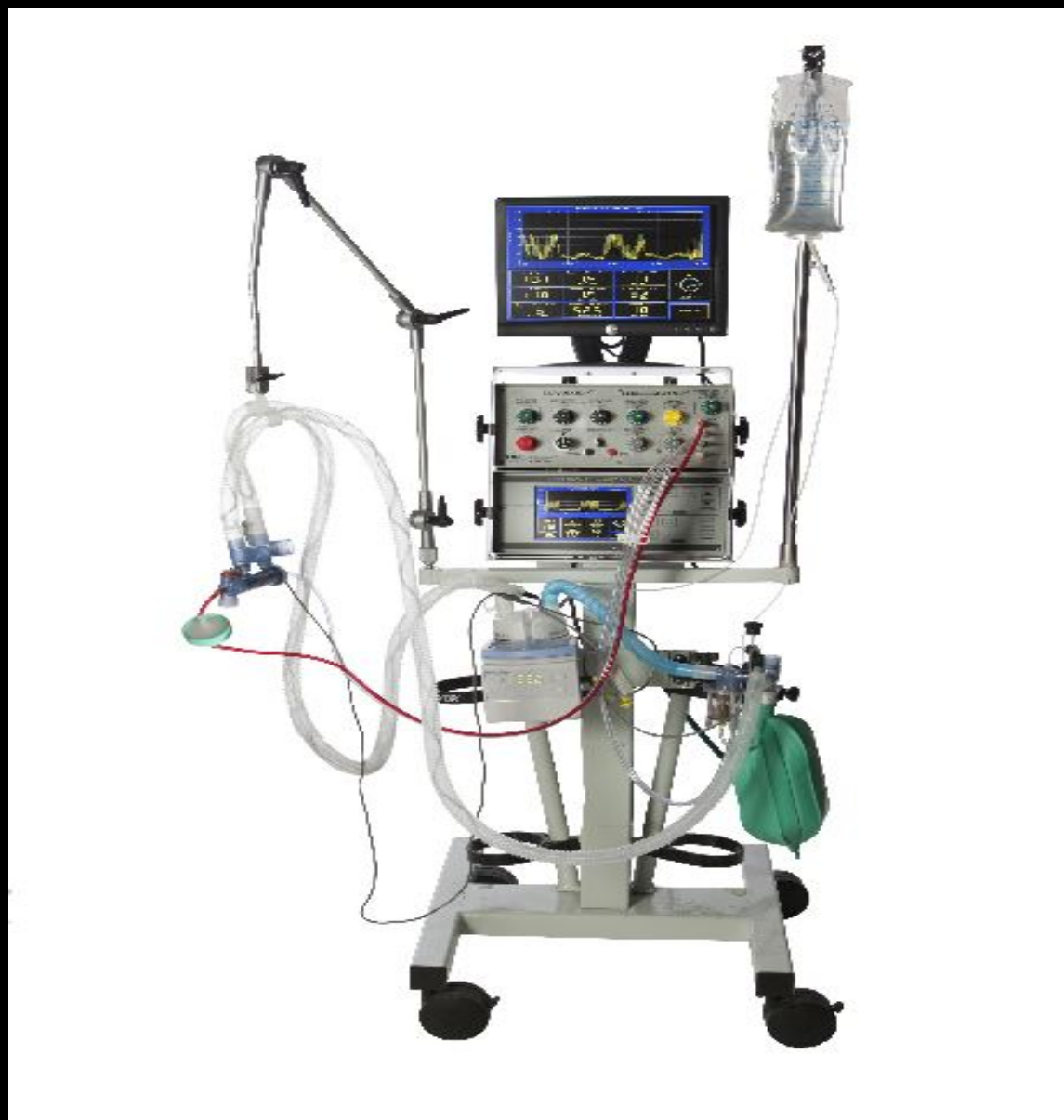
BECAUSE  
STUFF IS  
BETTER WITH  
HOLES IN IT.



# AH MUCH BETTER TWO EXAMPLES OF CONVENTIONAL VENTILATORS



# THE VDR- 4





# HOMOGENEOUS AND HETEROGENEOUS ALVEOLAR VENTILATION

Schiller et al. *Crit Care Med.* 2001;29:1049

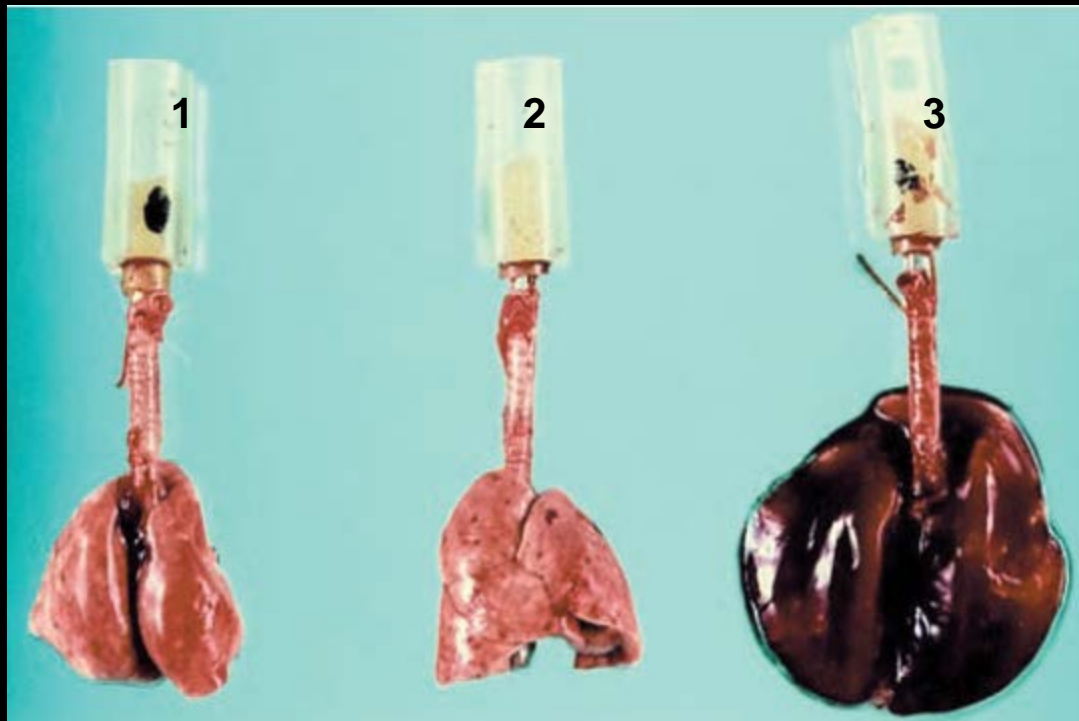


Normal Lung



ARDS Lung

- The accumulating body of evidence suggests that volutrauma and barotrauma contribute to the development and worsening of ALI and ARDS. (**Overstretching the lung**)



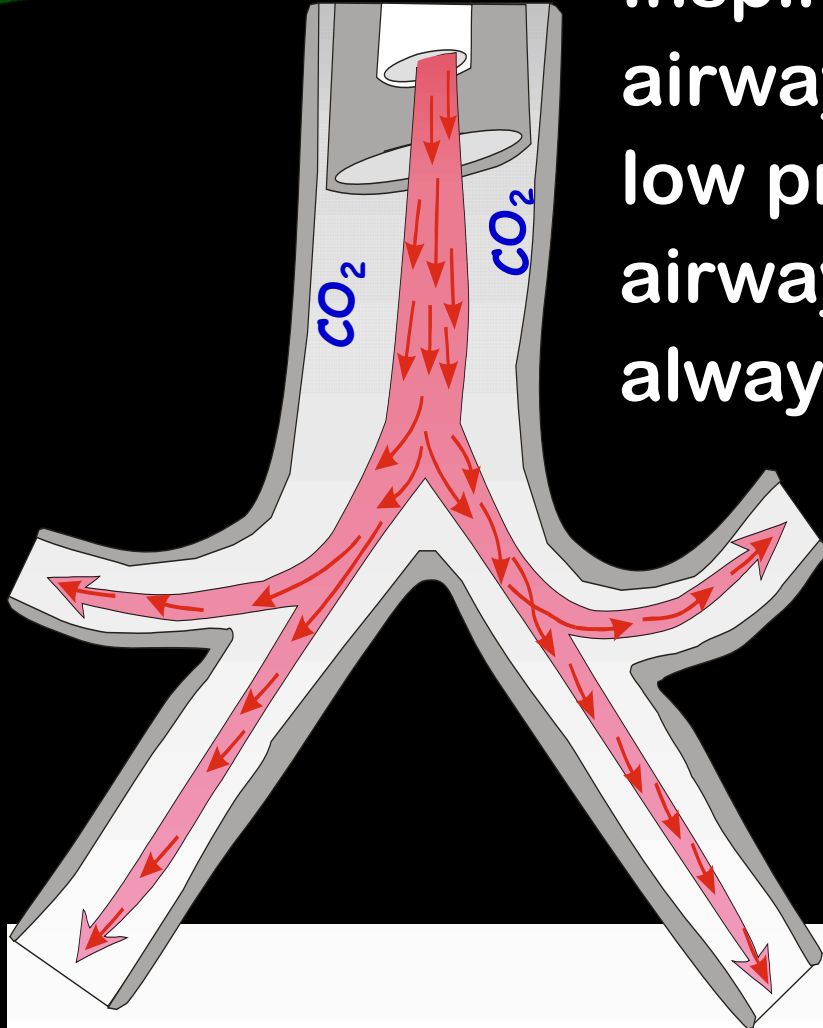
1. Normal Lungs
2. After 5 min of ventilation at a peak airway pressure of 45 cmH<sub>2</sub>O
3. After 20 min of ventilation at a peak airway pressure of 45 cmH<sub>2</sub>O

# BASICS OF FLOW VENTILATION

- Accelerated laminar flow
- Newton's third law of physics
- Fluidic flow principles



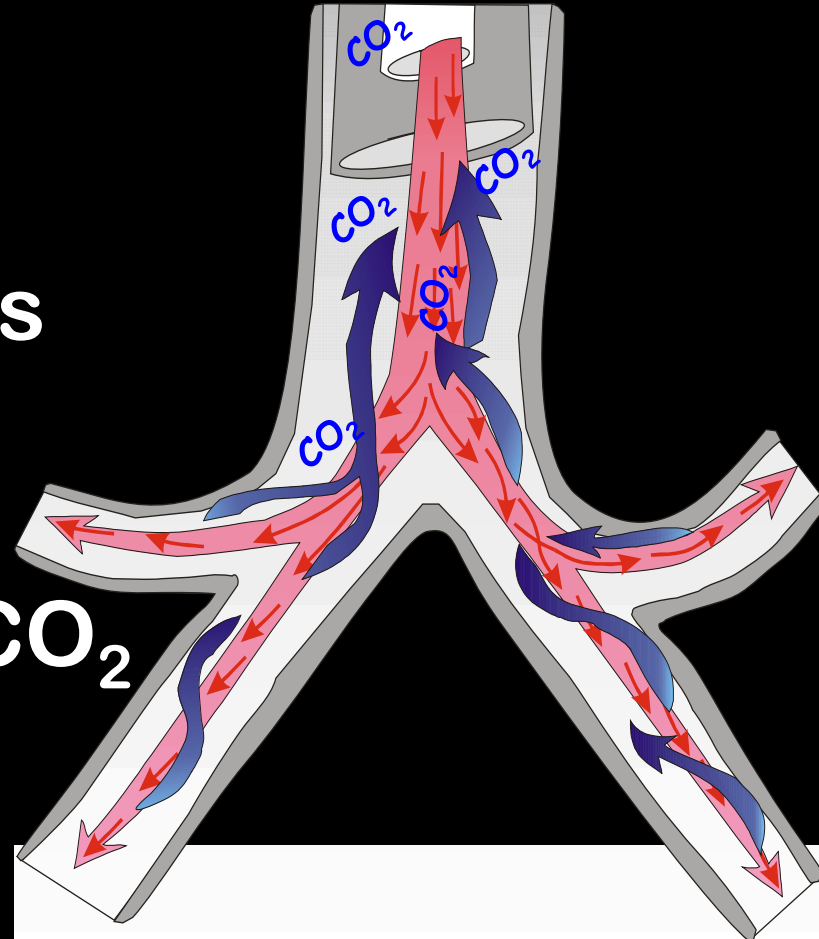
# GAS FLOW



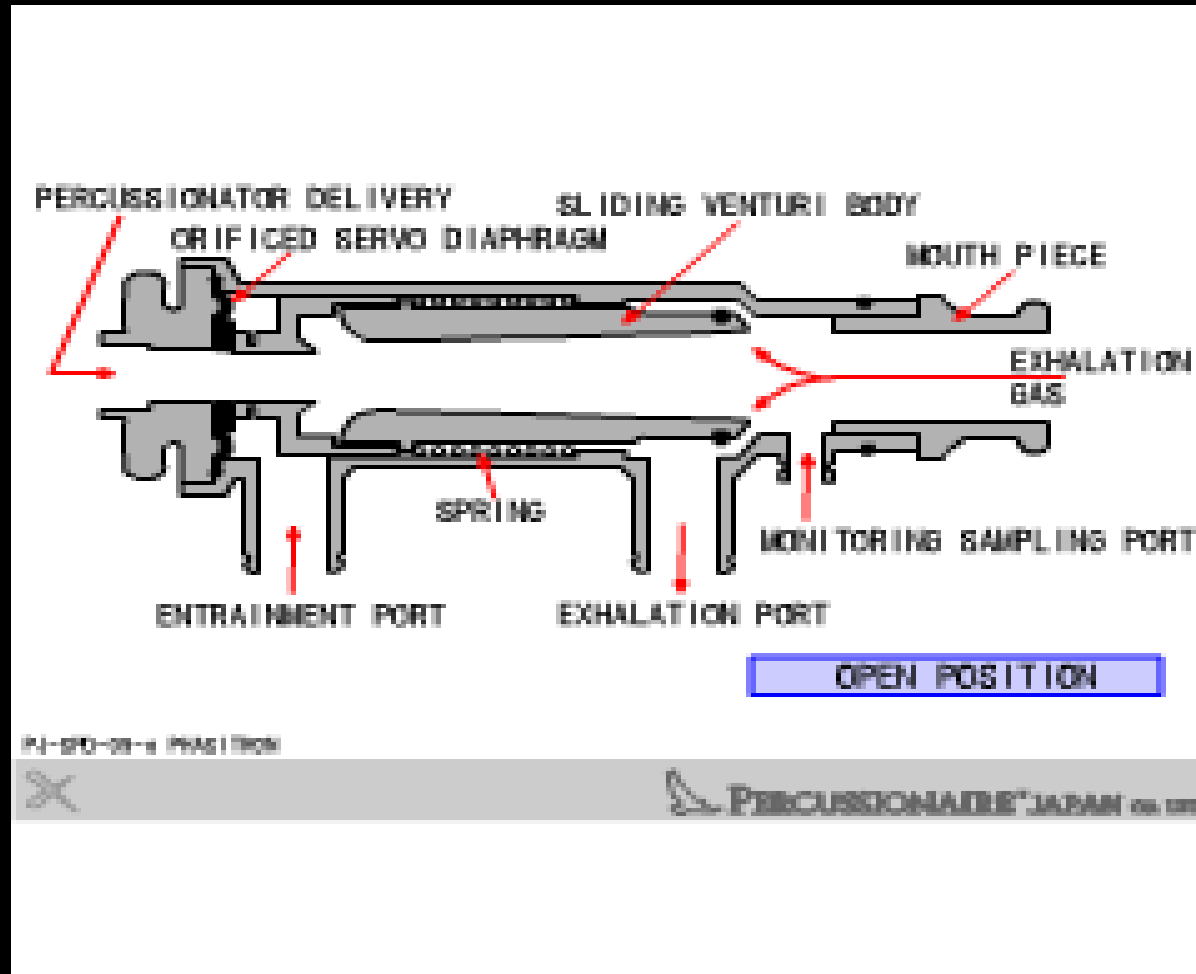
Inspired gas *streams* into the airways with high velocity, but low pressure. It streams down the airways, splitting at bifurcations, always seeking the path of least resistance in the center of the airways. The train of tiny tidal volumes moves high  $pO_2$  gas close to alveoli, while  $CO_2$  is compressed against airway walls.

# Gas Flow

1. Airways stay open at low  $\overline{P_{aw}}$ .
2. Exhaled gas swirls out along airway walls, facilitating mucociliary and  $CO_2$  clearance.



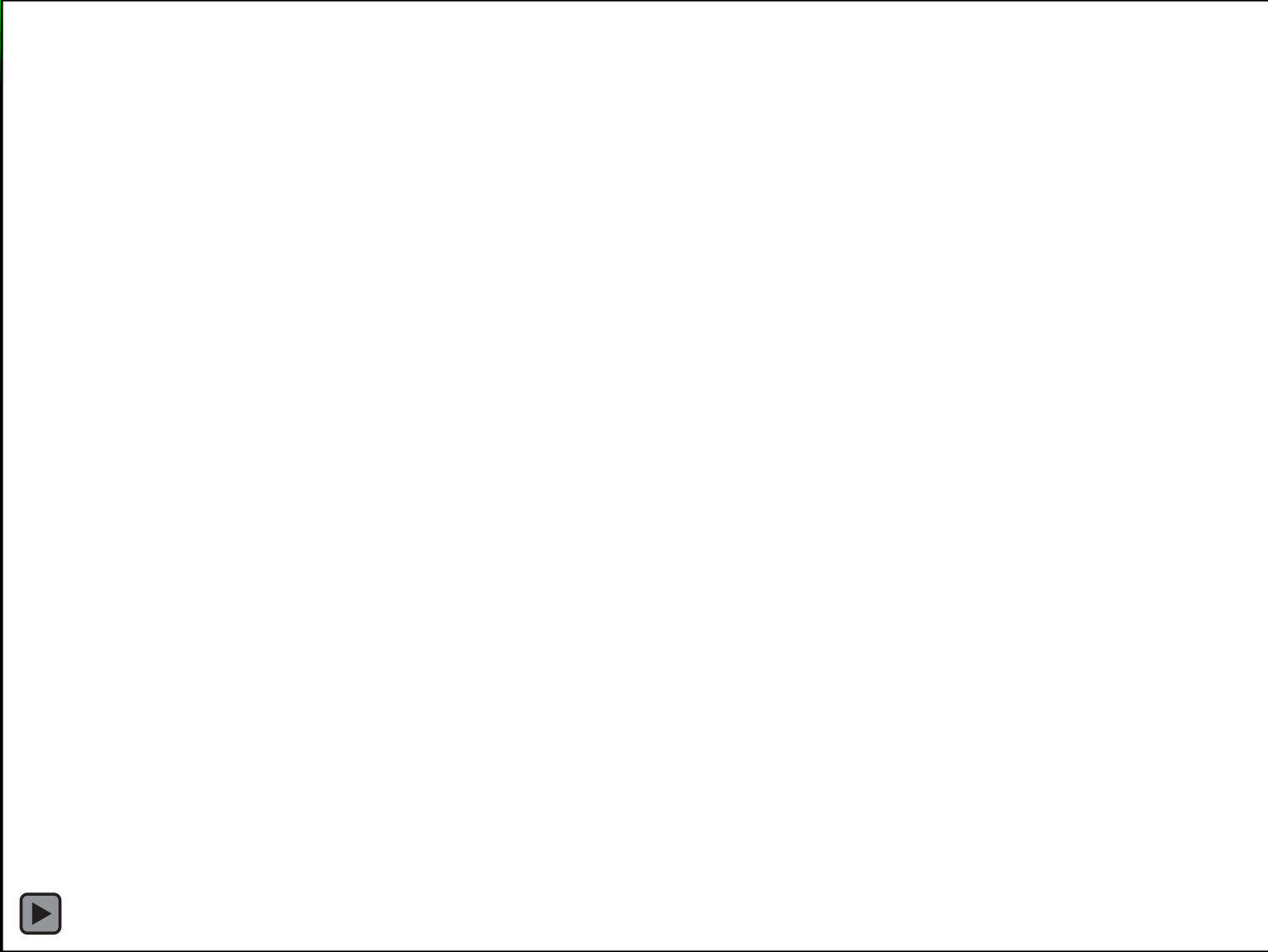
# The Phasitron; The patient interface

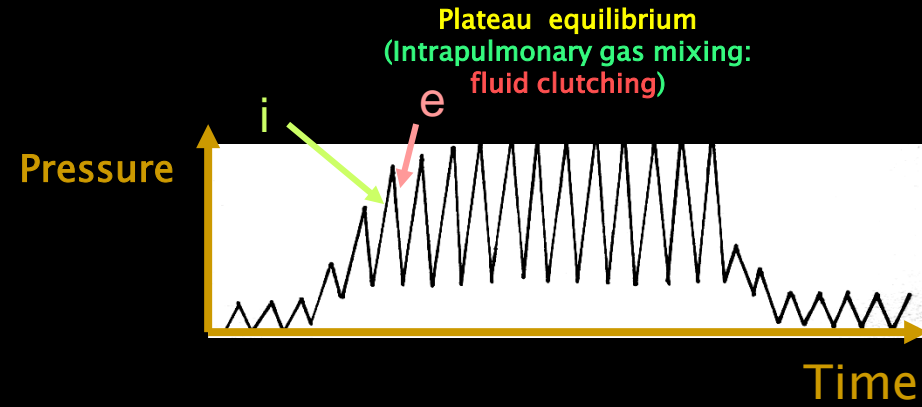
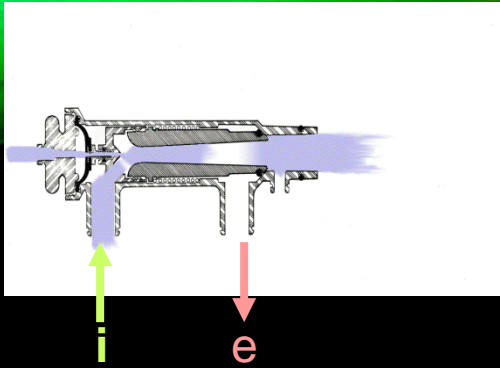


## A Sliding Venturi

- “floating” exhalation valve
- Entrainment during inspiratory
  - Entrainment up to 1:5
  - Pneumatic clutch – “feels” backpressure
- Open to ambient during expiratory
- Flow to pressure / pressure to flow converter





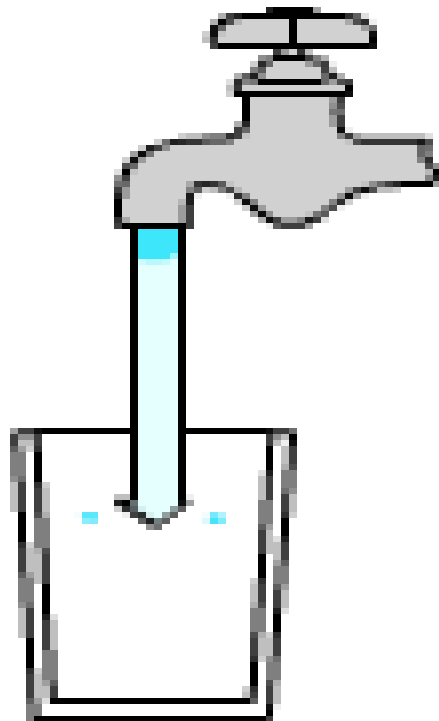


## “Fluidic Clutching”

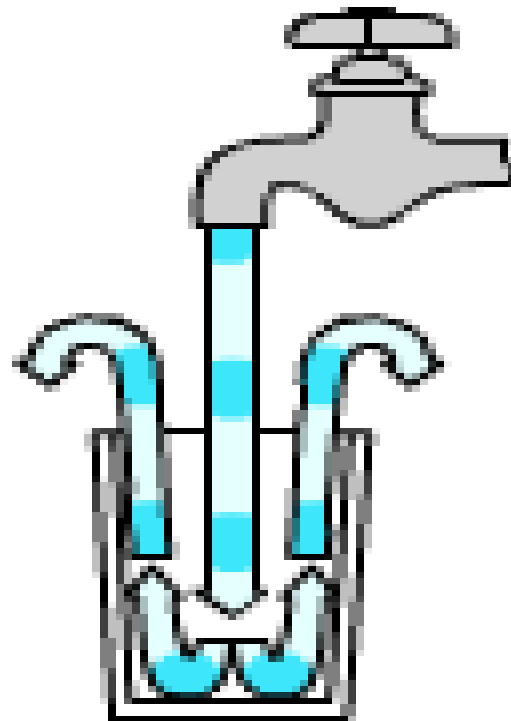
PIP is reached and lungs are inflated  
backpressure is reflected to venturi  
pressure increase downstream of  
venturi flows decreases

*This protects the lungs from dissecting pressures and flows.*

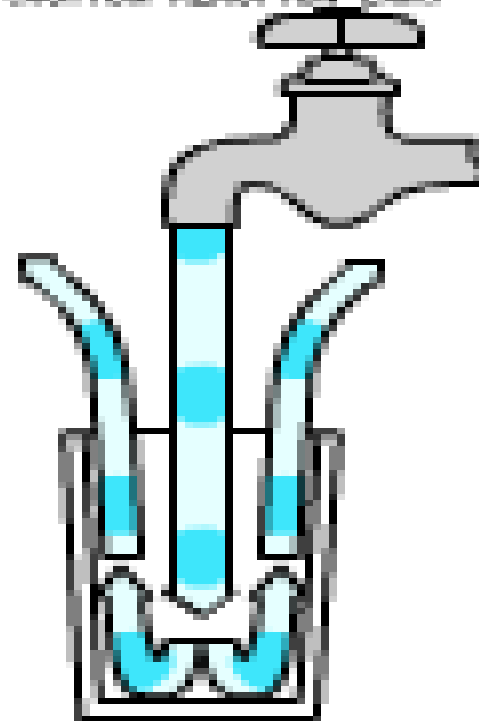
**SLOW SPEED**  
OVERFLOWING



**HIGHER SPEED**  
DEVELOPMENT OF COUNTER  
CURRENT FLOWS



**HIGHEST SPEED**  
HIGHEST COUNTER CURRENT  
LAMINAR FLOWS  
BY MERTON'S THIRD LAW  
CAUTION-REACTION LAM



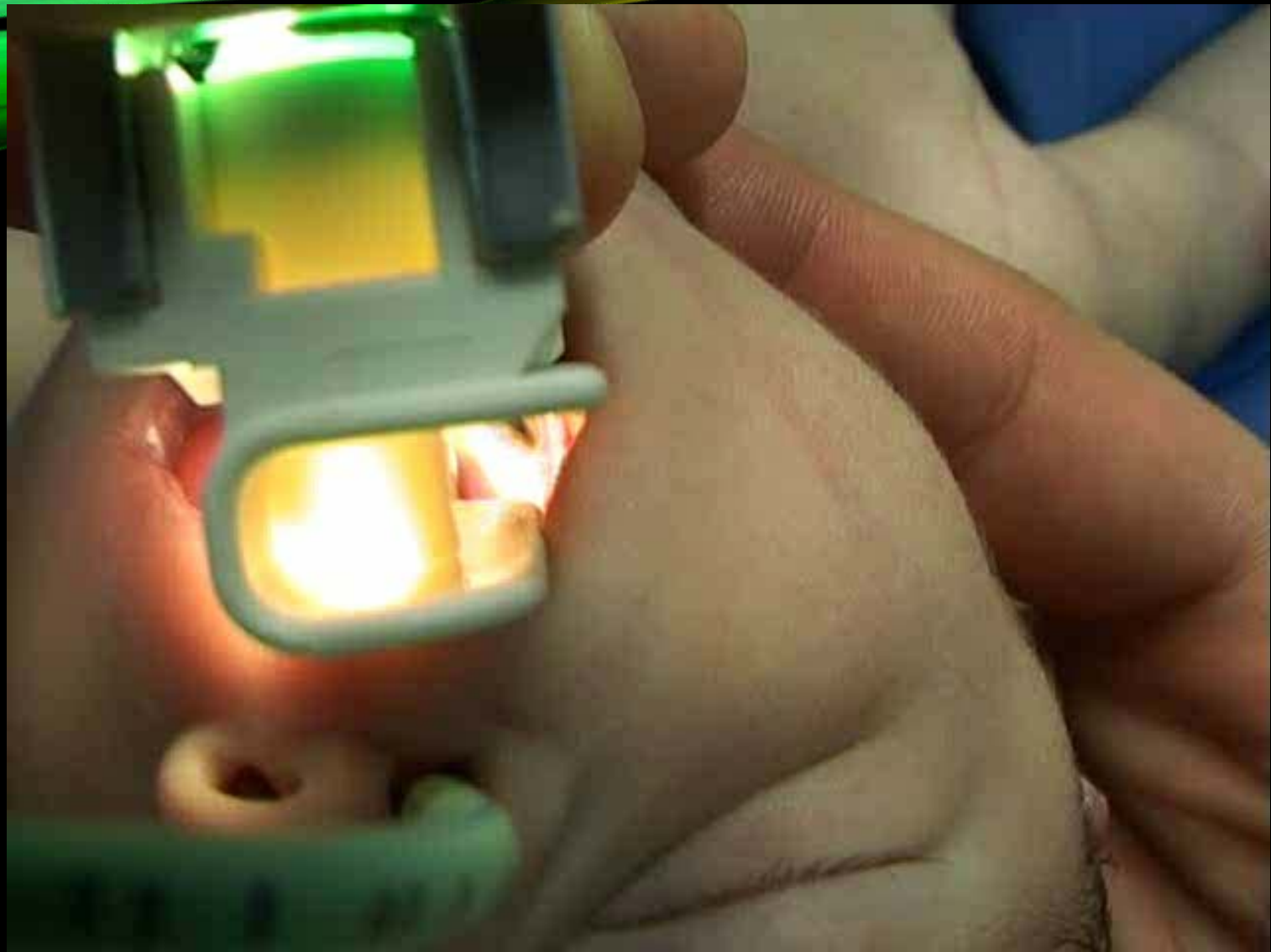
PJ-SPD-03-e TAP WATER



PERCUSSIONAIRE® JAPAN CO., LTD.







# WHAT ARE THE TOOLS IN OUR PULMONARY TOOLBOX

- Ecmo (both onsite and mobile)
- 22 VDR-4s
- 41 Hamilton G-5s
- 11 Hamilton T-1 transport ventilators
- 5 Percussionaire transport ventilators
- Multiple home ventilators to include LTV, Trilogy, Astral
- lots of IPV units
- vests
- cough assists
- Aerobika
- Aerogen and Ban nebs, NO, Heliox,

# HOW ABOUT TREATMENT DEVICES WITH FLOW VENTILATION?



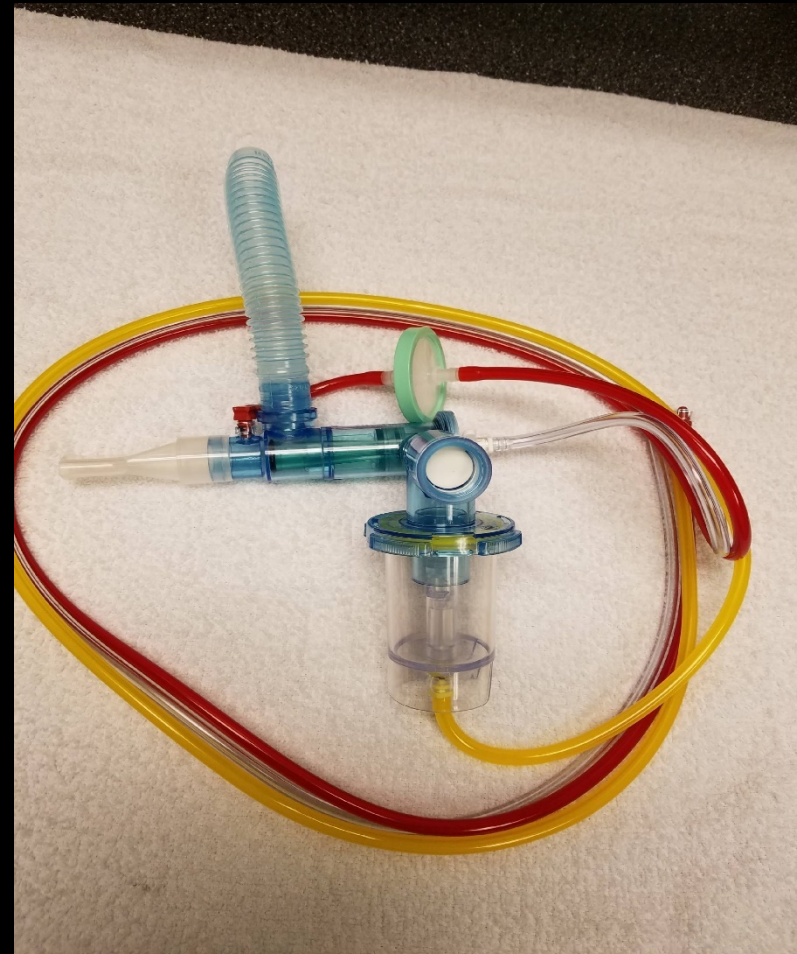


# LETS SIMPLIFY THINGS

Step # 1

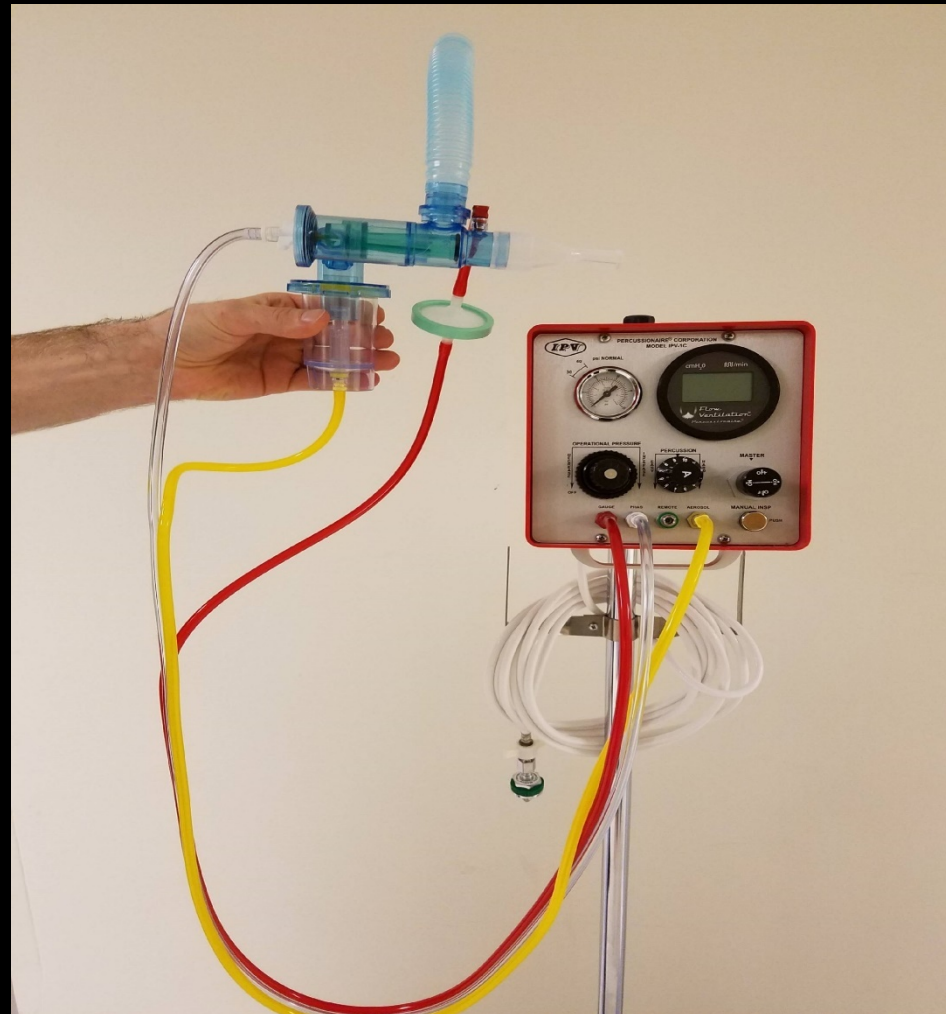


Step # 2





# PLACE ON IPV MACHINE



# IPV<sup>®</sup>-1C

- Color coded connections
- Master on/off

- Drive pressure control

"Amplitude"; start at about 20 – slowly increase. Target 25 – 30 for peds, 35 – 40 for adults (may take several treatments to reach these pressures).

- Percussion control

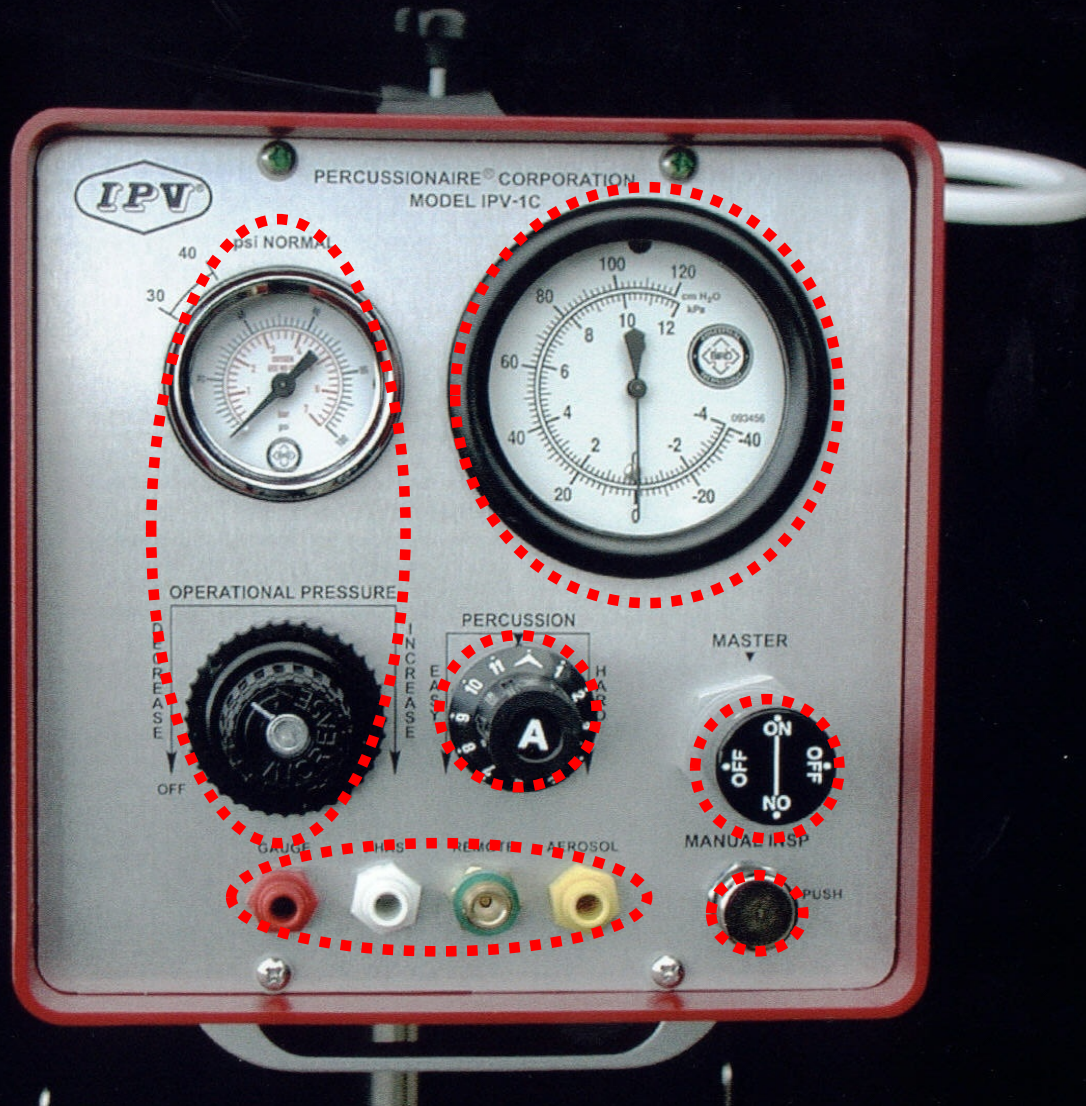
Hard (100 bpm) to easy (300 bpm) adjust for comfort and effect

Easy for more gas exchange and to loosen secretions, hard for more mobilization; scan through different rates later in the treatment

- Proximal pressure monitor

- Manual Breath

Try it on yourself before using on patient

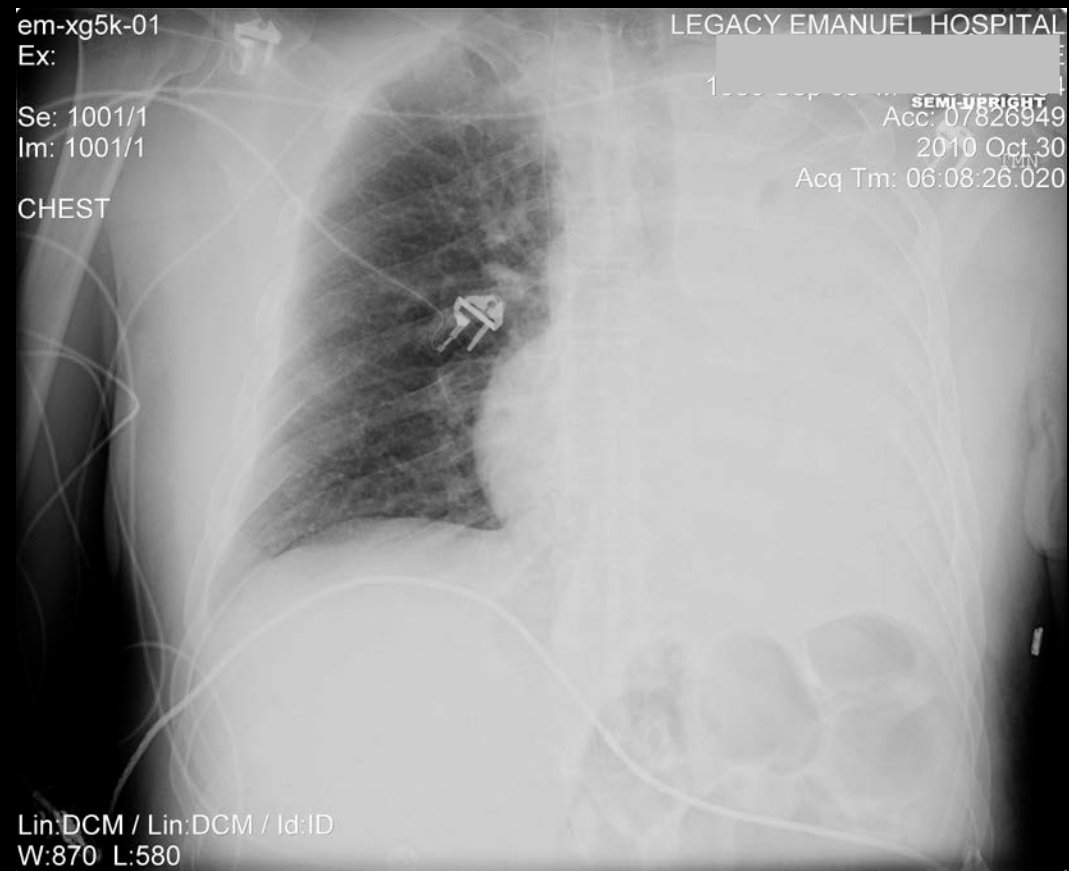


# 17 Y.O ADMITTED TO FLOORS

- 7 day history of cough, cold symptoms
- Elevated temp., rr=28, sao2=90- 92% on simple mask, hr=118, bp=120/78, moderate retractions noted.
- Extended history of repeat infections/ possible asthma
- Breath sounds are coarse rhonchi with left side diminished.



# AM X-RAY





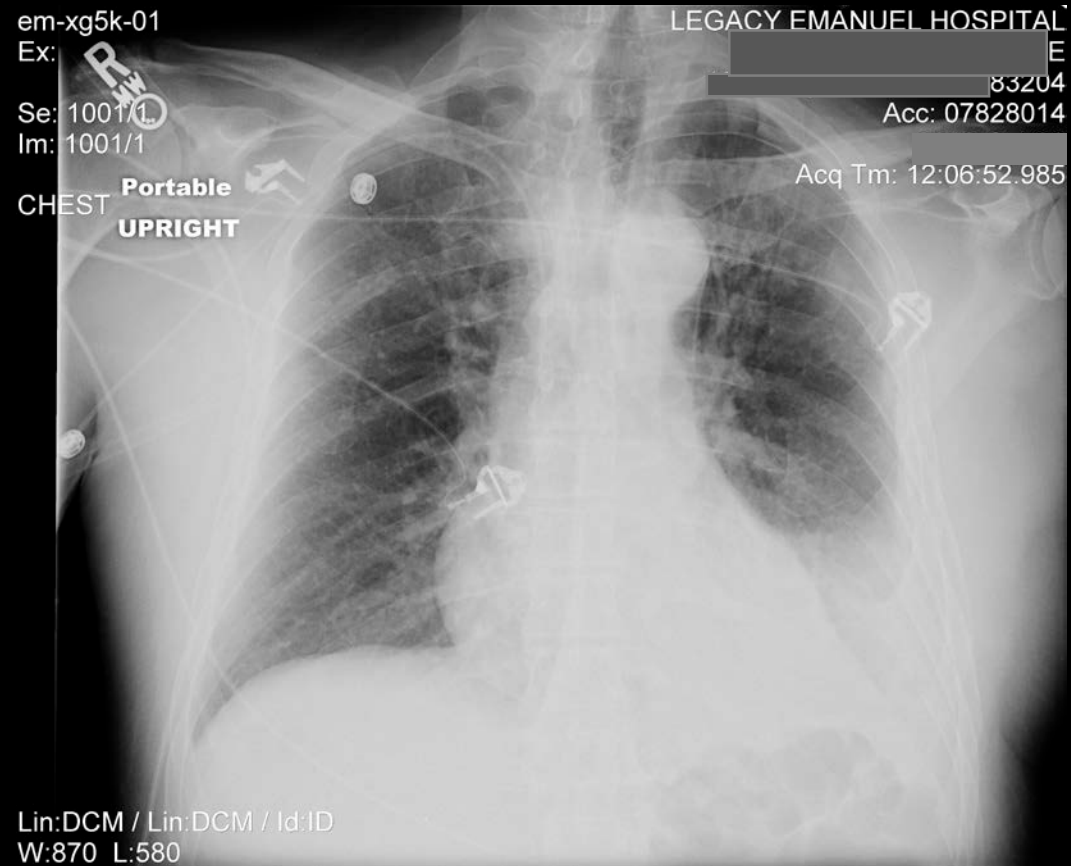
# 1ST YEAR RESIDENT SUGGESTS THAT WE SHOULD GO TO PICU

- Agree with resident and set-up for possible intubation/ cpap.
- CPT and albuterol
- Tell him to relax and get a cup of coffee
- IPV anyone?

# RESIDENT AGREES TO IPV BEGRUDGINGLY

- Patient's SAO<sub>2</sub> increases to 95-97% post tx with lots of coughing t/o.
- Pt's rr=20 with mild retractions with stable vitals.
- Patient placed on 4 liter nasal cannula with SaO<sub>2</sub>=94%.
- Resident still wants to send to PICU x-ray can't be improved and this is a temporary result.

# X-RAY SIX HOURS LATER AFTER ONE 20MIN. IPV RX



# PATIENT OVERVIEW

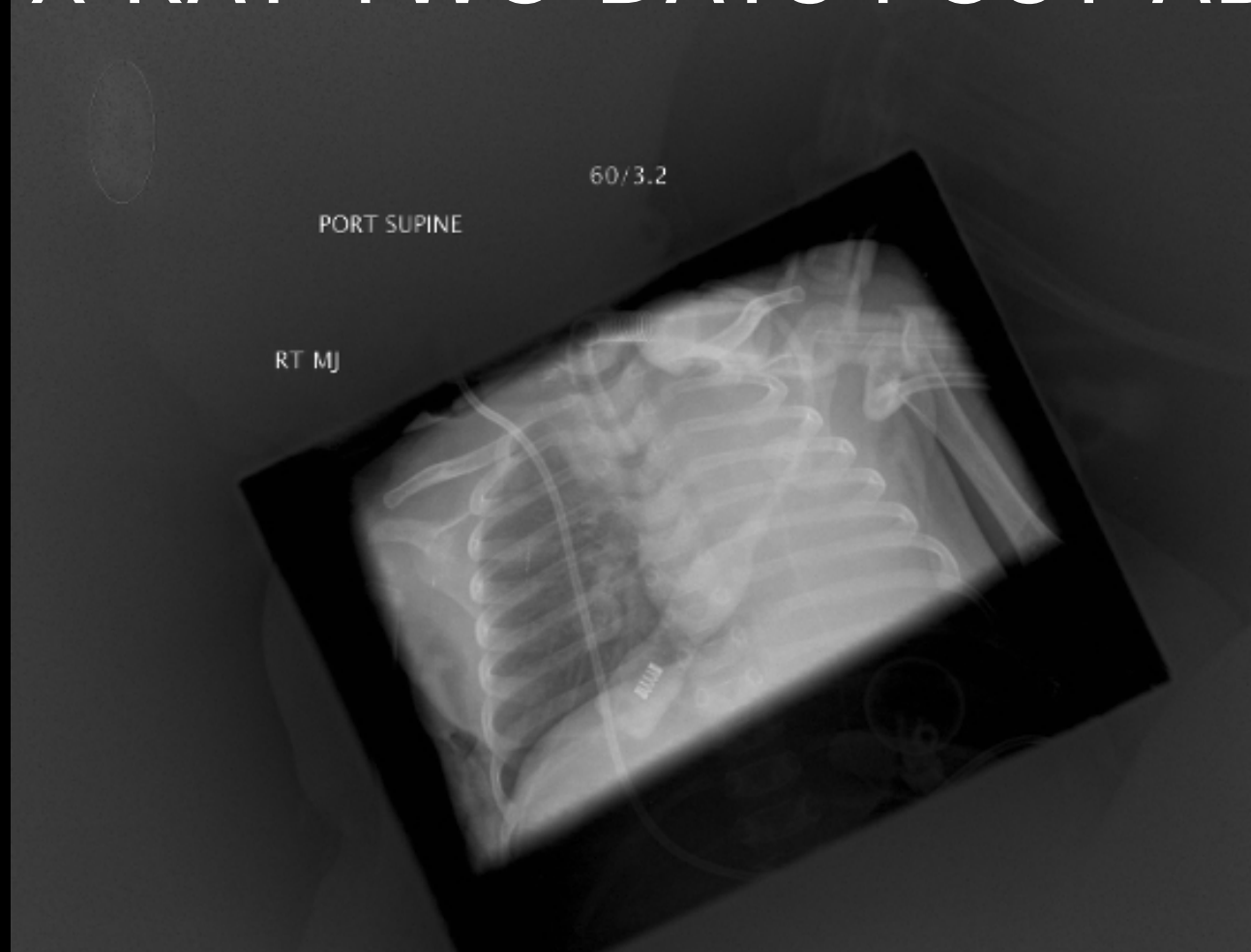
- 3 month old ventilator dependent infant living in long term care facility
- Admitted for bradycardia and desaturation: secondary to pneumonia
- Hx: 30 week Gestational age, moderate BPD, unstable apnea, bronchomalacia, congenital hydrocephalus, hypertension and club feet.



# Admitted to PICU

- Vent settings: mode=CMV, VT=7cc kg, peep=8, RR=24, fio2=65%, pip=30-34
- VBG= 7.29, CO2=63, O2=41, Bicarb=30
- History of frequent lung collapse: atelectasis and infiltrates with infections.
- Sedated comfortably on vent
  - Increased thick secretions noted by RT's.

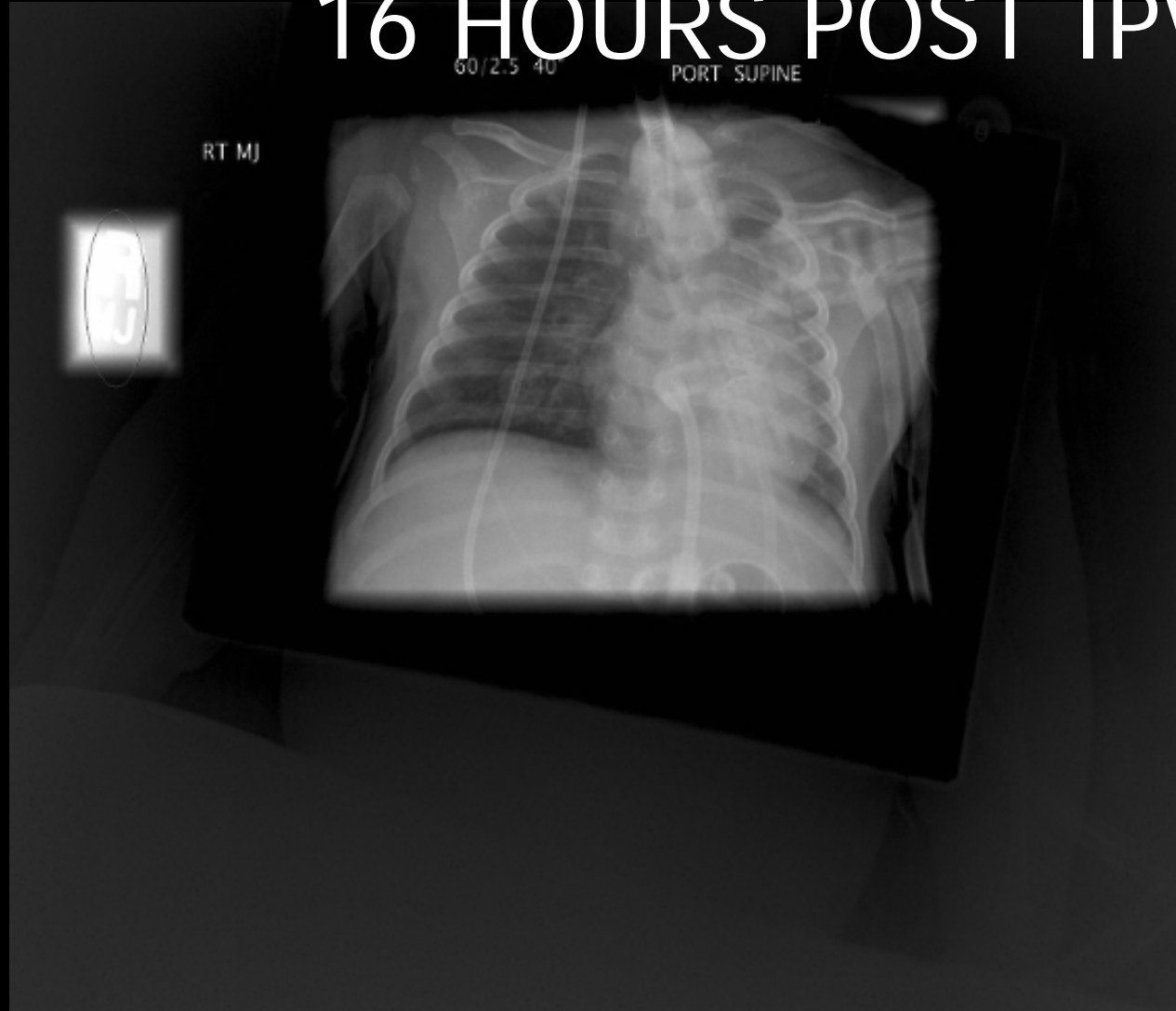
# X-RAY TWO DAYS POST ADMISSION



# DO WE DO ANYTHING?

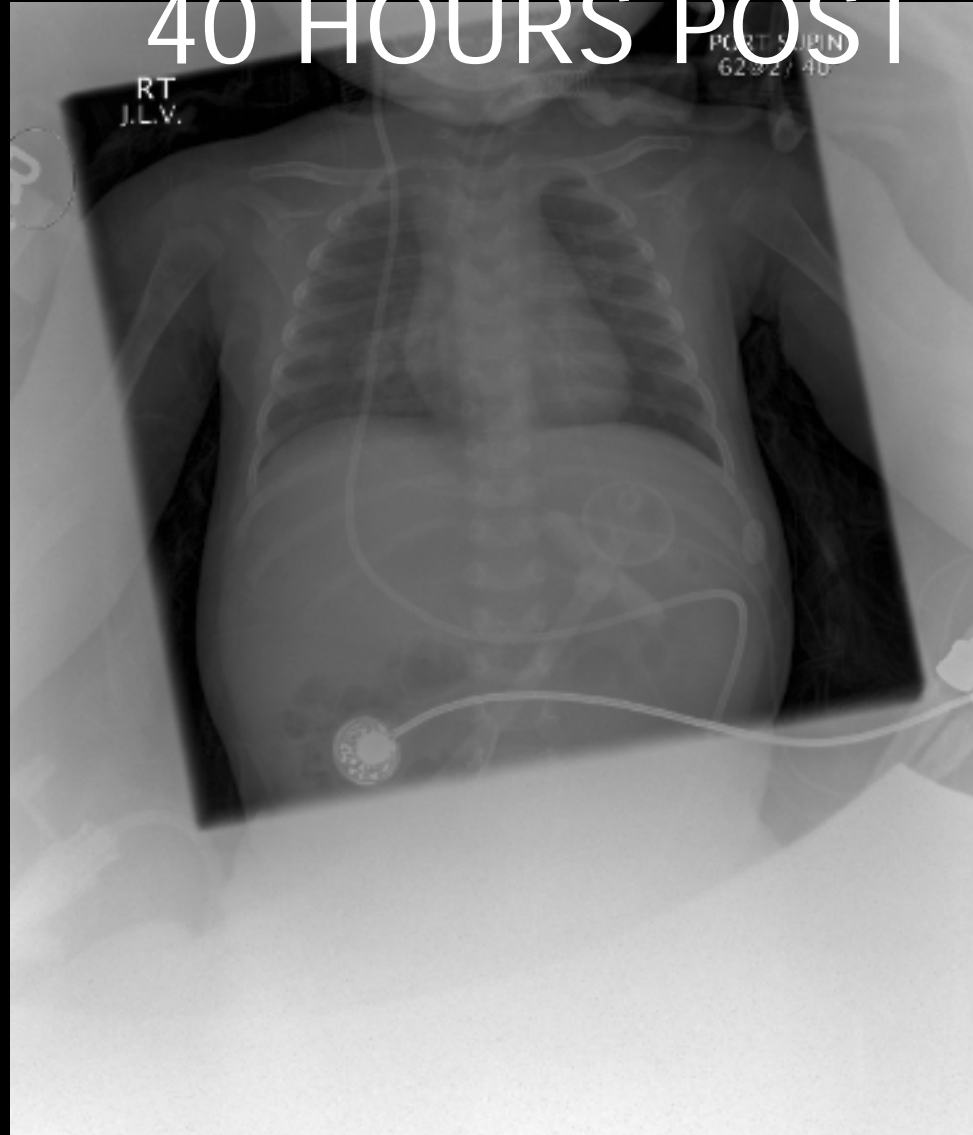
- CPT and Albuterol?
- Increase peep?
- Switch ventilator to 3100 HFOV
- Bronch this patient
- How about some of that IPV!

# 16 HOURS POST IPV PEEP+8





40 HOURS POST IPV PEEP+8



HOW DOES THIS RELATE TO HOME CARE?

# HOME VERSION OF IPV



# HOME CARE PATIENTS



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# COPD PATIENTS



# NEW HOMECARE COPD STUDIES WITH IPV

- In the next year there will be a 100 patient homecare COPD readmission study with IPV.
- In the next two years two other facilities in Southern California are also looking to do studies on this topic.

# CONCLUSIONS

- Flow ventilation can be used in the ICU for neonates to adults, but it also can be used in treatment form for home care patients from the small long term care pediatric patient to the adult COPD patient and have a great impact in their lives.

• You are!



**WHO'S AWESOME?**

You're awesome!





THANK YOU  
FOR YOUR TIME!