VIDANT HEALTH™

Mechanical Ventilation Weaning of the Difficult to Wean Morbidly Obese Patients: A Weighty Problem!

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Disclosure

I have none to report. No financial or other support was given. The study referenced in this presentation was approved by the Brody Medical School IRB at East Carolina University, and Vidant Medical Center.

Objectives

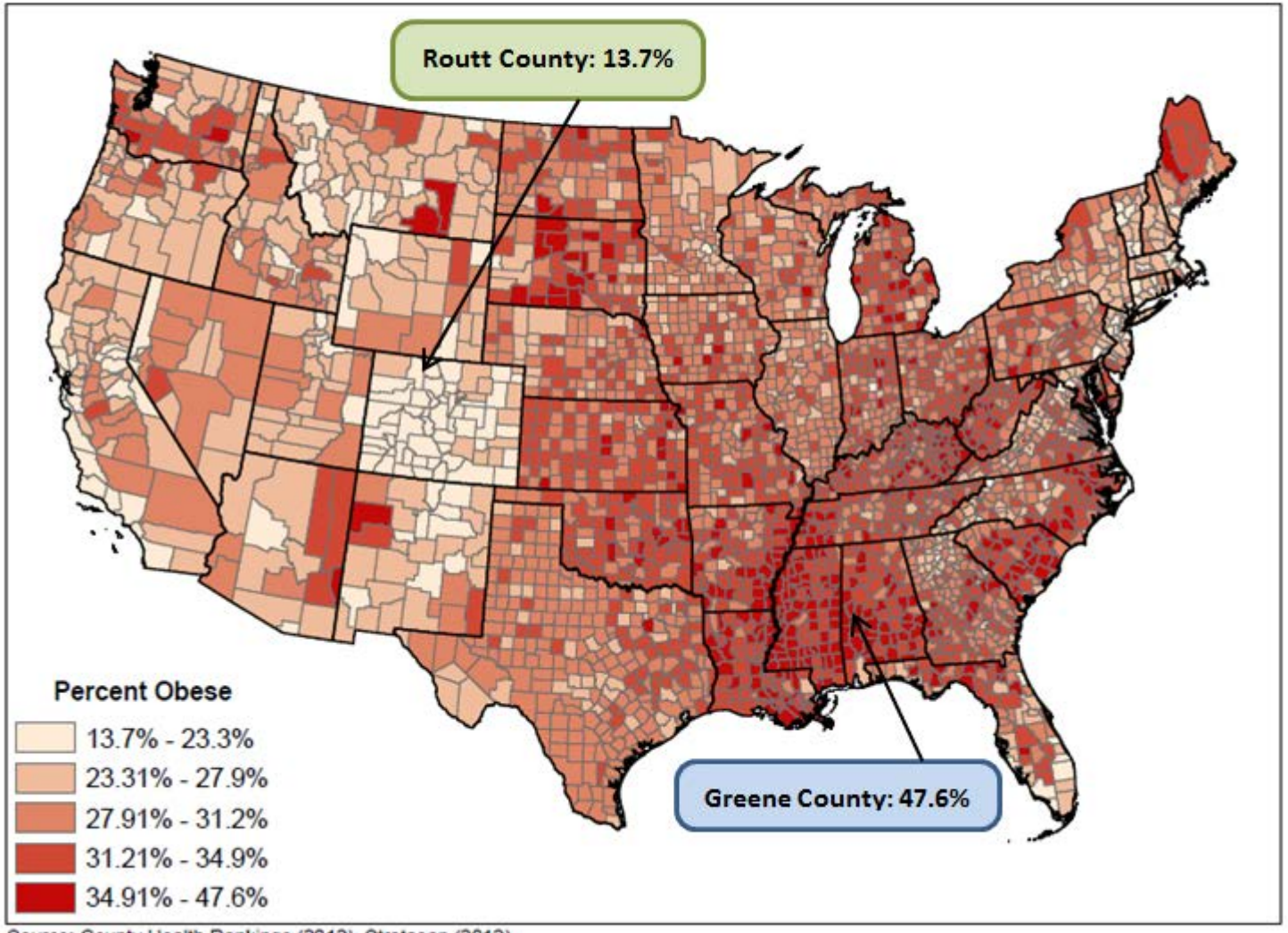
1. Define the prevalence of obesity and it's impact on liberating these patients from mechanical ventilation.
2. Review published information on obesity and its impact on physiologic function.
3. Review the use of a unique method to assist in liberation these patients from mechanical ventilation.

Size of the Problem

AMA now defines Obesity as a disease!

June 2013 “Defined 78 mil adults and 12 mil children as having a disease requiring treatment”

Obese Population by County 2012

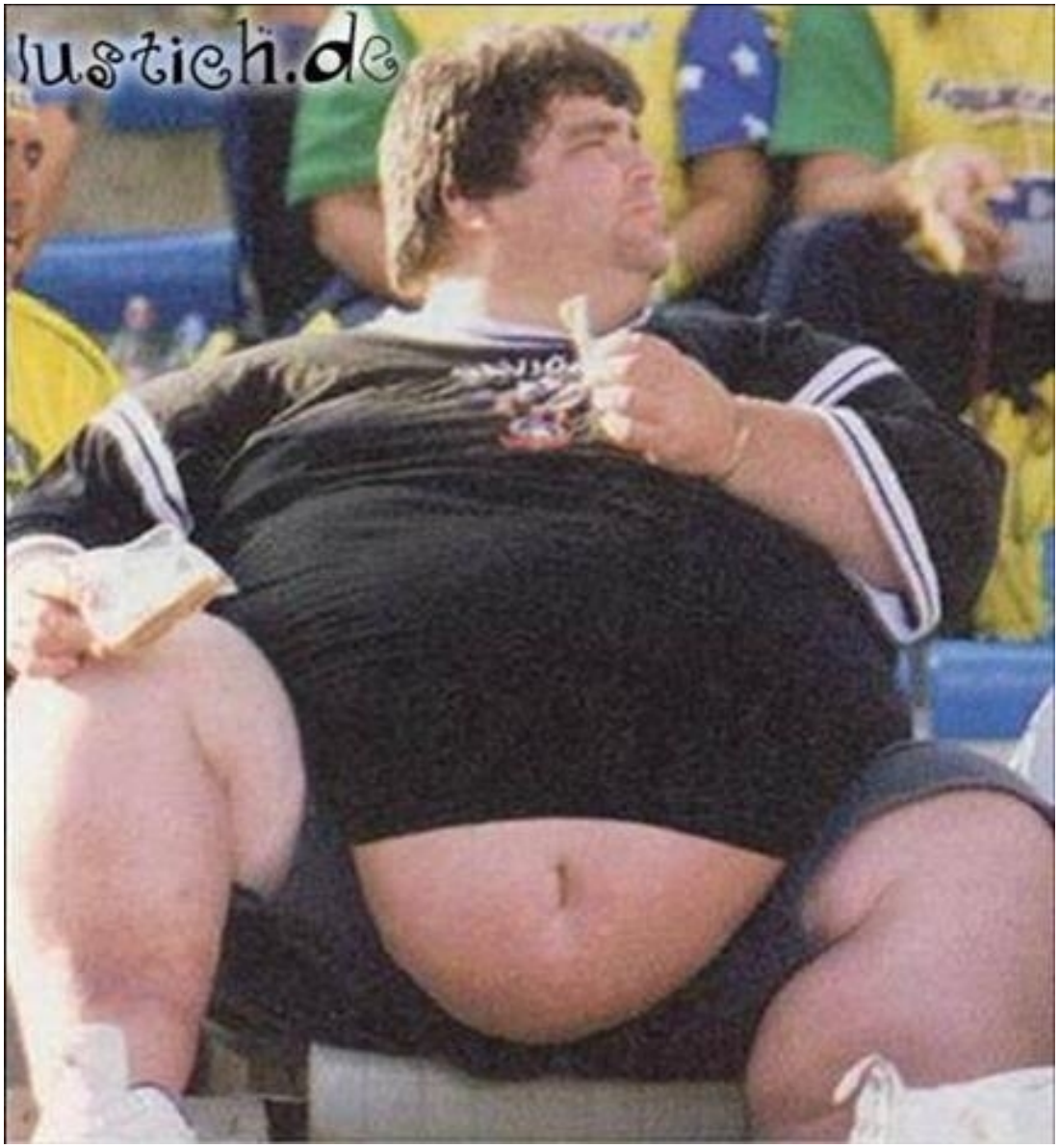


Source: County Health Rankings (2012), Stratasan (2012)

Some Definitions

- BMI : Body Mass Index Formula Weight (KG)/ Height squared (M2).
- BMI above 30 Obese
- BMI above 40 Morbidly Obese
- BMI above 50 Super Obese

- You will see BMI's at 100 I call them UBER OBESE.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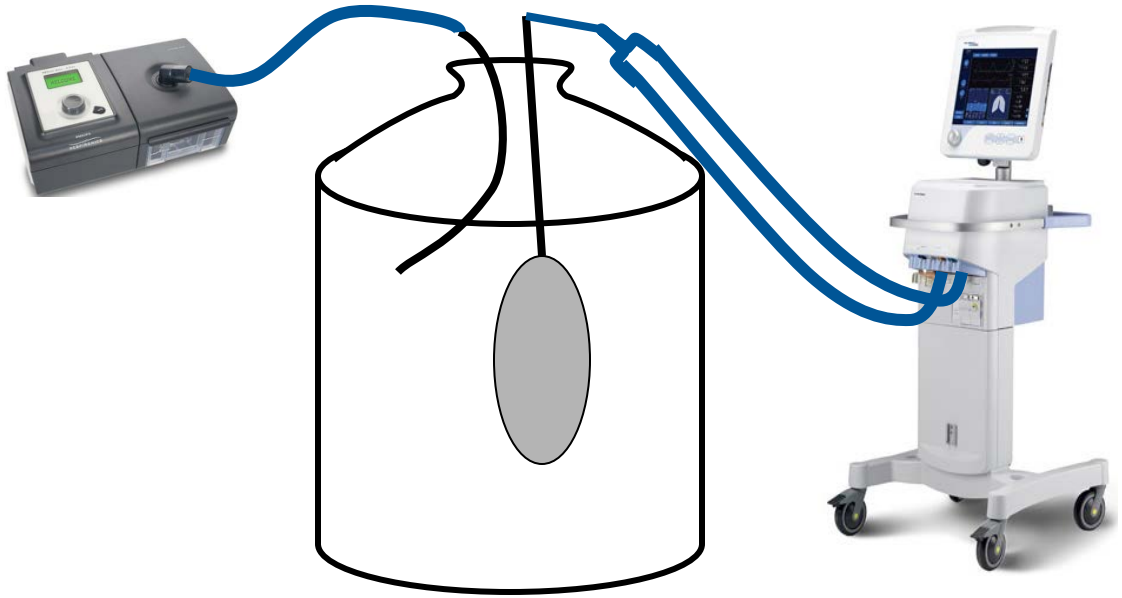
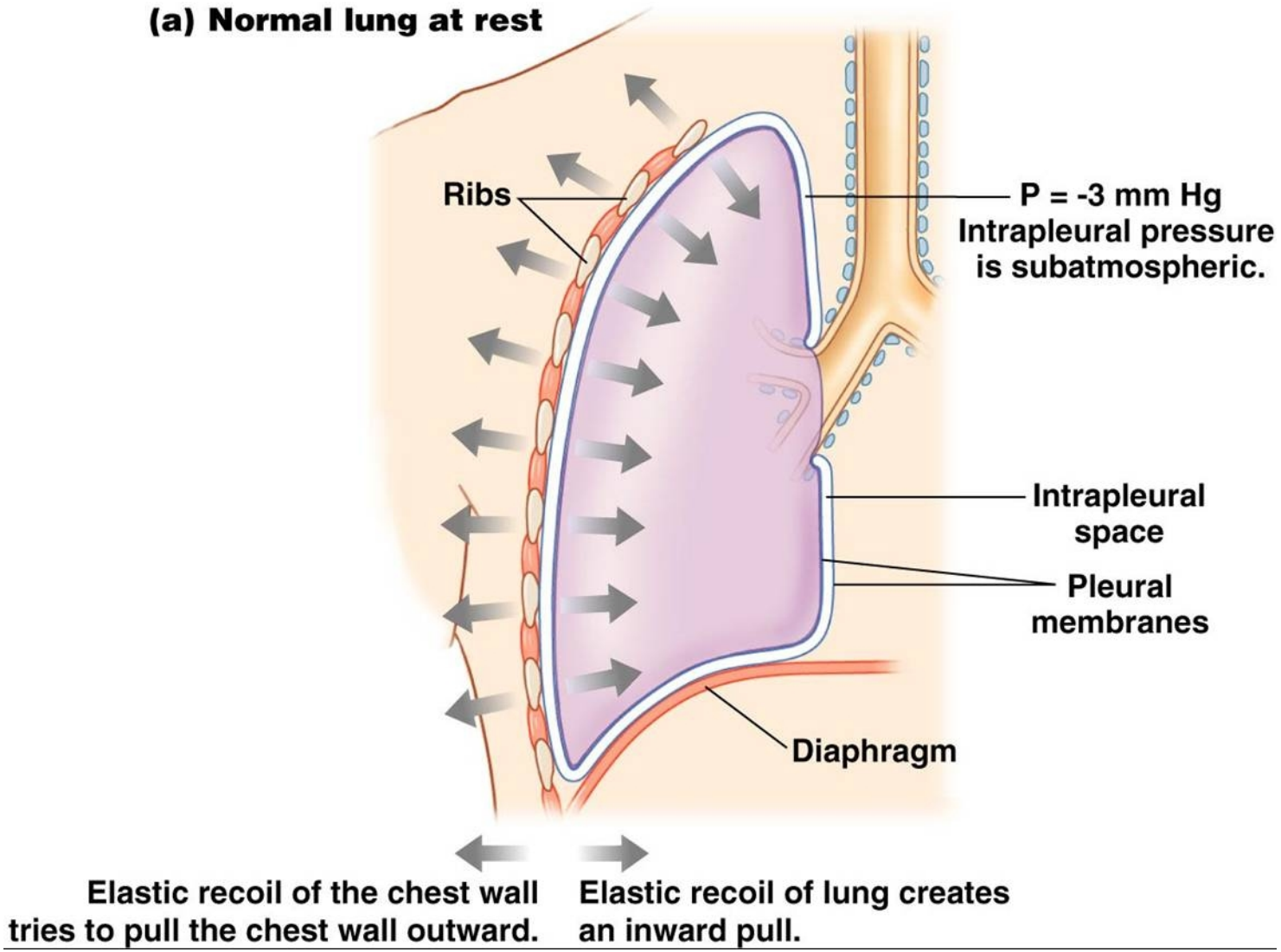
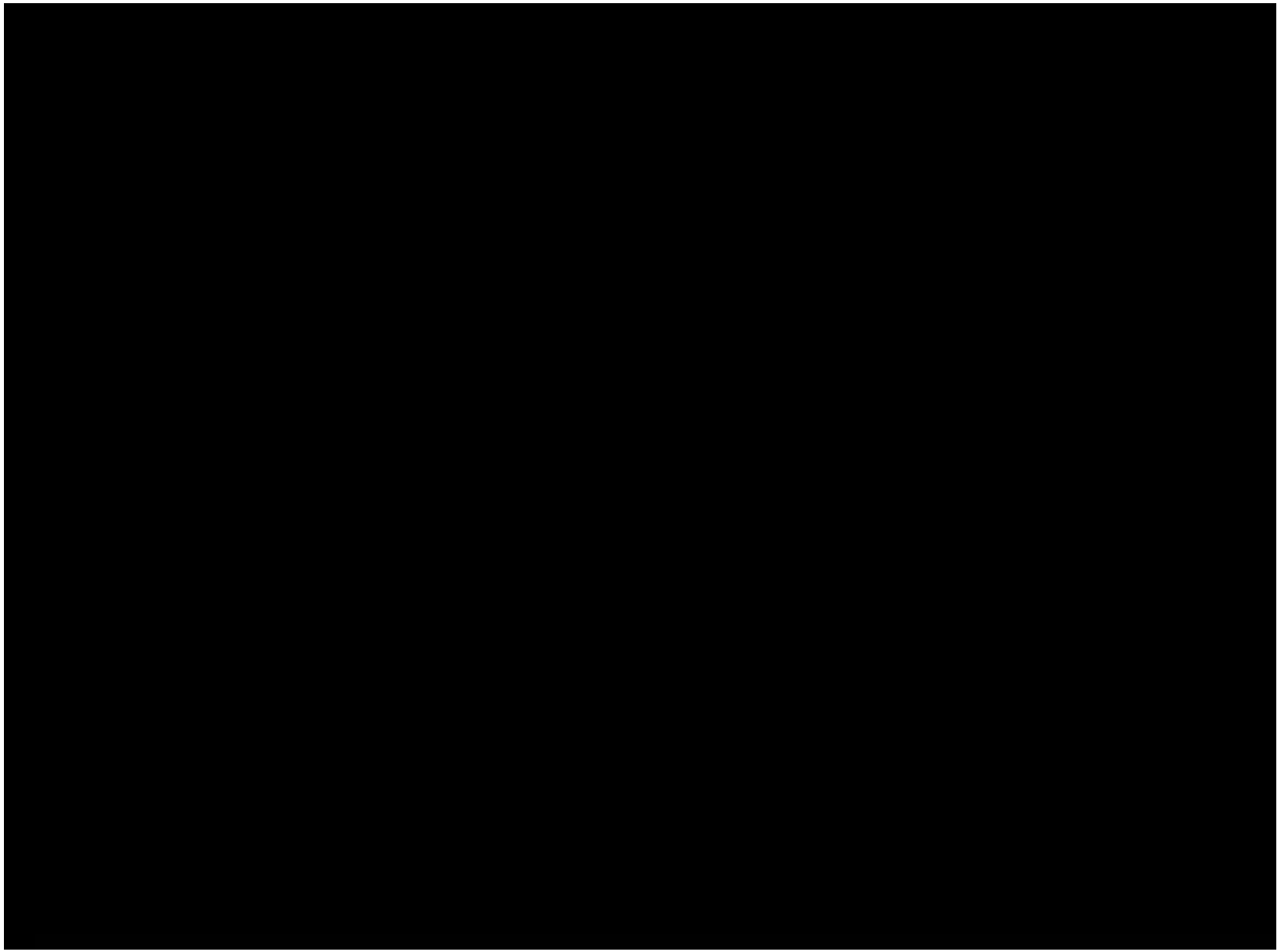
Trans Pulmonary Pressure

- Trans pulmonary Pressure: Alveolar pressure subtracted by the intra-plural pressure. Have to use substitute measures for both.
- Use of Airway pressure at specific points of the Total Cycle Time with corresponding measures of Esophageal pressures with a balloon catheter. Target points with no airflow.
- Formula: Pair- Pes= TPP
- Example: Spontaneous breathing patient Pair = 0 , Pes noted to be range of 2-5. result in TPP of - 2 to - 5. Noted effect of lung and chest wall elastic recoil.




(a) Normal lung at rest
Ribs
P = -3 mm Hg
Intrapleural pressure
is subatmospheric.
Intrapleural
space
Pleural
membranes
Diaphragm
Elastic recoil of the chest wall
tries to pull the chest wall outward.
Elastic recoil of lung creates
an inward pull.

Trans pulmonary Pressure Demo



More Terms Defined

- Lung Compliance: Change in volume over change in pressure.
- Naimark and Cherniack found the compliance in lean sitting subjects to be 100 to 119 ml/cmh20.
- We normally accept 40 to 50 ml / cmh20 on patients in the bed in ICUs as normal.
- Least Squares Fitting : 1st described by Carl F Gauss 1794. Uses the maximum likely hood criterion. Reduces variation used to fit a generalized linear model. This is used by several Ventilator companies to calculate “Cstat” measurements.

Back ground on LSF

- Intensive Care Medicine 1995 #21 pp 406-413

  " Respiratory Mechanics by Least Squares Fitting"

  Iotti et. al.

  Found that least squares fitting was able to measure respiratory mechanics. However when the pressure/ flow was lower LSF may over estimate the compliance as compared to esophageal pressure.

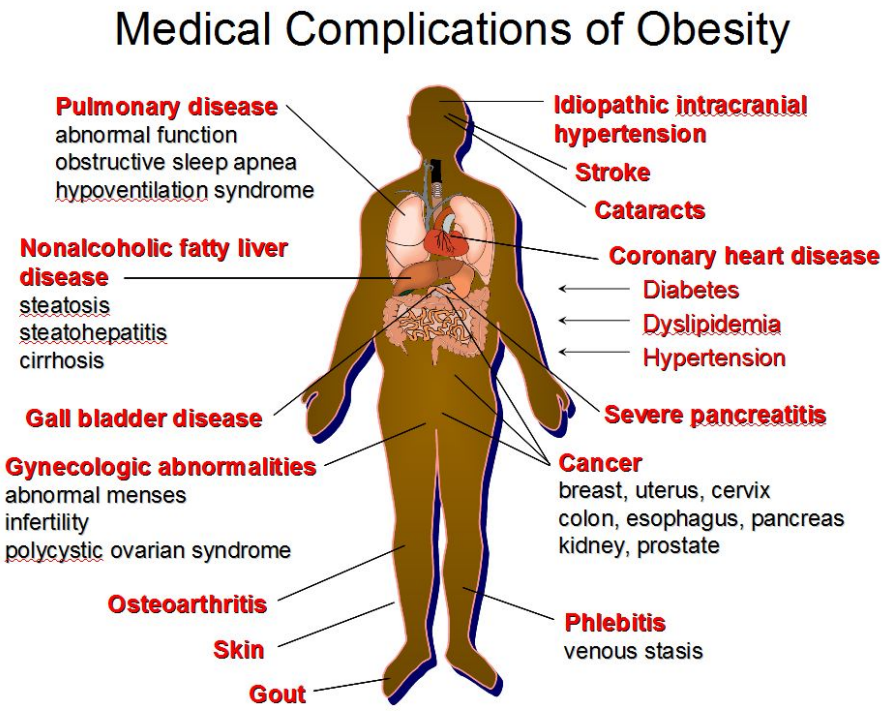
Journal Review

- Critical Care Med. June 2006 vol. 34 # 6 pp 1796-1804

  "Critical Care of the Bariatric Patient"

  Pieracci, Barie et al.

  Conclusion: "Obesity causes a large range of pathologic effects on all major organ systems"



Respiratory Care Dec. 2008 vol. 53 #12

"The obesity hypoventilation syndrome"

Mark Anthony Powers MD

Key points:

1. Patients with mild Obesity BMI 30-35 have a lower FRC, TLC, and RV than lean subjects.
2. Marked decline in ERV results in tidal breathing near RV is where the airway caliber is narrowest. This results in higher RAW.

He references Zerah et al who reported RAW was 56% higher in patients with BMI's over 46 KG/M2 than with BMIs of 27 KG/M2

- British Journal of Anesthesia 2012 109-(4) pp 493-502
  "Ventilation Strategies in Obese Patients undergoing Surgery a Quantitate Systematic Review and Meta Analysis"
  Aldenkort et. al.
  Reviewed 505 patients : Found recruitment maneuvers and peep improved intra-op oxygenation and compliance without adverse effects. They noted an immediate loss of compliance with general anesthesia in obese patients. They used 10 cmh20 of peep and recruitment maneuvers with 40 cmh20 of 40 Sec. Noted it had to be repeated to maintain.

- Critical Care Medicine 2006 May 34 (5) pp 1389-1394
  Talmor et al
  Respiratory Care Feb. 2010 Vol. 55 # 2
  "Are Esophageal Pressure Measurement Important in clinical decision making in mechanically ventilated patients?"
  Talmor/ Fesslor et. al.
  In both articles they raise the question of ESO pressure variations due to heart size, and catheter placement with closed lung verse open lung proximity. He does state in the RC journal article that in ARDS and ALI patients monitored with TPP had higher peep and oxygenation than those following the ARDS peep / FIO2 table.

Obesity Effects on Lung Mechanics

- Decreased FRC
- Decreased ERV
- Decreased FVC
- Decreased MVV
- Decreased compliance

- Increased RAW
- Increased WOB
- Increased VO2
- Increased CO2 production

- American Journal of Respiratory and Critical Care Medicine Feb. 2011 Vol. 183 # 3 pp 292-298

  " Obesity Hypoventilation Syndrome"

  Piper and Grunstien

  Defined Super obese as over BMI over 50 kg/M2, Est. that 10-20% of patients with a BMI over 50 has OHS. (noted some sources stating over 50%)

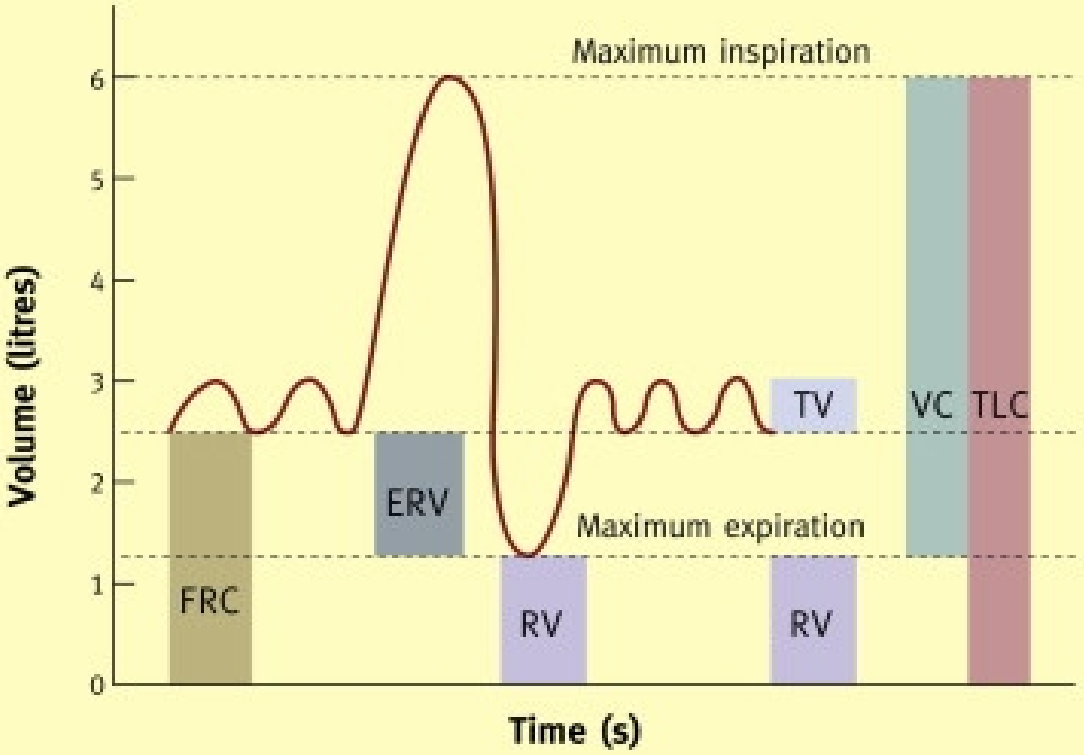
  Noted small caliber airways results in air trapping exp flow limitation and development of intrinsic peep. It was seen more in supine position and noted increased WOB. Described increased threshold on Inspiratory muscles. " It is not known if the development of intrinsic peep is greater in patients with OHS"


BUSTED

The Question?

- Do the obese patients that are difficult to wean off of mechanical ventilation have increased work of breathing due to lung closure? If so how did they breath off of the ventilator before they came into the hospital?

Normal lung volumes in a 70-kg individual



FRC, functional residual capacity (2.5 litres)
RV, residual volume (1.25–2.0 litres)
TV, tidal volume (0.5–0.6 litres)
ERV, expiratory reserve volume (1.25 litres)
VC, vital capacity (3.5–5.5 litres)
TLC, total lung capacity (6 litres)

What were we doing?

- In Eastern NC we are in ground zero for obesity. We noted that several (not all) obese patients were failing liberation from the ventilator and requiring tracheotomy tubes.
- We were having a hard time placing them in non acute care settings due to the BMI limitations.
- We started adjusting peep levels higher than most of the medical team was comfortable, however we started seeing some success.

- We found patients tolerated the higher peep but when we tried to do SBTs a good number were failing.
- So working with Dr. Robert Shaw as the primary investigator we developed an IRB approved study. I will present some preliminary results.
- Three years (with 29 patients) We have noticed a drop in referrals to the study. This appears due to the clinical teams changing practice to follow our protocol over time.

Obesity Peep study

- Criteria to enroll:
- BMI 40 or higher
- Previous failed attempts at liberation after trach
- On pressure support mode
- FIO2 .60 or less
- Hemodynamic status stable
- No acute non treated process

Method Summary

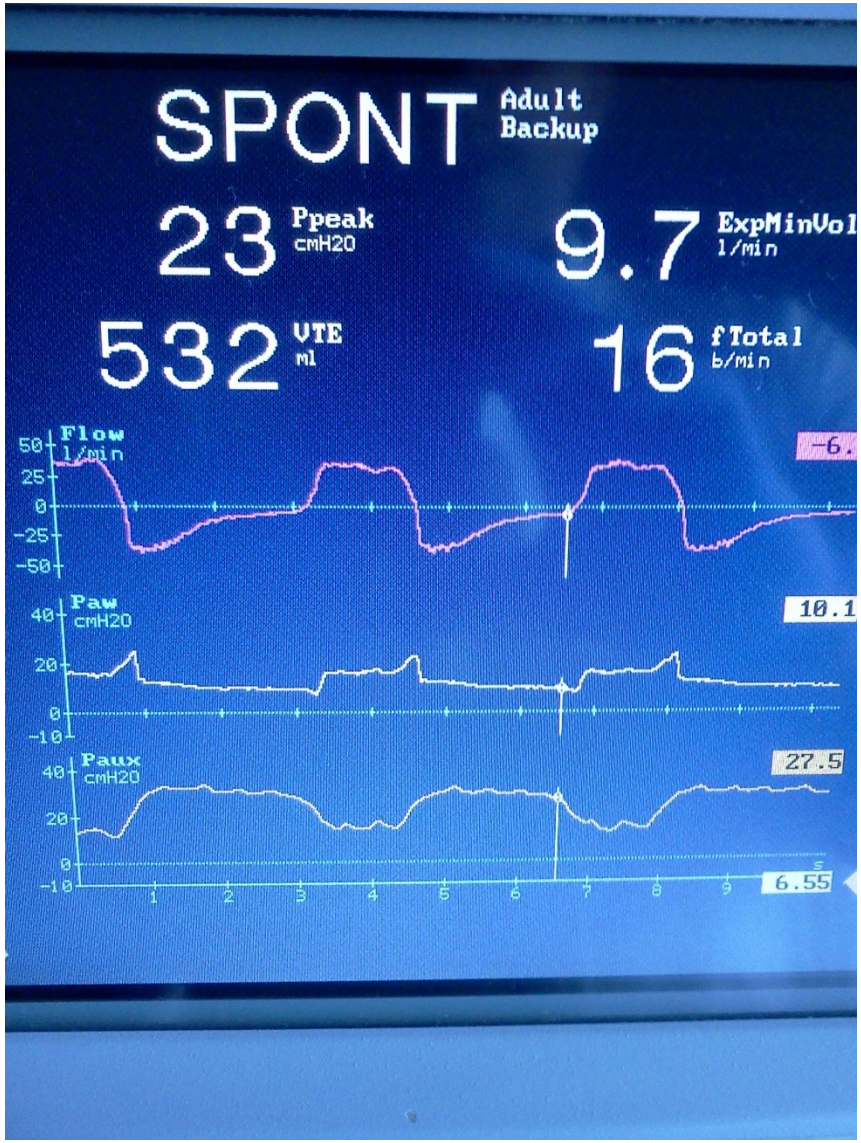
- Informed consent
- Random drawing for one of two study arms Cstat or ESO.
- Followed protocol for each arm Cstat increased peep in steps of 3 cmh20
- Measured exhaled VT average of 5 consecutive breaths and Cstat measured in 5 consecutive breaths.
- Adjusted peep until we measured less than a 5 % improvement in exhaled VT and/ or Cstat at the peep level.

Method Summary

- ESO we inserted an esophageal balloon and confirmed placement with cardiac inflections on the ESO wave form.
- We synched the waveforms of the airway pressure, flow wave and ESO.
- We used a curser to find the end expiratory flow using the flow and ESO waveforms as the driver. (The point just before flow starts rising.)
- We adjusted peep to have a confirmed TPP of 0 to +10. We targeted as close to 0 as possible.

Sample ESO Patient

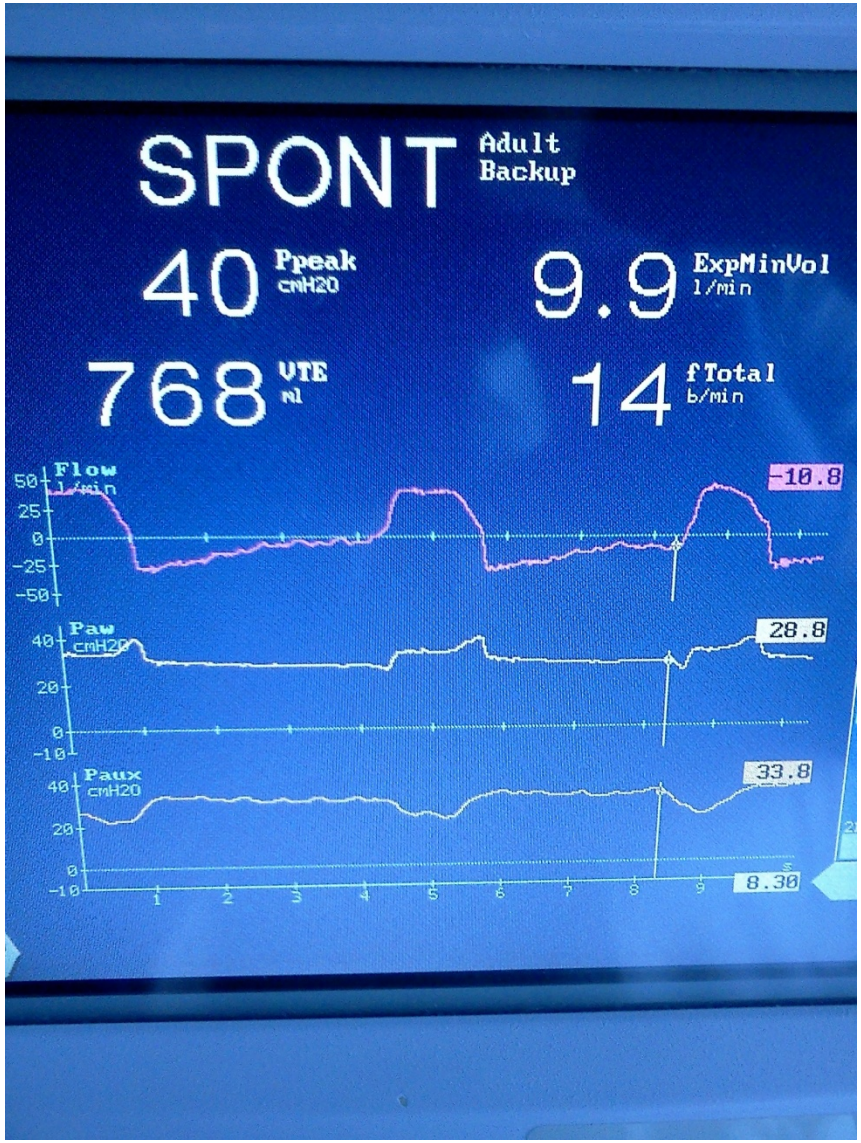
TPP -18



Note flow baseline

PSV
10/10
40% FIO2

TPP -5

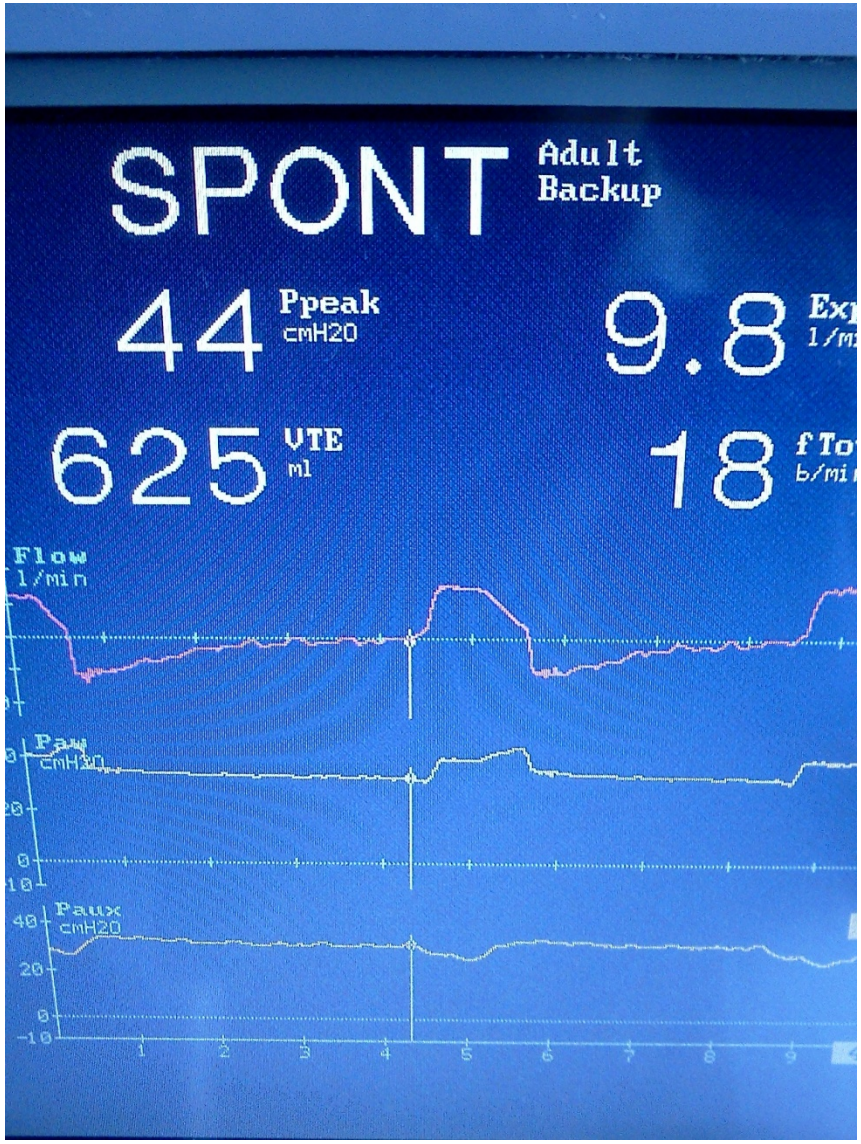


Note flow baseline

PSV
10/28
30% FIO2

TPP 0

Note Flow Baseline

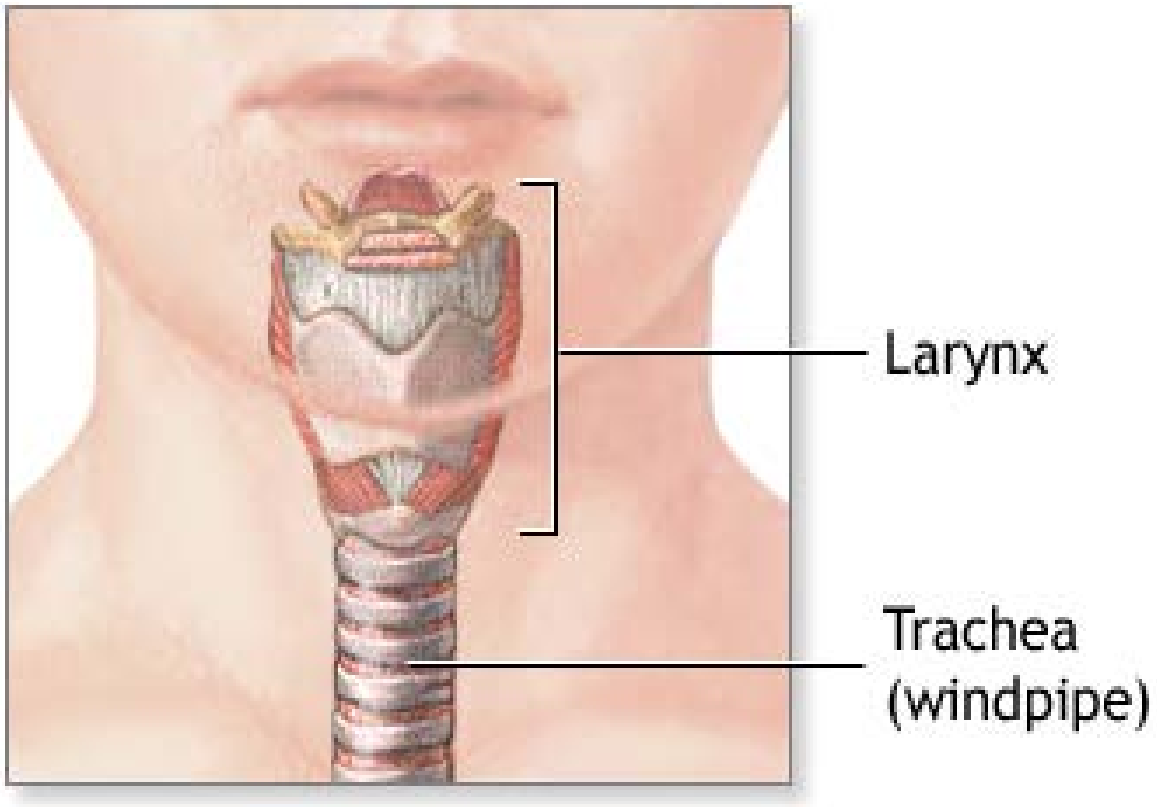


PSV
8/33
21% FIO2


SPONT
Adult
Backup
39
Ppeak
cmH2O
9.2
ExpMinVol
l/min
512
VTE
ml
19
fTotal
b/min
Flow
l/min
Paw
cmH2O
Paux
cmH2O
4
cmH2O
Psuppo
33
cmH2O
PEEP/CPA
21
%
Oxygen
Alarms

SBT issue

- We had patients lungs open but they were failing SBT. We questioned if the patients were having lung closure and its impact to ERV due to the open glottis with the artificial airway in place?
- The Passy Muir ® (PMV) valve was used due to the positive expiratory seal and its design.
- We found this to be extremely successful in both arms of the study.


Larynx
Trachea
(windpipe)

- We were able to measure ESO and airway pressure under the valve on 5 of these patients. We found that they averaged an airway pressure at the end of expiration of 25 cmh20 and a ESO pressure of 27 cmh20. The TPP average was -2 cmh20.
- This may suggest that the patient can auto regulate the intrinsic peep to maintain an ERV well enough to breath without the ventilator. We suggest the PMV allows the patient to use the glottis to close off before the lungs collapse, without the PMV the glottis area is bypassed.

Results

- Number of days to liberate. (off 24 hours cont.)
  Cstat arm 11.3 days
  ESO arm 5.4 days
- BMI
  Cstat arm 68.9 (45-93.8)
  ESO arm 68.45 (45- 113.8)
- Average peep before enrollment
  Cstat arm 13.64 (6-18)
  ESO arm 13.13 (8-20)
- Average peep after study adjustment
  Cstat arm 27.78 (13-37)
  ESO arm 27.07 (18-33)

Compare to before study

- We reviewed 54 patients in the two years leading up to the study that met the same inclusion criteria.

	Previous	Study group
Age	53 (+/- 13)	54 (+/- 12)
Sex	39% m/ 61% F	44% m/ 52% F
BMI	55 (+/- 15)	68 (+/- 18)
IBW	61 (+/- 10)	62 (+/- 13)
Peep	10 (+/- 4) (aver best)	27 (+/- 6)
VT aver.	466 (+/- 137)	473 (+/- 119)
# day lib.	13 (+/- 6)	9 (+/- 6)
Patients still liberated at 30 days:		
	68.56 %	76%

Conclusion

- This preliminary review of our study shows some promise and opens the doors for more intense investigation. There were no adverse effects of any sort noted with the higher peep levels. We improved the liberation length of time, and success was also noted at 30 days.
- The use of the PMV in these patients with high peep shows promise and we have had no adverse effects of using this for 24 hours a day, and we are sending the patients home with these devises as well. We plan to finalize the review and further study aspects of these findings as well.

Questions?