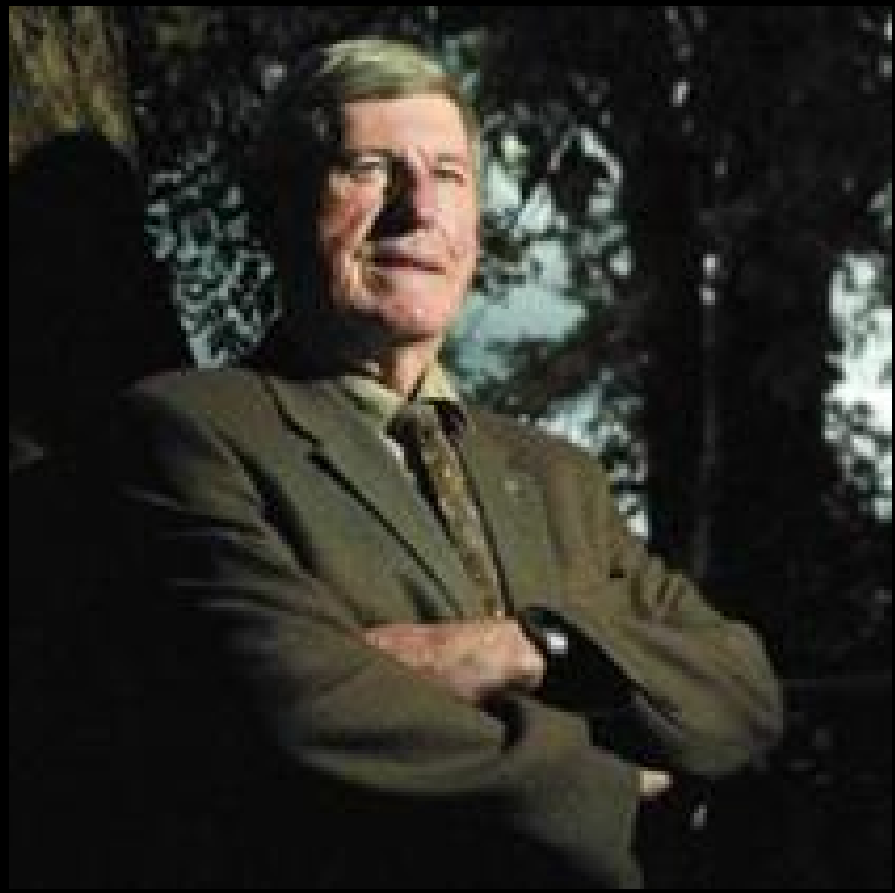
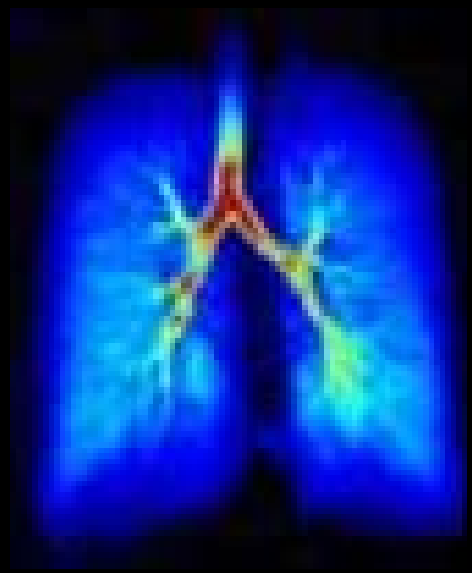


J. Earl Wynands

Lung Injury and Protection in the Perioperative Period

Non-injured Lungs:

- Perioperative Experience (Surgeon)



Injured Lungs:

- Anesthesiologist

78 y.o. Male, Chronic Gallstone Pancreatitis, Cholecystectomy

- 100 pack/year smoker
- Dyspnea > 1 flt. stairs
- WHY dyspneic?
- Rule-out Cardiac etiol: ECG, TTEcho, Myocardial perfusion stress assess
- Rule-in Respiratory etiology

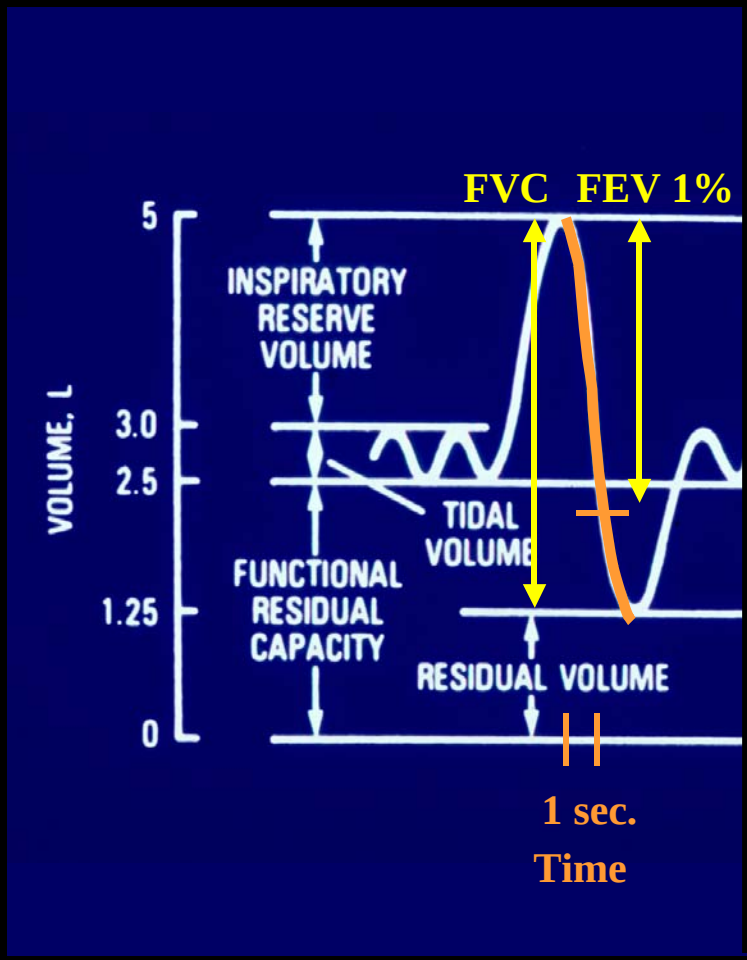
Preoperative Assessment

- History: cough , sputum, exercise Tol. ***(Infection)***
- Auscultation ***(Bronchospasm)***
- Lab tests:
  - CXR
  - Spirometry
  - ABG

Preoperative Assessment

- History: cough , sputum, exercise Tol. ***(Infection)***
- Auscultation ***(Bronchospasm)***
- Lab tests:
  - CXR
  - Spirometry
  - ABG

Spirometry:



- Forced Expiratory volume (FEV1%)
  - mild 80=50%
  - mod. 50-35%
  - severe < 35%
- FEV1/FVC ratio
  - < 0.7= obstruction
- Post-bronchodilator FEV1% increase
  - >10% =a/w reactivity

Bronchospasm after Tracheal Intubation

Silvanus M-T, et al. Anesthesiology 2004, 100: 1052-7

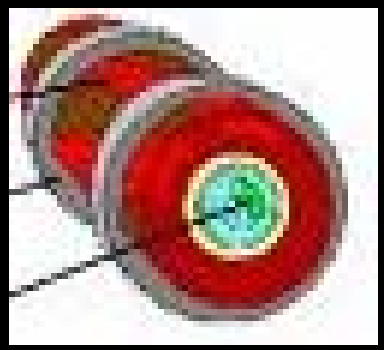
FEV1< 70 %, increase >10% post-bronchodil.

Preop. Therapy:	Post-Intub. B'spasm:
Albuterol 2 puffs x 1	8/10
Albuterol t.i.d. x 5 days	7/9
Albuterol + Methylpred. p.o. x 5 days	1/15 ($p<.01$)

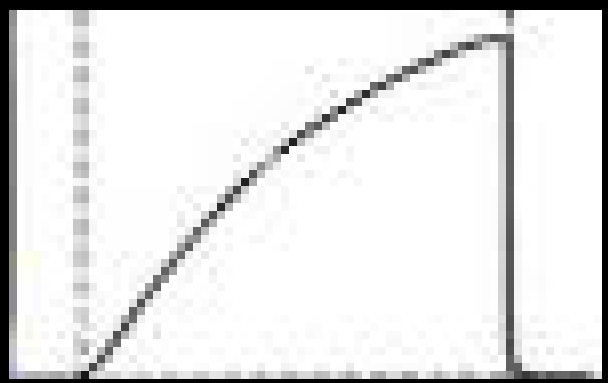
(Pentothal/ Fentanyl/ Vecuronium)

Preventing Intraoperative Bronchospasm

Broncho-constriction



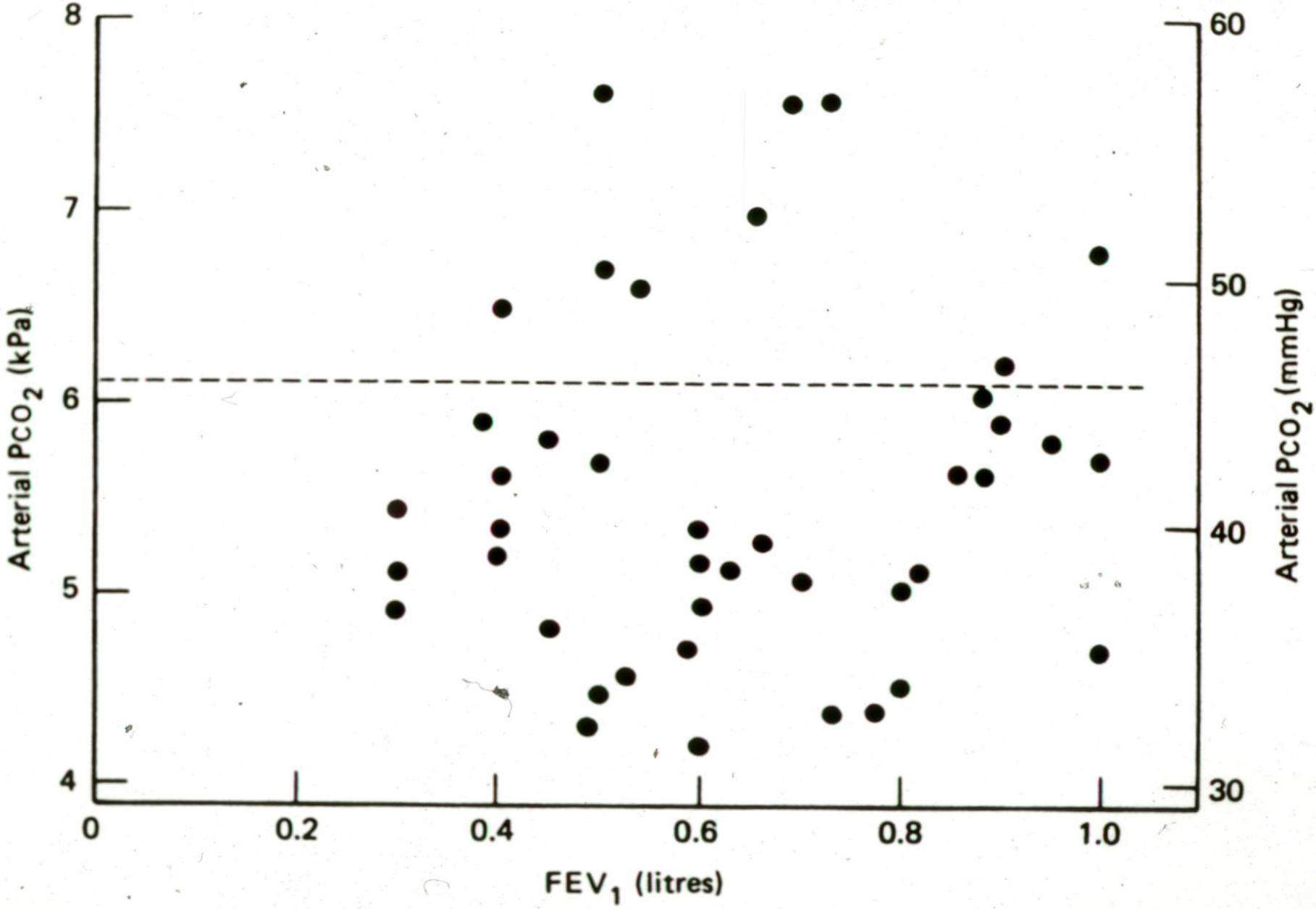
PetCO2



- Decrease preop. a/w hyper-reactivity
- Avoid instrumenting the airway
- Instrument the airway during deep anesthesia
- Use broncho-dilating anesthetics

Preoperative Assessment

- History: cough , sputum, exercise Tol. ***(Infection)***
- Auscultation ***(Bronchospasm)***
- Lab tests:
  - CXR
  - Spirometry
  - Arterial Blood Gas


8
7
6
5
4
60
50
40
30
0
0.2
0.4
0.6
0.8
1.0
Arterial PCO_2 (kPa)
Arterial PCO_2 (mmHg)
FEV_1 (litres)

Helping Surgical Patients Quit Smoking

Warner DO, Anesth Analg 2005; 101: 481-7

Surgical Benefits:

- Decrease ST changes intraop.: 2 days
- Decrease wound complic's: ≥4wk.
- Decrease Resp. Complications :
  - Cardiac: ≥8 wk.
  - Thoracic: 4 weeks

Abstinence @ 1yr:

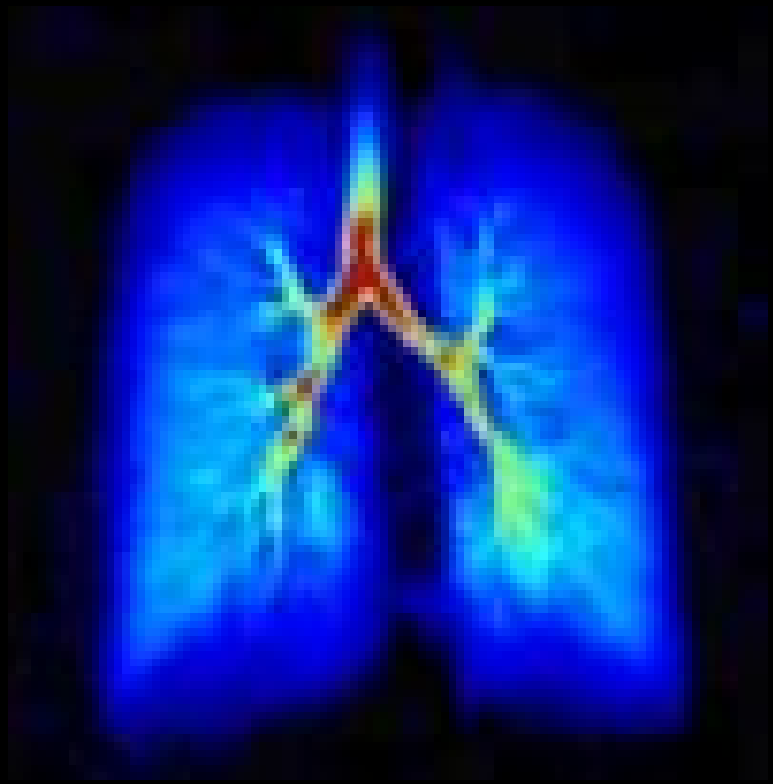
- After ACB: 55%
- Angioplasty : 25%
- Angiography: 14%

Preoperative Physiotherapy

- Proven decrease in pulmonary complications in COPD
- Particularly in patients with excessive secretions
- No proven superior modality

Warner DO, Anesthesiology 2000, 92: 1467

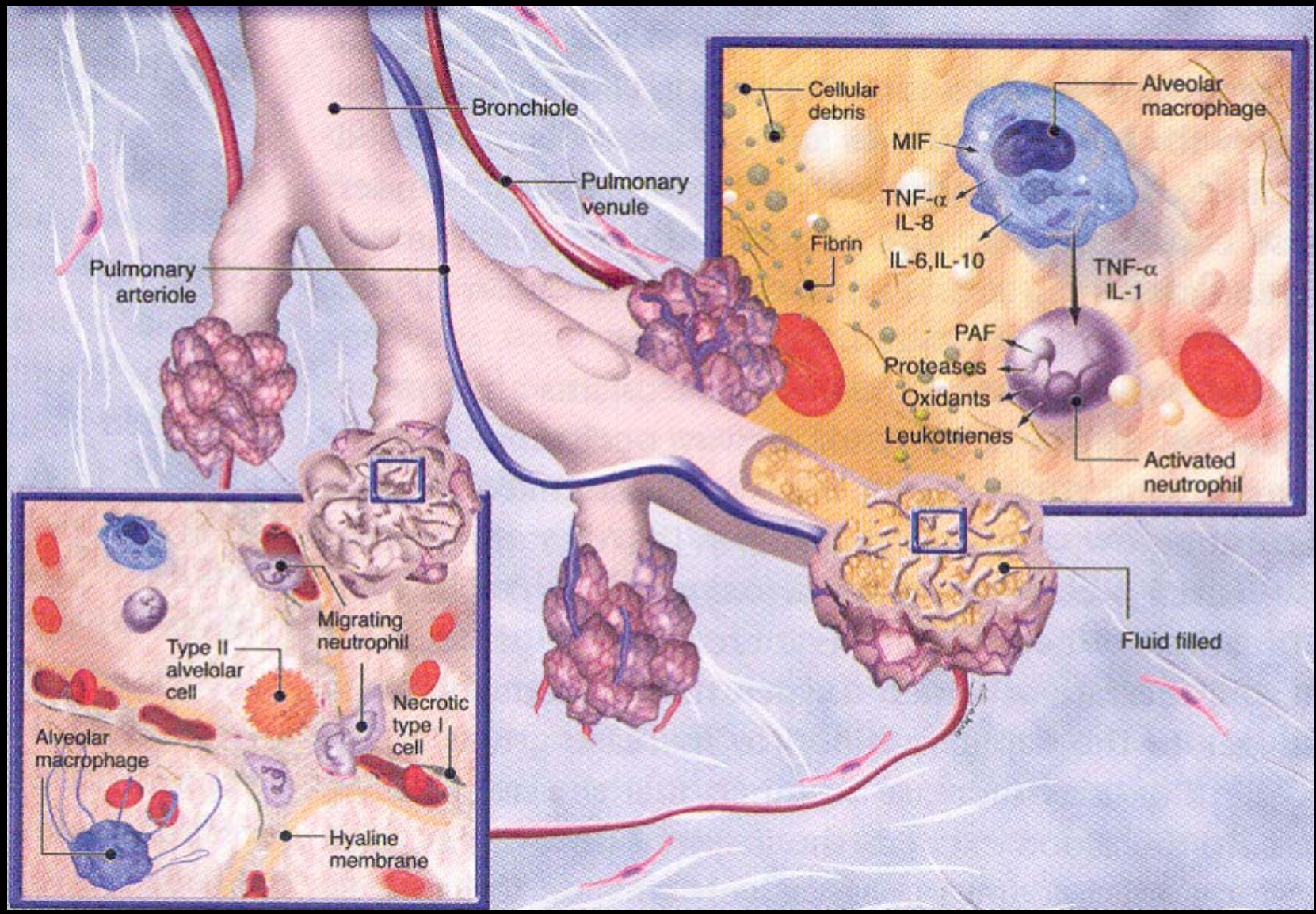
Protecting Non-Injured Lungs:



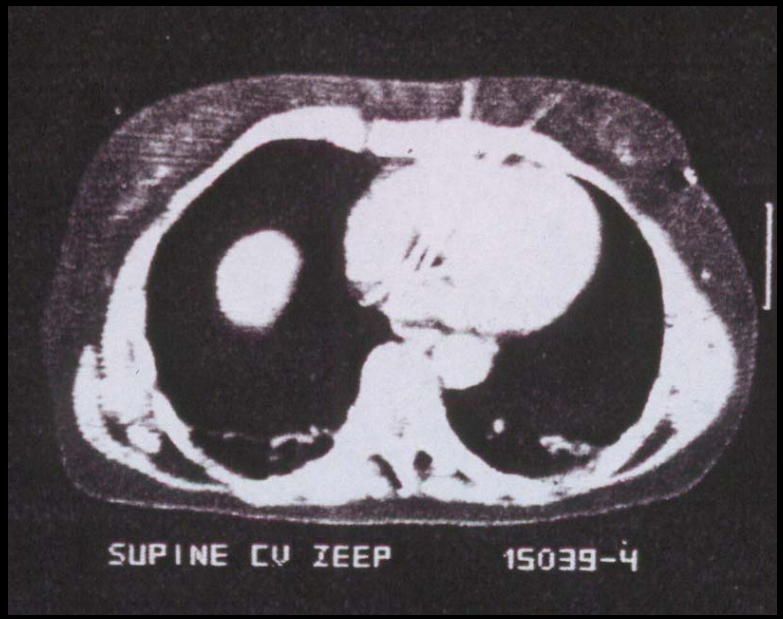
- The Perioperative Experience (Surgeon)
  - Atelectasis

Pulmonary Atelectasis

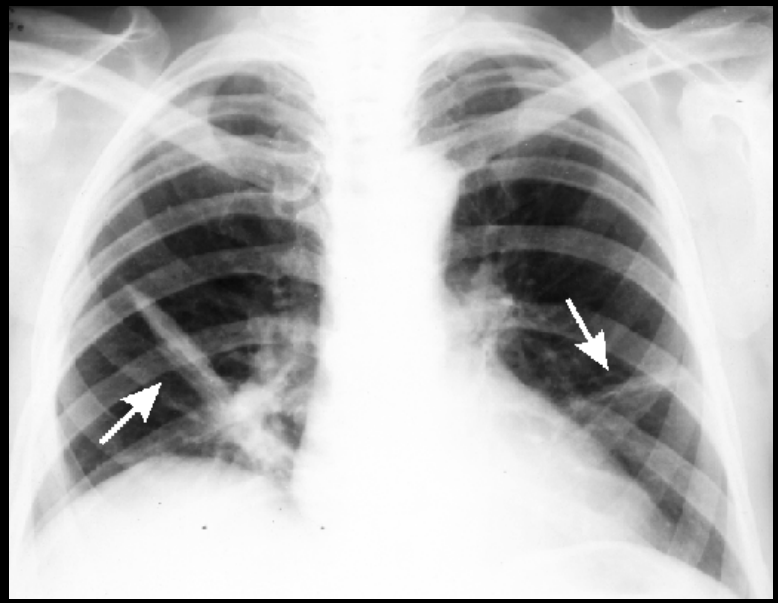
Duggan M, Kavanagh B. Anesthesiology 2005, 102: 838-54



Atelectasis



Intra-op.



Recovery Room

CPAP Treatment of Post-op. Hypoxemia

Squadrone V, et al. JAMA 2005, 293: 589-95

Patients:

- n= 209
- Major Abd. Surg.
- PaO2/FiO2<300 post-op. in Rec.Room
- FiO2 0.5 by mask or CPAP until PaO2/FiO2 stable >300 (19-28h)

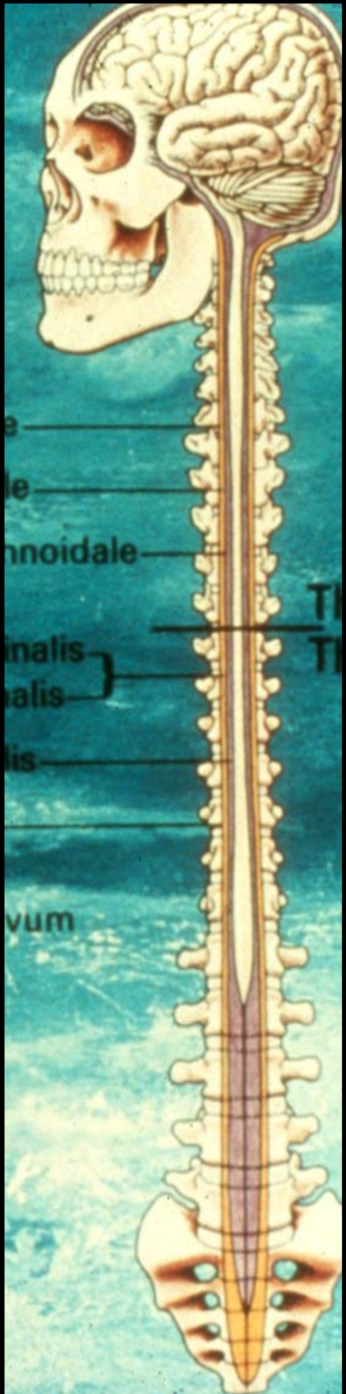
Results:

- CPAP decreased sepsis (p= .03)
- Decreased pneumonia (p= .02)
- Decreased re-intubation (p< .01)

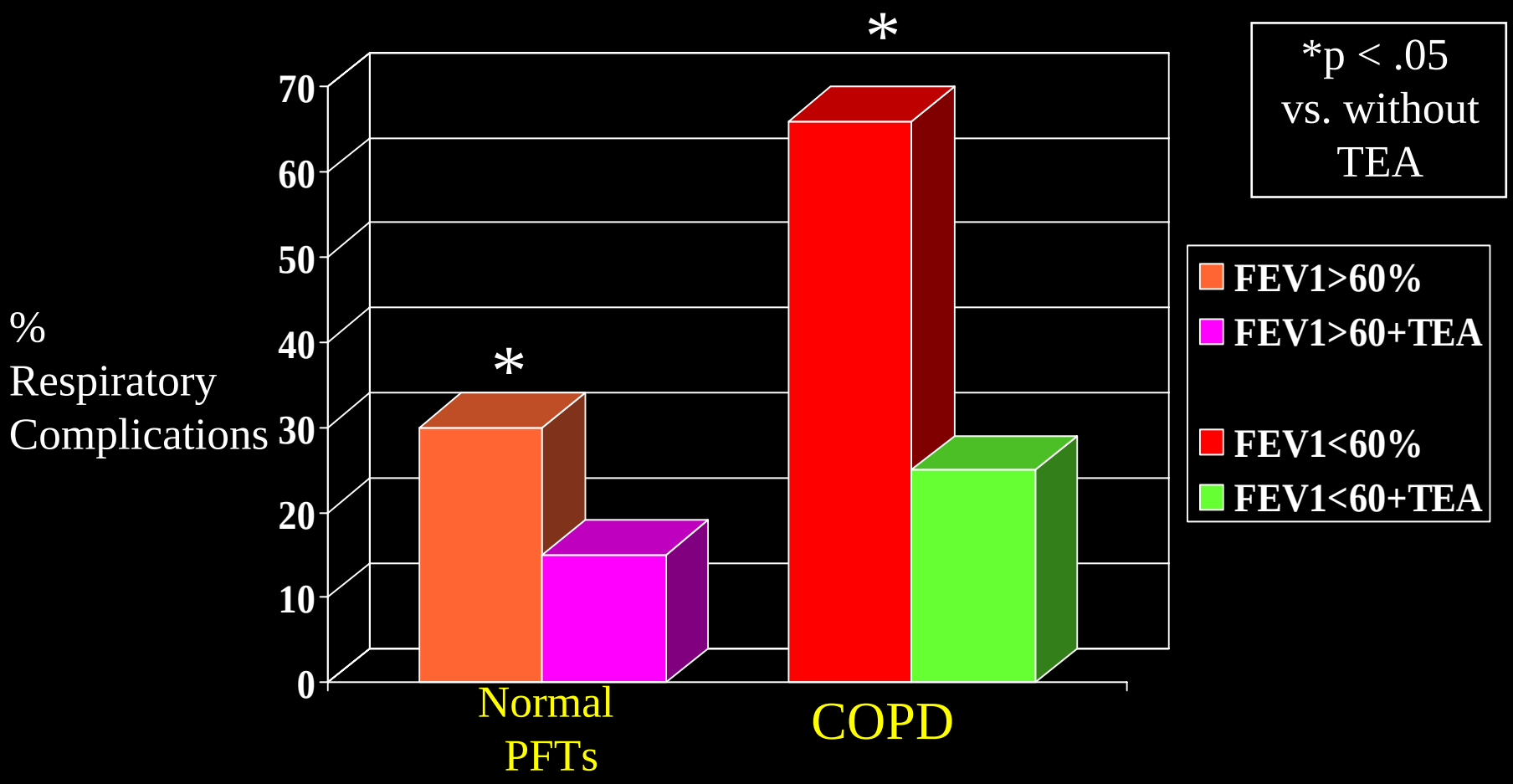
CPAP devices

Squadrone V, JAMA 2005

Maitre B , AJRCCM 2000



Reduction of Respiratory Complications in Lung Resection by Thoracic Epidural



Licker M, et al. Ann Thorac Surg 2006; 81: 1830-8

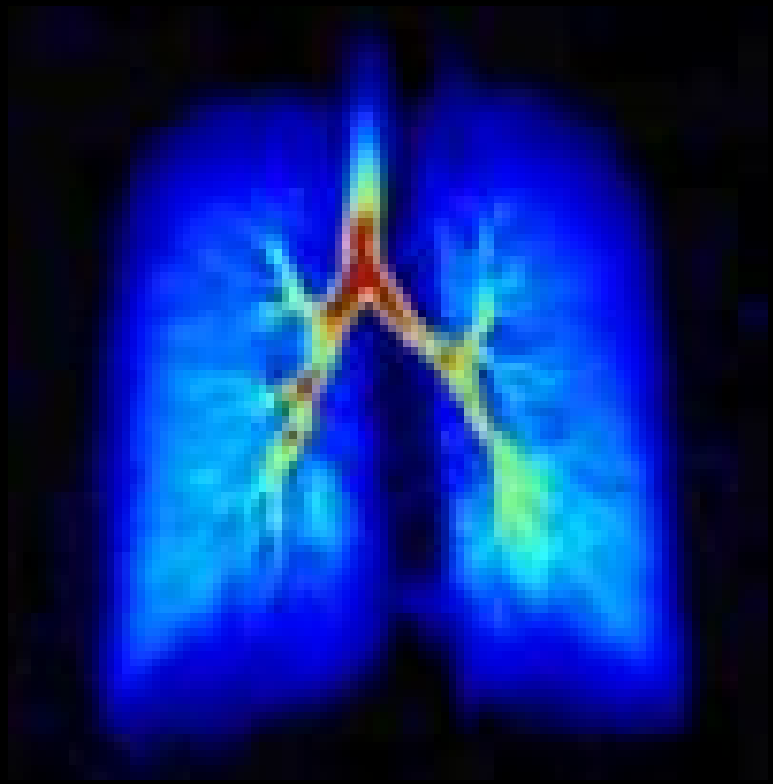
Epidural Anaesthesia and Analgesia and Outcome of Major Surgery (MASTER trial)

n =888, random., ASA >/=3, Abd./Esoph. Surg., 225/ 447 Epidural > 72h.

- Mortality Epidural vs. IV: ns.
- Cardiac/Renal/GI/ Sepsis: ns.
- Resp. Fail. Epid. vs. IV: 23% vs. 30% (.02)
- Analg. Epid. vs. IV: @ rest ns, cough <.001

Rigg JRA, et al. Lancet 359: 1276-82, 2002

Protecting Non-Injured Lungs:

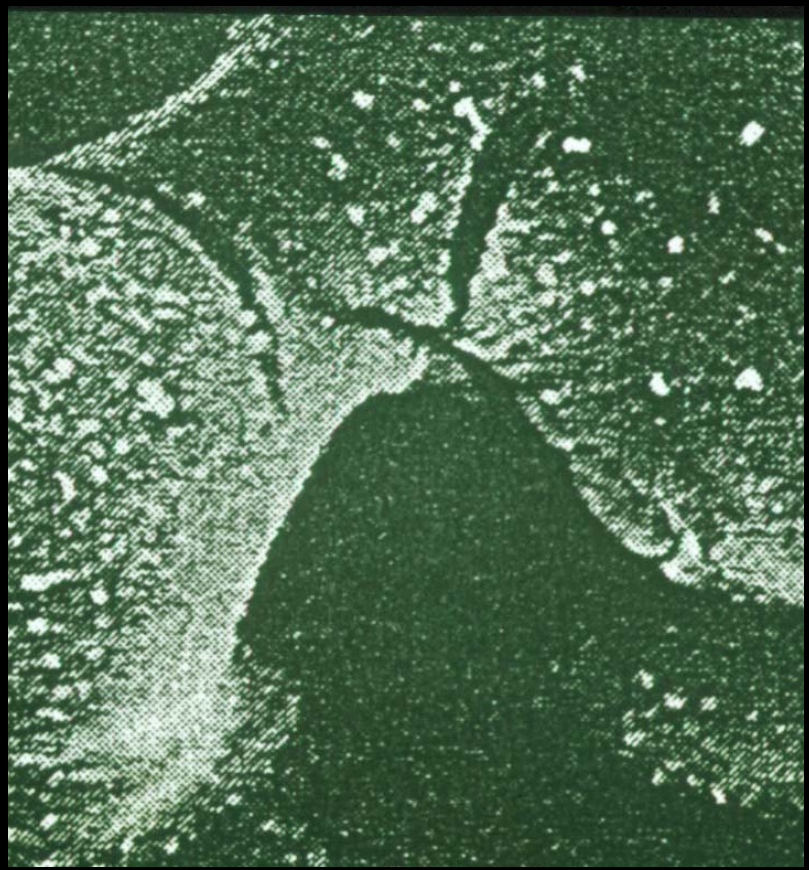


- The Perioperative Experience (Surgeon)
  - Open vs. Closed Surgery

Anesthesia and Lung Injury

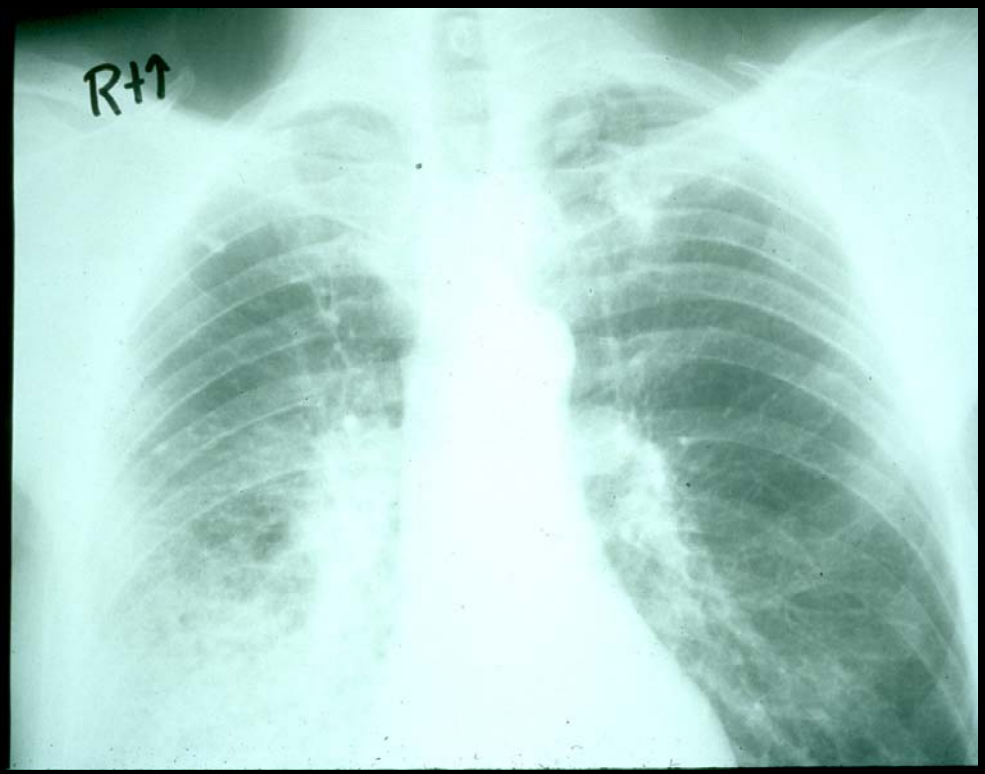
- Does Routine Intra-op. Ventilation (10-12 ml/kg x 10/min) injure the lungs?

Patients with Lung Injury:



- ARDS/ALI
- Lung Transplantation
- Major Pulmonary Resection
- Cardio-pulmonary bypass

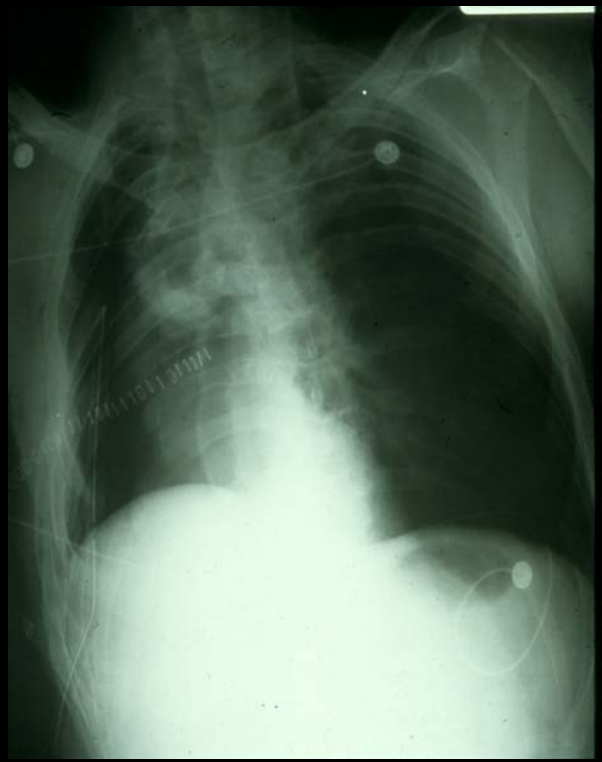
55 y.o. Male, R Mid+Lower Lung Ca.



- Smoker
- FEV1 78%, DLCO 83%, Ex. Tol. > 3 flights
- V/Q scan: R/L = 45/55

55 y.o. Male , Postop. Right Pneumonectomy

Day #1



Day #3

Post-pneumonectomy pulmonary edema: analysis and risk factors

Parquin F, et al. Eur J Cardiothorac Surg 10: 929,1996

"…we see so often our anesthetic colleagues believe that you can actually oxygenate the patient with Ringer's lactate...

...I think it is up to us to control what our anesthesia colleagues do, both in the operating theatre and postoperatively." Dr. B Ross

Postpneumonectomy Pulmonary Edema.
- Turnage and Lunn, 1993

- 806 pneumonectomies: 21 cases
- Right pneumonectomy 16, vs. left 5
- Mortality 21/21 (ARDS)
- Cases vs. controls:
    - fluid balance (n.s.)
    - fluid administration (n.s.)
    - PAOP (initial) 10, (final) 13mmHg (n.s.)

Post-operative Lung Injury and Oxidative Damage

Williams EA, et al. Eur Resp J 1998, 11: 1028-34

Operation	Increase Plasma Protein Carbonyl %
Pneumonectomy	26 ($p<.05$)
Bi-lobectomy	10
Lobectomy	5
Wedge/Biopsy	0
Abdominal Surgery	0

(n= 8/group)

Pulmonary Endothelial Permeability Changes after Major Lung Resection

Pneumx. =24, Lobx. =11, rad-labl. Alb., 8h post-op.

- Permeability Pneumx. > Lobx. ($p<.01$)
  (Low-Press., hi-Prot. PE fluid)
- Increase Perm. $\propto$ Increase PVR
- Increase MPAP $\propto$ 1/ pre MPAP

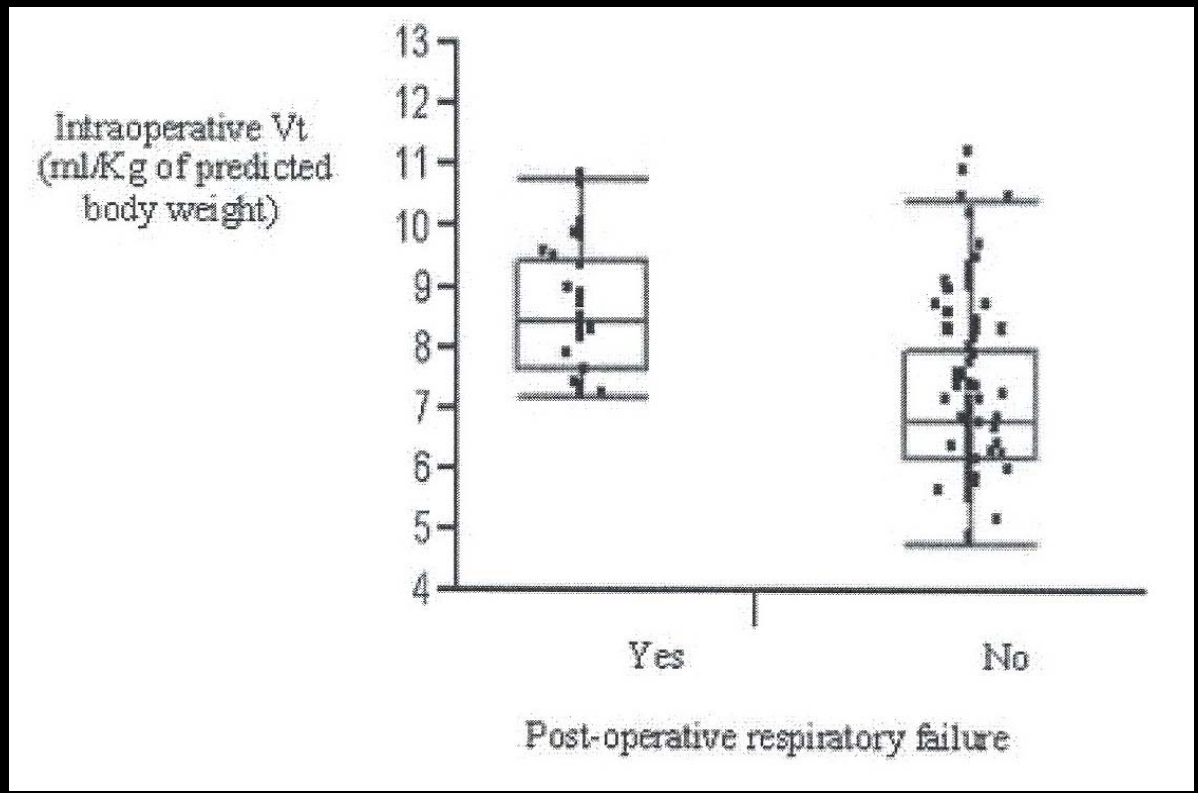
Waller DA, et al. Ann Thorac Surg 1996, 61: 1435-40

Modern Anesthetic Techniques for Thoracic Operations

"Tidal volume (10-12 ml/kg) should remain the same when changing from two-lung to one-lung ventilation, as relatively large tidal volumes are needed to recruit alveoli in the dependent ventilated lung."

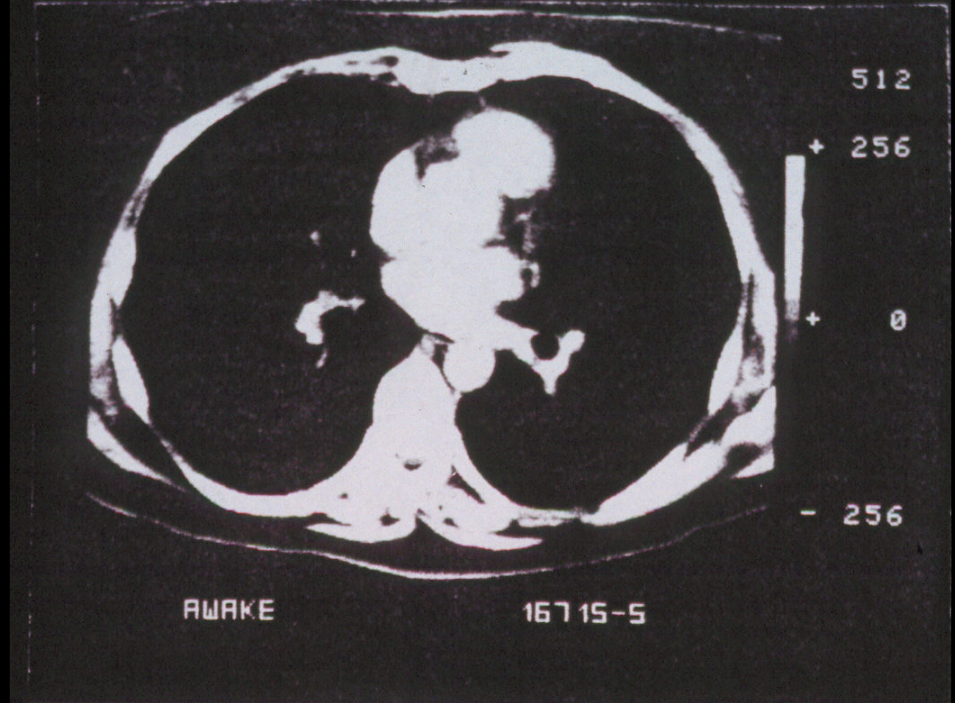
Brodsky JB, Fitzmaurice B. World J Surg 25: 162-6, 2001

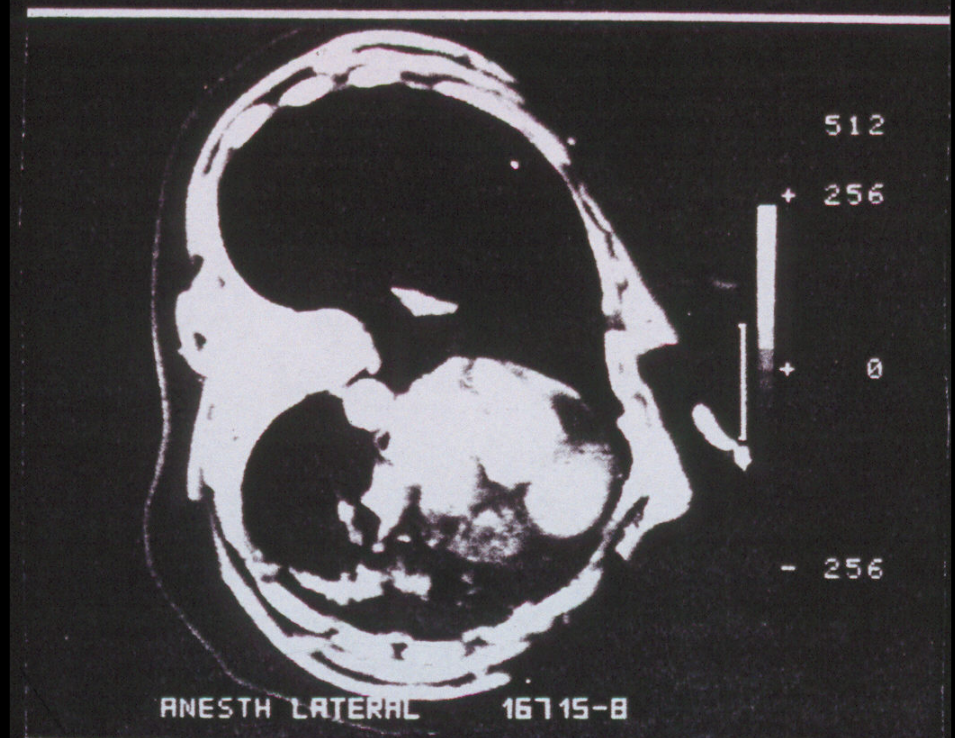
Tidal Volume vs. Post-pneumonectomy Respiratory Failure



- 30/170 Post-pneumx. Resp. Failure, p<.001
- 15/30 Acute Lung Injury
- Mortality 6/30 vs. 7/140
- LOS 32 vs. 7 days

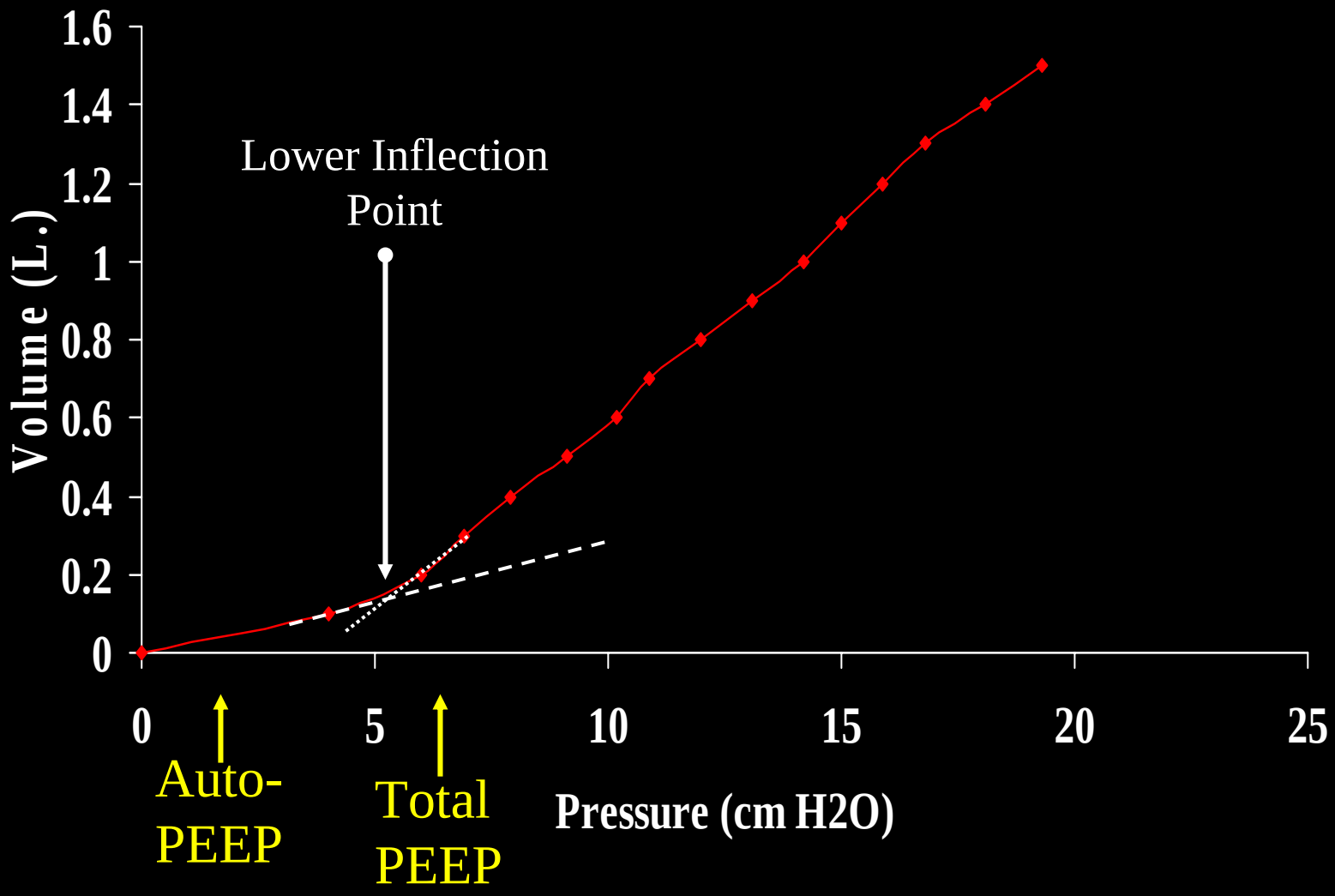
Fernandez-Perez ER, et al. Anesthesiology 2006, 105:14-18


512
+ 256
+ 0
- 256
AWAKE
16715-5


512
+ 256
+ 0
- 256
ANESTH LATERAL
16715-8

One-lung, Static Compliance Curve

Slinger P, et al. Anesthesiology 2001, 95: 1096



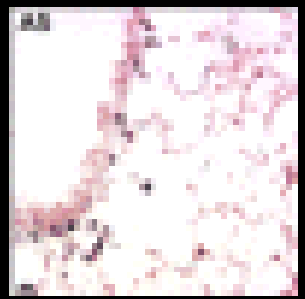
32 y.o. male, FEV1= 102%

Atelectasis Causes Lung Injury in Non-Atelectatic Lung Regions

Tschudia S, et al. AJRCCM 2006: 174: 279-89

Non-Depend.

Dependent



- Rat lung injury model
- Lg. Vol. Vent.
- Distal airway injury all regions
- Alveolar injury more severe in non-dependent, non-atelectatic regions

Principles of Lung-Protective Ventilation:

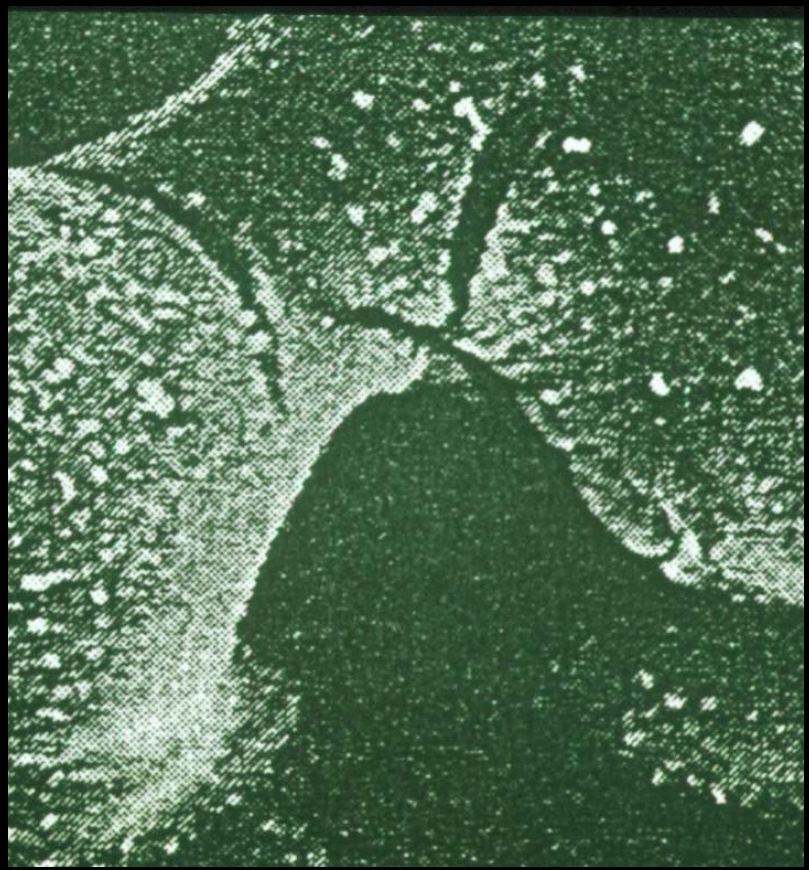
- Mimic normal spontaneous ventilation
- FiO2 as low as safe
- Tidal volumes 4-6 ml/kg
- Frequent recruitment maneuvers
- Vary position / vary tidal volume
- Pressure-control ventilation
- PEEP to maintain FRC

Fan E, et al. JAMA. 2005; 294:2889-96

Individualizing One-lung Ventilation:

		Exceptions:
Tidal Vol.	5-6 ml/kg	Pk. a/w P<35 Plat. a/w P<25
PEEP	Total 5 cm.	Not added if COPD
Resp. Rate	12	Maint. N PaCO2
Mode	Vol.-Cont. Vent.	P-C V:LTx, Pneumnx

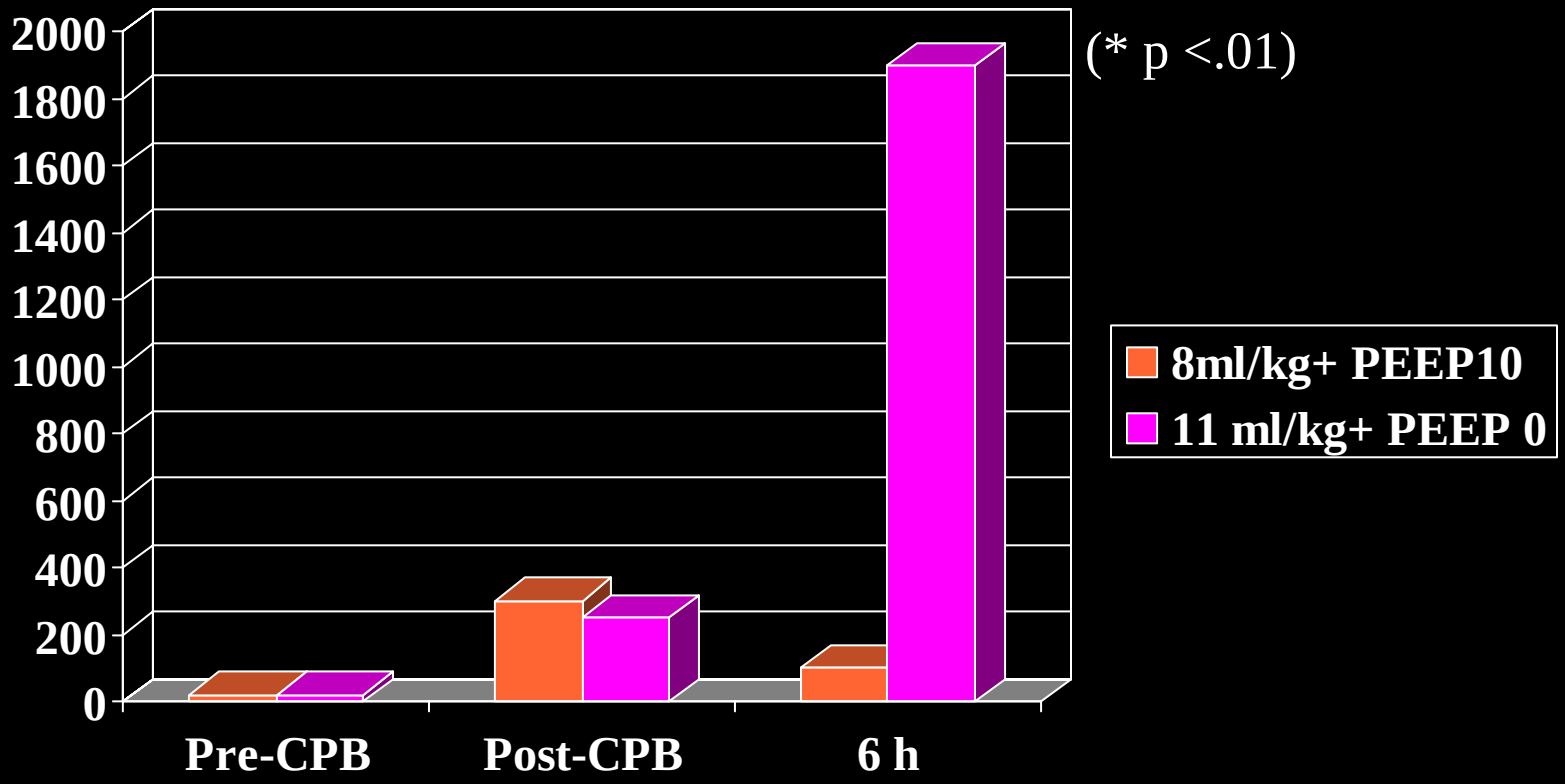
Patients with Lung Injury:



- ARDS/ALI
- Lung Transplantation
- Pneumonectomy
- Cardiopulmonary Bypass

Pulmonary Inflammatory Mediators During Mechanical Ventilation after Cardiac Surgery

BAL
IL 6

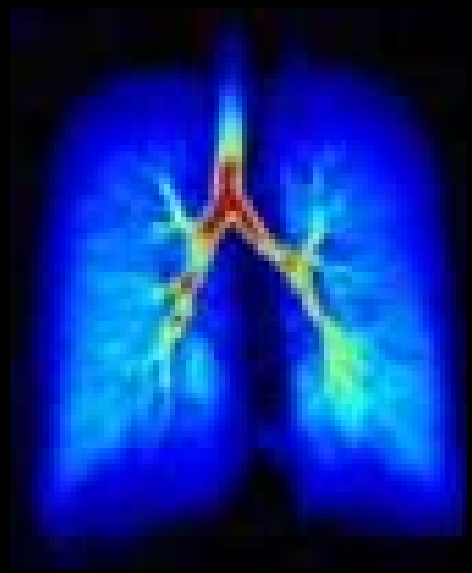


Zupanich E, et al. JTCS 2005, 130: 378-83

Protecting the Lungs

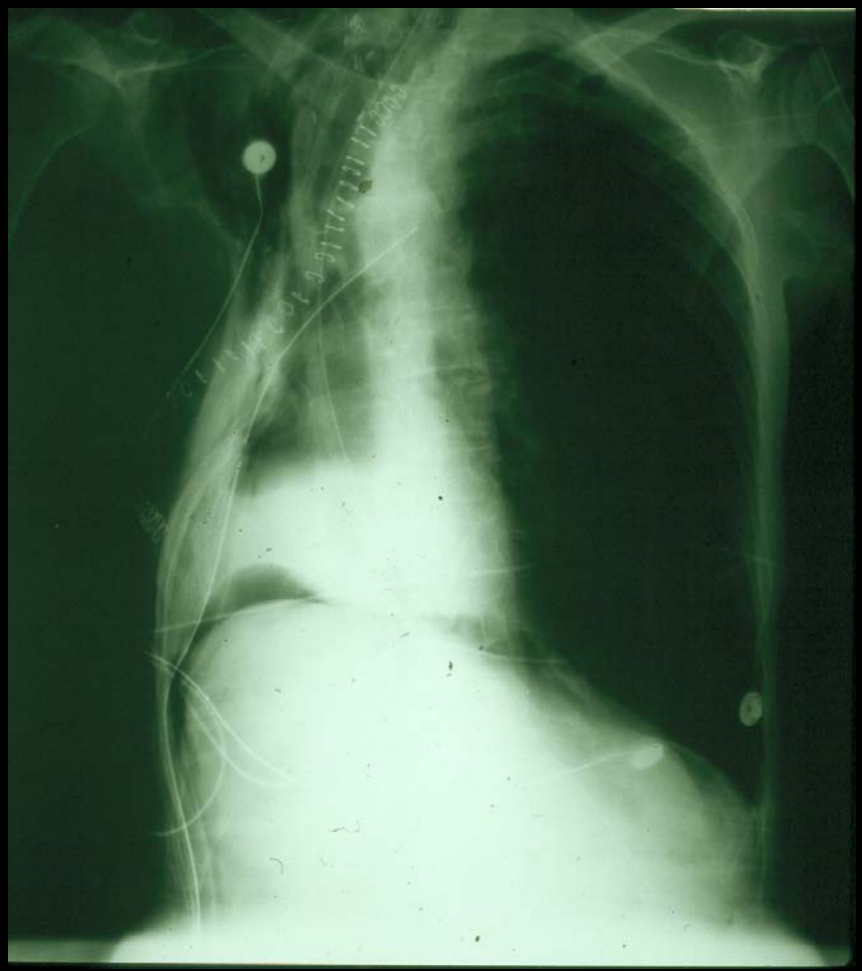
Non-Injured Lungs:

- Aggressive Rx atelectasis
- D/C smoking, Chest Physio, TEA
- Minimally invasive surgery

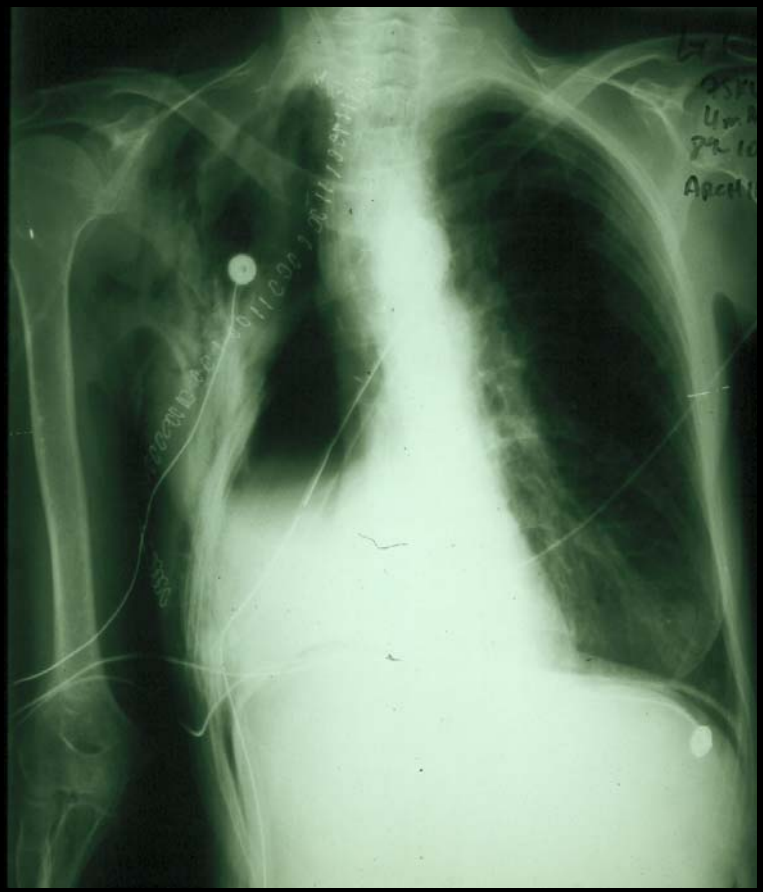


Injured Lungs:

- Lung-Protective Ventilation



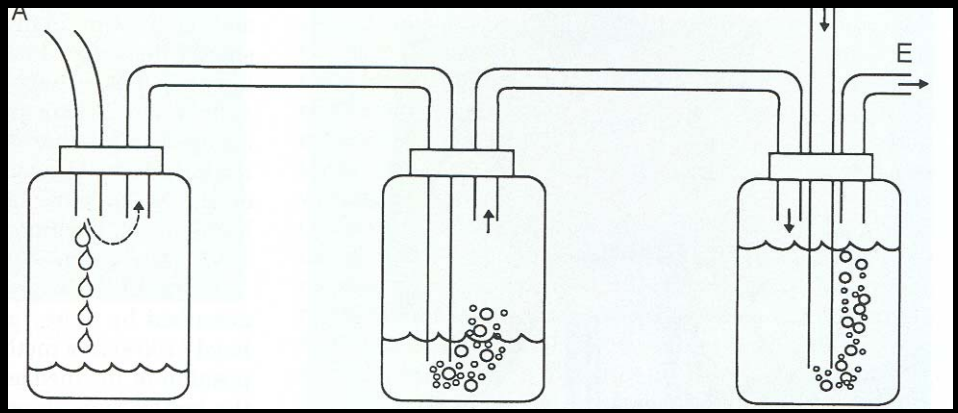
- 70 y.0. Female
- Post-op. R pneumonectomy + chest wall resection
- Underwater seal chest drain

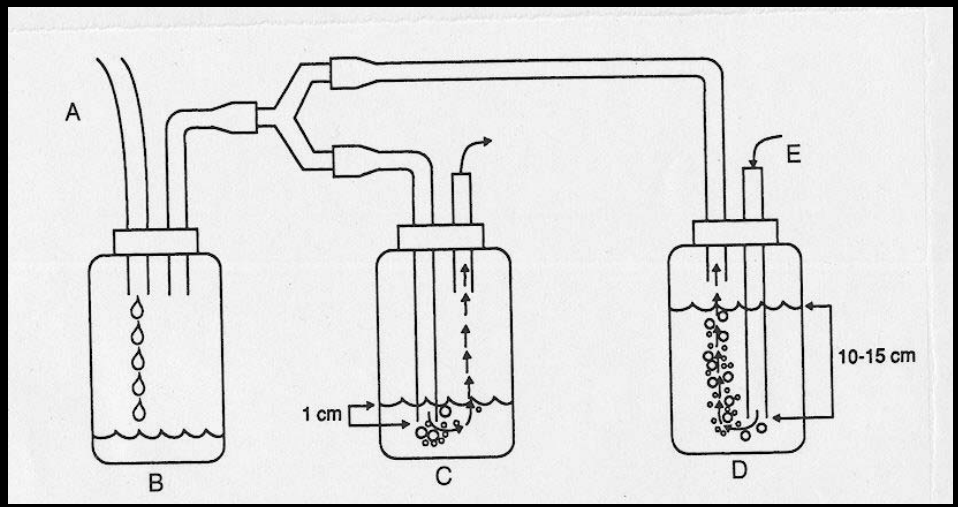


- 70 y.0. Female
- Post-op. R pneumonectomy + chest wall resection
- Balanced chest drain system

Chest Drainage Systems

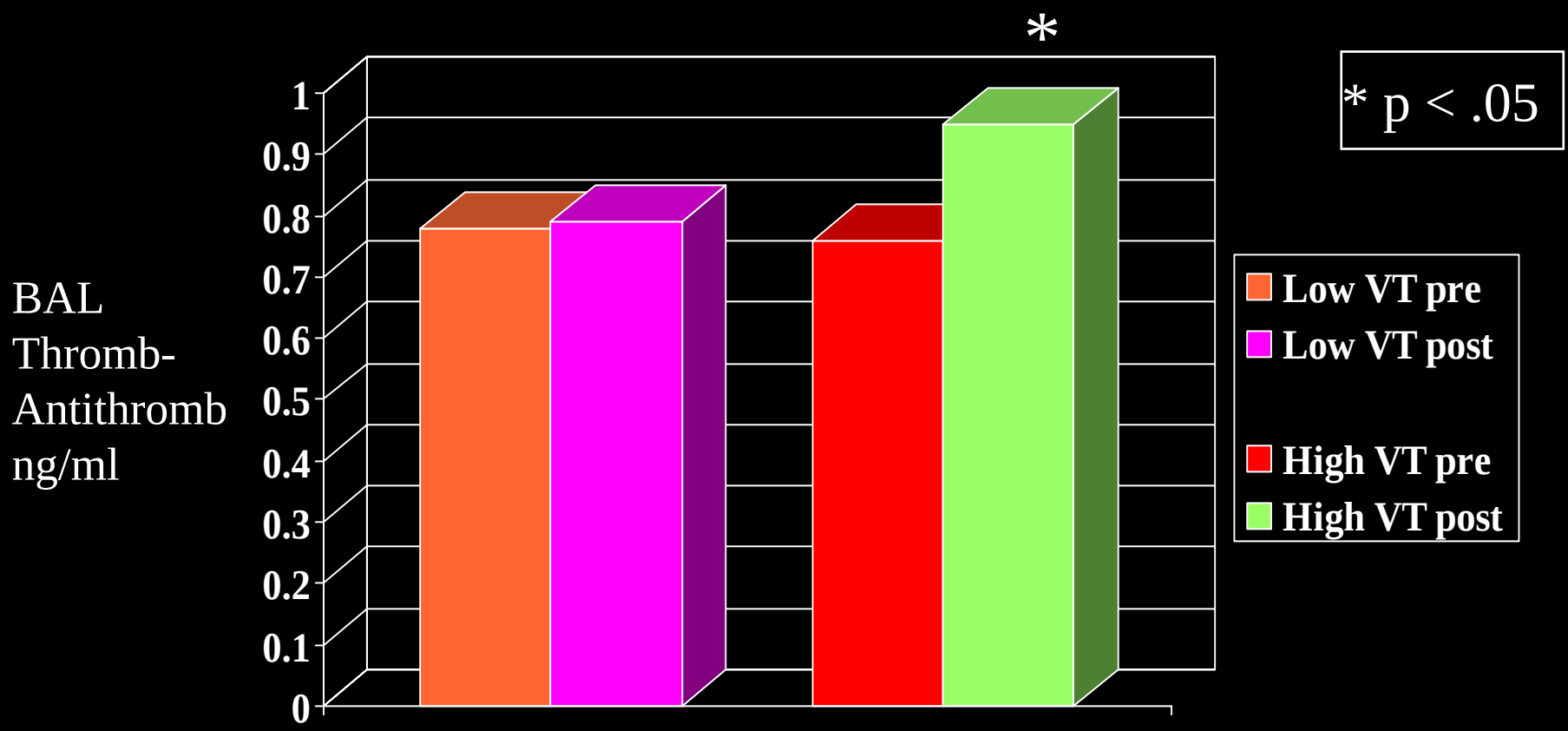
Standard (series)





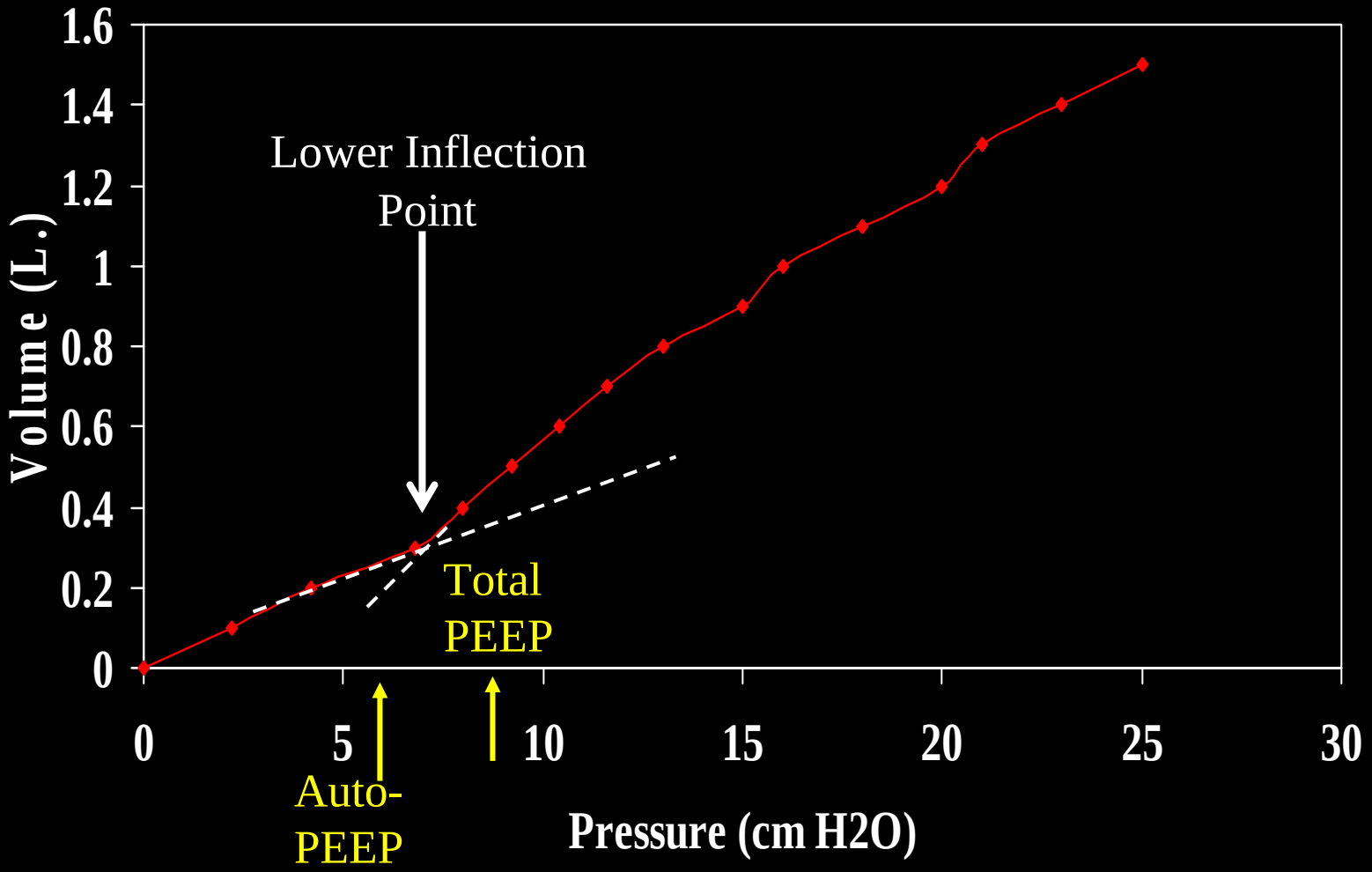
Pneumonectomy (parallel)

Low Tidal Vol. + PEEP Prevents Alveolar Coagulation in Patients Without Lung Injury



N=40, Abd. Surg. 5h PPV,
VT= 12ml/kg vs. 6 ml/kg -/+ 10cmH2O PEEP
Choi G, et al. Anesthesiology 2006; 105: 689-95

Static Compliance curve of the Ventilated (dependent) lung, 57 y.o. female, FEV1= 72%



Slinger P, et al. Anesthesiology 95:1096, 2001