Protecting the Lungs: From Who/What?

**Healthy Lungs:**
- The Perioperative Experience (Surgeon)

**Unhealthy Lungs:**
- The Anaesthesiologist: Bronchospasm Lung injury
Atelectasis

Intra-op.

Recovery Room
Pulmonary Atelectasis

Duggan M, Kavanagh B. Anesthesiology 2005, 102: 838-54
Patients:
- n = 209
- 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
“Boussignac Mask”
The Comparative Effects of Analgesia on Pulmonary Outcomes: Meta-Analysis


- Atelectasis decreased Epidural opioid/LA vs. Systemic opioid
- **Pulmonary Infections** decreased Epidural opioid/LA vs. Systemic opioid
- Pain VAS movement (not PFTs) correlate with outcome
The Pharmacokinetics of Continuous Epidural Sufentanil and Bupivacaine Infusion after Thoracotomy

(n=37, double blind, lumbar CSF samples)

(signif. p<.05 between all 3 techniques for dose and concentrations)
Reduction of Respiratory Complications in Lung Resection by Thoracic Epidural

* \( p < .05 \)

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

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

- Analgesia: Epid. vs. IV @ rest n.s., with cough < .001

- Resp. Fail. Epid. vs. IV: 23% vs. 30% (.02)

Epidural Analgesia and Survival after Intermediate-to-high Risk Non-Cardiac Surgery


n = 88,000, 1994-2004
Protecting the Lungs: From Who/What?

Healthy Lungs:
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Unhealthy Lungs:
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Preventing Bronchospasm

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

PetCO2
Protecting the Lungs: From Who/What?

- Healthy Lungs:
  - The Perioperative Experience (Surgeon)

- Unhealthy Lungs:
  - The Anesthesiologist: Bronchospasm
  - Lung injury
Principles of Lung-Protective Ventilation:

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

Patients with Micro-Vascular Lung Injury:

- ARDS/ALI
- Lung Transplantation
- Major Pulmonary Resection
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.”

55 y.o. Male, R Pneumonectomy

- Postop. Day 3
- Increasing Dyspnea x 24h
- SpO2 90%, FiO2 0.5
- Other Vitals Stable
“…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 theater and post-operatively.”

B Ross
Post-Pneumonectomy Pulmonary Edema
Turnage WS, Lunn JL. Chest 103: 1646-50, 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.)
  Mean PAOP: initial 10, final 13 (n.s.)
Causes of Post-Pneumonectomy Pulmonary Edema

**Probable:**
- Endothelial injury
- Capillary pressure
- Lung Lymphatic damage
- Fluid overload
- Lung Hyperinflation

**Possible:**
- RV dysfunction
- Cytokines
- Oxygen toxicity
Extravascular Lung Water after Pneumonecctomy in Sheep

Extrapulmonary Ventilation for ARDS after Pulmonary Resection


- N=9/239 (3%) resections
  - 7 Pneumonex, 2 lobex
- Novalung 4.3 (+/- 2 days)
- Flow 1.4 (+/- 0.4 l/min)
- Mean Vent settings: Vt 3ml/kg, RR 6, Pa/w peak 19, PEEP 12, FiO2 0.5
- 6/7 (86%) survive to discharge
Low Tidal Vol. + PEEP Prevents Alveolar Coagulation in Patients Without Lung Injury

\[ * \ p < .05 \]

BAL Thromb-Antithromb ng/ml

N=40, Abd. Surg. 5h PPV,
VT= 12ml/kg vs. 6 ml/kg +/- 10cmH2O PEEP
Transfusion-Related Acute Lung Injury

Normal Circulating Neutrophil
Damaged Pulmonary Capillary

ICAM

“One Hit”

Cytokine Release

“Two Hit”
Protecting the Lungs: From Who/What?

- **The Patient:**
  - Smoking Cessation
  - Physiotherapy

- **The Perioperative Experience:**
  - Atelectasis
  - Analgesia

- **Anesthesiologist:**
  - Ventilation Injury
  - TRALI