

# “18. National Cardiovascular Anesthesia and Intensive Care Congress”



Bodrum, Turkey, 2012

# *Bodrum is sun, sea and after all it is history...*



- ❖ “Wind blows different, sea smells else”.
- ❖ “Bodrum is the naughtiest”
- ❖ “Women feel more beautiful here”
- ❖ “Men are more intriguing”

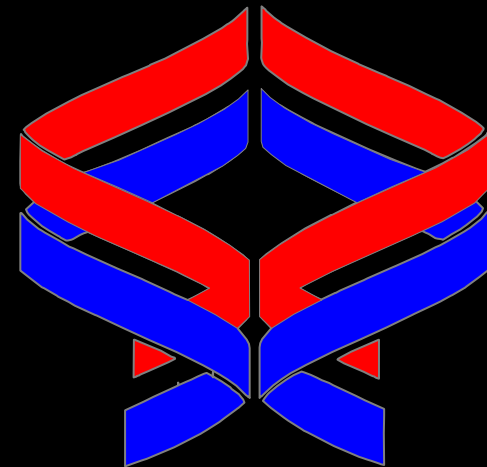






# *ANAESTHESIA FOR LUNG TRANSPLANTATION: EXCITING AND CHALLENGING*

*Nandor Marczin, MD, PhD*



**Imperial College London**

**Royal Brompton Harefield NHS Trust**

*ANAESTHESIA*  
*FOR LUNG TRANSPLANTATION:*  
*EXCITING AND CHALLENGING*

❖ Humanity: end stage disease, only solution



# *ANAESTHESIA*

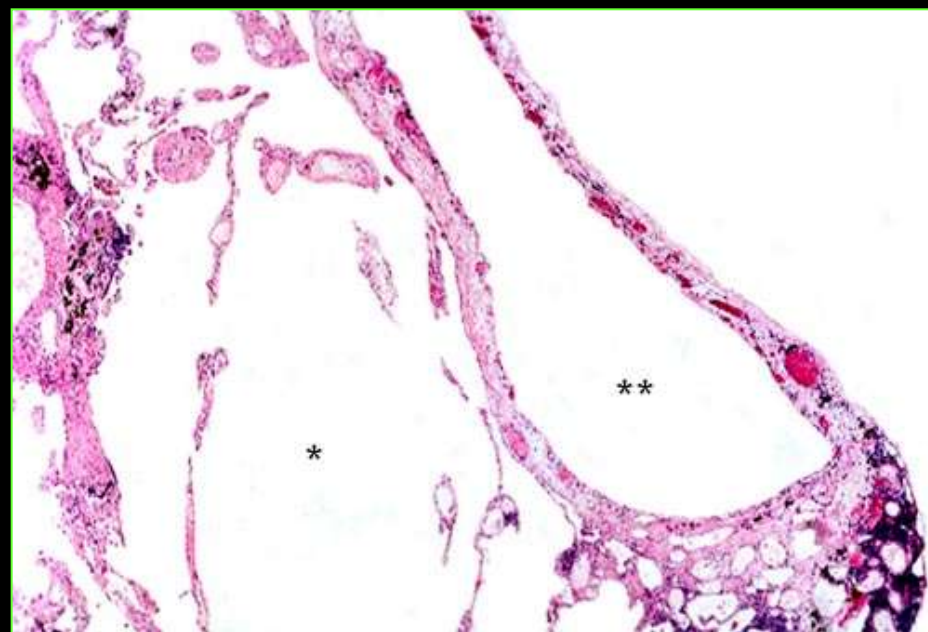
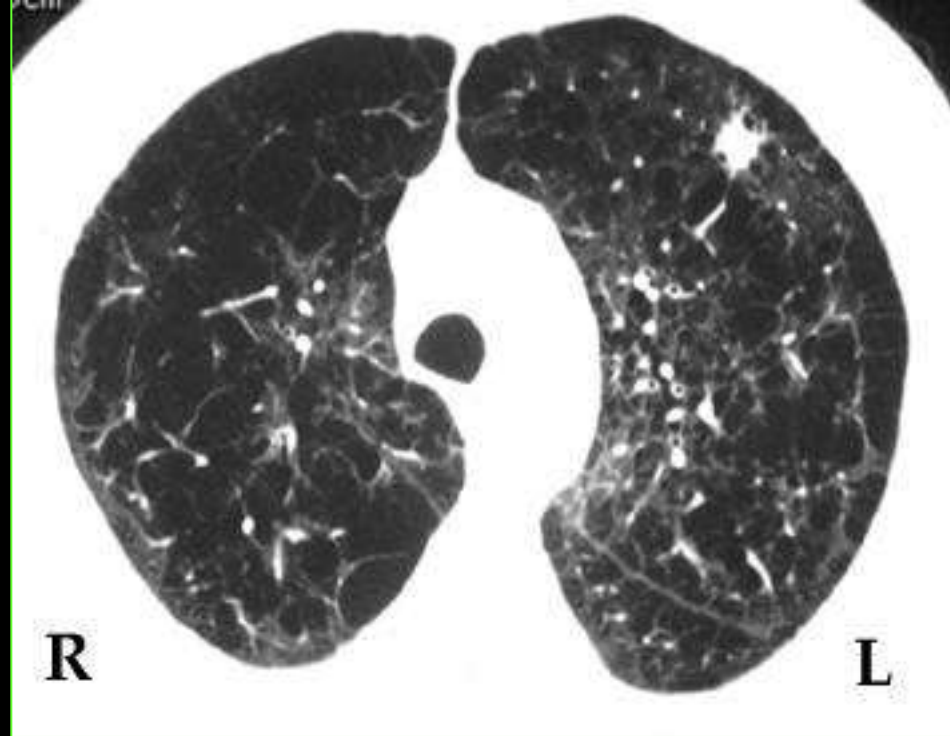
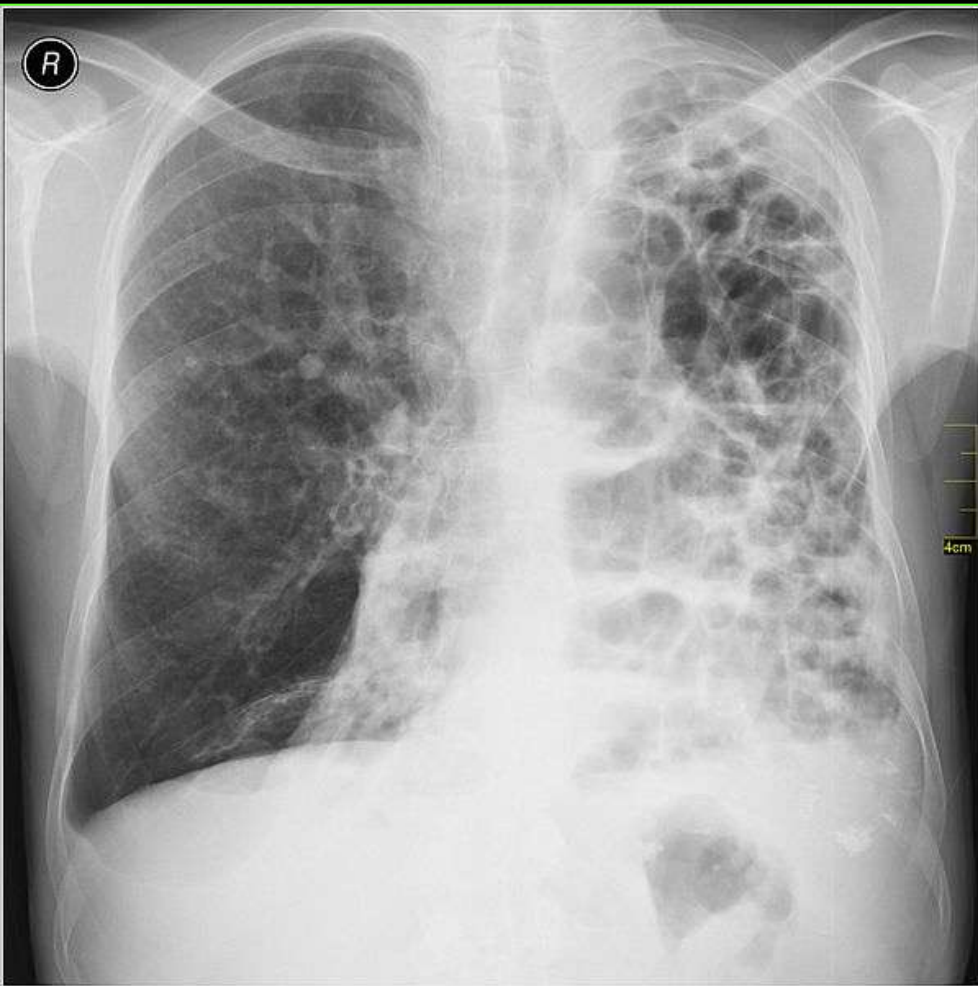
## *FOR LUNG TRANSPLANTATION:*

### *EXCITING AND CHALLENGING*

- ❖ Humanity: end stage disease, only solution
- ❖ Spectrum: Multiple conditions with unique clinical and anaesthetic challenges

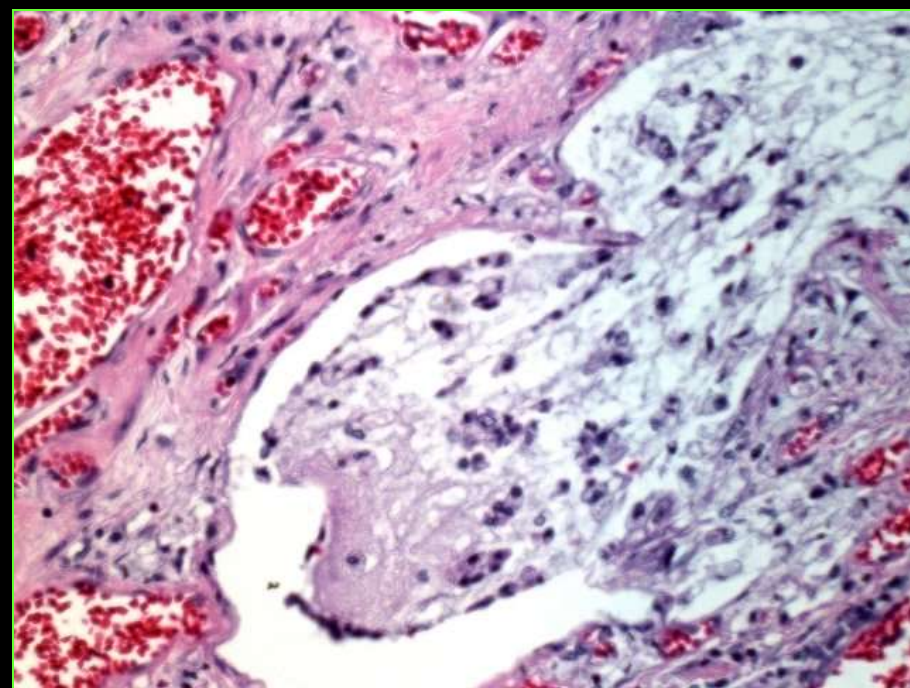
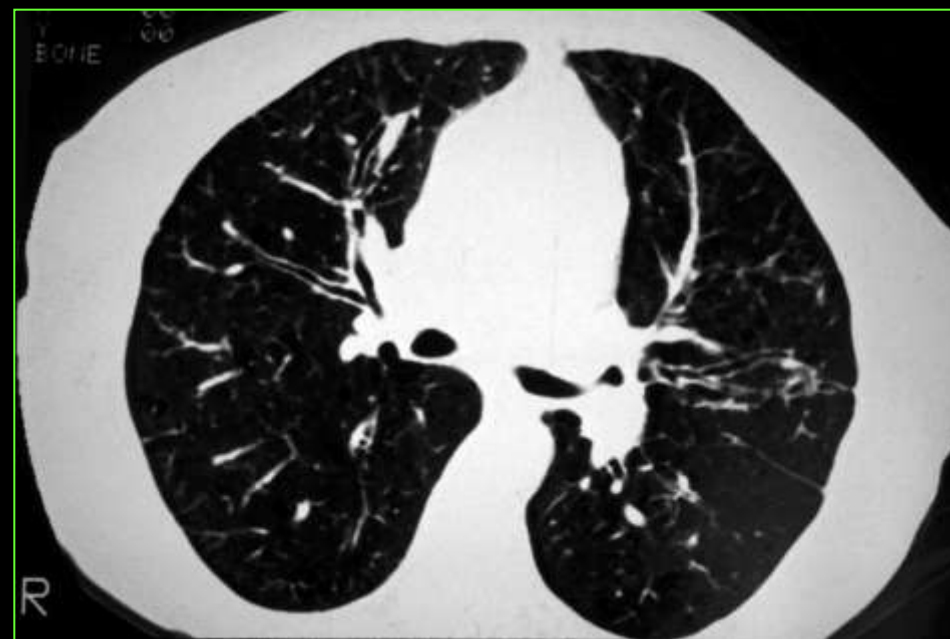
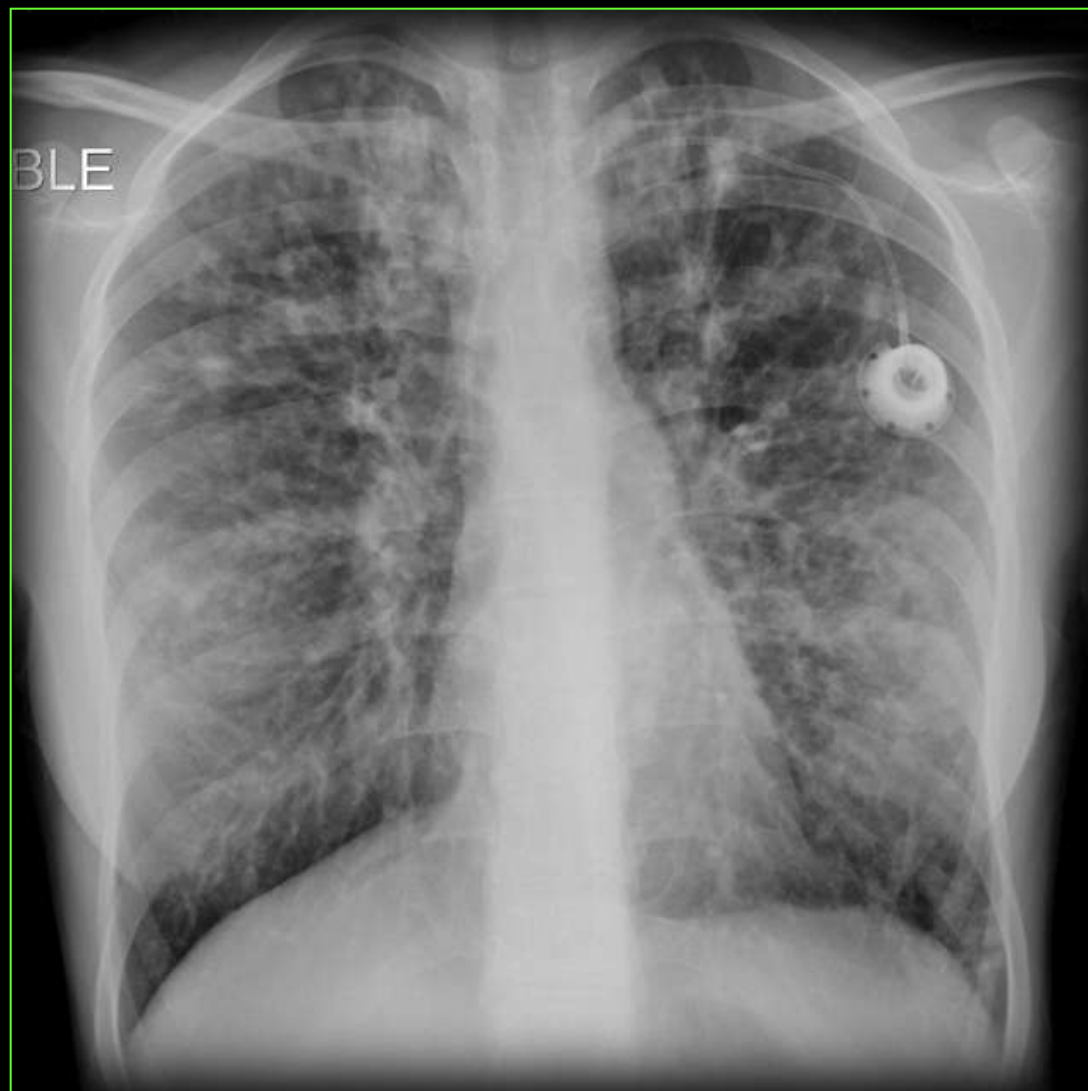


# COPD

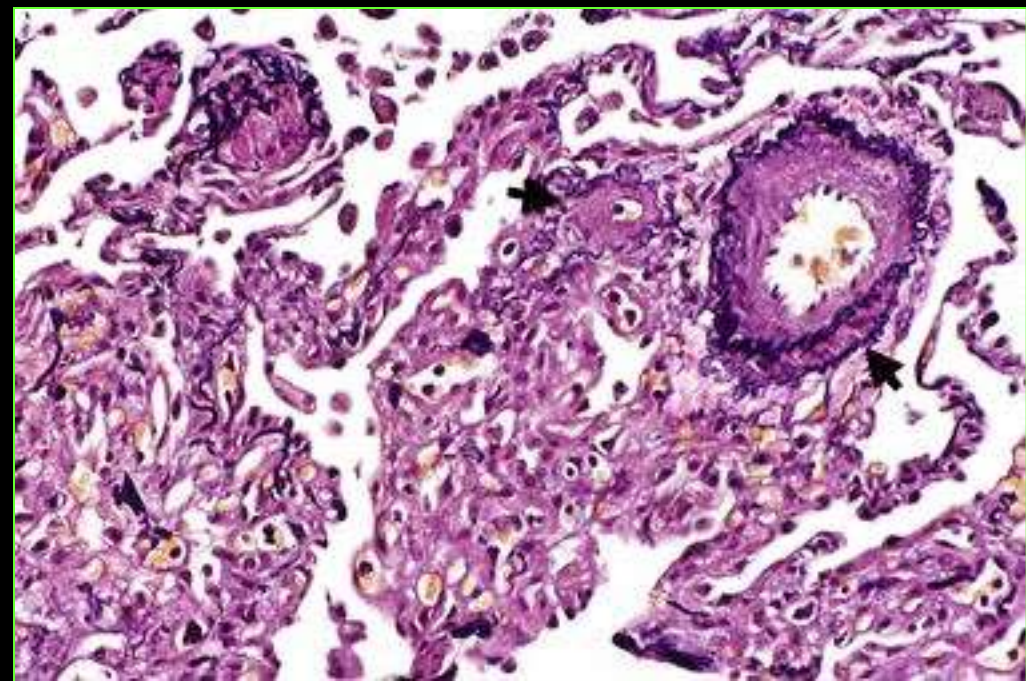
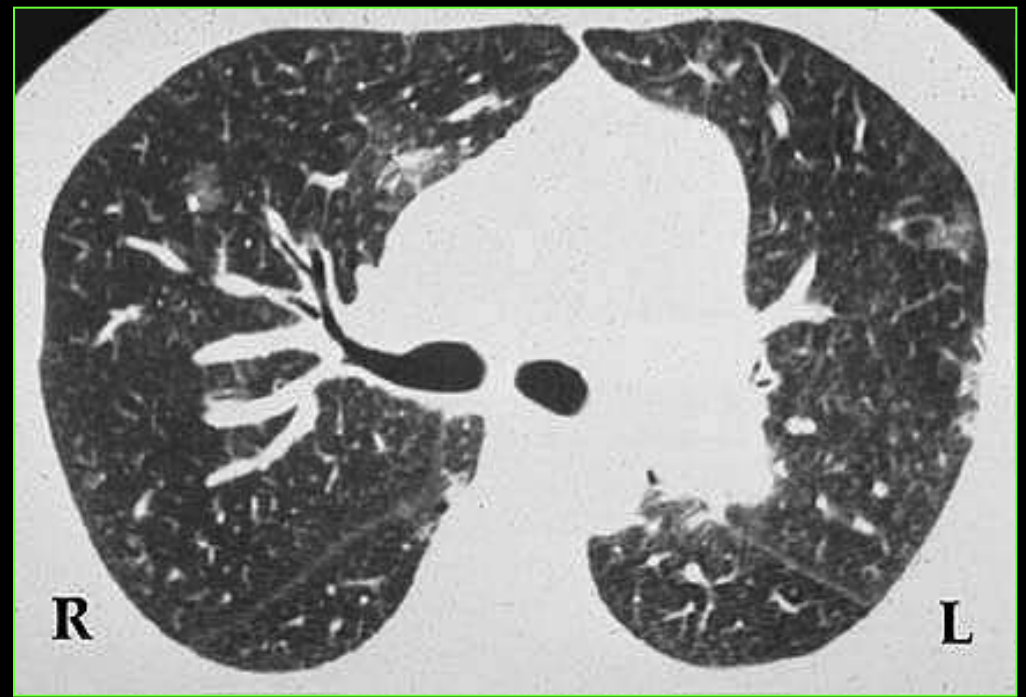
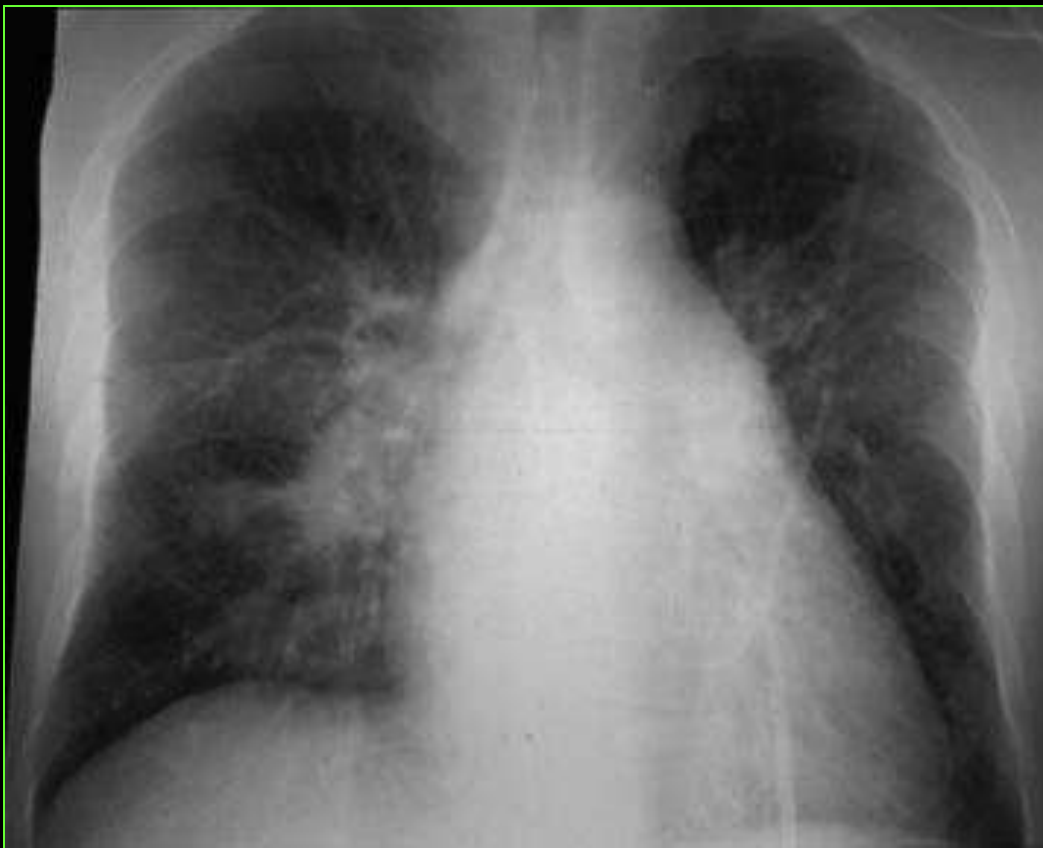




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# *ANAESTHESIA*

## *FOR LUNG TRANSPLANTATION:* *EXCITING AND CHALLENGING*

- ❖ Humanity: end stage disease, only solution
- ❖ Spectrum: Multiple conditions with unique clinical and anaesthetic challenges
- ❖ Evolving surgical technologies: New anaesthetic demands



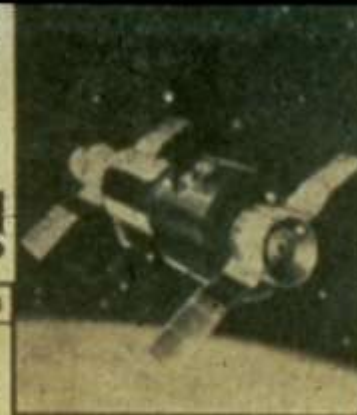
# NEWS

October 28, 1966

30587

VOL. 8, Issue 3

**SPACE SENSATION!**  
Ruins of ancient city  
found on Jupiter moon!



Top secret operation rocks the medical world!

# HUMAN HEAD TRANSPLANT!

In the most controversial operation ever, surgeons transplanted a young boy's head onto his sister's body after a horrifying auto accident that destroyed his vital organs and left her brain dead!

New minimally invasive surgeries =  
maximum anaesthetic demands



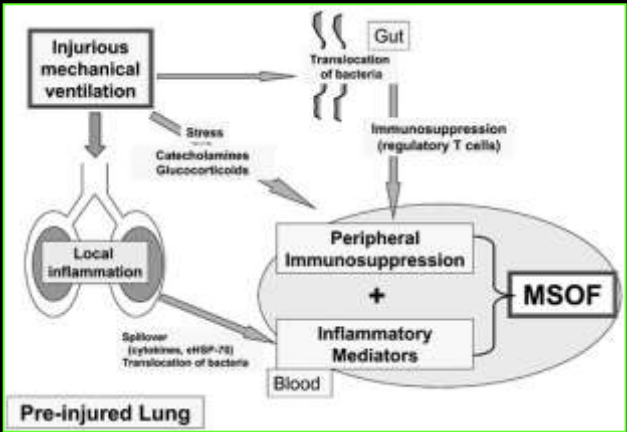
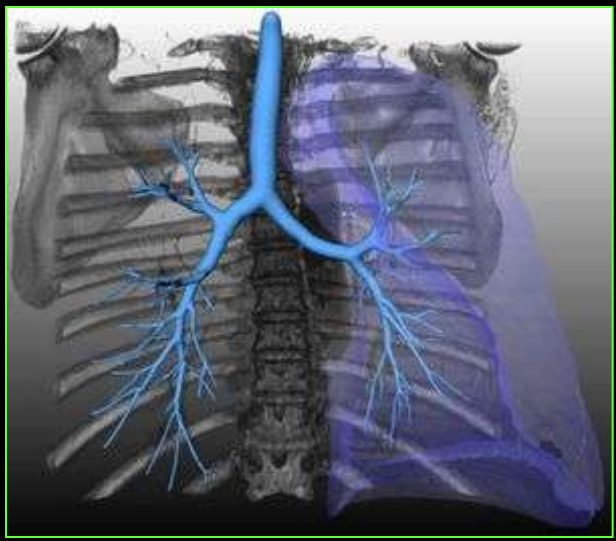
# *ANAESTHESIA*

## *FOR LUNG TRANSPLANTATION:*

### *EXCITING AND CHALLENGING*

- ❖ Humanity: end stage disease, only solution
- ❖ Spectrum: Multiple conditions with unique clinical and anaesthetic challenges
- ❖ Evolving surgical technologies: New anaesthetic demands
- ❖ Application of many novel concepts
  - Physiology, biology, pharmacology, monitoring





# *ANAESTHESIA FOR LUNG TRANSPLANTATION: EXCITING AND CHALLENGING*



***ANAESTHESIA***  
***FOR LUNG TRANSPLANTATION:***  
***EXCITING AND CHALLENGING***





# For worse?

*British Journal of Anaesthesia* 102 (4): 506–14 (2009)  
doi:10.1093/bja/aep008 Advance Access publication February 17, 2009

BJA

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## CRITICAL CARE

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### **Does anaesthetic management affect early outcomes after lung transplant? An exploratory analysis**

**D. R. McIlroy<sup>1 2\*</sup>, D. V. Pilcher<sup>3</sup> and G. I. Snell<sup>4</sup>**

<sup>1</sup>*Department of Anaesthesia and Perioperative Medicine, Alfred Hospital and Monash University, Melbourne, Australia.* <sup>2</sup>*Department of Anesthesiology, Columbia-Presbyterian Medical Center, New York, NY, USA.*

<sup>3</sup>*Department of Intensive Care Medicine and* <sup>4</sup>*Department of Respiratory Medicine, Alfred Hospital, Melbourne, Australia*

# Prepare yourself



# Prepare yourself

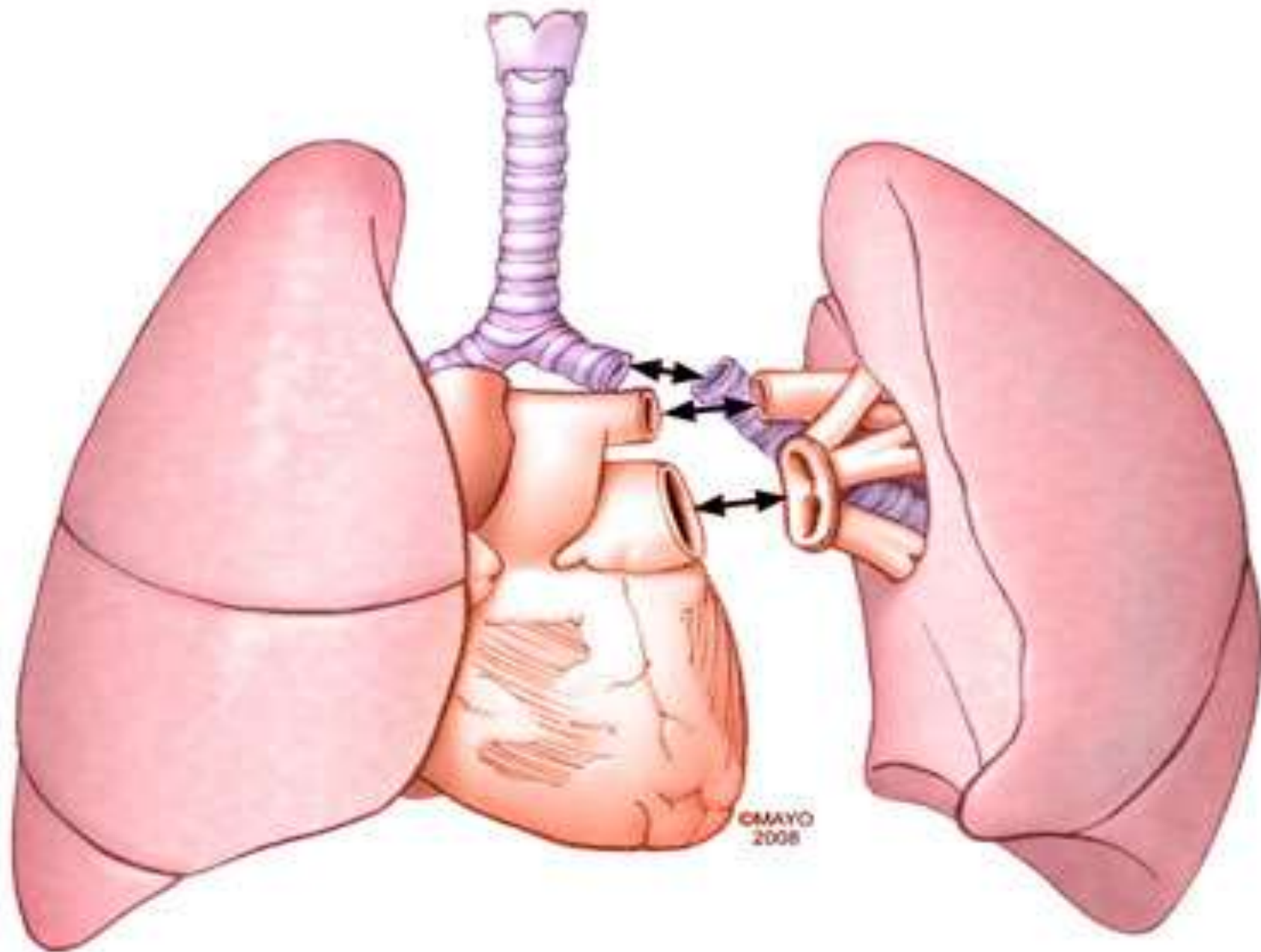




# Prepare equipment

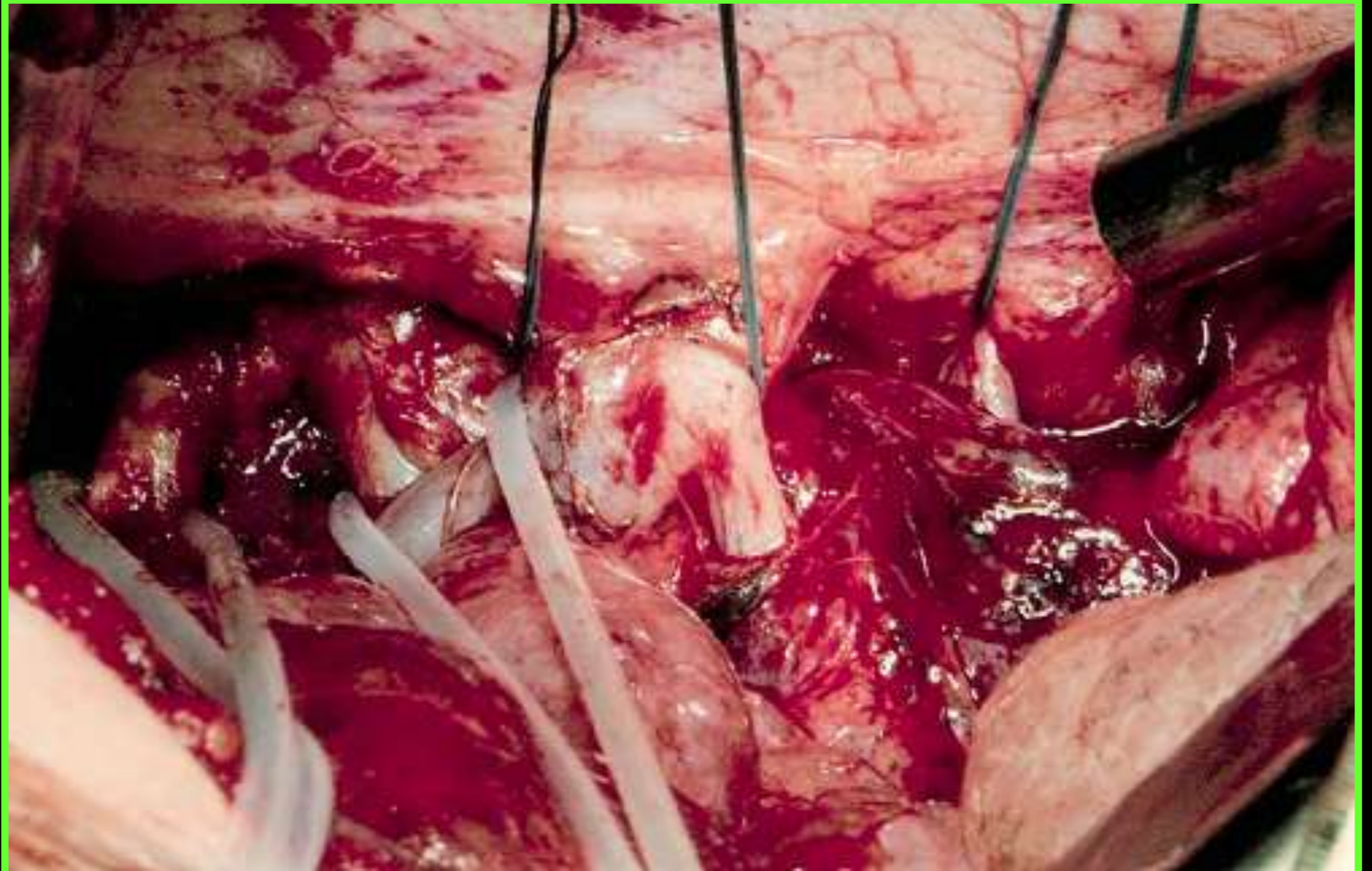


- ❖ Hemodynamics
  - CCO
  - TOE
- ❖ Vasoactive management
  - iNO
  - Inotropes
- ❖ Volume replacement
  - Large bore access
  - Perfusor
- ❖ Warming devices
  - Fluido
  - Bair Hugger





# Bilateral sequential Lung TX





# Goals of anaesthetic management

- ❖ Safe induction and maintenance
  - Preserve gas exchange
  - Hemodynamic stability
- ❖ Facilitate surgery
  - Perfect lung isolation
  - Avoid cardiopulmonary bypass
- ❖ PROTECT GRAFT FUNCTION
- ❖ Promote early extubation
- ❖ Patient comfort, pain control

# Anaesthesia for lung transplant: A smooth ride



# Preop evaluation

- ❖ Ideally senior consultant, not junior doctor
- ❖ Excellent patient documentation:
  - Tx assessment, MDT recods, critical issues flagged up by coordinator notes
- ❖ Critical issues
  - Pulmonary hemodynamics, RV function
  - Lung mechanics, gas exchange
  - Pt nutrition, general functional condition



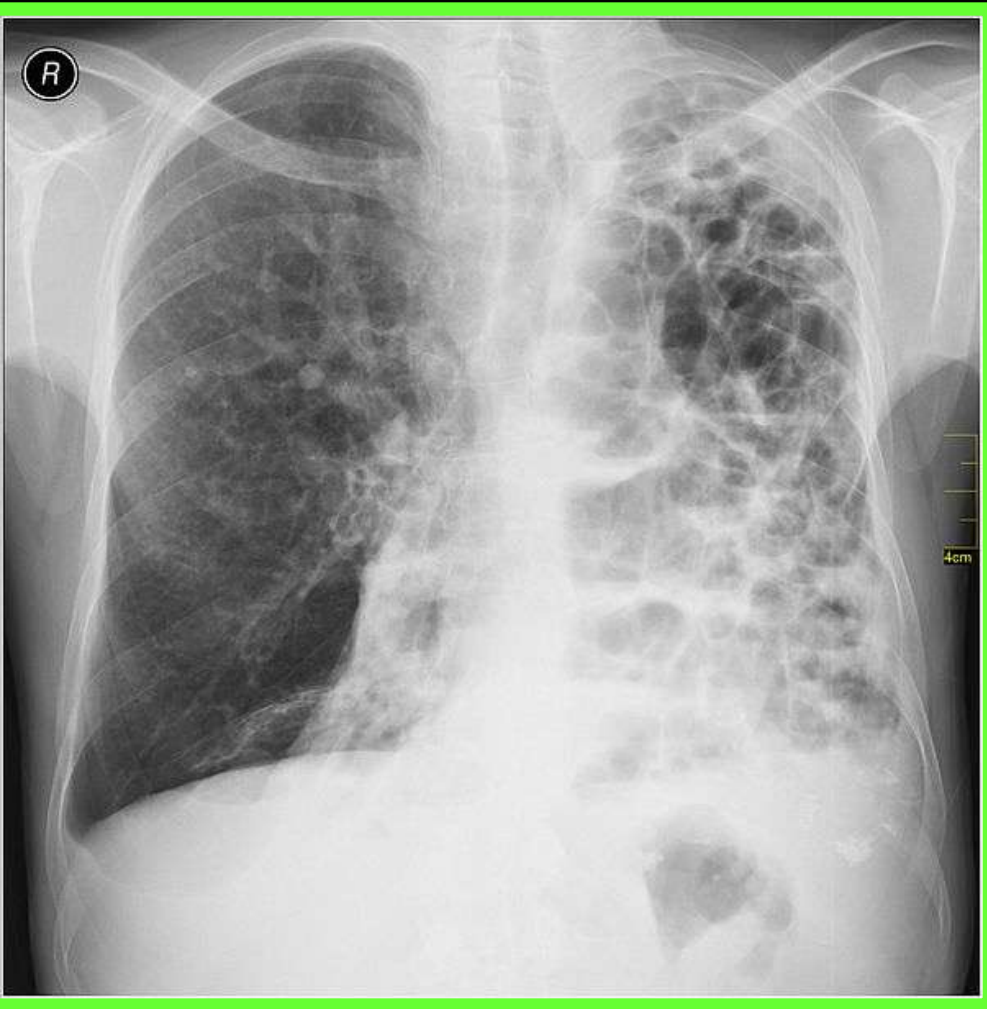
# Preop evaluation

- ❖ Little or NO premed
- ❖ Anxiolytics: family and coordinator
- ❖ Bronchodilator therapy to continue
- ❖ Supplemental oxygen in sitting up position
- ❖ Basal immunosuppression and antibiotics

# Anaesthetic room

- ❖ Accompanied by coordinator
- ❖ Baseline monitoring (5 lead ECG, SpO<sub>2</sub>)
- ❖ Peripheral lines (awake)
  - Strict asepsis, especially Seldinger art lines
  - Midazolam & alfentanil, fentanyl titration
- ❖ Induction
  - Adequate preoxygenation
  - Judicious fluid preload
  - May need rapid sequence induction
- ❖ Anticipate, prevent and treat
  - hypotension, hypoventilation, pulm hypertension

# COPD



## ❖ Auto PEEP (DHI)

– Hypotension

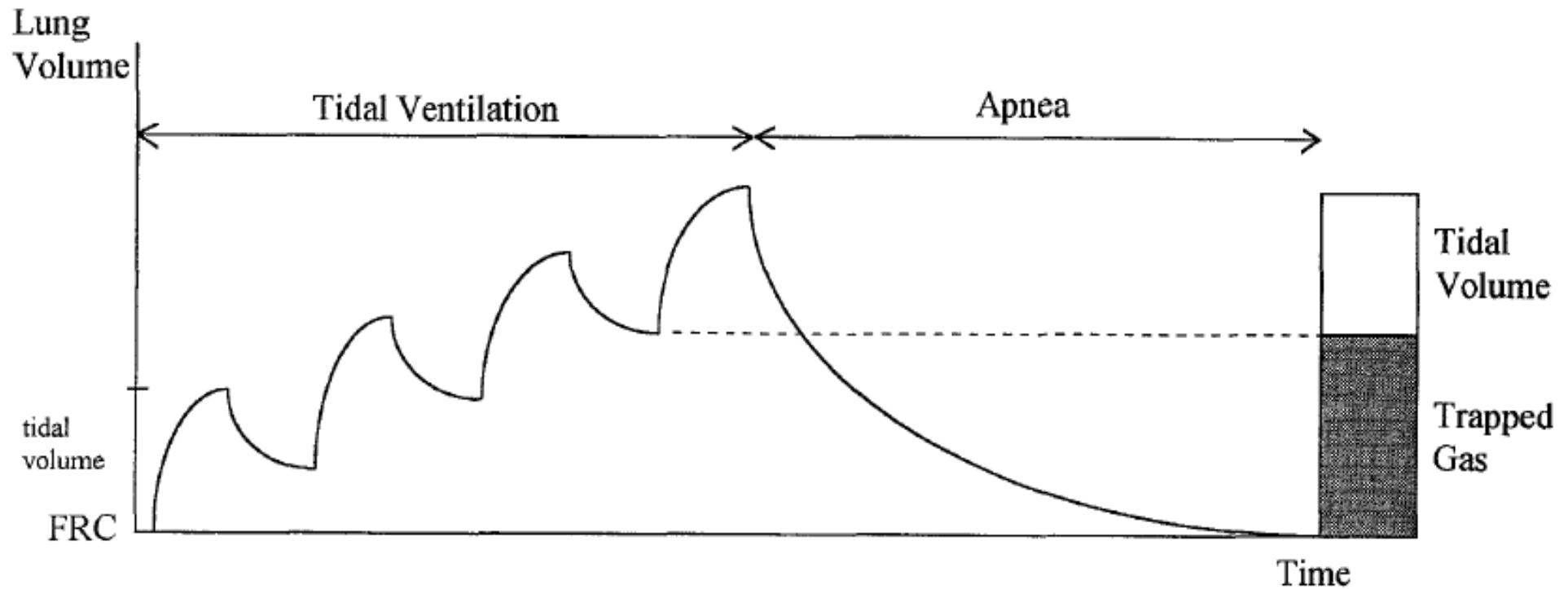
– Pneumothorax

## ❖ Hypercarbia, Resp acidosis

## ❖ Oxygenation rarely problem



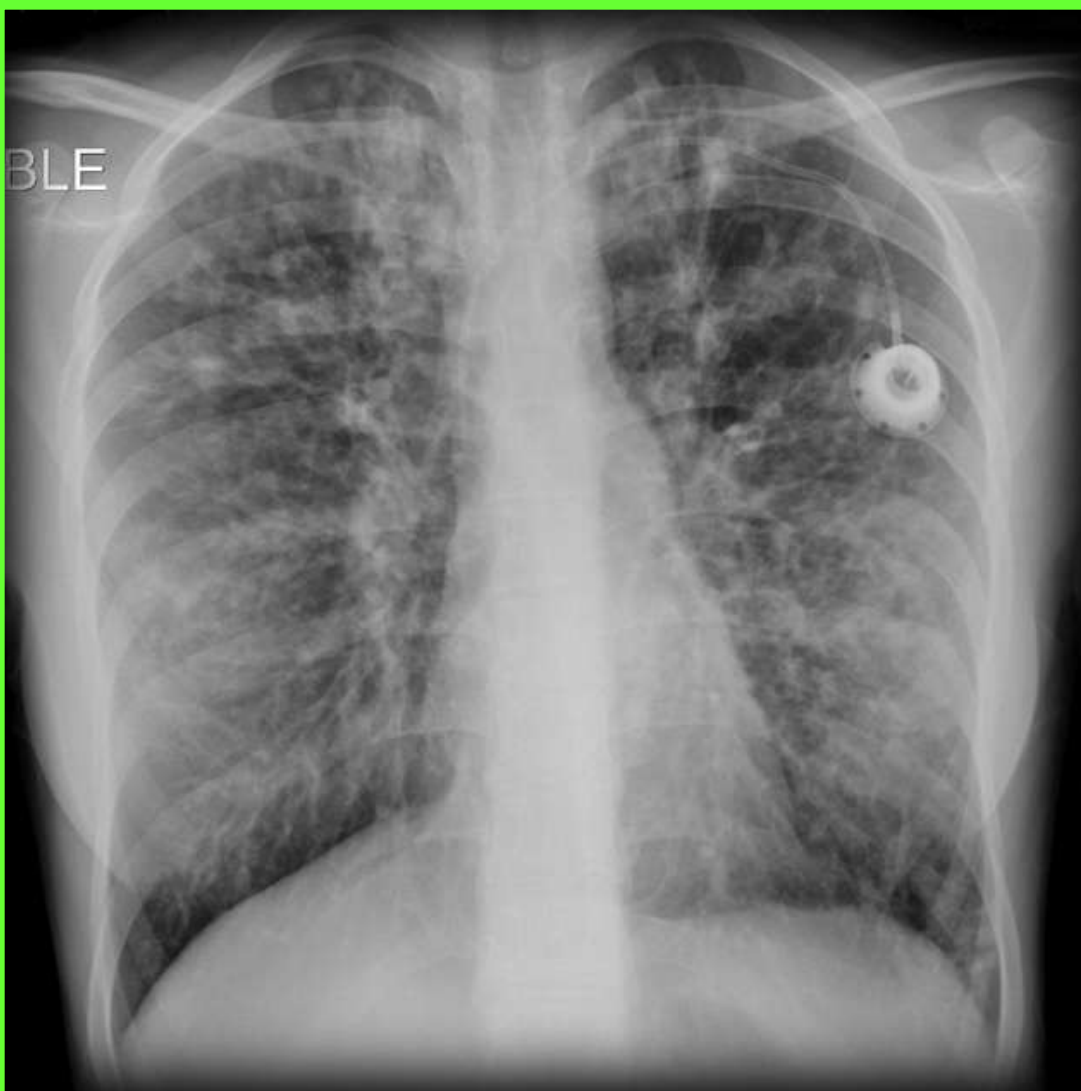
# Dynamic hyperinflation



# COPD Management

- ❖ thorough pre-oxygenation, fluid preload  
invasive monitoring,
- ❖ apneic periods as required
- ❖ gentle ventilation
  - Low (ish) Respiratory rate 6-8/min
  - Limit PIP
  - Prolonged expiratory times (I:E ratio <1: 4)
- ❖ immediate availability of inotropes
- ❖ permissive hypercapnia, treat acidosis

# Cystic Fibrosis



- ❖ Thick pus , secretion management
  - Initially single lumen ET,
  - Segmental BAL
- ❖ Both inspiratory expiratory flow resistance
- ❖ Gas exchange
  - Use high PIP, slow inspiration, increase RR

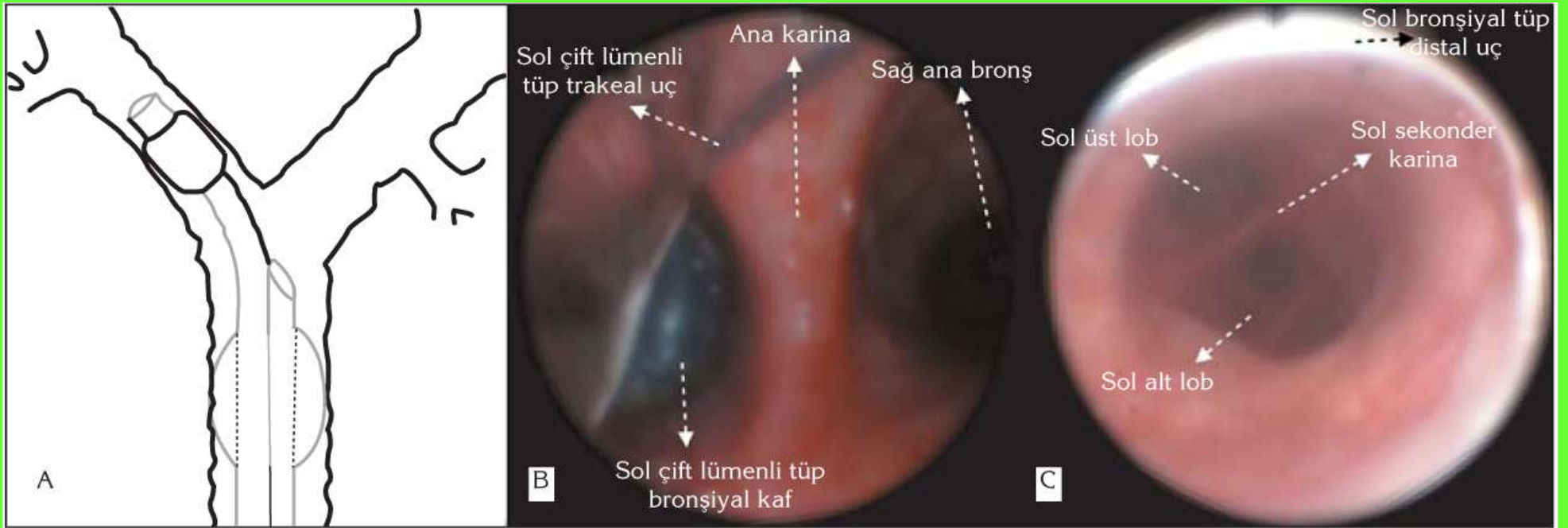


# Pulmonary Hypertension



- ❖ Increased PVR
- ❖ RV failure > hypotension
  
- ❖ Mild hyperventilation
- ❖ Tachycardia
- ❖ Aggressive vasoactive support
  - iNO
  - GTN, SNP
  - Milrinone
  - Norad, vasopressin

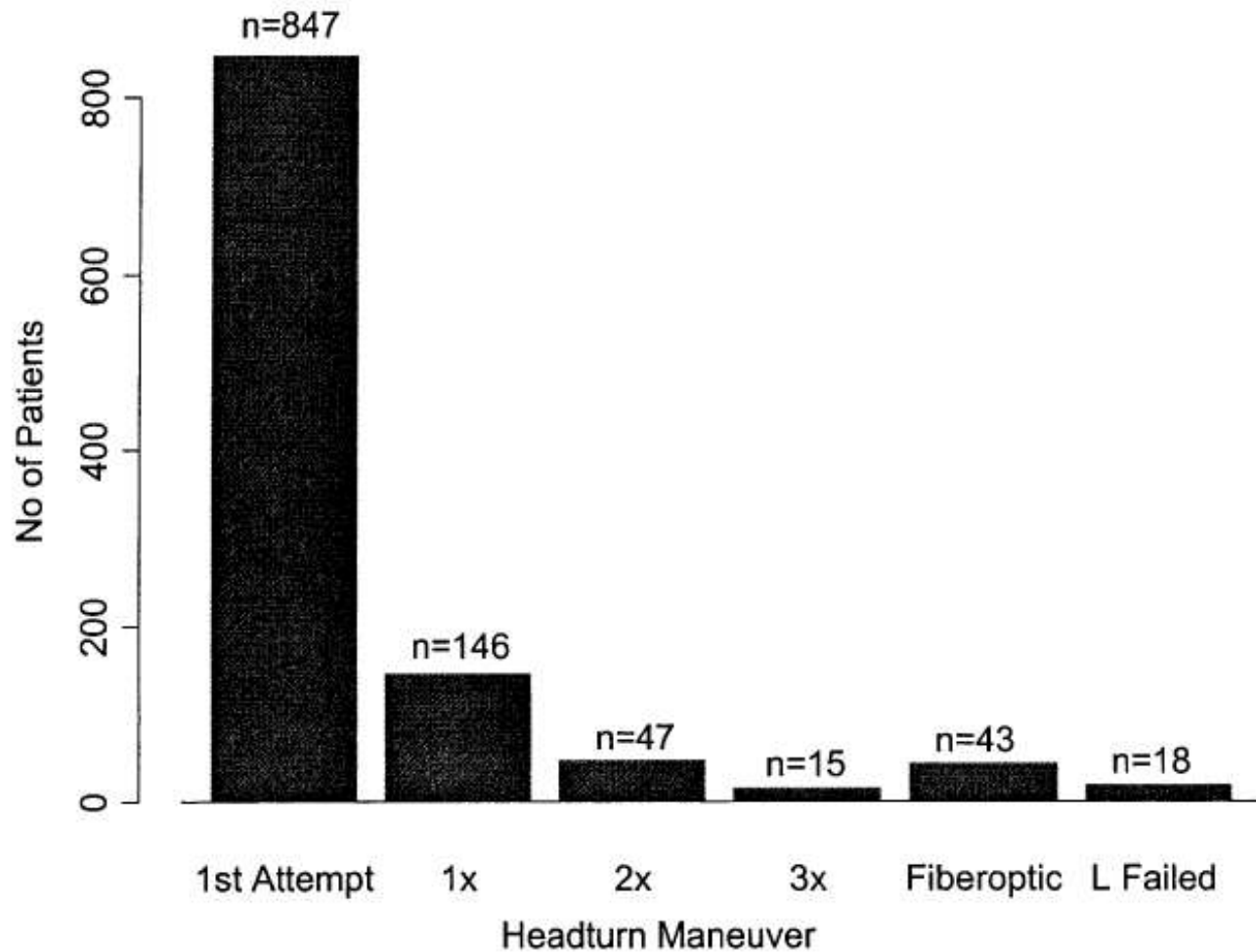
# Lung isolation



Resim 4. Sol çift lümenli tüpün optimal yerleşimi, grafik görüntüsü (A), trakeal lümeden (B) ve bronşiyal lümeden (C) bronkoskopik görüntü.

Hoşten T, Topçu S. Tuberk Toraks. 2011;59(4):416-26.

# Positioning Left DLBT





# Engage with the surgical team



# Pre explant

- ❖ DLT positioning, isolation, bronchus toilet, trial one lung ventilation
- ❖ Baseline hemodynamics, CO, SVO<sub>2</sub>, Pulmonary hemodynamics
- ❖ Baseline TOE, especially R heart, PV, LV contractility, CX territory
- ❖ Optimise hemodynamics for PA clamping

# Pre explant



**INOmax<sup>®</sup>**  
(nitric oxide) **FOR INHALATION**

Turn it on. Sooner.



# 1<sup>st</sup> Lung Explant

- ❖ Lung isolation, beware of hypoxia, CO<sub>2</sub> retention; hyperinflation of COPD lung, PTX
  - 1st decision CPB due to Resp Failure?
  
- ❖ Clamping the R PA
  - Sats should improve
  - Hemodynamic Stable?

# RV ASSESSMENT



# RV ASSESSMENT



# RV OVERLOAD





# 1<sup>st</sup> Lung Explant

- ❖ Lung isolation, beware of hypoxia, CO<sub>2</sub> retention; hyperinflation of COPD lung, PTX
  - 1st decision CPB due to Resp Failure?
  
- ❖ Clamping the R PA
  - Sats should improve
  - Hemodynamic UNStable? (PAP, RV, arrhythmias)
  - 2<sup>nd</sup> decision CPB due to PVR > RV failure

# IMPLANTATION, PRE REPERFUSION THINK CLINICAL

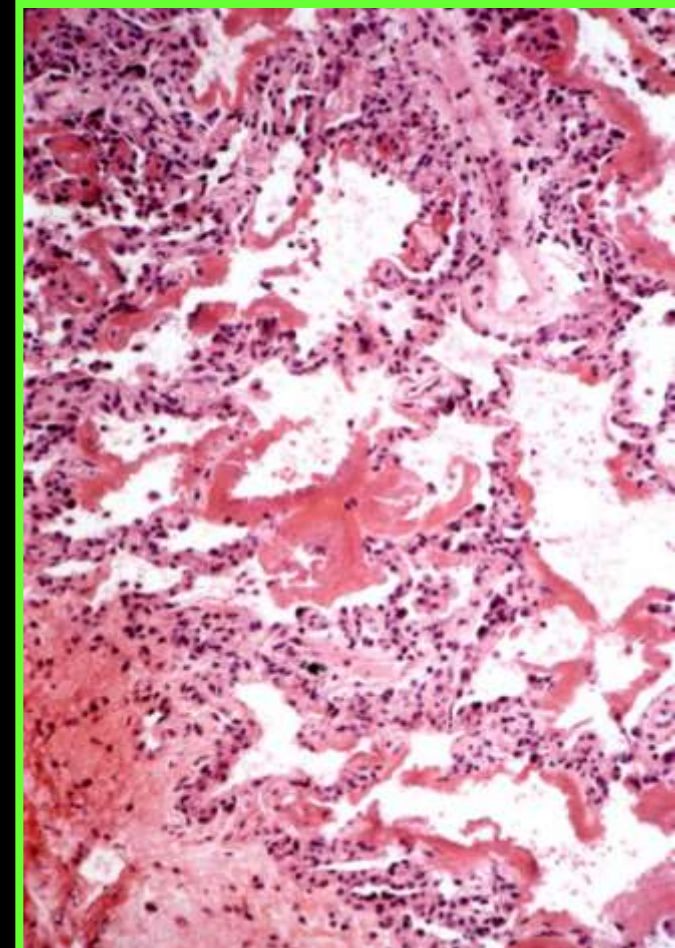
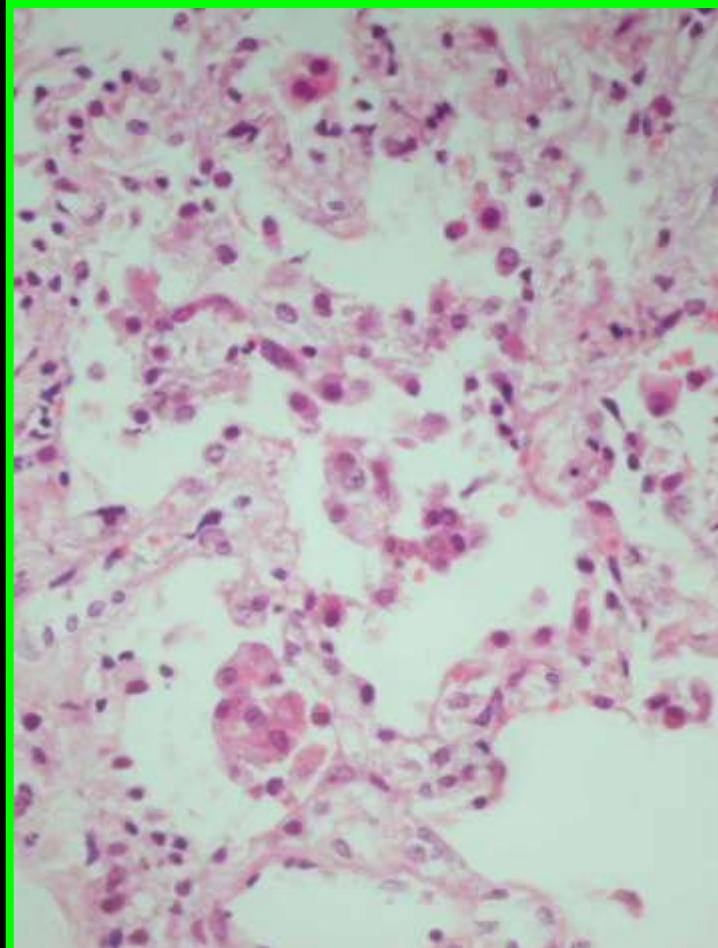
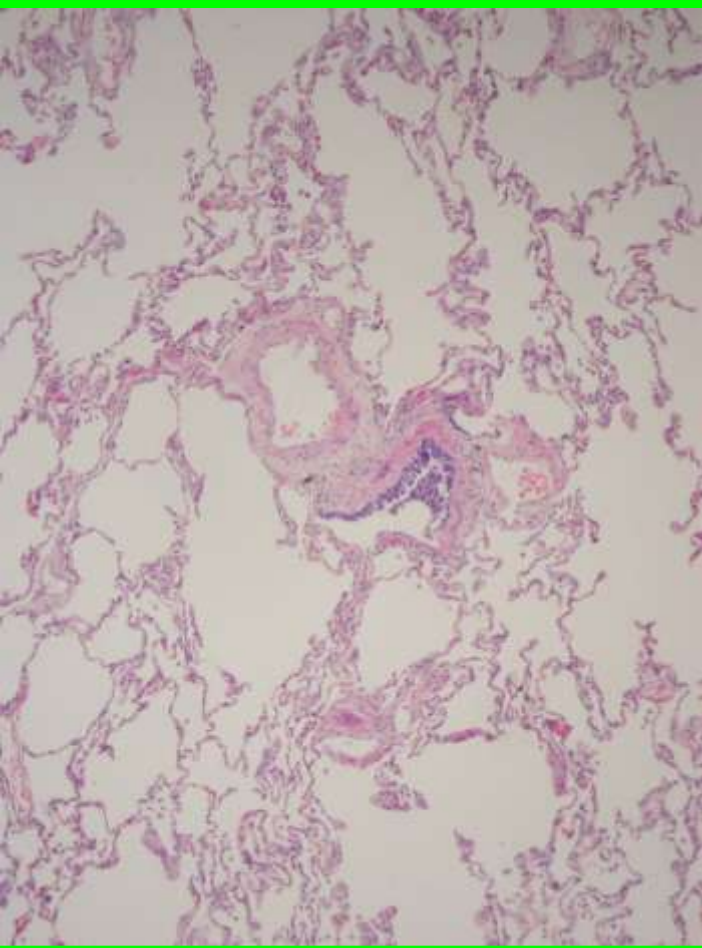
- ❖ Bronch for anastomosis and toilet
- ❖ Methylpred prior to reperfusion
- ❖ TOE
  - CHECK anastomosis
  - MONITOR of DE-AIRING
- ❖ PREPARE FOR SEVERE
  - HYPOXIA due to severe shunt
  - HYPOTENSION due to volume shift or massive bleed
- ❖ 3<sup>rd</sup> decision to go on CPB

# REPERFUSION: PROTECT THE GRAFT THINK BIOLOGICAL



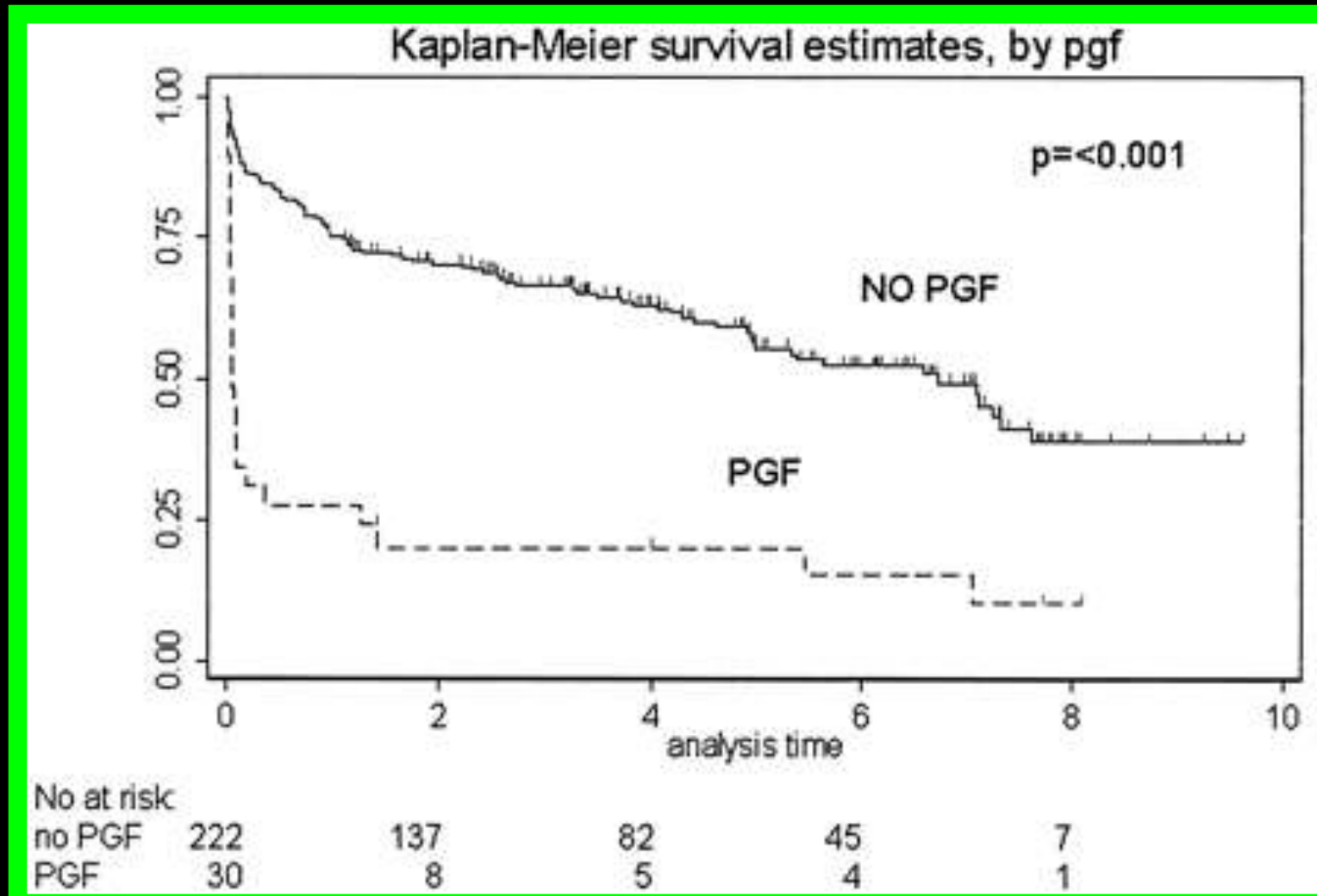


# PGD: Inflammatory response

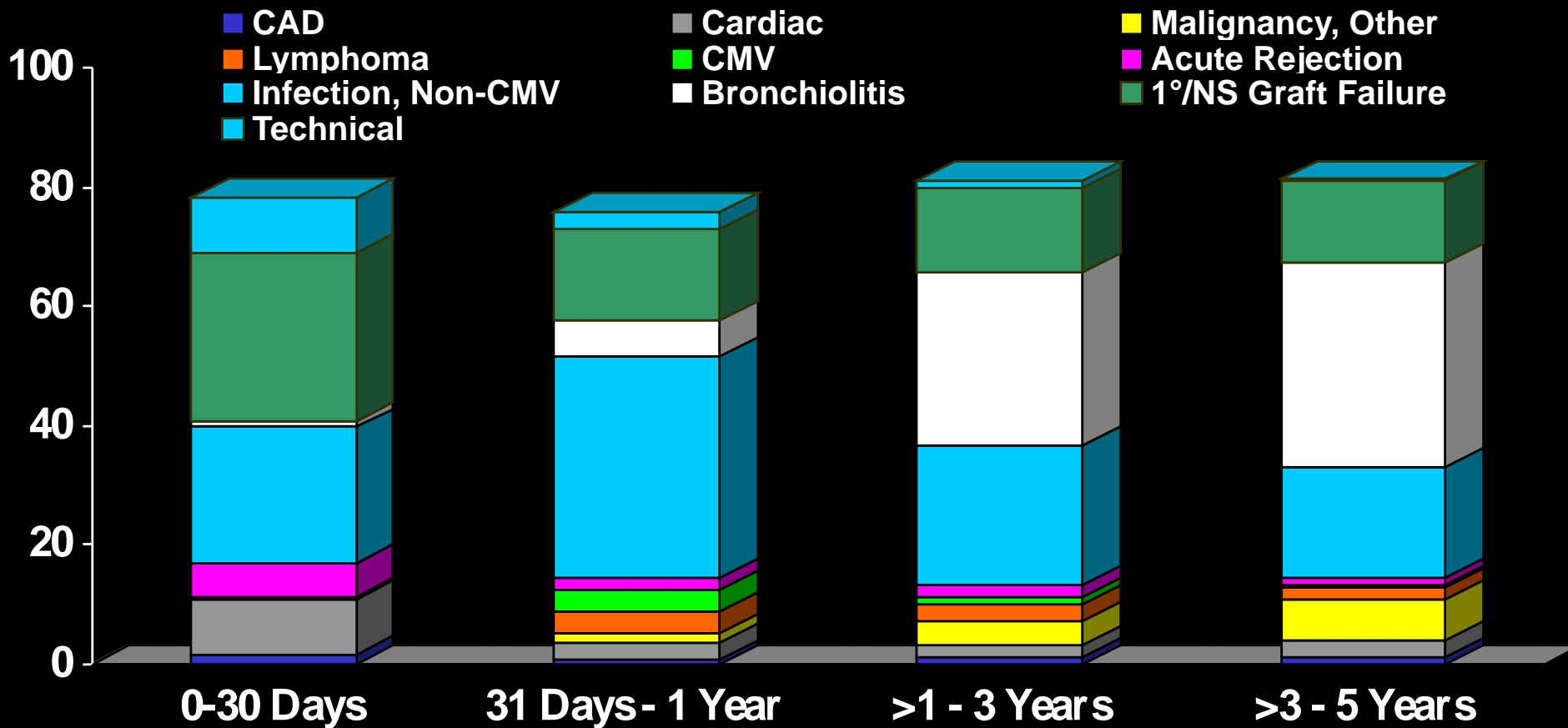


# Mortality following PGF

Christie et al, *Chest*. 2005;127:161-165



# LUNG TRANSPLANTS: CAUSE OF DEATH (1982-2000)

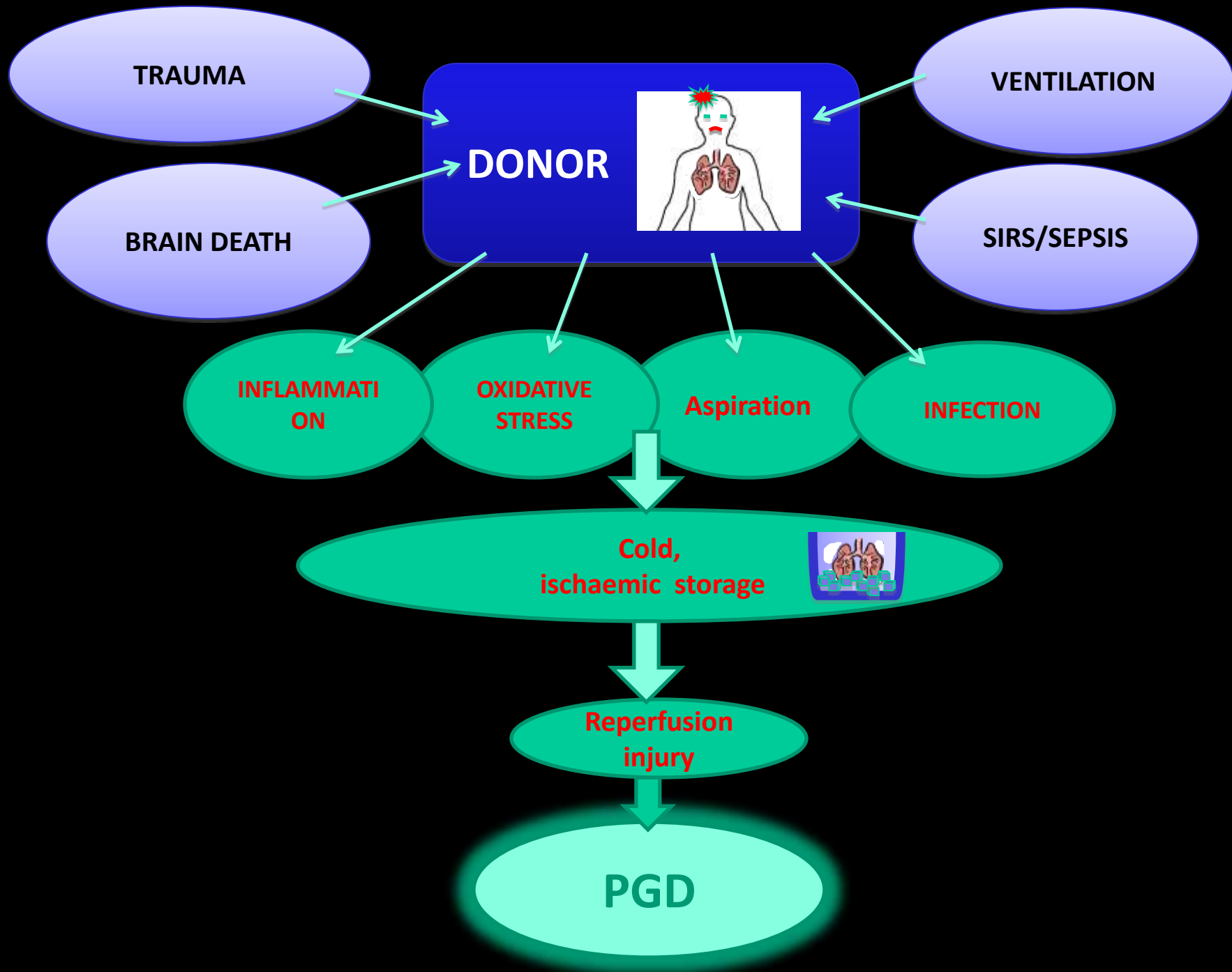


# PROTECT FROM REPERFUSION INJURY

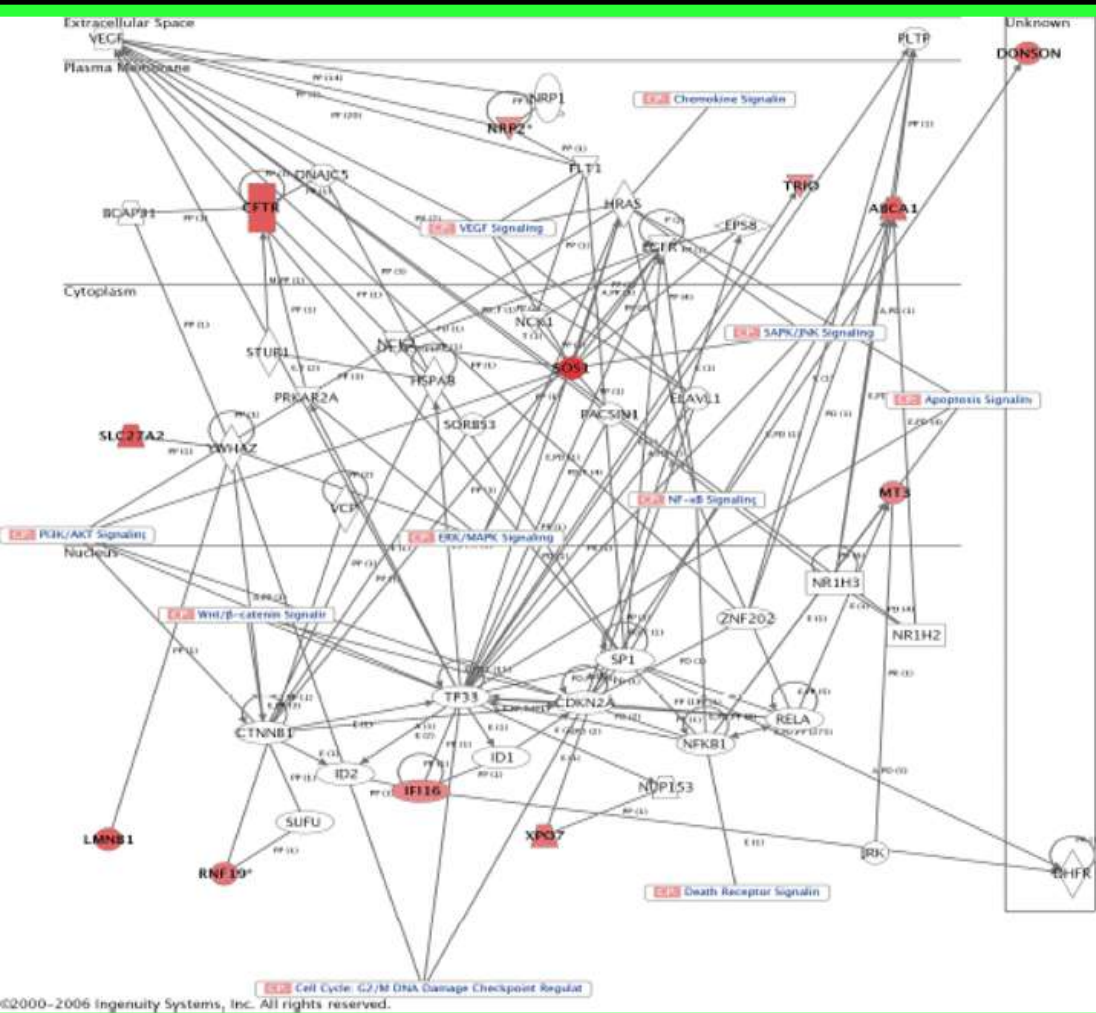
❖ “The die has been cast”

- Subclinical donor lung injury with inflammation and oxidative stress





# Gene profiling in human Lung Tx

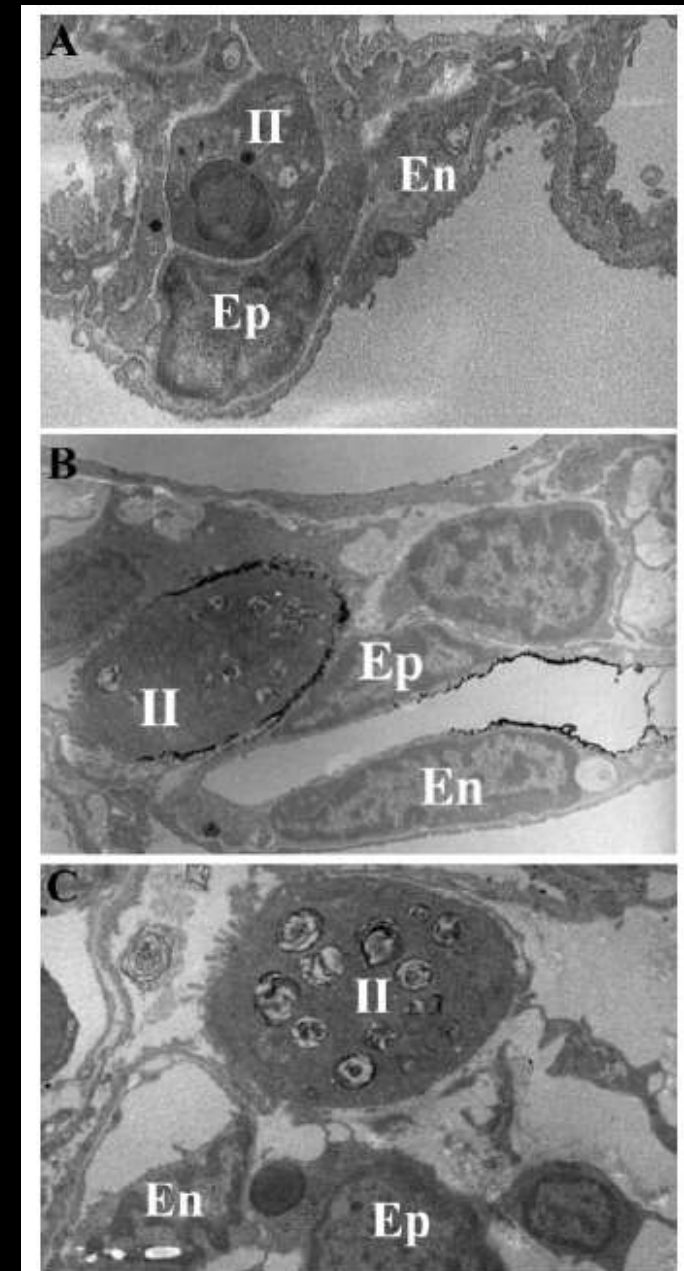
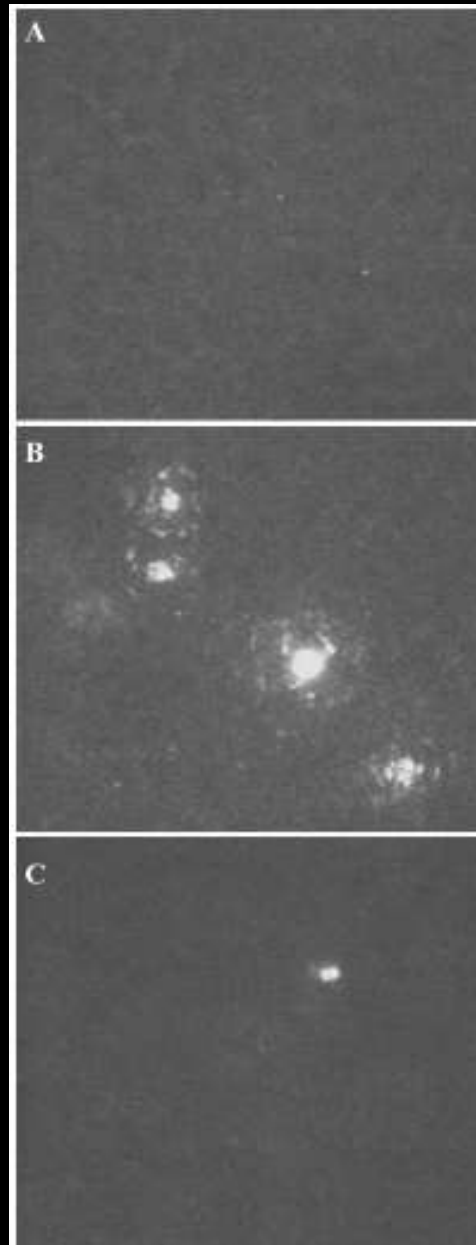


## ❖ Differential transcripts

- Oxidative stress
- apoptosis
- stress-activated pathways.

## ❖ Results also indicate the role of metallothionein 3

Free radical  
production  
during re-  
expansion

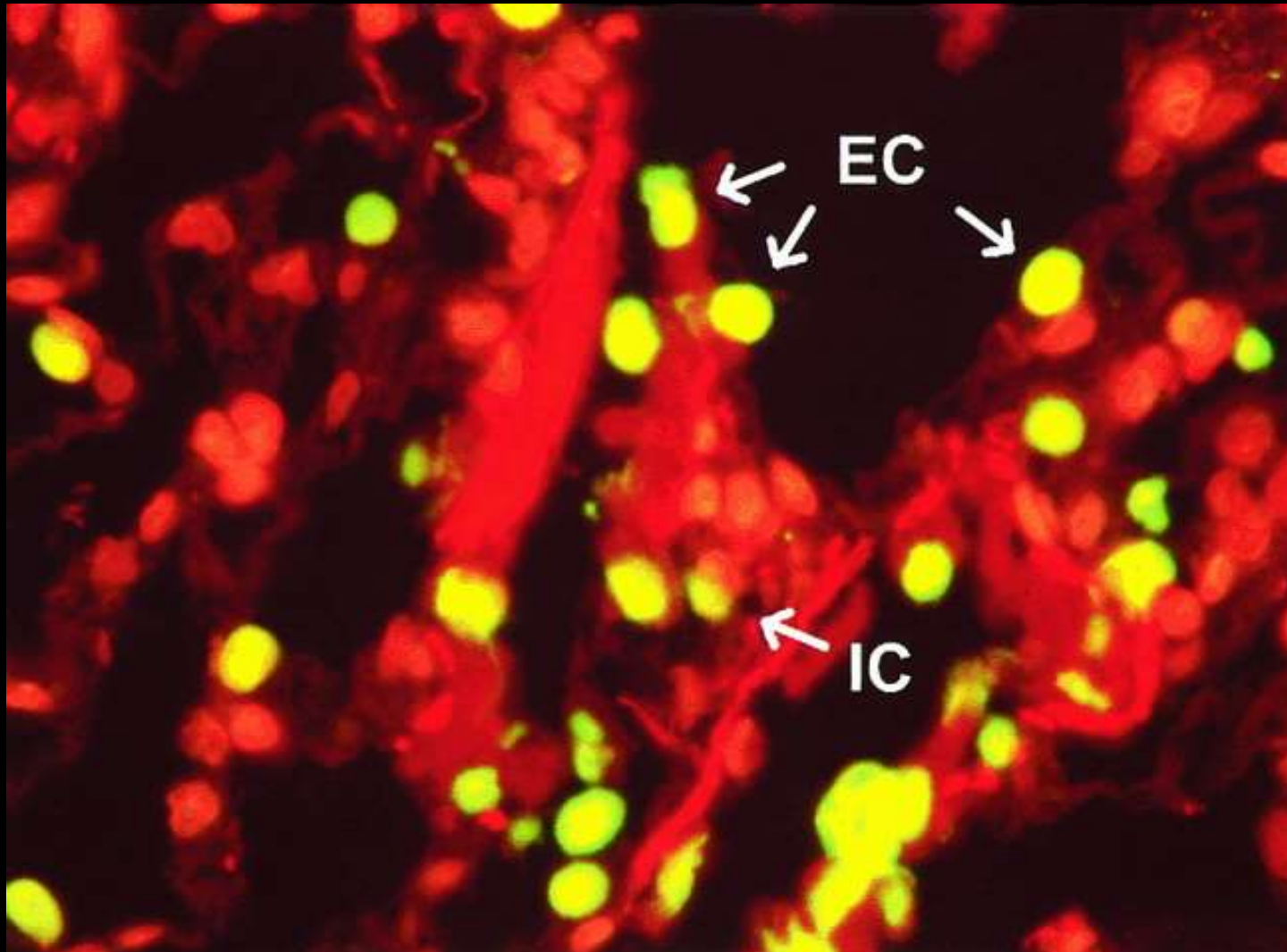


# PROTECT FROM REPERFUSION INJURY

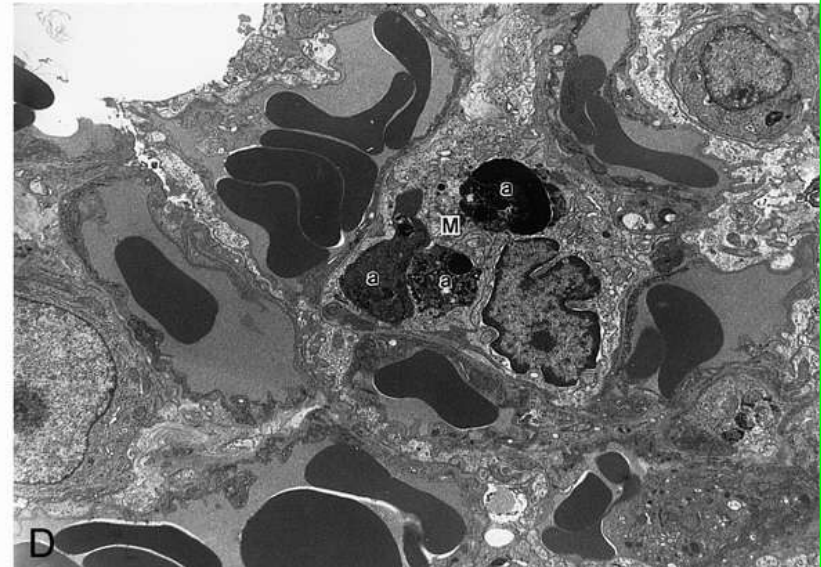
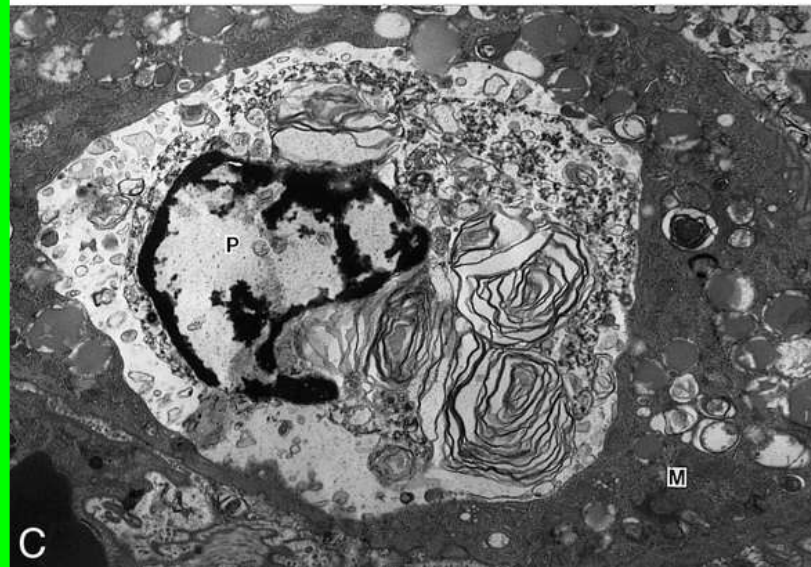
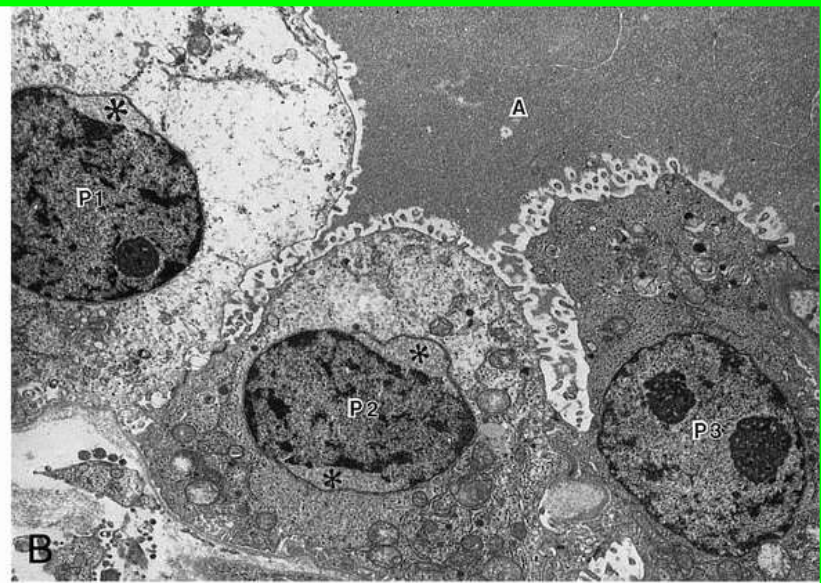
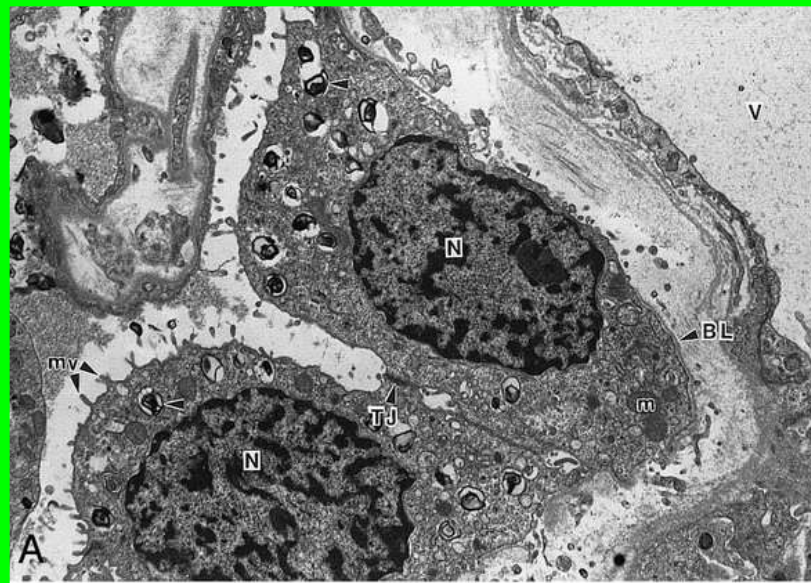
- ❖ The dice has been cast
  - Subclinical donor lung injury with inflammation and oxidative stress
- ❖ Many pulmonary cells are just about to die!



## 2 hours reperfusion: apoptosis

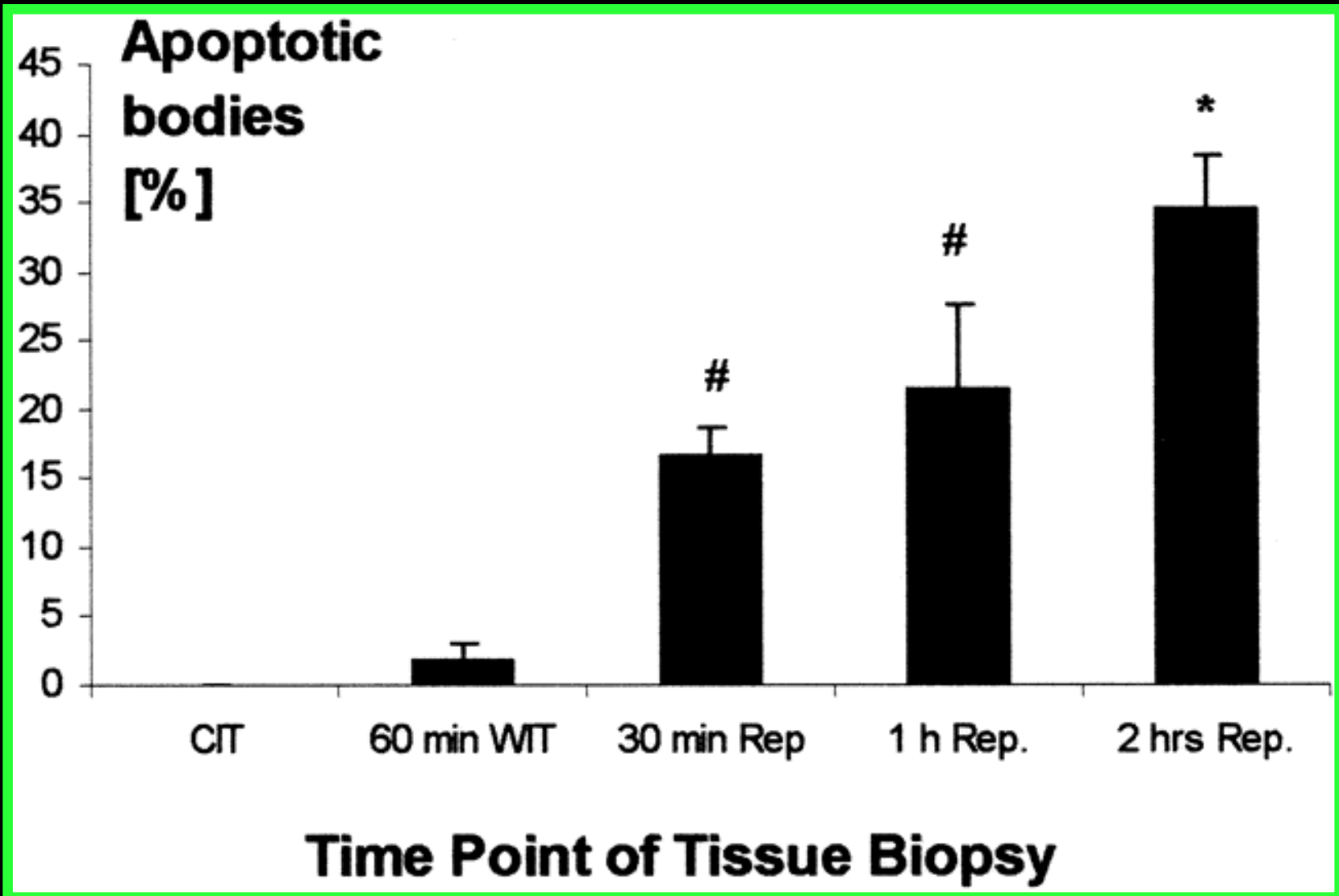


# Electron microscopy





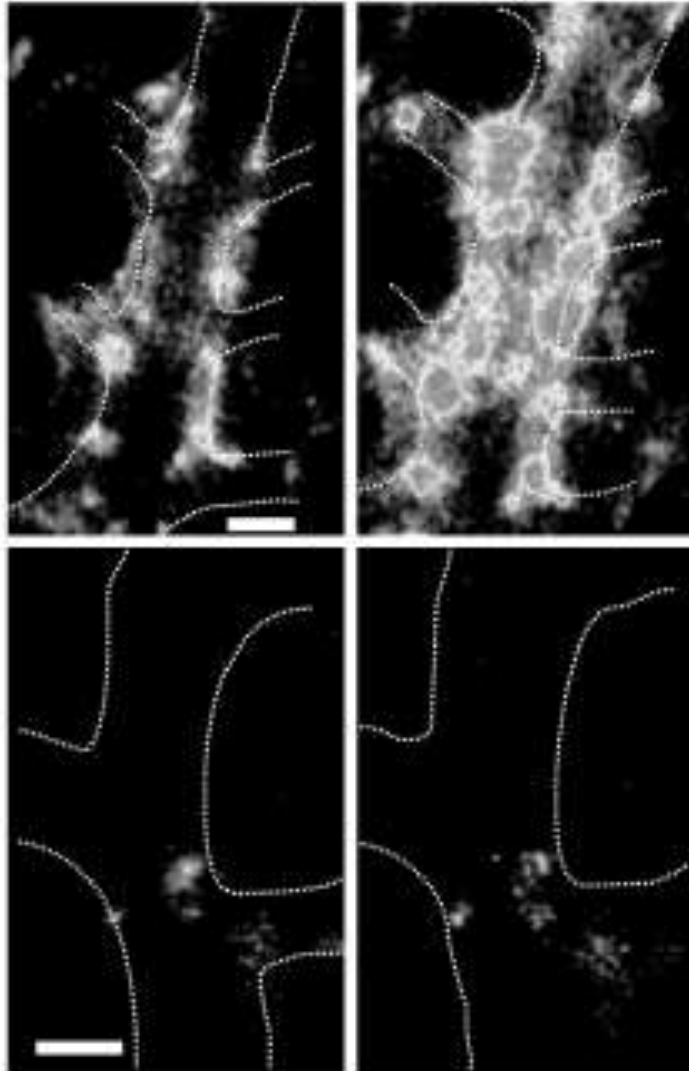
# Extent of apoptosis in Lung TX



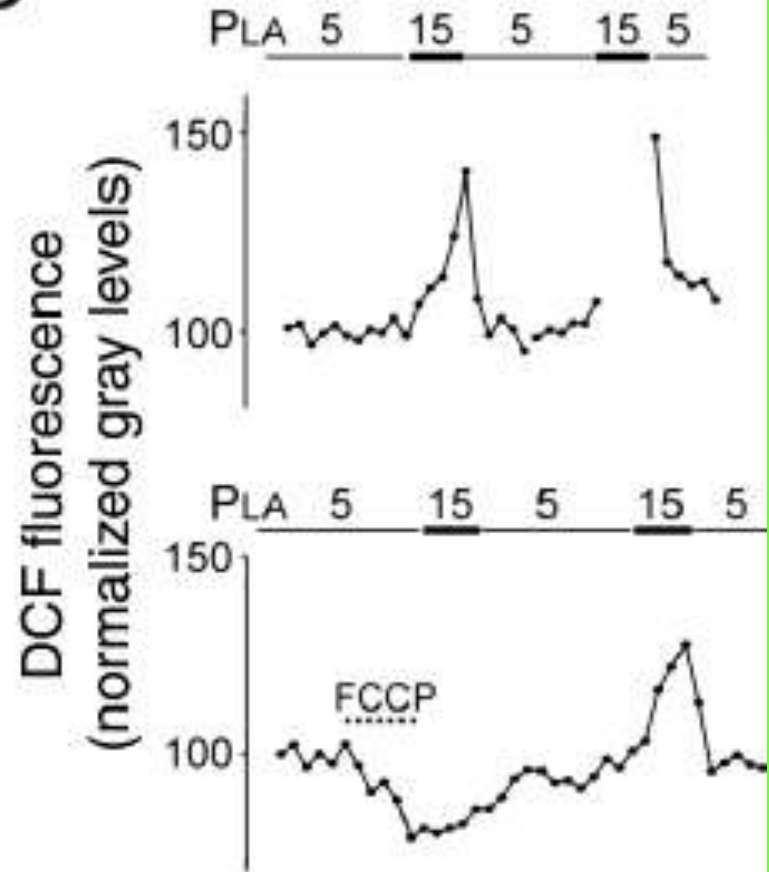
# PROTECT FROM REPERFUSION INJURY

- ❖ The dice has been cast
  - Subclinical donor lung injury with inflammation and oxidative stress
- ❖ Many pulmonary cells are just about to die!
- ❖ But you can make it worse or better
  - Hydrostatic forces, controlled reperfusion
  - hyperoxia



**a**PLA (cmH<sub>2</sub>O) 5

15

**b**

ORIGINAL ARTICLES: GENERAL THORACIC

# Lowering Reperfusion Pressure Reduces the Injury After Pulmonary Ischemia

Ari O. Halldorsson, MD, Michael T. Kronon, MD, Bradley S. Allen, MD, Shaikh Rahman, PhD, and Tingrong Wang, MD

Division of Cardiothoracic Surgery, Heart Institute for Children, Hope Children's Hospital, Oak Lawn, and The University of Illinois at Chicago, Chicago, Illinois

# Modified reperfusion in clinical lung transplantation: The results of 100 consecutive cases

Gabriel T. Schnickel, MD,<sup>a</sup> David J. Ross, MD,<sup>b</sup> Ramin Beygui, MD,<sup>a</sup> Ali Shefizadeh, BS,<sup>a</sup> Hillel Laks, MD,<sup>a</sup>  
Rajan Sagar, MD,<sup>b</sup> Joseph P. Lynch III, MD,<sup>b</sup> and Abbas Ardehali, MD<sup>a</sup>

*J Thorac Cardiovasc Surg* 2006;131:218-223

doi:10.1510/icvts.2009.211730

INTERACTIVE  
CARDIOVASCULAR AND  
THORACIC SURGERY

Interactive CardioVascular and Thoracic Surgery 9 (2009) 932-933

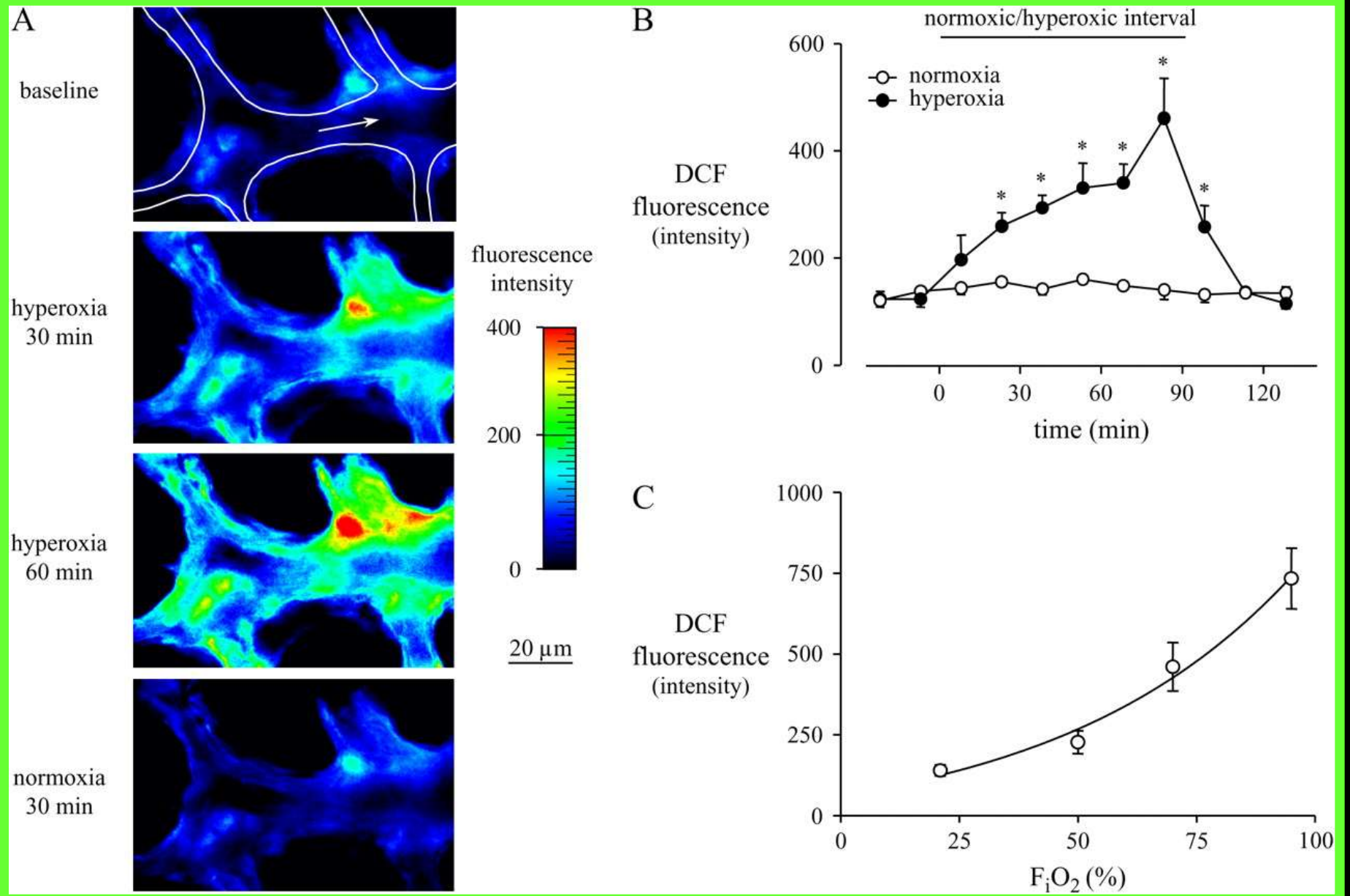
www.icvts.org

New ideas - Pulmonary

## Controlled antegrade single lung reperfusion during double lung transplant

Zain Khalpey\*, Michael S. Gilfeather, Phillip C. Camp Jr, Michael T. Jaklitsch

*Brigham and Women's Hospital, Harvard Medical School, Boston, MA 02115, USA*





# PROTECT FROM REPERFUSION INJURY

## ❖ Microvascular protection

- Apply control reperfusion (slow release of clamp)
- Control PAP pressures and LV diastolic dysfunction

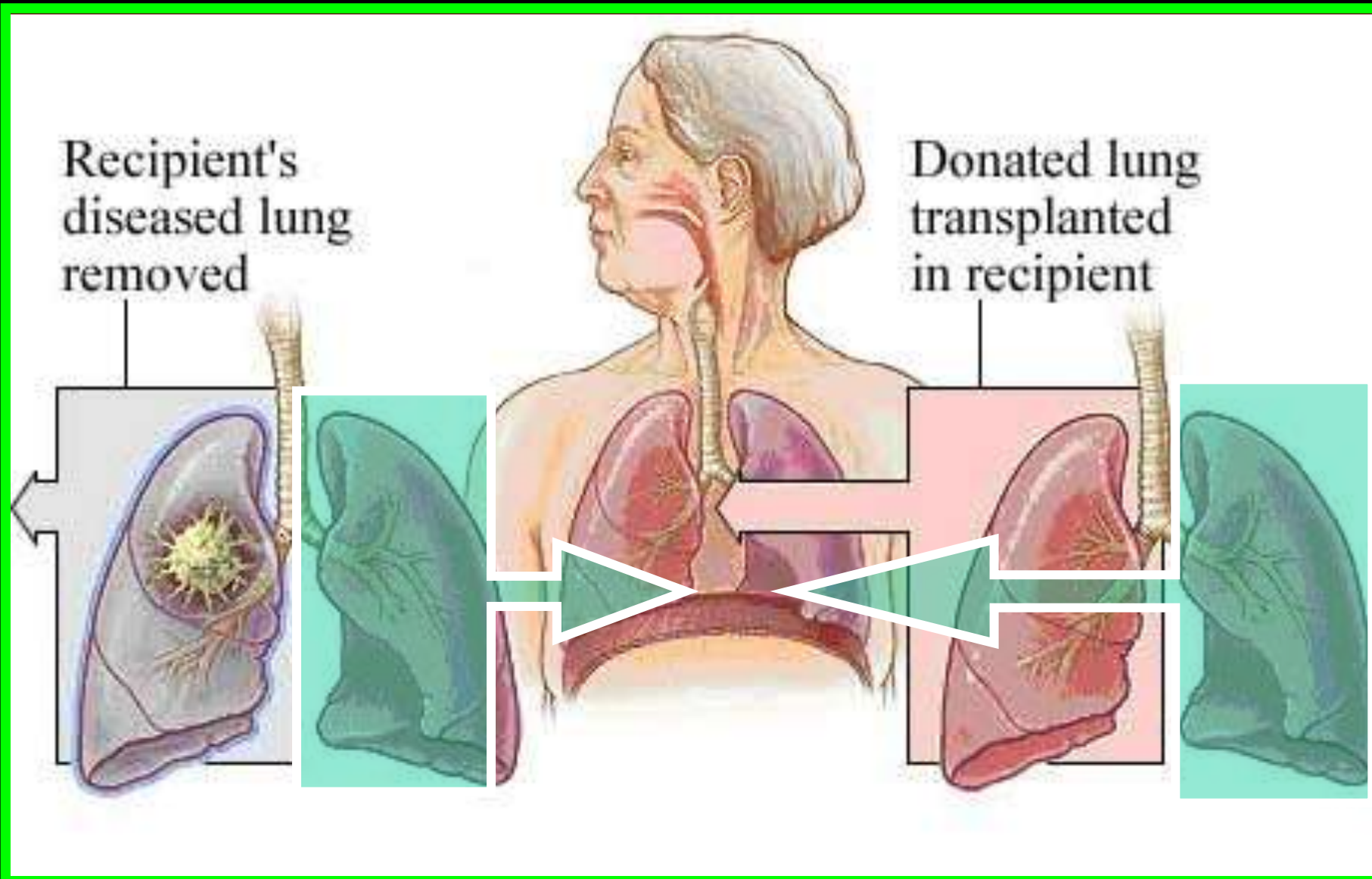
## ❖ Minimise biotrauma

- Protective lung ventilation strategies ( $V_t$ , PEEP, recruit)

## ❖ Influence oxidative stress and inflammation

- Consider biological agents, antioxidants NAC, iNO

# Bilateral sequential Lung TX



## 2<sup>nd</sup> Thoracotomy, explantation

- ❖ Dissection: Potential for new V-P mismatch
  - Avoid iNO to L lung
  - May need differential ventilation with AIR
- ❖ Clamping PA
  - RV overload depending on implanted lung PVR
  - Implanted lung pressure and volume overload
    - Oedema, reduced compliance, increasing hypoxia
- ❖ 4<sup>th</sup> decision to go on CPB



Surgical  
manupulations,  
Pushing on the  
heart



# L implantation = Cx OPCAB situation

- ❖ Table and Pt positioning
- ❖ Vasoconstrictors
- ❖ Volume optimisation
- ❖ Dialogue with surgeon
  
- ❖ Do not ignore impact on implanted lung
  - Pulm oedema
  - Worsening R lung mechanics



# *ANAESTHESIA FOR LUNG TRANSPLANTATION: EXCITING AND CHALLENGING*



- ❖ Critical edge of physiological reserve and tolerability
- ❖ Improved monitoring and management tools
- ❖ Safety of CPB
  
- ❖ Emerging biological concepts but limited biological tools





# VIGILANCE, COMMUNICATION

