



Course n°: (3)

# ALI/ARDS after pulmonary resections: etiology and management

Session V

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## ACUTE RESPIRATORY DISTRESS SYNDROME

(ARDS)

### Signs & Symptoms

Tachypnea  
Dyspnea  
Retractions  
Hypoxia  
Tachycardia  
↓ Pulmonary Compliance

### ABGs

↓  $P_{O_2}$  ↑ Dyspnea  
(Pt's NOT Getting Better, even with  $F_{I(O_2)}$ )



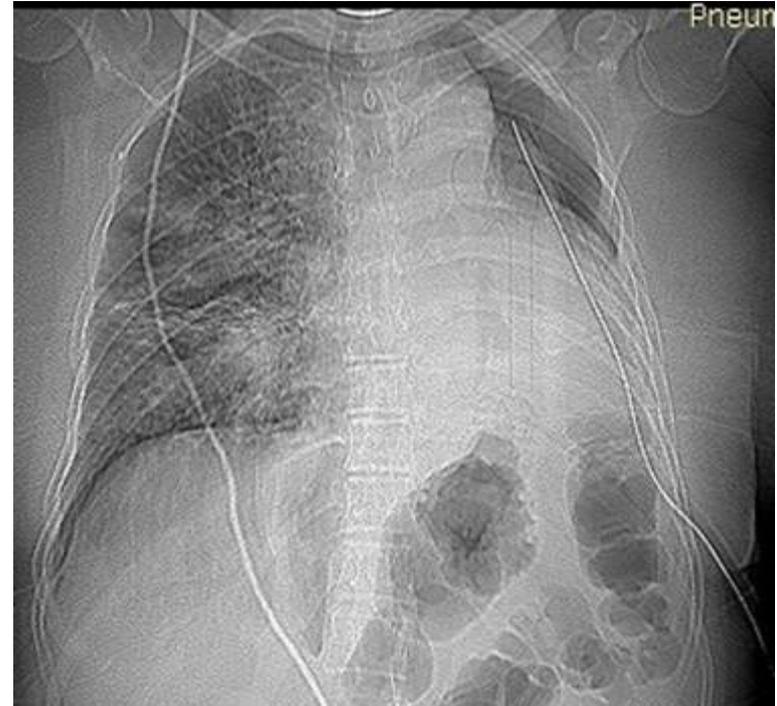
### Causes

- \* Trauma
- \* Pulmonary Infection/Aspiration
- \* Prolonged Cardiopulmonary Bypass
- \* Shock
- \* Fat Emboli
- \* Sepsis

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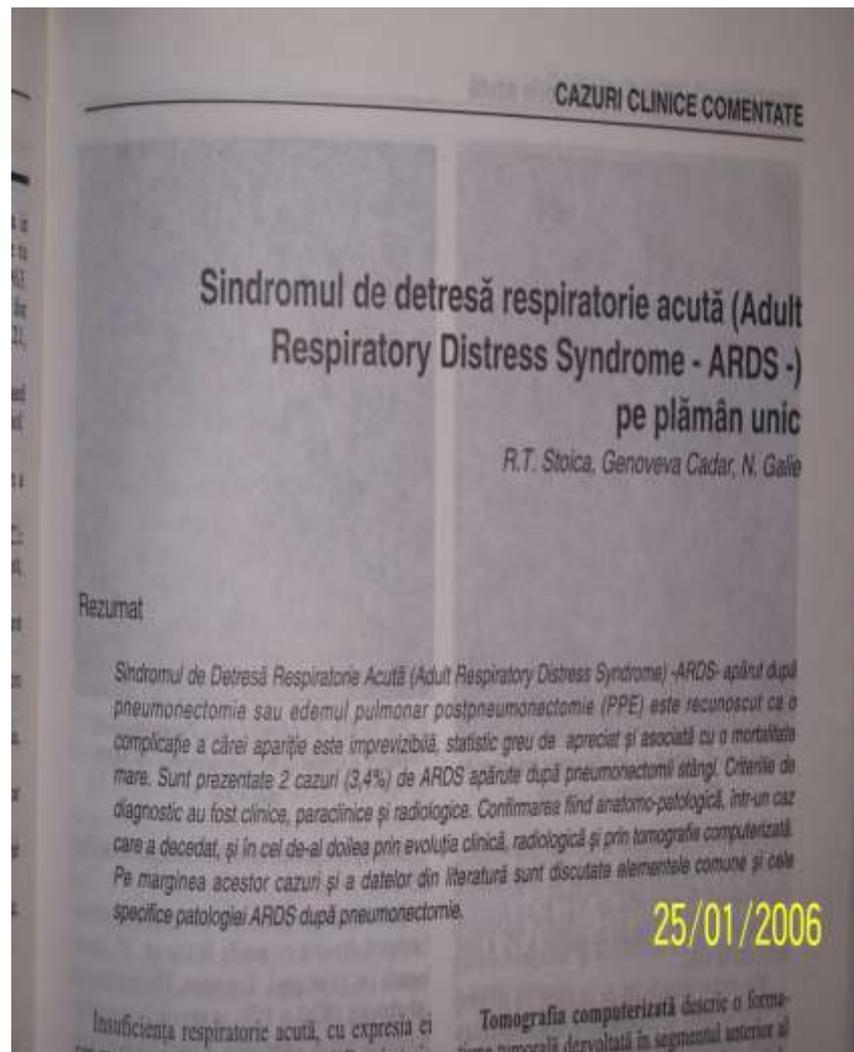
# Postpneumonectomy ARDS



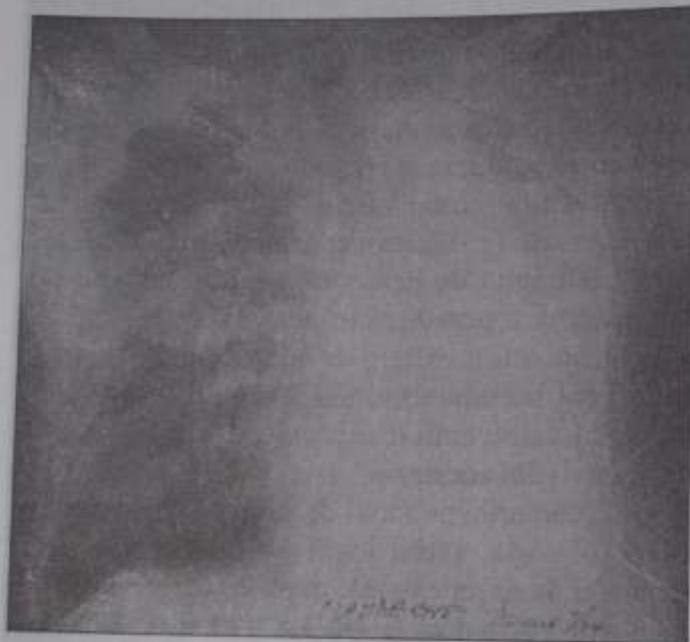
[J Thorac Cardiovasc Surg.](#) 1984 Mar;87(3):359-65.

**Postpneumonectomy pulmonary edema.**

[Zeldin RA](#), [Normandin D](#), [Landtwing D](#), [Peters RM](#).



... și unede. Securi de ...  
 fost 1,8. Se reinstituie VM cu SIMV alternând în  
 timpul zilei cu ASB- cu PEEP de 5-7cmH<sub>2</sub>O, și  
 FiO<sub>2</sub> de 0,4-0,6. Bronhoscopic se evidențiază  
 secreții minime, din aspiratul bronșic culturile  
 fiind sterile.

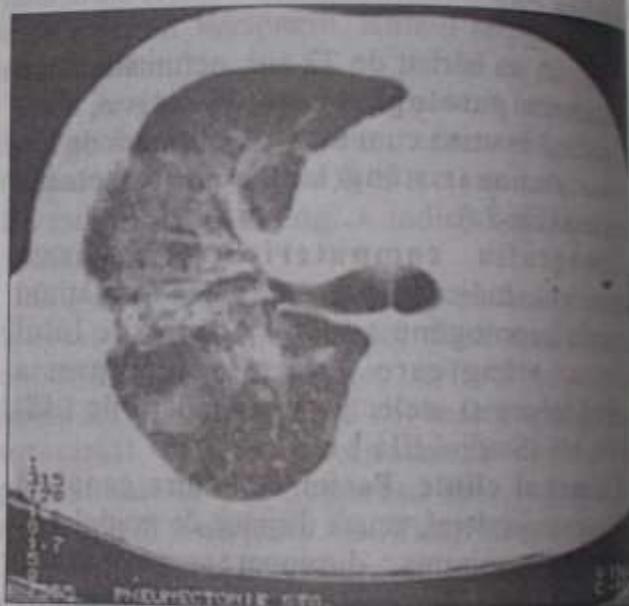


*Fig. 2b. M.D., bărbat, 72 ani, a 3-a zi postoperator cu imagine de ARDS*

trabeculare.

### Discuții

ARDS este o formă de insuficiență respiratorie acută în care modificările schimburilor gazoase pulmonare duc la hipoxemie severă și sunt datorate edemului pulmonar necardiogen, rezolu-



*Fig. 3a*

# ARDS after pulmonary resections

**How often**

Etiology

Diagnosis

Prevention and treatment

Mortality

Incidence of ALI/ARDS postoperative 3,1% (44 from 1428 patients with curative lung resections for cancer (jan 2001- june 2004). (Sloan-Kettering Cancer Center, NY)

*CHEST | 103 | 6 | JUNE, 1993*

*W Sherman: Postpneumonectomy Pulmonary Edema. A Retrospective Analysis of Associated Variables*

*Incidence of 2,6%. 21 patients from 806 pneumonectomies from 1977-1988. (Mayo Clinic)*

*CHEST 2006; 130:73–78*

*Dulu A et al: Prevalence and Mortality of Acute Lung Injury and ARDS After Lung Resection*

Prevalence ALI/ARDS: postpneumonectomy 2,45%, lobectomy 2,96%, sublobar resections 0,99% (2192 resections(2002-2004)

**- South-corean study:**

**Postpneumonectomy ALI / ARDS developed within the first postoperative week in 18 (12%) patients!!**

*Jeon K et al Risk factors for post-pneumonectomy acute lung injury/acute respiratory distress syndrome in primary lung cancer patients. Anaesth Intensive Care 2009 Jan;37(1):14-9.*

**- British Study:**

**Incidence and mortality compared in two periods:**

***1991-1997 and 2000-2005***

**The incidence and mortality from ARDS had fallen significantly over the two study periods (incidence from 3.2% to 1.6%,  $p = 0.01$ ; mortality from 72% to 45%,  $p = 0.05$ )**

*Tang SSK et al, The mortality from acute respiratory distress syndrome after pulmonary resection is reducing: a 10-year single institutional experience, European Journal of Cardio-thoracic Surgery 34 (2008) 898—902*

# ARDS after pulmonary resections

**How often**

**Etiology**

**Diagnosis**

**Prevention and treatment**

**Mortality**

# Etiology?

## Excessive perioperative fluid administration

*Licker M, al. Risk factors for acute lung injury after thoracic surgery for lung cancer. Anesth Analg 2003; 97:1558-1565.*

## Previous treatment with radiotherapy

*Parquin F, Marchal M, Mehiri S, et al. Post-pneumonectomy pulmonary edema: analysis and risk factors. Eur J Cardiothorac Surg 1996;10:929–32*

## Duration of operation

*Turnage WS, Lunn JJ. Postpneumonectomy pulmonary edema. A retrospective analysis of associated variables. Chest 1993; 103:1646-1650.*

## Right-sided pneumonectomy

*Kutlu CA et al. Acute lung injury and acute respiratory distress syndrome after pulmonary resection. Ann Thorac Surg 2000;69:376–80.*

## High intraoperative airway pressure (Paw)

*K. Leon et al.: Anesthesia and Intensive care, Jan 2009: Risk factors for post-pneumonectomy acute lung injury/acute respiratory distress syndrome in primary lung cancer patients*

Other risk factors for ALI after thoracotomy:

COPD, postop  $FEV_1 < 45\%$ , ppo lung perfusion  $< 55\%$  vs preop, no previous physiotherapy, alcohol abuse, male sex, age  $> 60$ , intraoperative fluid administration  $> 2L$ , fresh frozen plasma administration

*$FEV_1$  in the multivariate analysis:*

- *decreased postoperative predicted lung function and increased perioperative fluid administration remained independent predictors of postoperative lung injury.*
- *predicted decreased ppoDlco remained a significant, independent risk factor.*

*Alam N et al Incidence and Risk Factors for Lung Injury After Lung Cancer Resection Ann Thorac Surg 2007;84:1085–91*

The pathogenesis of post-pneumonectomy ALI/ARDS is not fully understood.

# ARDS after pulmonary surgery: risk factors

Risk factors: peri-operative	Direct surgical pulmonary tissue injury Transfusion of blood products (TRALI) Ischemia-reperfusion lesions Volutrauma during one lung anesthesia Slowing the lymphatic drainage Innapropriate thoracic drainage
Other risk factors	Pulmonary capillary bed reduction with edema and increased alveolo-capillary permeability Chronic acoolism Pulmonary dysfunction (moderate –severe) Advanced age Oncologic therapy High ASA score Others...

An increase in blood flow through the remaining lung in some patients may promote disruption of the capillary endothelial cell- alveolar cell barrier, allowing protein-rich fluid to flood the alveolus.

Mathru M et al Permeability pulmonary edema following lung resection. Chest 1990; 98:1216-18

Mediators of inflammation, such as leukotrienes, platelet-activating factor, and various other cytokines, cause an increase in pulmonary capillary pressure without a change in capillary permeability. ...Even though inflammation and increased permeability may be prominent features of ARDS, the formation of edema fluid is increased by increases in pulmonary capillary hydrostatic pressure.

Cope DK et al. Pulmonary capillary pressure: a review. Crit Care Med 1992; 20:1043-56

**DR NAVEED ALAM (Memorial Sloan-Kettering Cancer Center, NY): Certainly in the initial experiments by Dr Zeldin he thought that it was related to some form of increased permeability of the capillaries and increased hydrostatic effects. And some physiologic studies with animals have been done. But I do not think we really know. I think the consensus now is that this is really just another form of ARDS (acute respiratory distress syndrome) with the inciting factor being surgical lung trauma.**

**So.....**

# ALI/ARDS after pulmonary resections

## The conceptual model of ARDS

- ARDS is the type of acute lung injury associated with recognized risk factors characterized by inflammation leading to increased pulmonary vascular permeability and loss of aerated lung tissues.
- The hallmarks of clinical syndrome are hypoxemia and bilateral radiographic opacities on standard chest X-ray or CT scan. ARDS is associated with recognized risk factors characterized by inflammation.
- Physiological derangements includes: increased pulmonary venous admixture, increased physiological dead space, decreased pulmonary compliance
- Morphological hallmarks are: lung edema, inflammation, hyaline membrane and alveolar hemorrhage.

*(Dr Andrei Schwartz, ARDS Berlin Definition.2011. Is more usefully ? ppt )*

# ARDS after pulmonary resections

How often

Etiology

**Diagnosis**

Prevention

Mortality

Update

# Diagnosis

***Post-pneumonectomy ALI/ARDS begins a few days after surgery:***

The mean time from operation to presentation with ALI was  $5.2 \pm 1.7$  days and for ARDS  $4.2 \pm 1.1$  days (Kutlu et al)

***Diagnosis criteria for ALI/ARDS:***

- ***American-European Consensus Conference on ARDS (1994)***
- ***Berlin Definition 2011***

Sometimes difficult to appreciate the PAWP after pneumonectomy

Pumonary Hypertension and Congestive heart disease may co-exist

*Ranieri VM et al, Acute respiratory distress syndrome: the Berlin Definition. ARDS Definition Task Force. JAMA. 2012 20:2526-33*

- 356 With ALI/ARDS Berlin definition and necroptic examination: 159 (45%) with histopathological lesions of DAD (diffuse alveolar damage) compatible with ALI/ARDS.
- Histopathological confirmation is proportional with severity of the illness
- 14% of cases had normal lungs
- Regarding histopathological confirmation sensitivity and specificity of ALI/ARDS diagnosis (Berlin criteria) was 89%, respectively 63%

*Thille AW, Esteban A, Fernandez-Sergoviano P et al, Comparison of the Berlin definition for the acute respiratory distress syndrome with autopsy, Am J Respir Crit Care Med, 2013; 187:761-767*

# ARDS after pulmonary resections

How often

Etiology

Diagnosis

**Prevention and treatment**

Mortality

# Prevention and treatment

Early admission in ICU

Prevention : risk factors!

- Excessive preoperative fluid administration (Zeldin)  
*(increasing fluid administration causes injury or is an effect of the injury itself !?)*
- *Should the patients be kept “dry” ?*

High dose steroids? No!! (ARDS Clinical Trial Network)

*Cerfolio et al. reported on the administration of steroids before ligation of the pulmonary artery in patients undergoing pneumonectomy, suggesting that this strategy reduced the incidence of post-pneumonectomy ARDS!*

*Intraoperative Solumedrol helps prevent postpneumonectomy pulmonary edema. Ann Thorac Surg 2003;76:1029–35.*

# What about protective ventilation?

Protective ventilatory strategy during OLV decreases the proinflammatory response, improves lung function and results in earlier extubation

*Michelet P et al. Protective ventilation influences systemic inflammation after esophagectomy: a randomized controlled study. Anesthesiology 2006; 105:911-919.*

32 patients who underwent lung resection: the levels of inflammatory markers in bronchoalveolar lavage fluid were higher after OLV with a  $V_T$  of 10 ml/kg vs. 5 ml/kg

*Schilling T et al. The pulmonary immune effects of mechanical ventilation in patients undergoing thoracic surgery. Anesth Analg 2005; 101:957-965*

***Recruitment manoeuvres: at the beginning of the intervention or when starting OLV!***

# ARDS after pulmonary resections

How often

Etiology

Diagnosis

Prevention and treatment

**Prognosis and Mortality**

# Mortality

Mortality rate 40% (20 patients/50), 50% after pneumonectomy, 42% after lobectomy and 22% after sublobar resections (*A.Dulu, Chest,2006*)

*Increased age associated with higher mortality*

*Marginally significant association between mortality and time of presentation to the ICU after surgery (p 0.06).*

To prevent stump fistula (high pressure) it may be necessary HFJV or DLT intubation

*(S. Turnage, Chest 1993)*

Mortality 64,4% ALI/ARDS after pulmonary resections.

*(Kutlu 2000)*

*Berlin ALI/ARDS definition: mortality of any ALI/ARDS etiology is in mild forms 27%, 32% and respectively și 45% in moderate and severe forms*

Ranieri VM, Rubenfeld GD, Thompson BT et al, Acute respiratory distress syndrome: the Berlin Definition. ARDS Definition Task Force. *JAMA*. 2012 20;307(23):2526-33

# Conclusions

**ALI/ARDS post pulmonary resection: severe condition with high mortality**

**Rapid ICU admission and treatment on mechanical ventilation**

**Prevention strategies?**

# CEEA Identifying patients with risk factors



# Surgical sparing strategies ?



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# CEEA Protective ventilation during OLA

Before Recruitment Man

After RM with 7cm H2O PEEP

Patient ID <i>COMANEER</i>		Patient ID <i>COMANEER</i>		Sex	Physician	Location
Birthdate		Birthdate				
Age		Age				
<b>SYRINGE SAMPLE ACID/BASE 37°C</b>						
pH	7.340	pH	7.349			
pCO2	41.5	pCO2	39.1	mmHg		( 7
pO2	67.2	pO2	299.5	mmHg		(
HCO3-act	21.9	HCO3-act	21.1	mmol/L		
HCO3-std	21.4	HCO3-std	21.0	mmol/L		
ctCO2	23.2	ctCO2	22.3	mmol/L		
BE(B)	-3.6	BE(B)	-4.2	mmol/L		
BE(ecf)	-3.9	BE(ecf)	-4.6	mmol/L		
<b>OXYGEN STATUS 37°C</b>						
ctHb	6.8	ctHb	6.3	g/dL		(
Hct	20	Hct	19	%		
ctO2(a)	8.9	ctO2(a)	9.4	mL/dL		(
BO2	9.1	BO2	8.5	mL/dL		(
pO2	67.2	pO2	299.5	mmHg		(
sO2	95.4	sO2	99.7	%		(
F02Hb	92.1	F02Hb	96.6	%		(
FCOhb	3.3	FCOhb	2.0	%		(
FMethb	0.2	FMethb	0.3	%		(
FHHb	4.4	FHHb	0.3	%		(

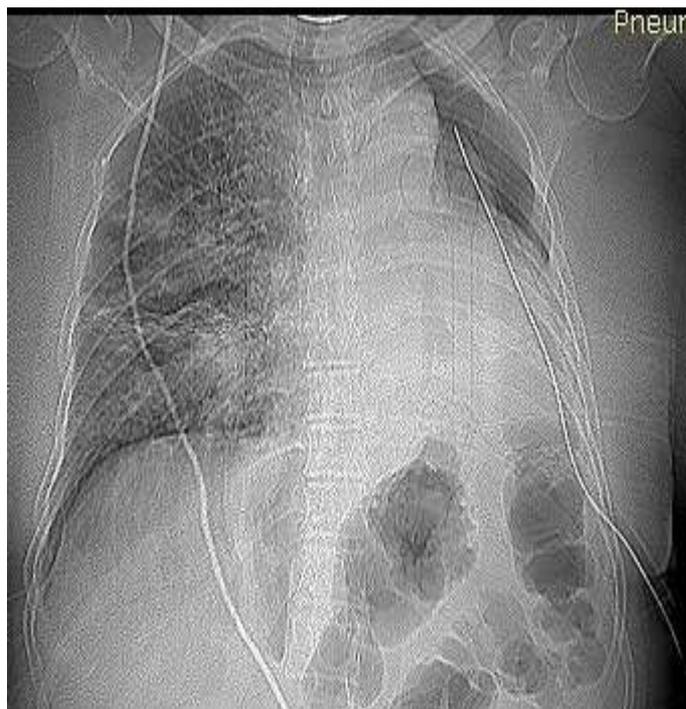
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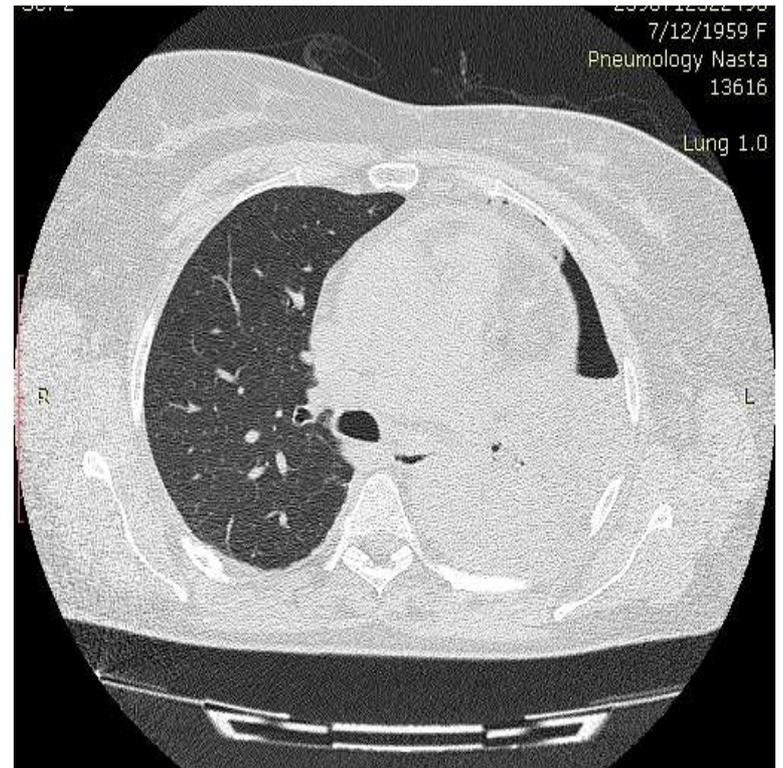
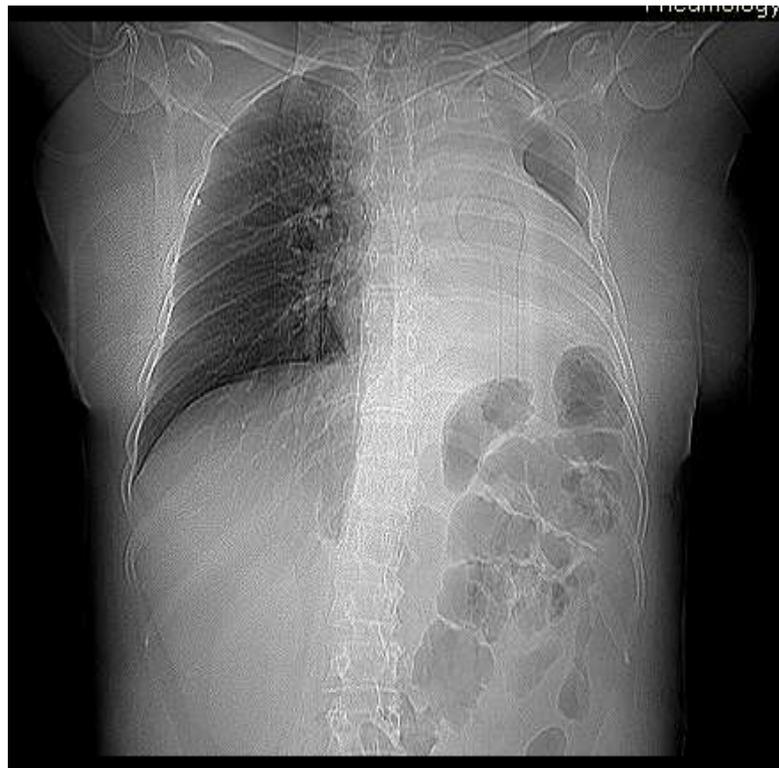
## **Descending trend of ALI/ARDS after pulmonary resections:**

- reducing the number of pneumonectomies (better cancer staging and oncologic therapy)**
  
- Protective strategies of ventilation during OLA and MV in ALI ARDS patients**

# ARDS post left Pneumectomy

DM. F, 55 y





# C.V, 64 y, ARDS after left pneumonectomy

