22th Congress of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society

ERAS in thoracic surgery

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* No conflict of interests declared

Agenda

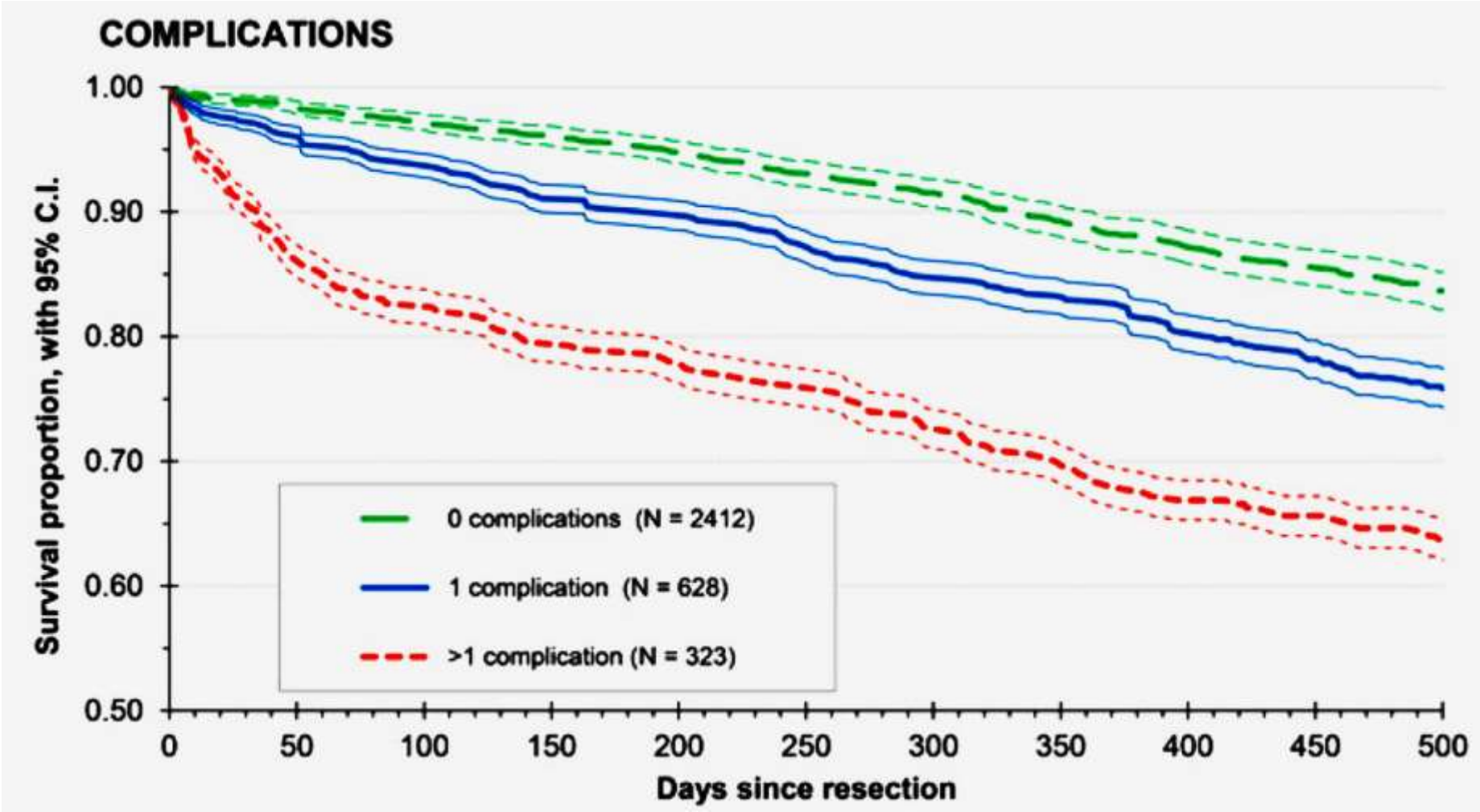
- Thoracic surgery – Morbidity and Mortality
- ERAS after thoracic surgery
- Summary

STS Database Risk Models

- 18.800 lung resections
- 2/3 Thoracotomy / Lobectomy
- > 25% smoker, 75 % ASA 3
- Mortality: 413 patients (2.2%)
- Morbidity: 1.491 patients (7.9%)
  - Pneumonia (n = 722)
  - Re-intubation (n = 654)
  - Mechanical ventilation > 48 hours (n = 176)
  - ARDS (n = 220)
  - Myocardial infarction (n = 67)

Kozower BD et al. Ann Thorac Surg 2010;90:875– 883

The mortality after surgery in primary lung cancer: results from the Danish Lung Cancer Registry†



Green A et al. Eur J Cardio-Thorac Surg 2016;49:589-594

Agenda

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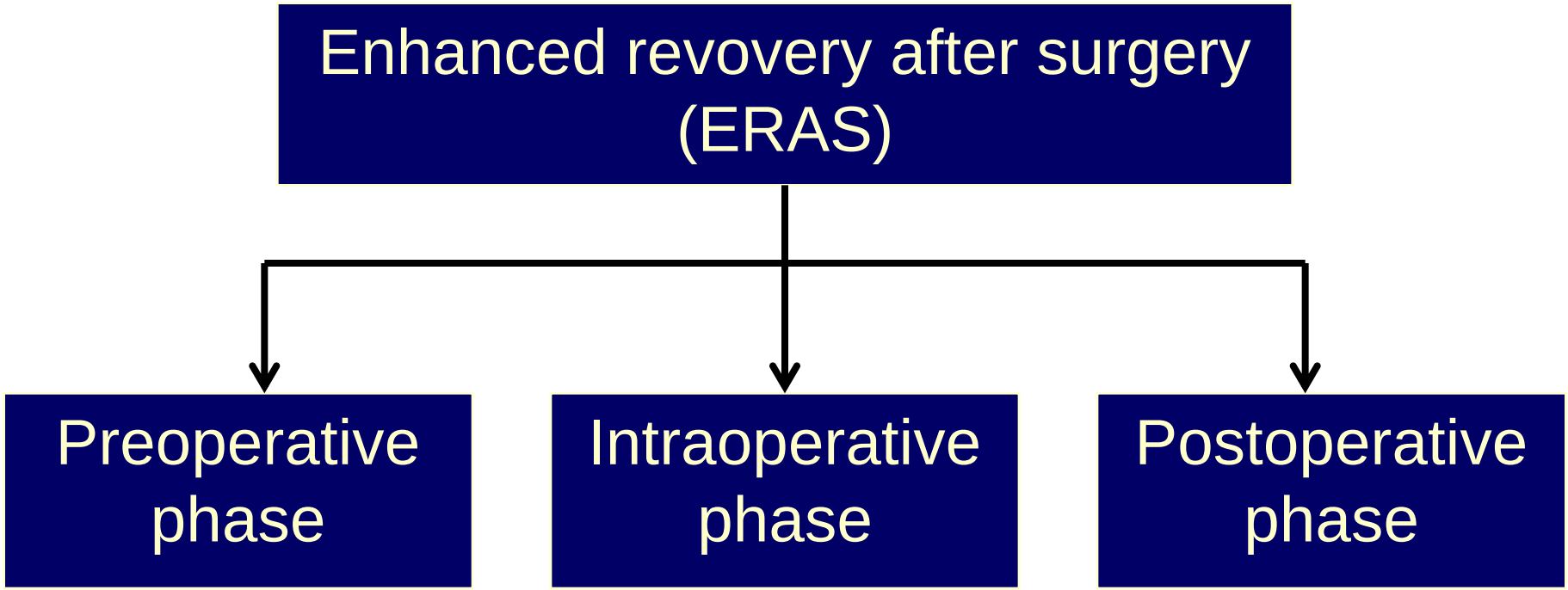
Principle goals of ERAS



Loop T. Curr Opin Anesthesiol 2016;29:20-25

ERAS – Preoperative phase

- Risk assessment
- Education and counselling
- Exercise testing and training
- Smoking cessation
- No prolonged fasting
- Antibiotic prophalaxis
- Incentive spirometry

Loop T. Curr Opin Anesthesiol 2016;29:20-25

Risk assessment

Low risk **90 days mortality OR 1.0**	**Moderate risk** **90 days mortality OR 6.1**	**High risk** **90 days mortality OR 43.0**
Female	Male	Male
56 years	70 years	81 years
ASA 2	ASA 3	ASA 3
FEV_1 81 %	FEV_1 65 %	FEV_1 50 %
Arterial hypertension	Arterial hypertension	Arterial hypertension
Ex-smoker	Smoker	Ex-smoker
		Ischaemic cardiac disease
		COPD, Diabetes mellitus
NSCLC Stade IB	NSCLC Stadium IIB	NSCLC Stadium IIB
Elective lobectomy	Elective lobectomy	Elective pneumonectomy

NSCLC = non-small cell lung cancer

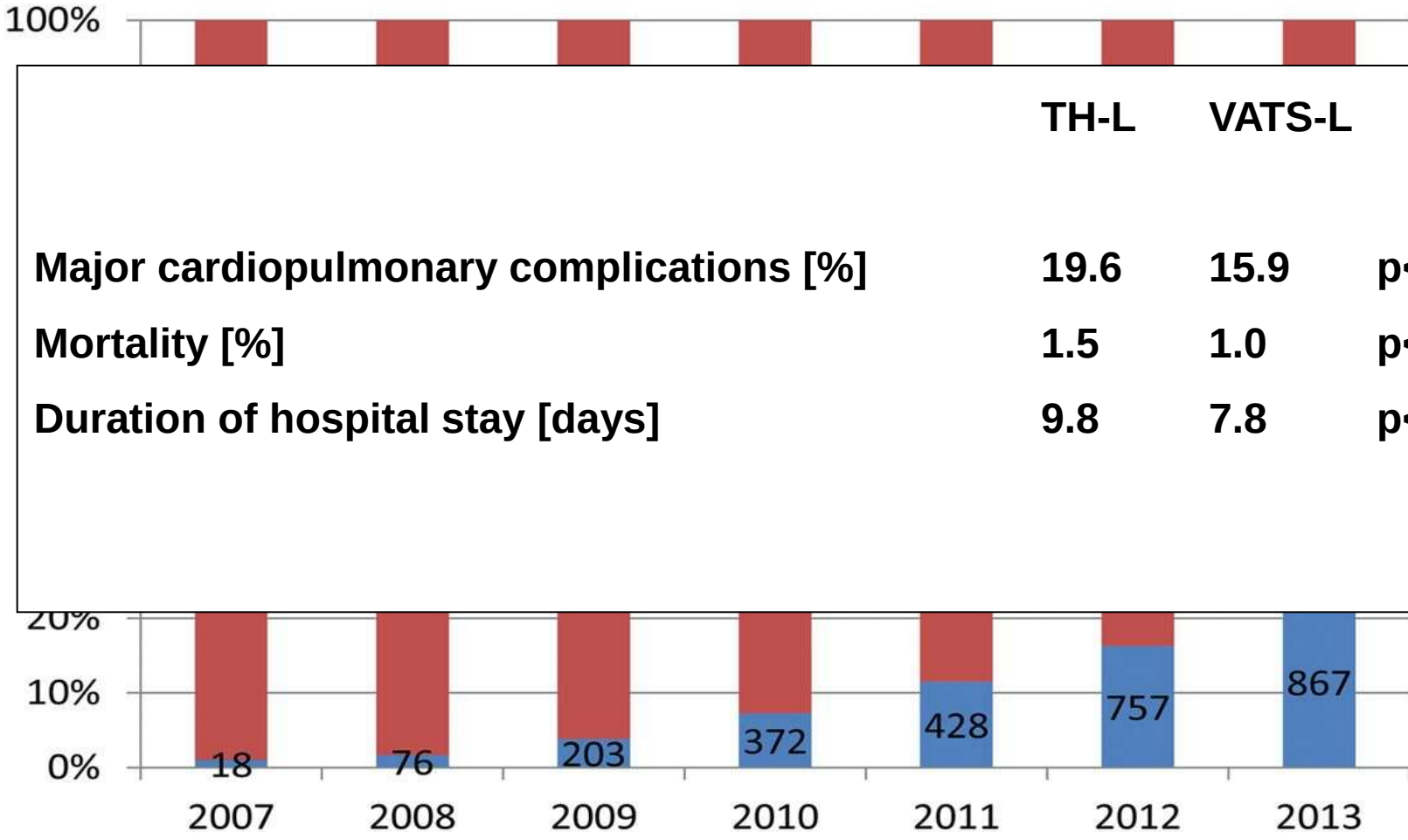
Powell HA et al. Thorax 2013;68:826-834

ERAS – Intraoperative phase

- Decrease the physical impact of the operation on the patient
- Minimize complications from the operation
- Avoidance of fluid overload
- Normothermia
- Short-acting anaesthetic drugs
- Lung-protective ventilation

Loop T. Curr Opin Anesthesiol 2016;29:20-25

Lobectomy – VATS vs. Thoracotomy



	TH-L	VATS-L	
Major cardiopulmonary complications [%]	**19.6**	**15.9**	**p<0.01**
Mortality [%]	**1.5**	**1.0**	**p<0.02**
Duration of hospital stay [days]	**9.8**	**7.8**	**p<0.003**

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

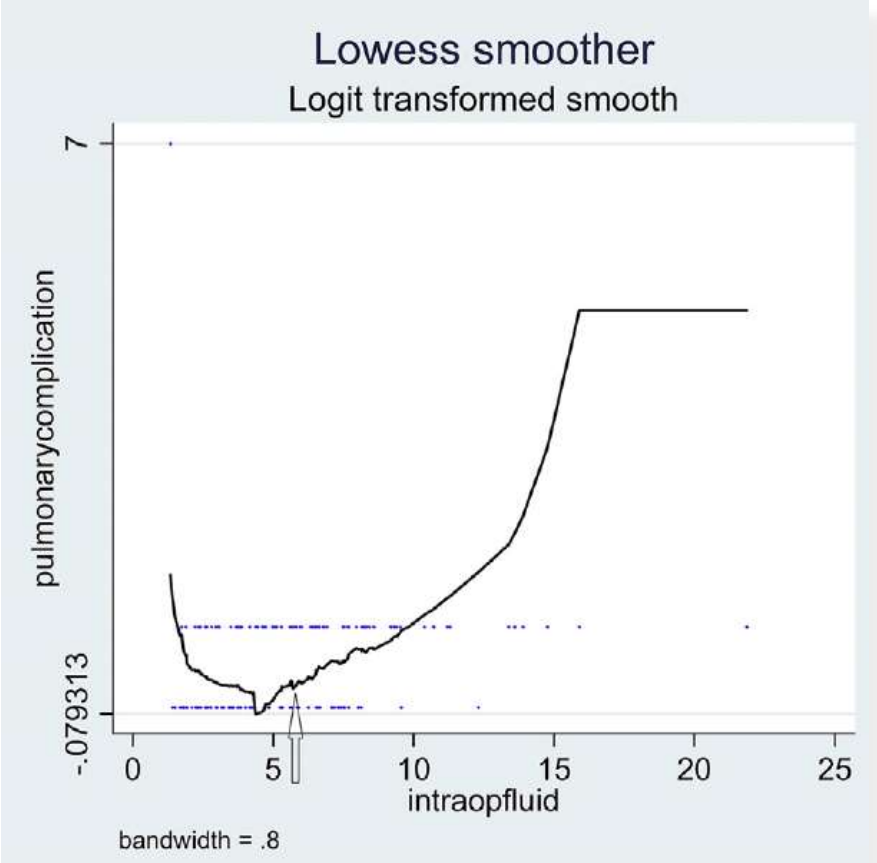
Falcoz PE et al. Eur J Cardiothorac Surg 2016;49:602-609

Fluid management

- Total positive fluid balance (24 hours post-OP) < 20ml/kg
- Crystalloid infusion < 2 l intraoperatively
- Crystalloid infusion < 3 l postoperatively
- Colloid infusion to replace equivalent volume of blood loss
- Maintain Hb > 8 g/dl
- Urine output 0.5 ml/kg/hour
- Appropriate haemodynamic monitoring

Effect of the amount of intraoperative fluid administration on postoperative pulmonary complications following anatomic lung resections

- Pulmonary complication
  - Total amount of infused fluid
    - 2501 ± 1510 ml
  - Amount of crystalloid
    - 2030 ± 1004 ml
- No pulmonary complication
  - Total amount of infused fluid
    - 1778 ± 1064 ml
  - Amount of crystalloid
    - 1499 ± 804 ml



Arslantas M et al. J Thorac Cardiovasc Surg 2015;149:14-20

Acute Kidney Injury After Lung Resection Surgery: Incidence and Perioperative Risk Factors

Variable	OR_{unadj}	OR_{adj}	95% CI	*P* value
Age in years (per year)	1.0	1.0	0.98–1.0	0.75
Hypertension	3.3	2.0	1.1–3.8	0.03
Peripheral vascular disease	5.5	4.4	1.8–10.0	0.001
eGFR (per 10 mL · min^{-1} · 1.73 m^{-2})	0.74	0.80	0.69–0.93	0.003
Angiotensin II receptor blocker	3.5	2.2	1.1–4.4	0.04
HES (per 250 mL)	1.6	1.5	1.1–2.1	0.01
Crystalloids (per 250 mL)	1.1	1.0	0.90–1.1	0.87
Intraoperative RBC transfusion	5.6	2.1	0.54–7.8	0.29
Thoracoscopy	0.22	0.37	0.15–0.90	0.03
Duration of surgery (per minute)	1.0	1.0	1.0–1.0	0.54
Surgical procedure				
Wedge resection/ bullectomy	1.0	1.0	—	—
Segmentectomy/ lobectomy	3.2	1.5	0.59–3.8	0.39
Pneumonectomy	6.6	2.1	0.61–7.2	0.24

Ishikawa S et al. Anesth Analg 2012;114:1256-1262

Lung protective OLV

- Ventilated lung
  - Pressure controlled ventilation
  - P_{AW} < 30 cmH_2O
  - Tidal volume 5 - 7 ml/kg
  - FIO_2 < 0.7
  - Alveolar recruitment maneuver
  - PEEP 5 cmH_2O
- Non-ventilated lung
  - FIO_2 0.5
  - CPAP 5 cmH_2O
- saO_2 > 90 %
- $paCO_2$ ~ 40 – 60 mmHg

Future clinical studies

PROtective ventilation with higher versus lower PEEP during one-lung ventilation for THORacic surgery – PROTHOR: A randomized controlled trial

For the PROVE NETWORK Investigators

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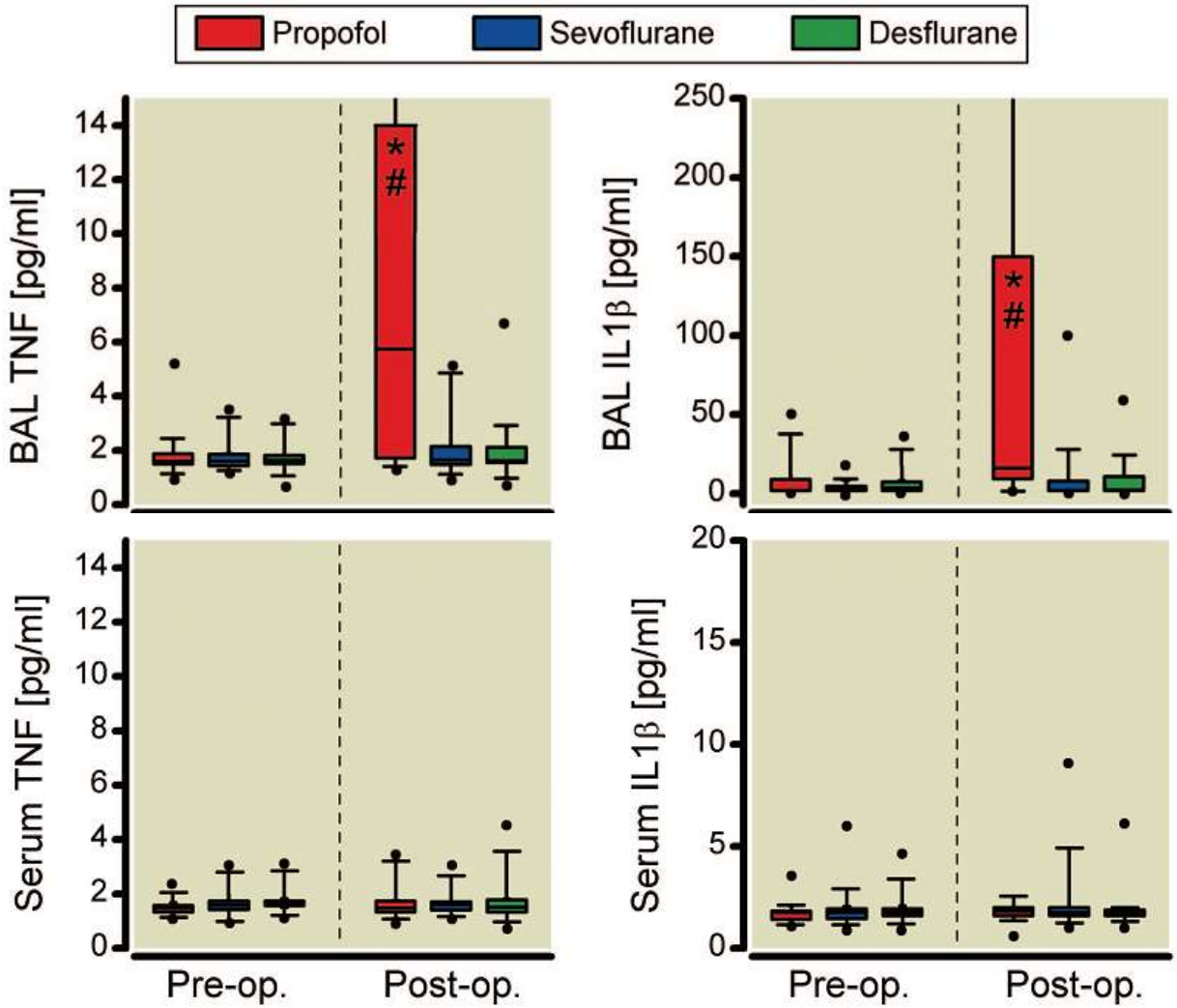
TIVA *vs.* Inhalational anesthesia



Pulmonary Inflammation

Systemic Inflammation

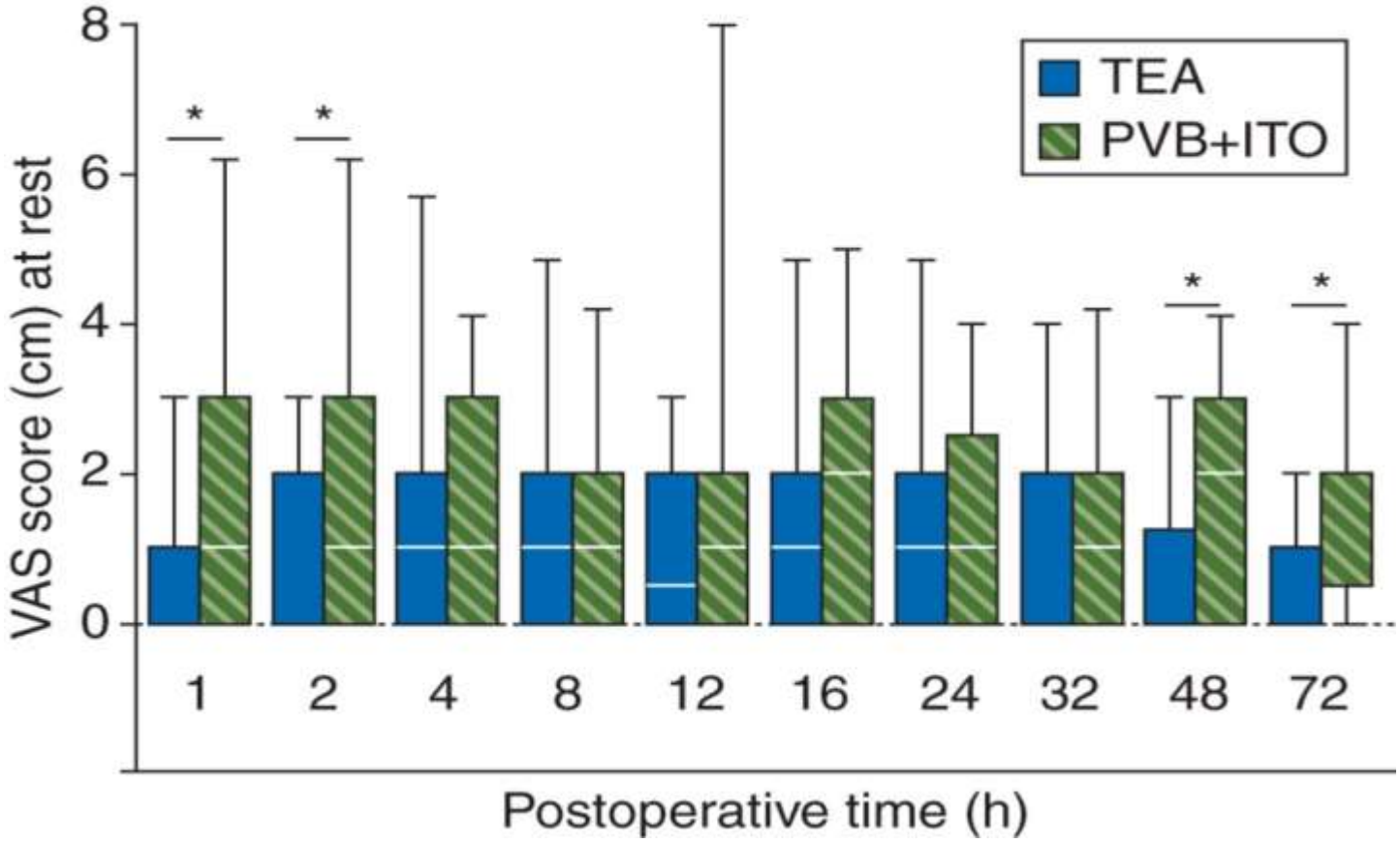
Schilling T et al. Anesthesiology 2011;115:65-74

ERAS – Postoperative phase

- Thoracic epidural anaesthesia
- Avoidance of fluid overload
- Prevention of PONV
- Early removal of drains / catheters
- Early mobilisation
- Early nutrition
- Incentive spirometry

Loop T. Curr Opin Anesthesiol 2016;29:20-25

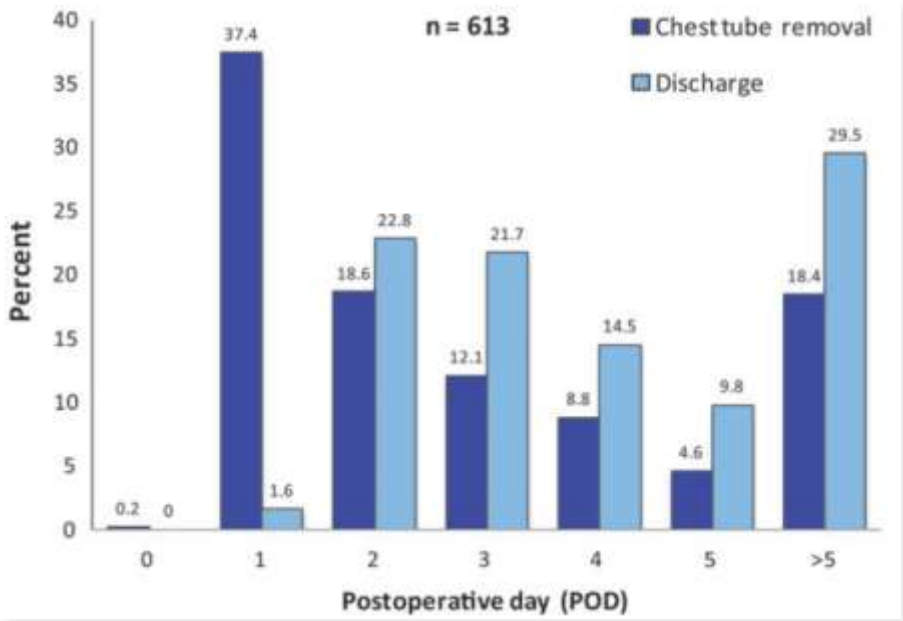
Thoracic epidural anaesthesia (TEA)



TEA = Thoracic Epidural anaesthesia, PVB + ITO = Paravertebral block + intrathecal opioid

Dango S et al. Br J Anaesth 2013;110:443-9

Early chest tube removal after video-assisted thoracic surgery lobectomy with serous fluid production up to 500 ml/day



Chest tube removed	Number of patients (%)			
	POD 0–1, *n* = 227	POD 2–3, *n* = 182	POD ≥ 4, *n* = 190	Total, *n* = 599
Reinsertion of chest tube due to pleural effusion	1 (0.4)	2 (1.1)	2 (1.1)	5 (0.8)
Pleurocentesis due to pleural effusion	8 (3.5)	2 (1.1)	2 (1.1)	12 (2.0)

Bjerregaard L et al. Eur J Cardio-Thoracic Surg 2014;45:241-246

Summary

- Enhanced recovery after thoracic surgery protocols involve different interdisciplinary interventions
- ERAS concepts may reduce postoperative complications, immobolization, length of hospital stay, and costs
- Thoracic anaesthesiologists play an important role in all steps of the ERAS protocoll
- There is some uncertainity of the evidence-based state of the best practice


Thank you!

TEA - systemic opioid-based analgesia

Lobectomy

	EDA group (n = 359)	Opioid group (n = 203)	p-value
Age (years)	62.1 ± 11.0	64.2 ± 10.4	0.02
Male gender (%)	58.5	54.2	n.s.
Hospital stay (days)	10.3 ± 4.9	10.6 ± 5.1	n.s.
Pre-existing pain therapy (%)	6.4	13.8	0.004
Dismission with oral opioid (%)	87.7	75.4	<0.001
Opiod dose after dismission (mg)	28.2 ± 14.5	24.7 ± 15.1	0.02
Time to first dejection (days)	3.8 ± 1.6	4.2 ± 2.7	0.06
EDA duration (days)	4.3 ± 1.5	-	

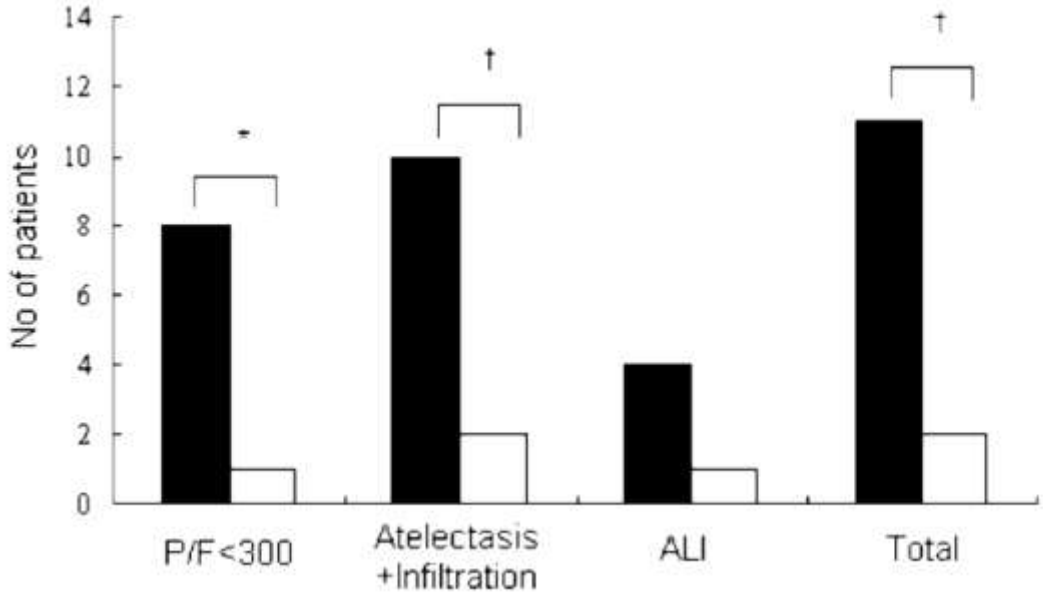
Wedge excision, metastasectomy, bullectomy, and tumor extirpation

	EDA group (n = 206)	Opioid group (n = 253)	p-value
Age (years)	58.7 ± 13.3	58.9 ± 15.1	n.s.
Male gender (%)	61.2	60.1	n.s.
Hospital stay (days)	8.4 ± 4.0	7.8 ± 3.9	0.09
Pre-existing pain therapy (%)	6.8	11.9	0.08
Dismission with oral opioid (%)	86.4	84.6	n.s.
Opiod dose after dismission (mg)	32.4 ± 14.5	27.8 ± 14.8	0.002
Time to first dejection (days)	3.4 ± 1.6	3.4 ± 1.5	n.s.
EDA duration (days)	4.1 ± 1.3	-	

Kampe S et al. J Cardiothorac Surg 2014;19:175

Does a Protective Ventilation Strategy Reduce the Risk of Pulmonary Complications After Lung Cancer Surgery?

A Randomized Controlled Trial



V_T = 10 ml/kg

FIO_2 = 1.0

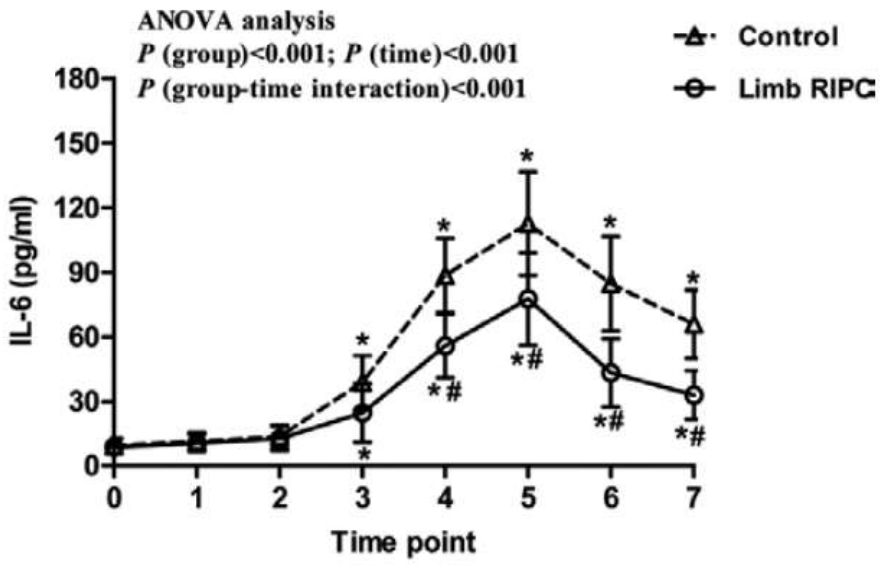
V_T = 6 ml/kg

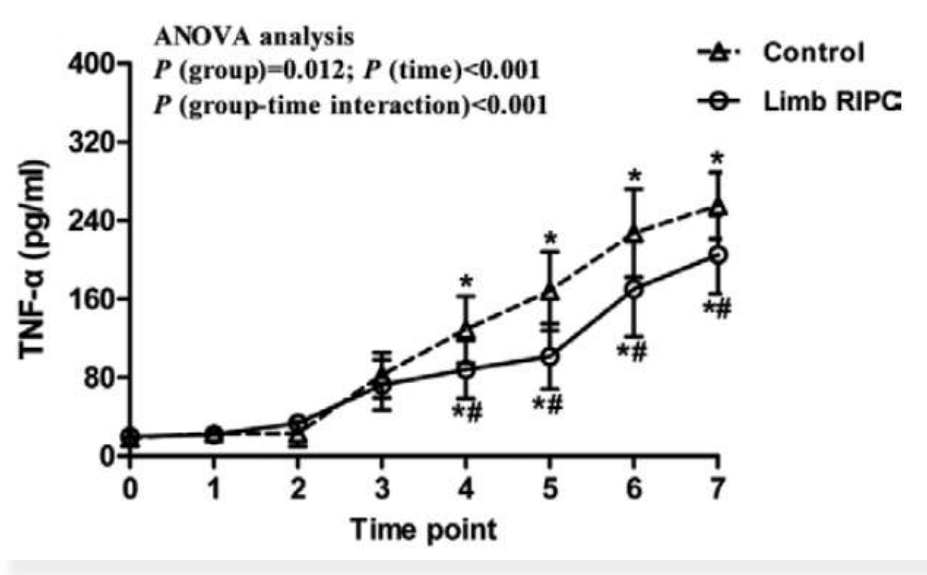
FIO_2 = 0.5

PEEP = 5 cmH_2O

Yang M et al. Chest 2011;139:530-537

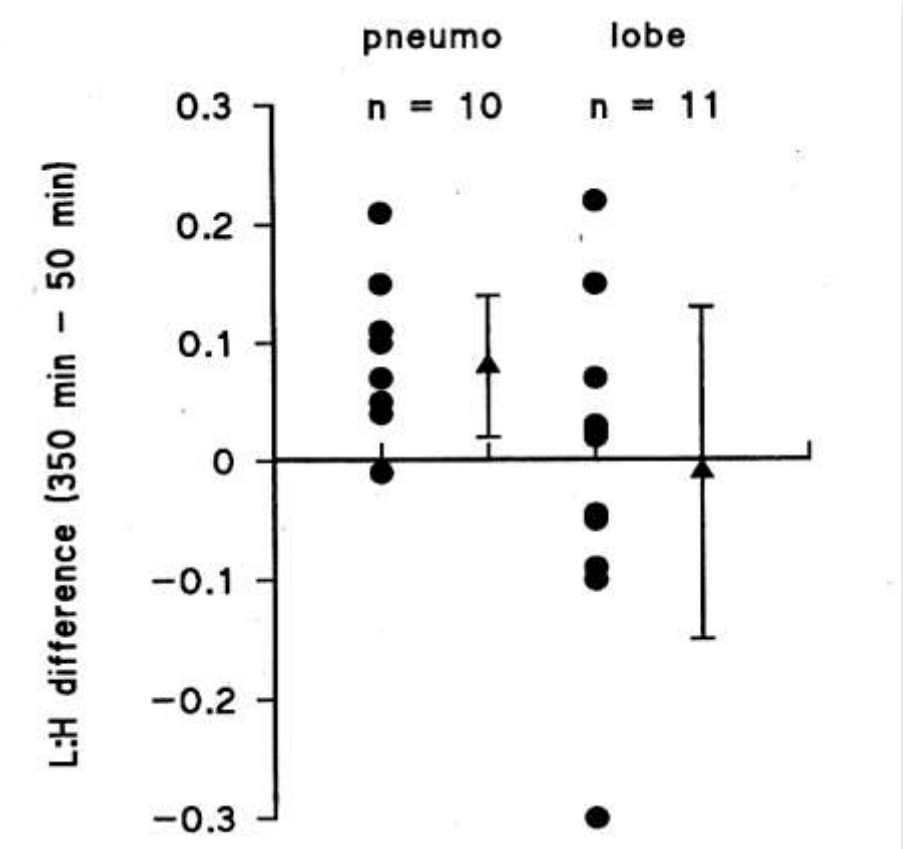
Limb Remote Ischemic Preconditioning Attenuates Lung Injury after Pulmonary Resection under Propofol–Remifentanil Anesthesia





Li C et al. Anesthesiology 2014;121:249-59

Alveolocapillary permeability

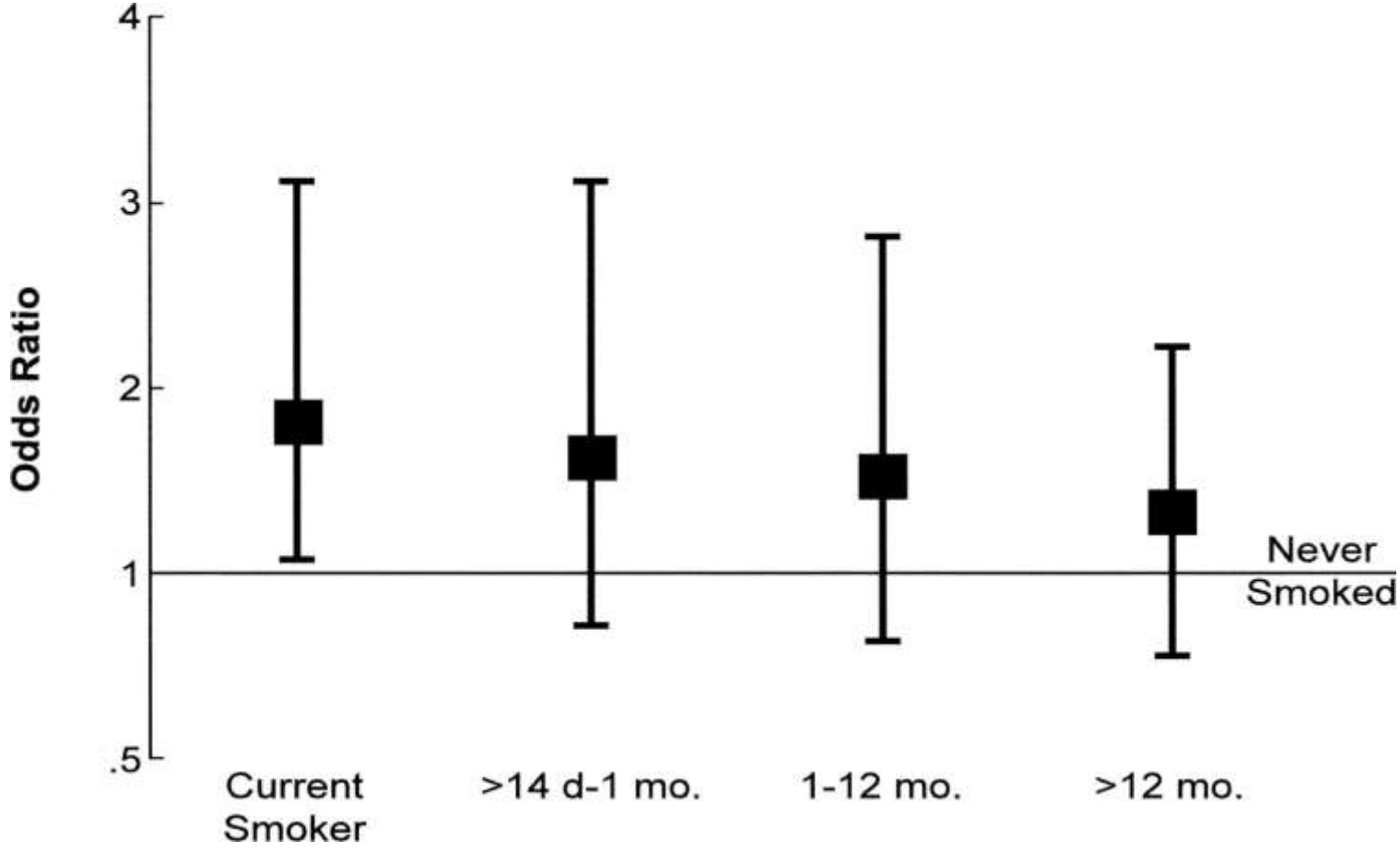


- Lobectomy
- Pneumonectomy
- Lung scintigraphy
  - ^{99m}Tc-Albumin 1 mSv
- IL 8, Elastase

- Increased endothelial permeability after pneumonectomy

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

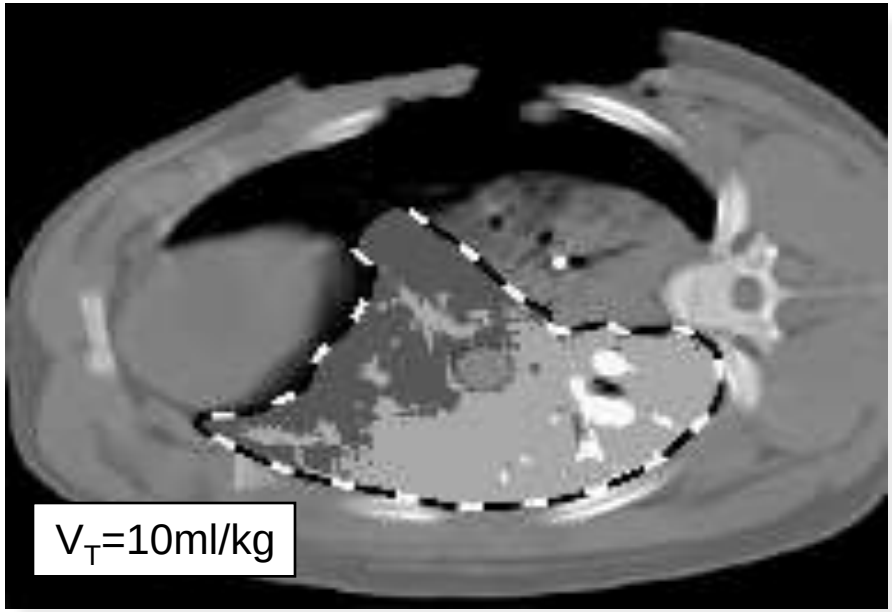
Smoking cessation



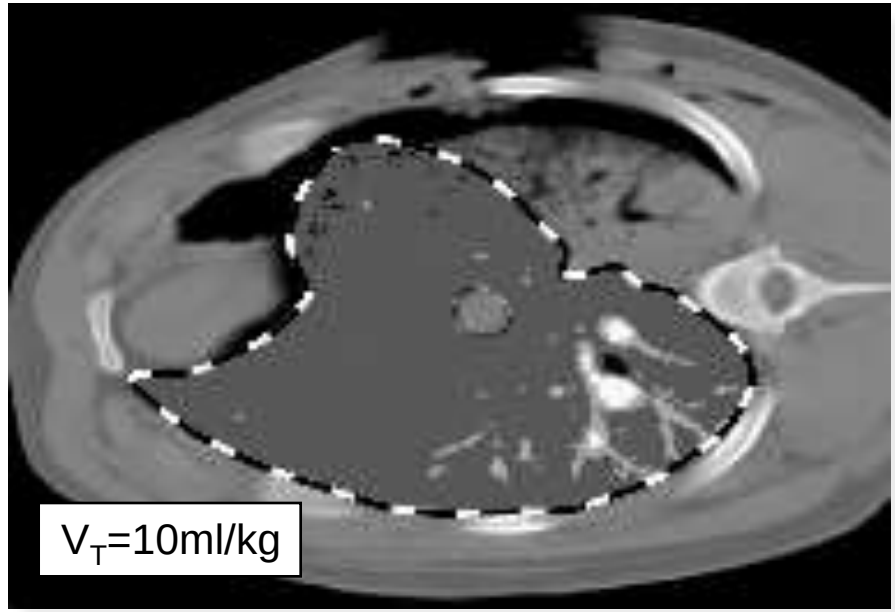
Mason DP et al. Ann Thorac Surg 2009;88:362-71

OLV- Cyclic recruitment

Expiration



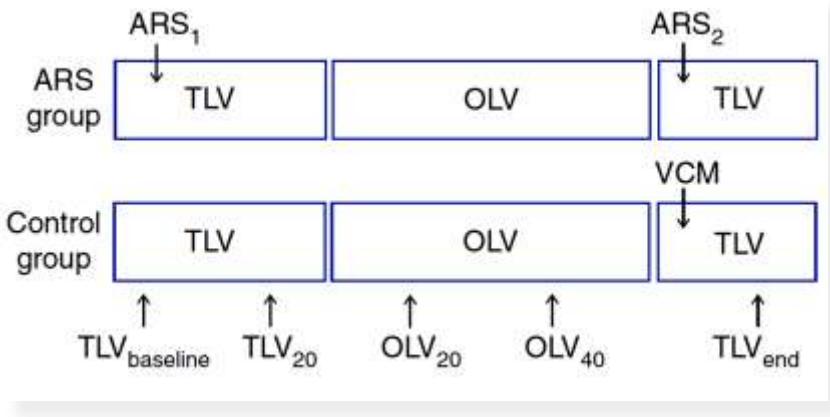
Inspiration

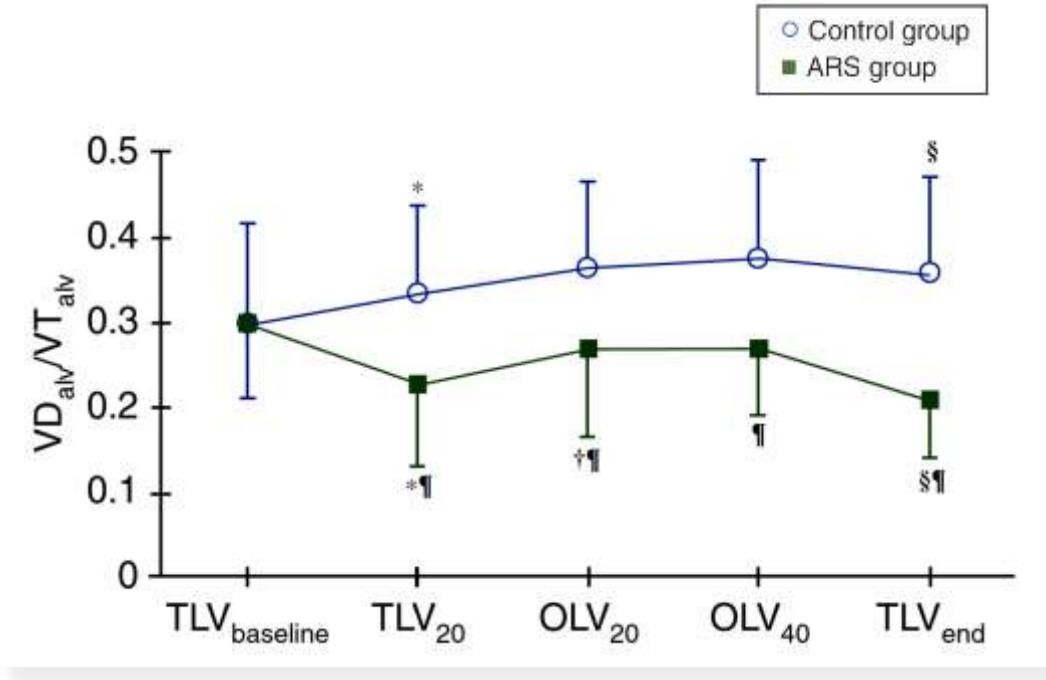


overaerated
normally aerated
poorly aerated
atelectatic

Kozian A et al. Br J Anaesth 2009;102:551-60

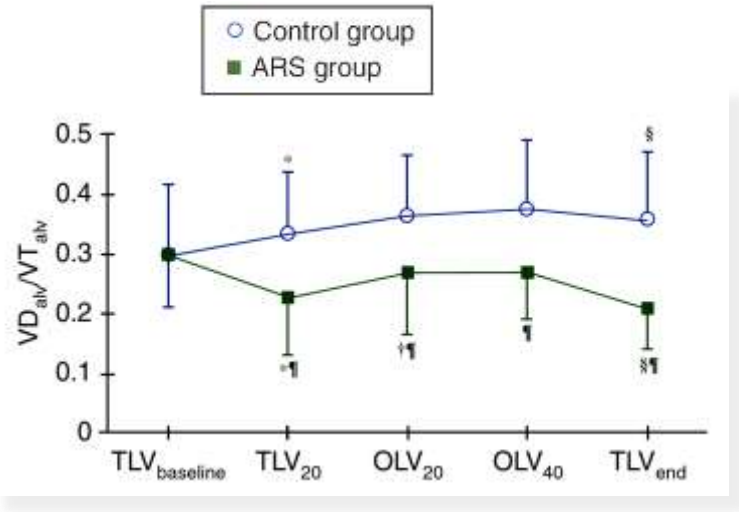
Alveolar recruitment improves ventilation during thoracic surgery: a randomized controlled trial

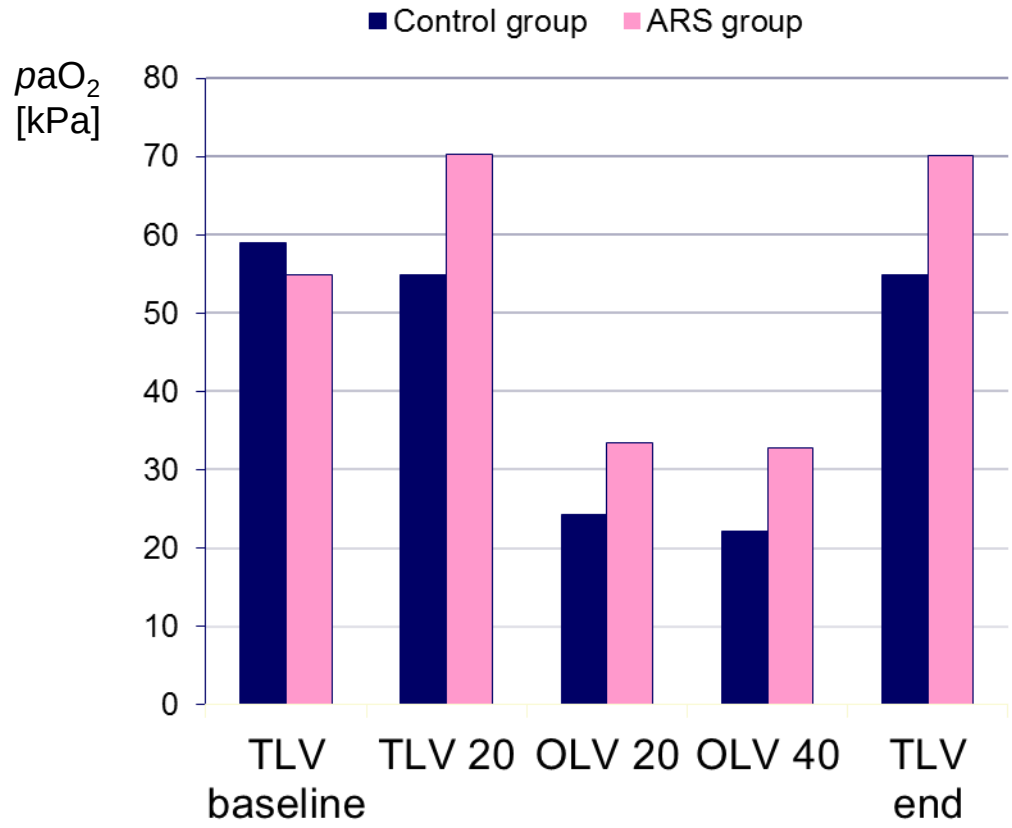




Unzueta C et al. Br J Anaesth 2012;108:517-24

Alveolar recruitment strategy - OLV





Unzueta C et al. Br J Anaesth 2012;108:517-24

Thorac surgery in awake patients

Two-Year Improvement in Multidimensional Body Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity Index After Nonresectional Lung Volume Reduction Surgery in Awake Patients

Eugenio Pompeo, MD, and Tommaso C. Mineo, MD

Thoracic Surgery Division, Emphysema Center, Tor Vergata University, Rome, Italy

Background. This study analyzed the comprehensive 2-year outcome of nonresectional lung volume reduction surgery (LVRS) in awake patients, including calculation of the multidimensional BODE index (body mass index, degree of airflow obstruction assessed by spirometry, modified Medical Research Council dyspnea grade, and 6-minute walking distance), which has proved a useful predictor of survival in patients with chronic obstructive pulmonary disease.

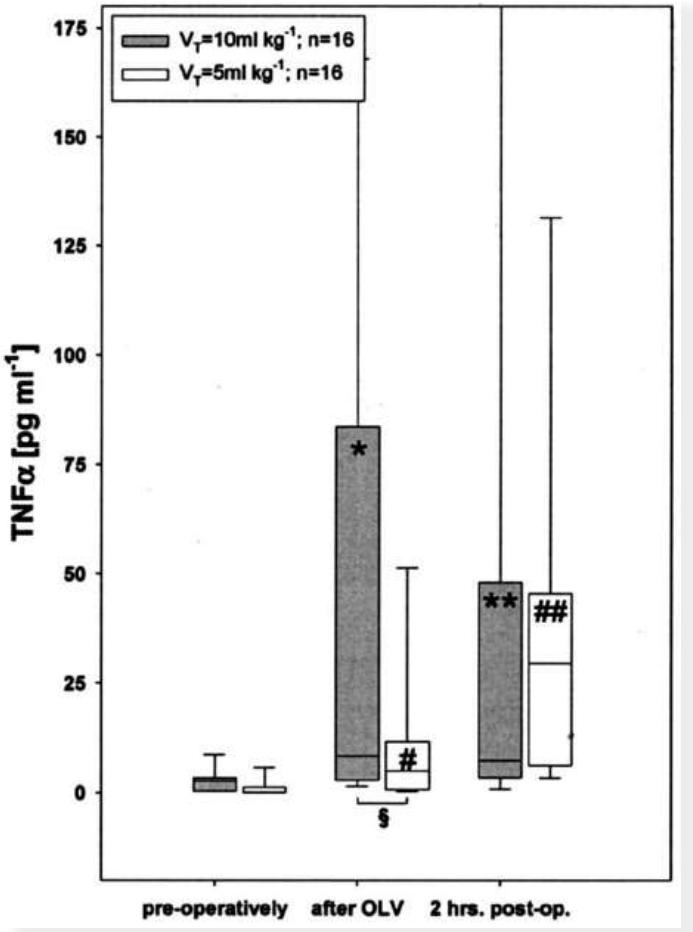
Methods. The study cohort included 42 patients undergoing LVRS while awake within a staged bilateral program entailing unilateral LVRS, followed by contralateral treatment performed at the reappearance of disabling symptoms. Outcome measures included hospital stay, procedure-related costs, calculation of the multidimensional BODE index, actuarial survival, and freedom from contralateral LVRS. Results were compared with those of a control group undergoing resectional LVRS under general anesthesia.

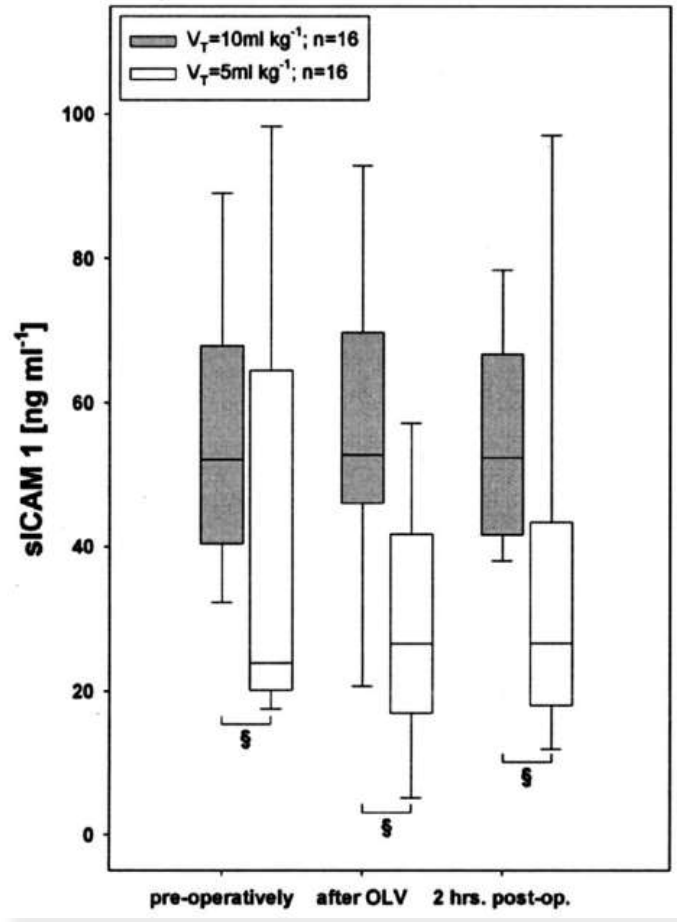
Results. The groups were well matched in demographics and baseline measures. There was no operative mortality. Median hospital stay was significantly shorter in the awake group (6 days versus 9 days, $p < 0.0001$); median procedure-related costs were significantly lower in the awake group (€5220 versus €8580; $p < 0.0001$). At intergroup comparisons of awake versus control group of clinical results, the BODE index improved postoperatively in both groups (-2.24 ± 1.0 versus -1.95 ± 1.0, intergroup $p = 0.35$) and remained improved for up to 2 years (-1.95 ± 1.3 versus -1.37 ± 1.4, intergroup $p = 0.1$); 2-year survival and freedom from contralateral LVRS rates were 87% versus 91% ($p = 0.52$) and 74% versus 73% ($p = 0.71$), respectively.

Conclusions. A significant improvement in the BODE index, satisfactory survival, and high rate of freedom from contralateral LVRS occurred both in the awake and control group, although the awake procedure proved more cost-effective.

(Ann Thorac Surg 2007;84:1862–9)

Tidal volume – Inflammatory response

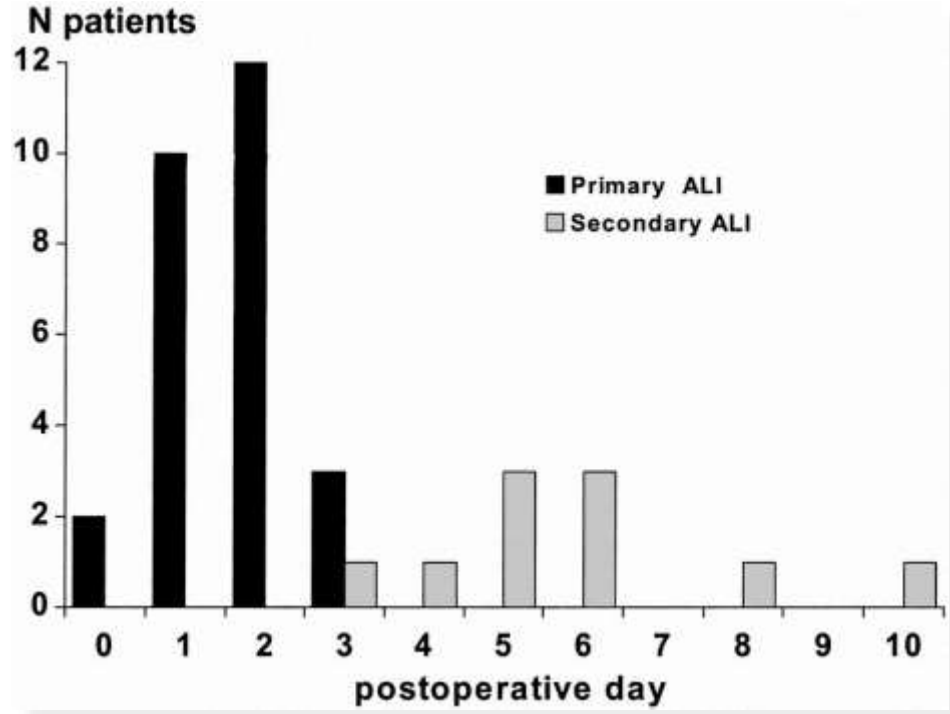




Schilling T et al. Anesth Analg 2005;101:957-965

Thoracic surgery – acute lung injury

- Thoracic surgery for lung cancer (n = 879)
- 37 ALI (4,2%)
- Mortality
  - Primary ALI 25%
  - Secondary ALI 60 %
- Risk factors
  - High airway pressure
  - Intravenous fluid management
  - Pneumonectomy
  - Alcohol consumption



Licker M et al. Anesth Analg 2003;97:1558-65

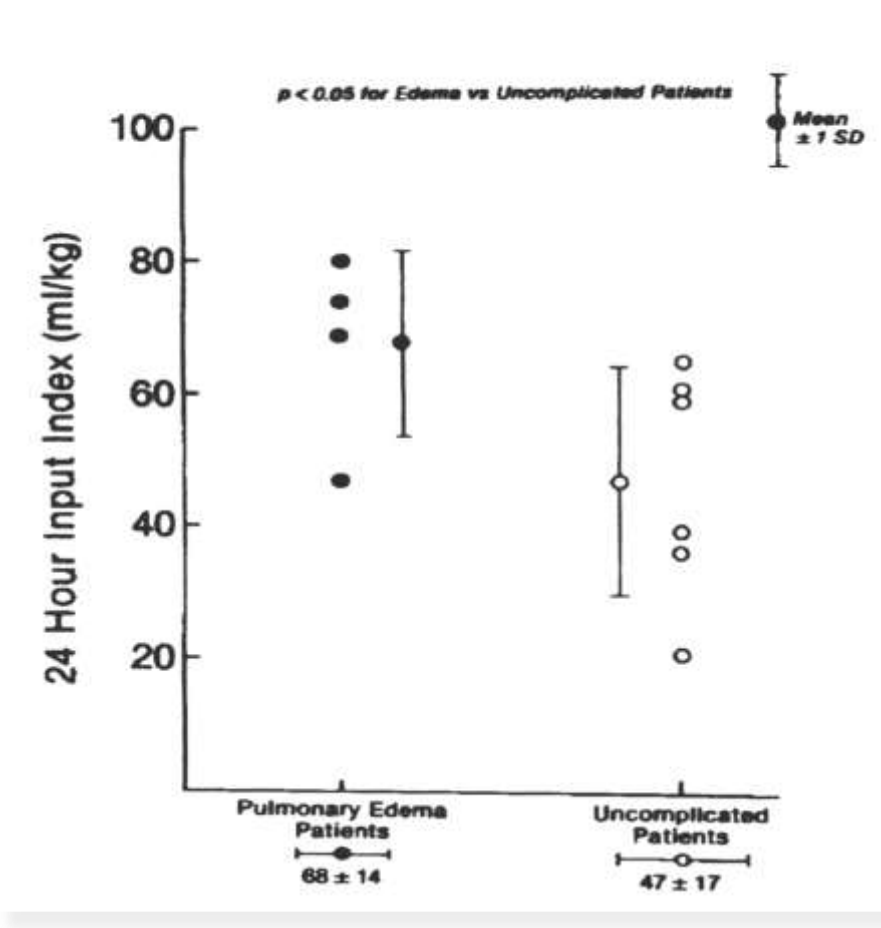
Early mortality after surgical resection for lung cancer: an analysis of the English National Lung cancer audit

Procedure	Overall [%] n = 10.991	Died within 30 days [n = 334]	Died between 31 and 90 days [n = 313]
Segmentectomy	1.671 [15,2]	2,1	2,1
Lobectomy	7.051 [64,2]	2,3	2,3
Bi-lobectomy	431 [3,9]	5,8	3,0
Pneumonectomy	1.121 [10,2]	7,0	4,5
Other	717 [6,5]	5,0	6,8

Powell HA et al. Thorax 2013;68:826-834

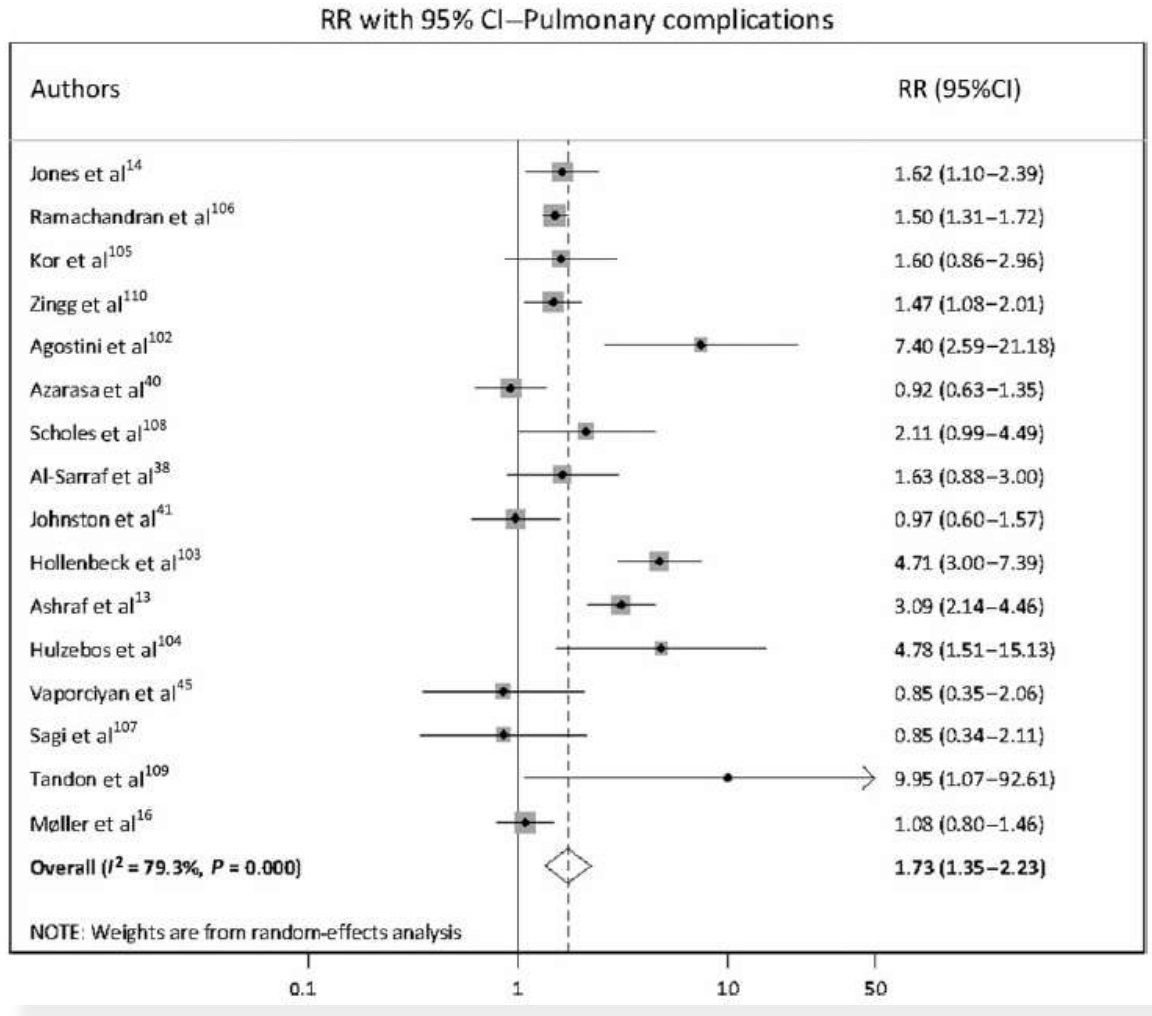
Fluid management

„…the most important thing we can do… is to watch our anesthetists as they start loading the patient up with fluid.“



Zeldin RA et al. J Thorac Cardiovasc Surg 1984;87:359-365

Smoking cessation



Grønkjær M et al. Ann Surg 2014;259:52-71