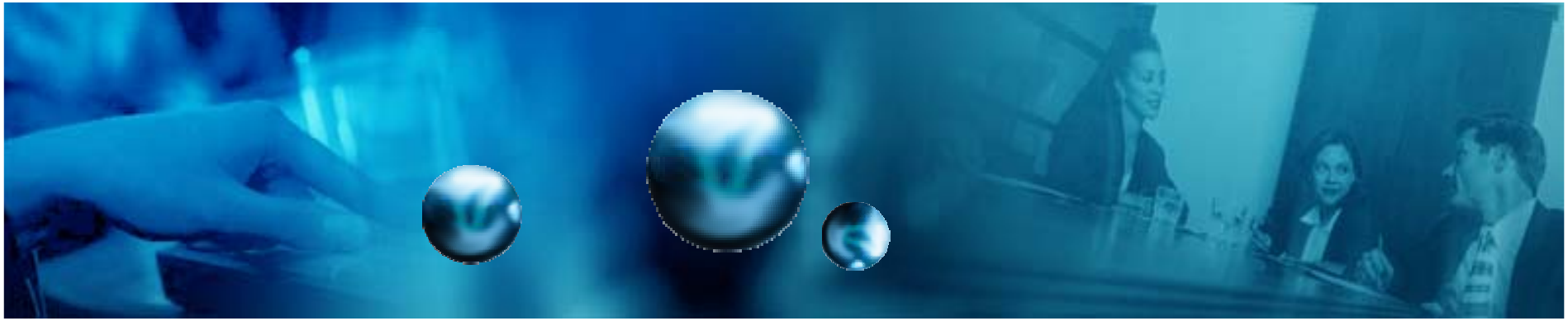
ARDS合理选择肺保护策略



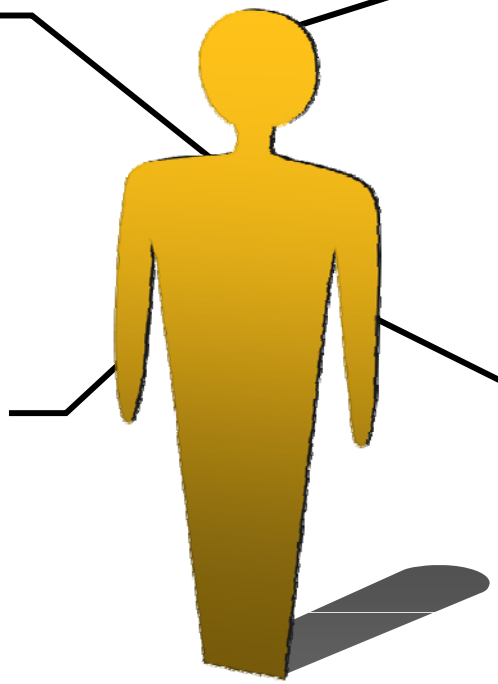
上海交通大学医学院附属新华医院

急救中心　　潘曙明

CASE 上海第三例重症H1NI患者

呼吸频率
38次/分
心率**75**次/分

入院体温
39℃



53岁，男性
基础疾病：**2**型糖尿病、糖尿病肾病　慢性心衰、高血压、冠心病
双下肢浮肿**1**月、高热**3**天伴气促就诊

氧饱和度
$SO_2$70%

基础信息

X-RAY

2009-12-3

2009-12-5

2009-12-6

纲　要

1. ARDS实施肺保护策略的病生基础
2. ARDS实施肺保护策略的核心内容
3. ARDS实施肺保护策略的补救治疗

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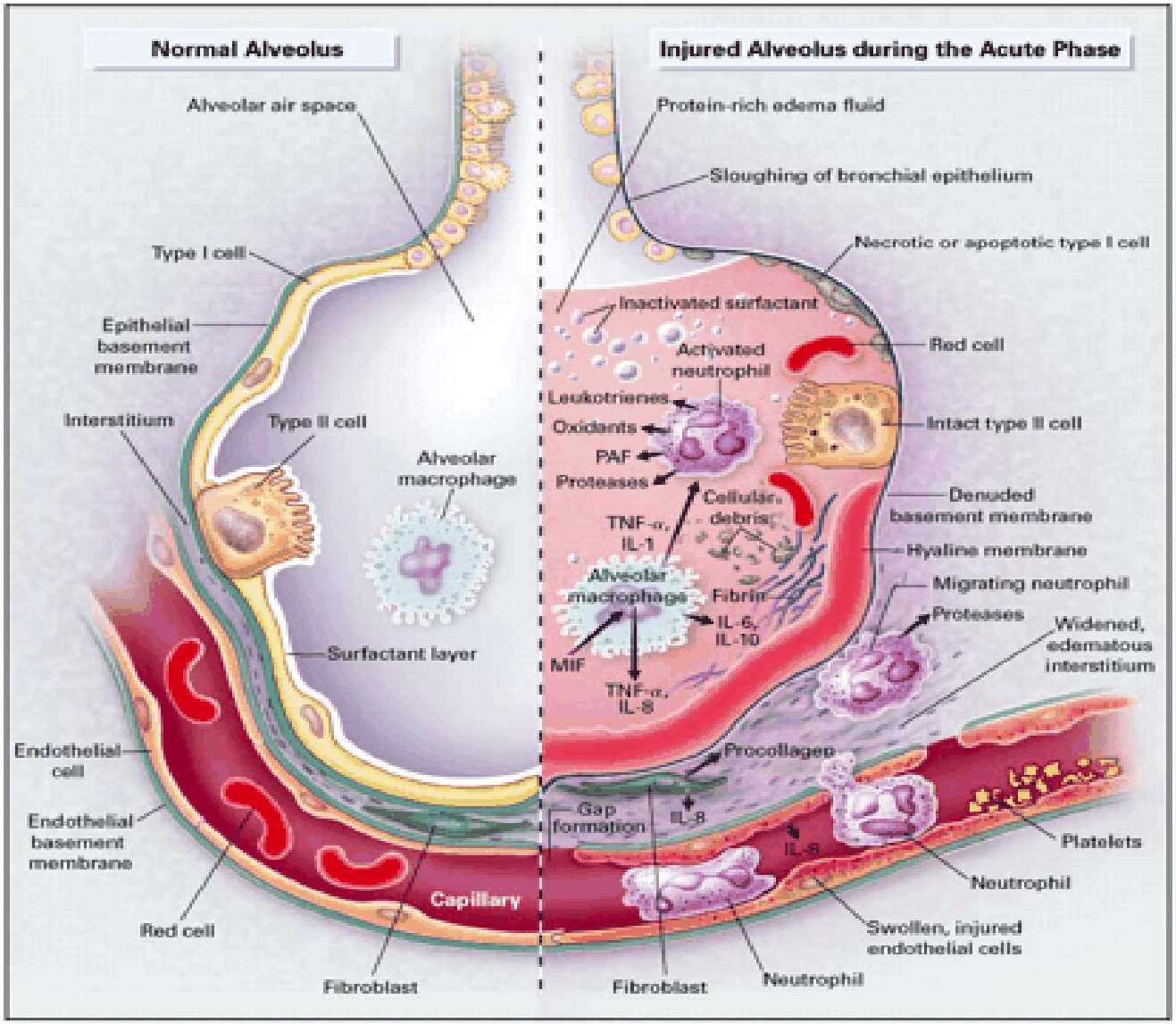
ARDS的根本原因： 过度和失衡的炎症

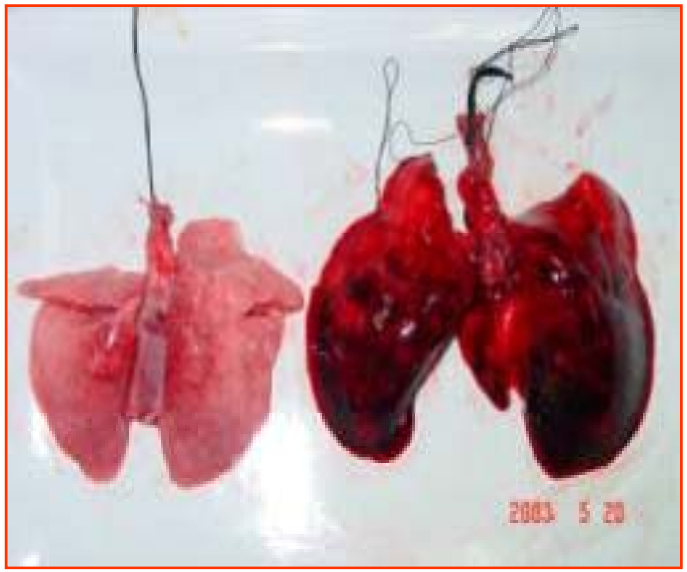


ARDS的病理生理特点

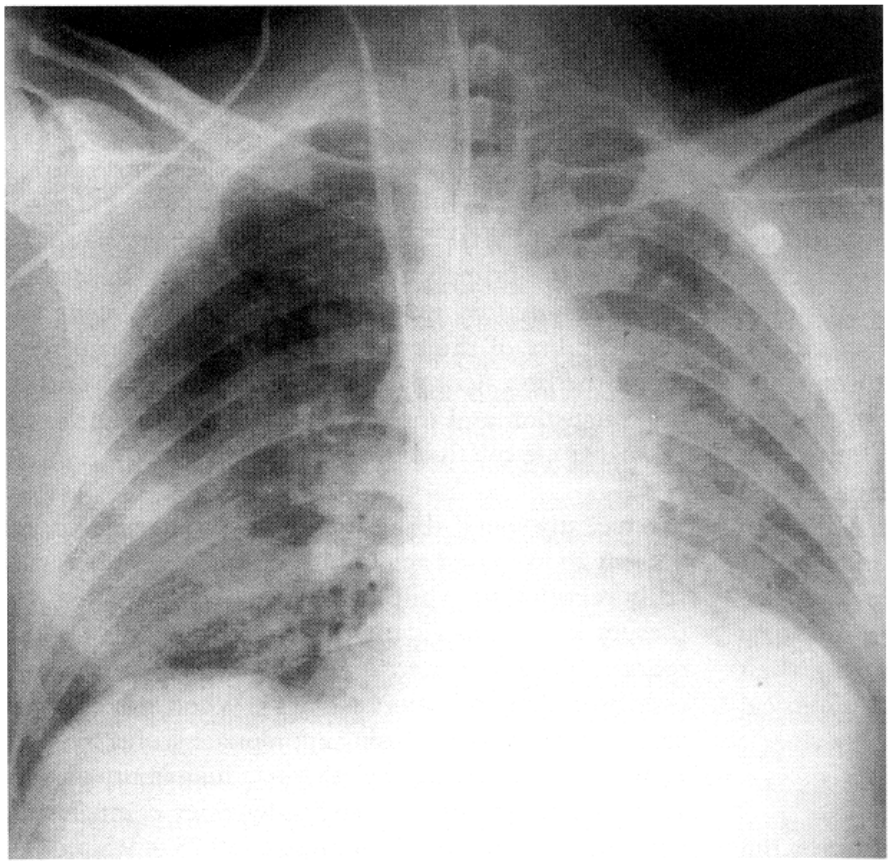
肺泡塌陷肺容积缩小

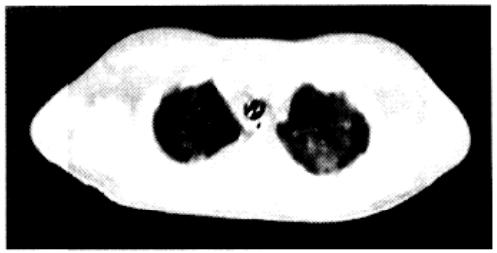
肺损伤不均匀性

通气／血流比例失调

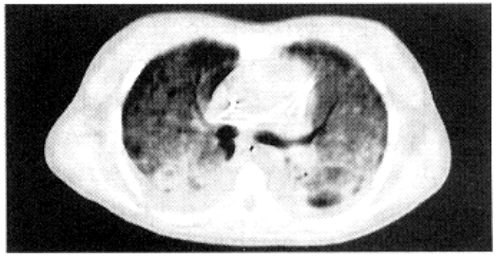


ARDS的影像学：不均匀性

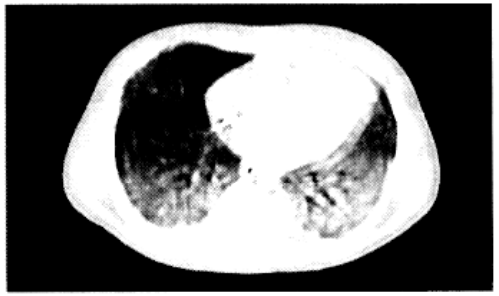




上 正常肺泡

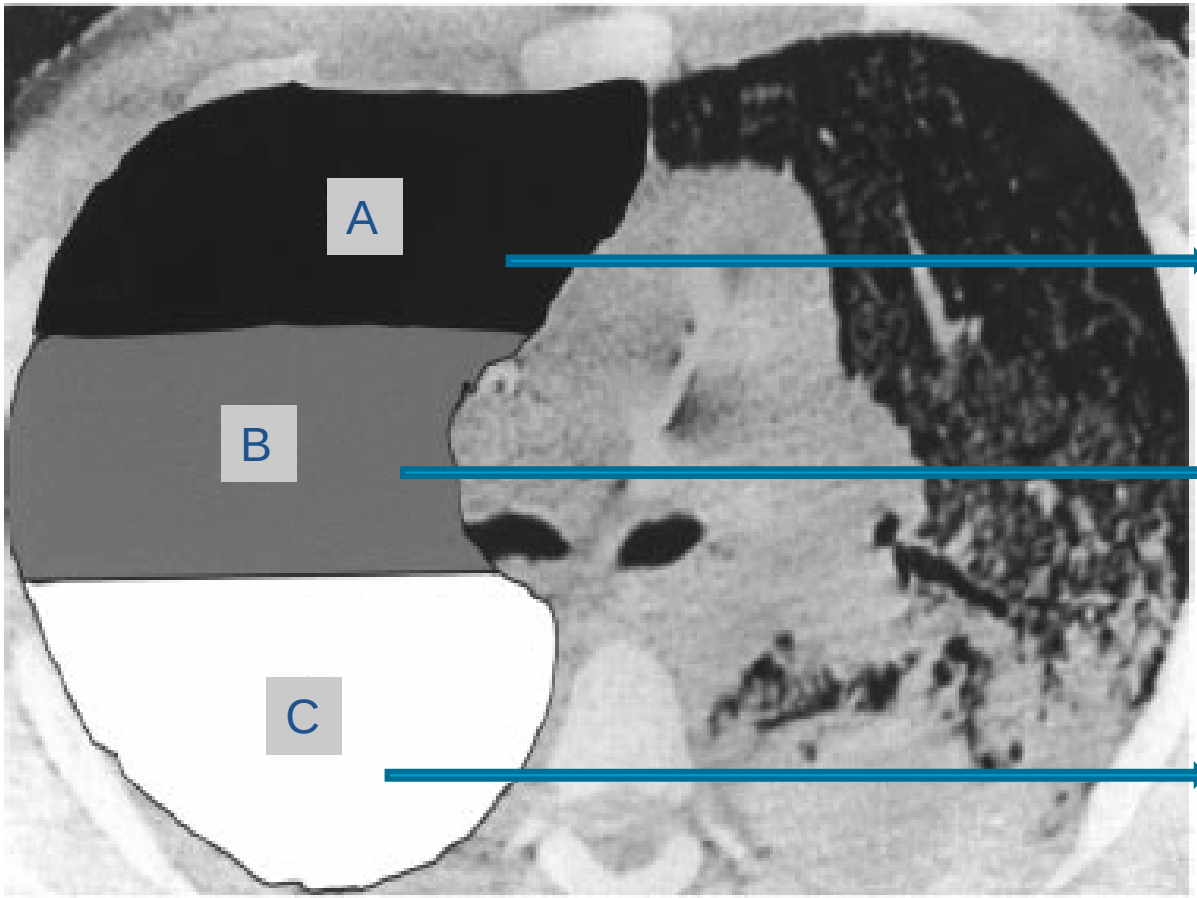


中 可复张肺泡



下 实变肺泡

ARDS肺形态学特点

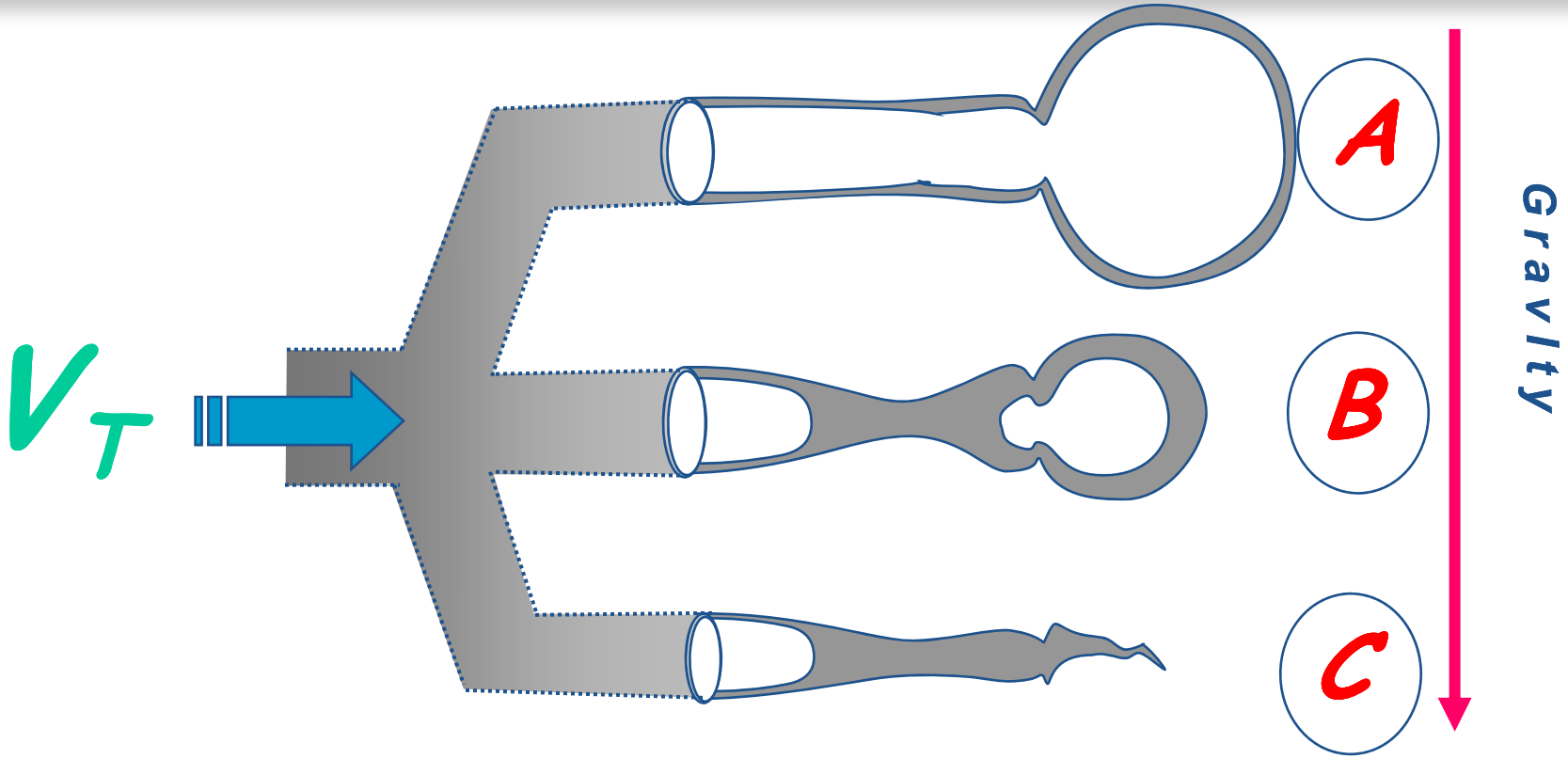


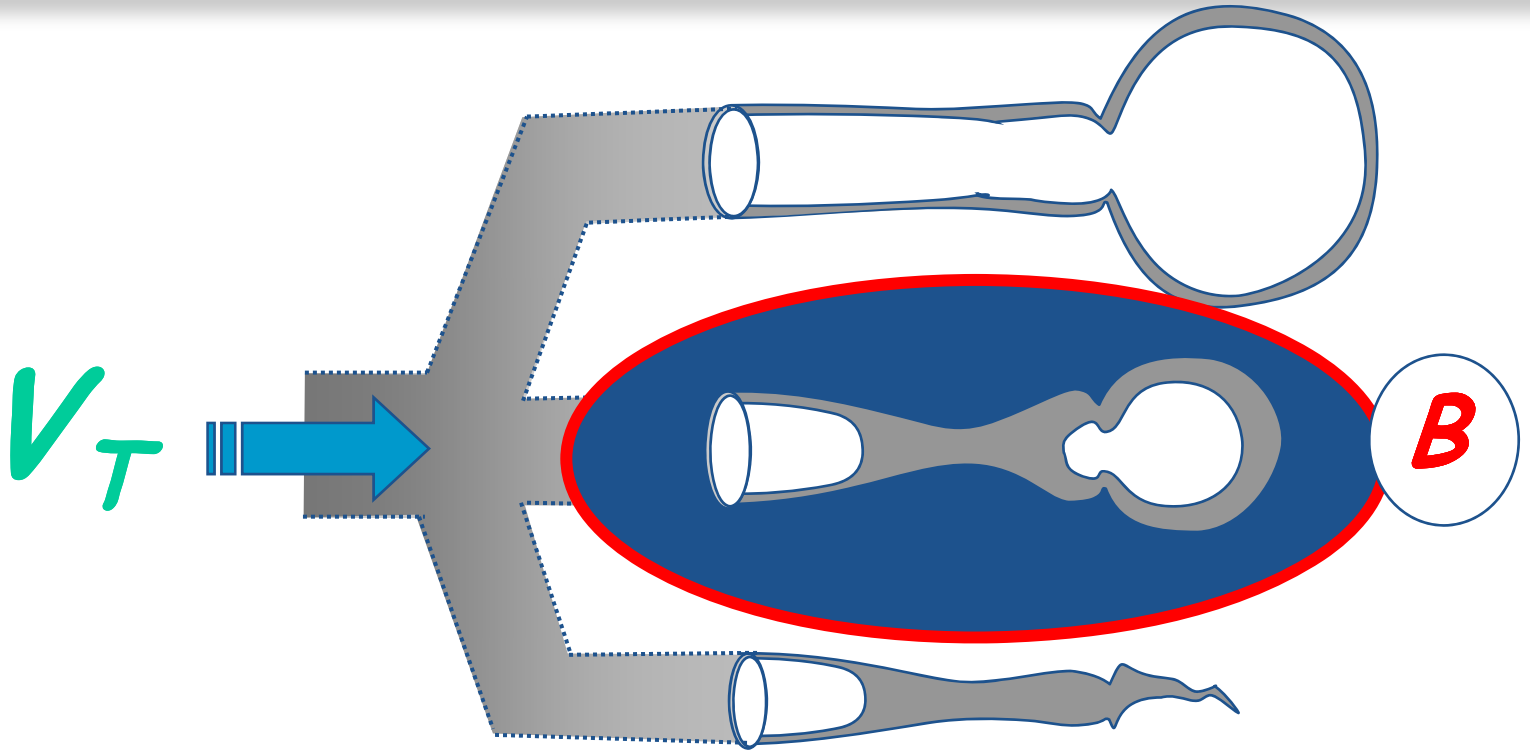
三类肺区
“婴儿肺”

A区 顺应性好，易过度通气

B区 动态性开放与塌陷
剪切伤
生物伤

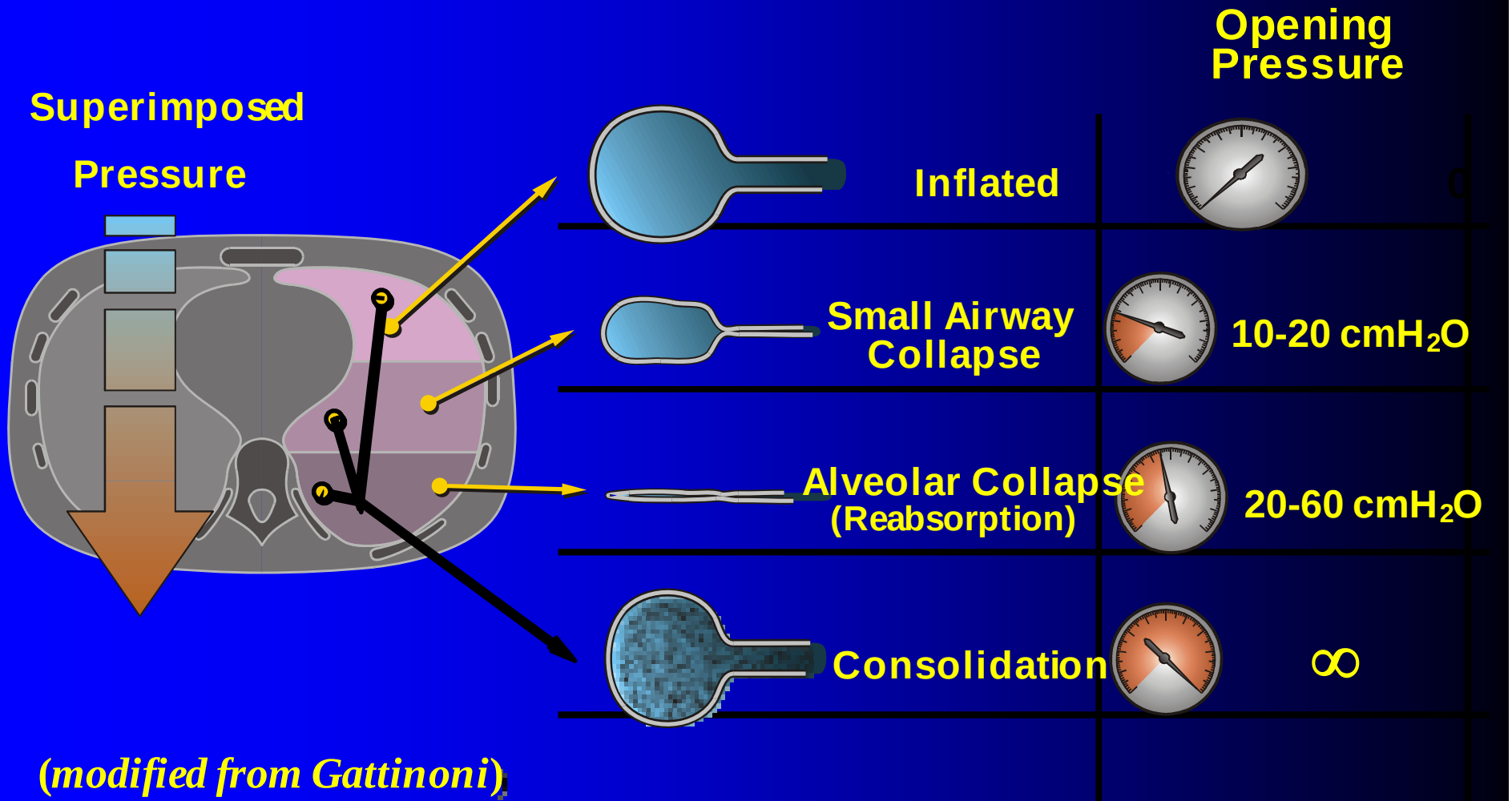
C区 静态塌陷
通气/血流比失调


V_T
A
B
C
Gravity



Tidal Volume dependent

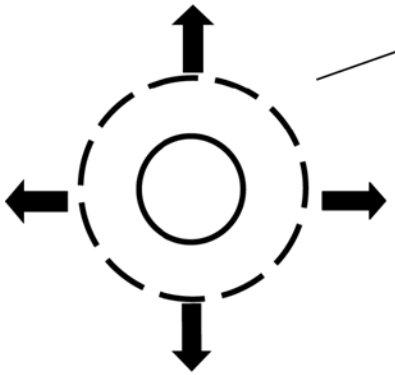
不同区域的开放压

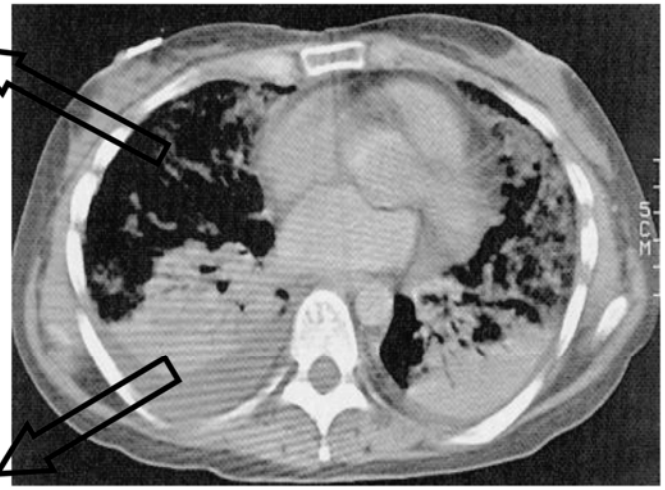


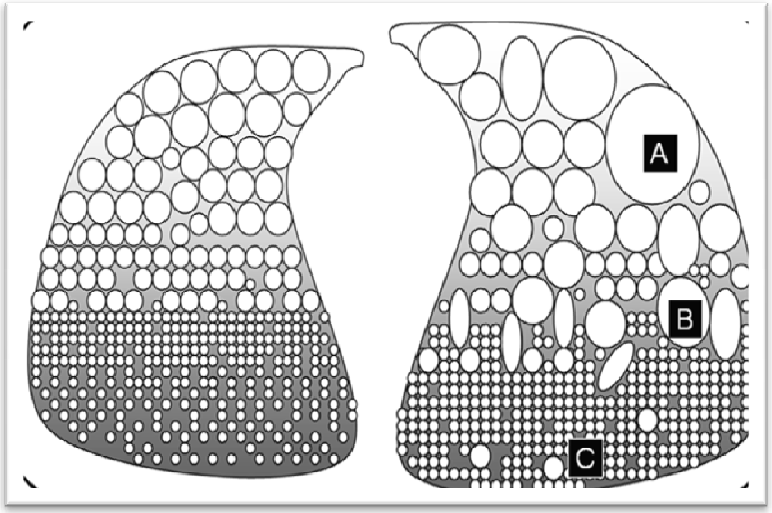
(modified from Gattinoni)

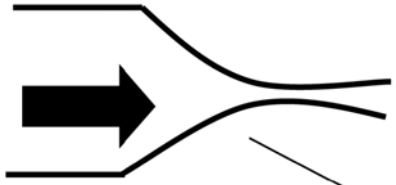
呼吸机相关性肺损伤（VALI）的产生

机械通气时可能肺过度膨胀导致VILI

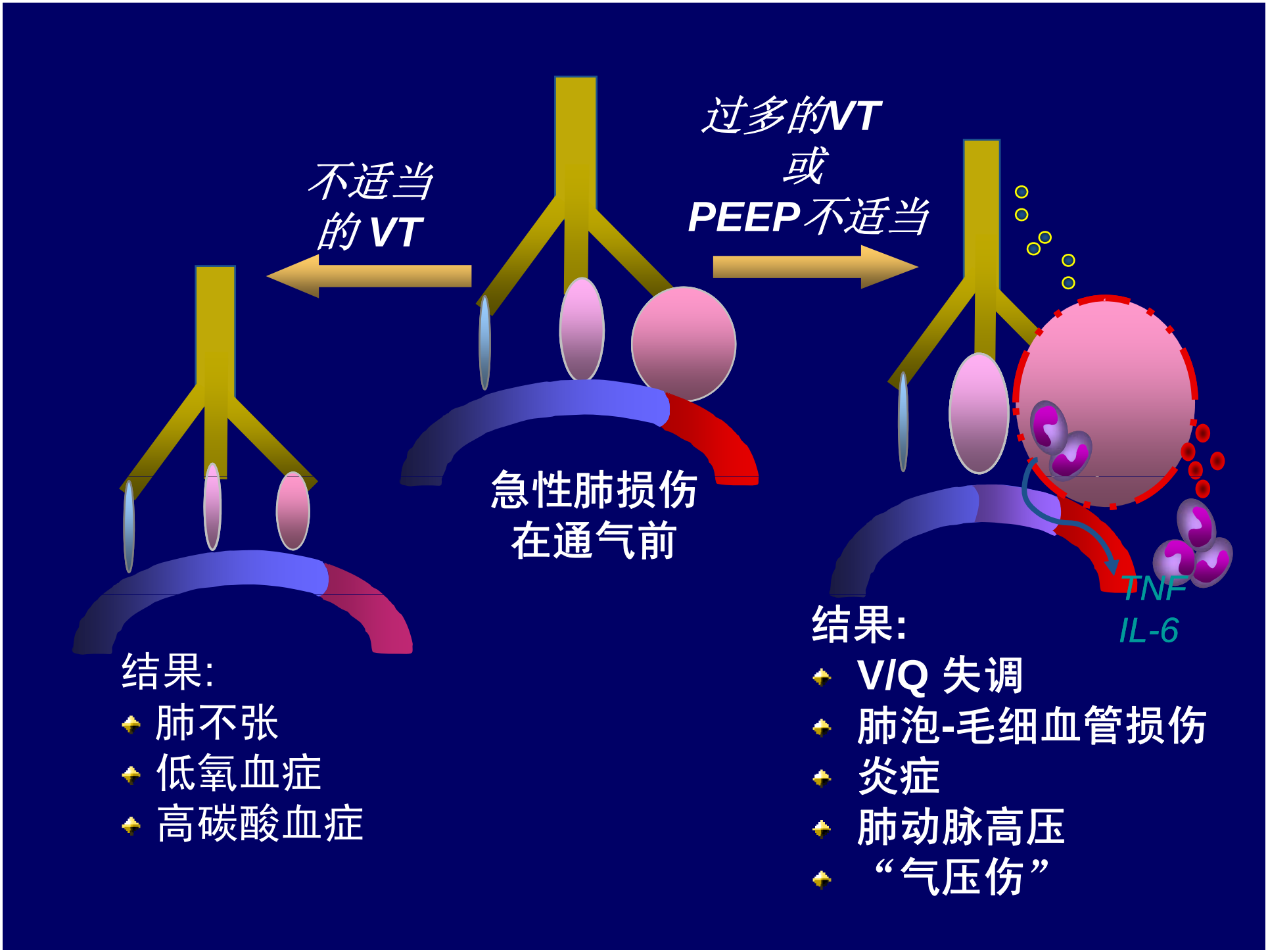


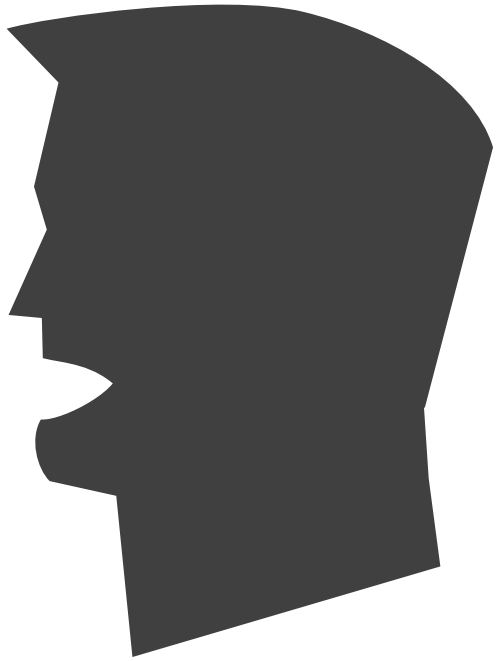






机械通气时塌陷肺泡的反复开闭形成剪切伤而至VILI

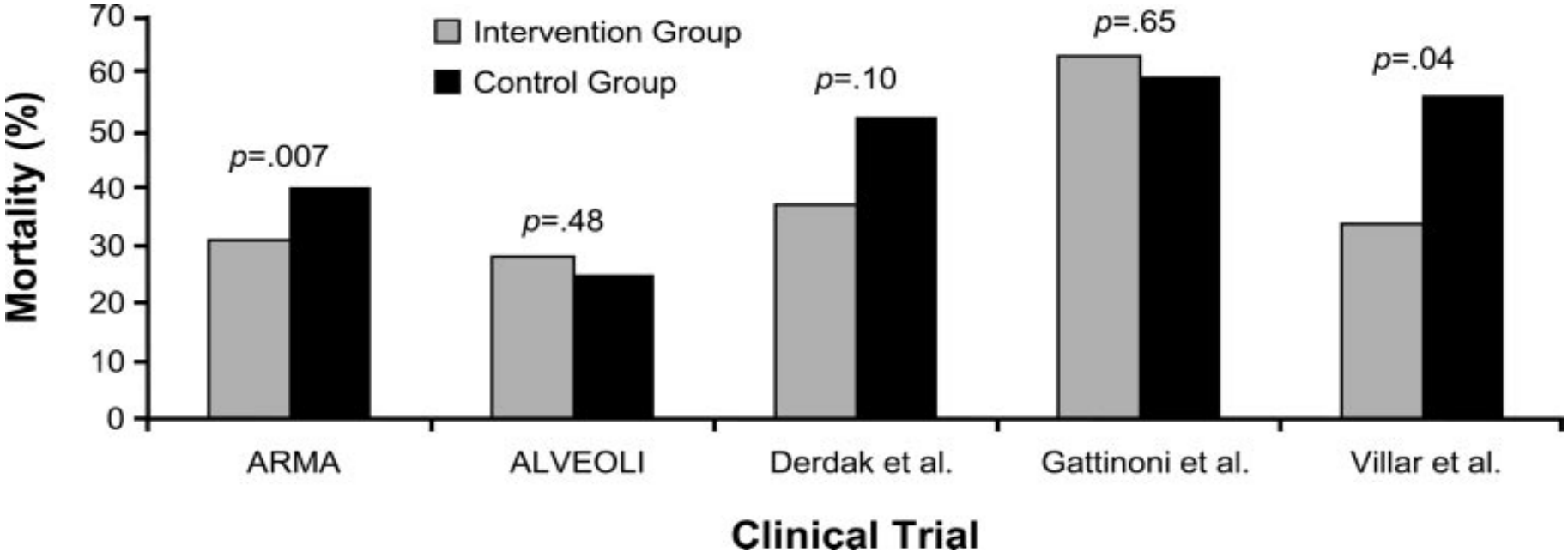

不适当
的VT
过多的VT
或
PEEP不适当
急性肺损伤
在通气前
TNF
IL-6
结果:
肺不张
低氧血症
高碳酸血症
结果:
V/Q 失调
肺泡-毛细血管损伤
炎症
肺动脉高压
“气压伤”



纲　　要

1. ARDS实施肺保护策略的病生基础
2. ARDS实施肺保护策略的核心内容
3. ARDS实施肺小潮气量通气的争议

不同肺保护通气方法的代表性RCT研究



ARMA： 低Vt和高Vt
ALVEOLI： 高PEEP和低PEEP
Derdak: 高频振荡和常规通气模式
Gattinoni： 俯卧位通气和常规通气‘
Villar： 低Vt+高PEEP和高Vt+低PEEP

Chest 2007;131;921-929

The New England
Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

ABSTRACT

Background Traditional approaches to mechanical ventilation use tidal volumes of 10 to 15 ml per kilogram of body weight and may cause stretch-induced lung injury in patients with acute lung injury and the acute respiratory distress syndrome. We therefore conducted a trial to determine whether ventilation with lower tidal volumes would improve the clinical outcomes in these patients.

Methods Patients with acute lung injury and the acute respiratory distress syndrome were enrolled in a multicenter, randomized trial. The trial compared traditional ventilation treatment, which involved an initial tidal volume of 12 ml per kilogram of predicted body weight and an airway pressure measured after a 0.5-second pause at the end of inspiration (plateau pressure) of 50 cm of water or less, with ventilation with a lower tidal volume, which involved an initial tidal volume of 6 ml per kilogram of predicted body

THE mortality rate from acute lung injury and the acute respiratory distress syndrome[1] is approximately 40 to 50 percent.[2-4] Although substantial progress has been made in elucidating the mechanisms of acute lung injury,[5] there has been little progress in developing effective treatments.

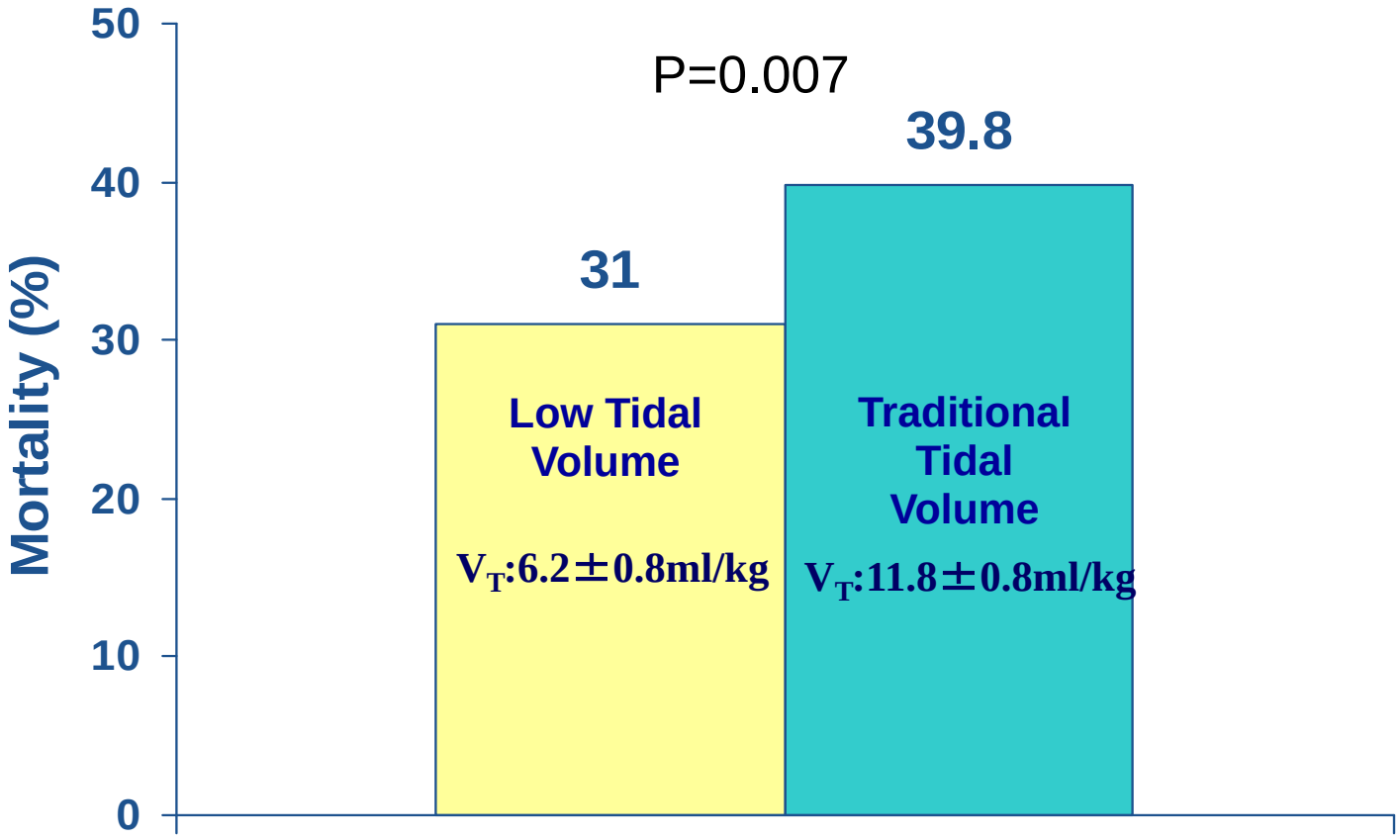
Traditional approaches to mechanical ventilation use tidal volumes of 10 to 15 ml per kilogram of body weight.[6] These volumes are larger than those in normal subjects at rest (range, 7 to 8 ml per kilogram), but they are frequently necessary to achieve normal values for the partial pressure of arterial carbon dioxide and pH. Since atelectasis and edema reduce aerated lung volumes in patients with acute lung injury and the acute respiratory distress syndrome,[7,8] inspiratory airway pressures are often high, suggesting the

ARDSNet试验方案

参数	试验方案
模式	容量控制—辅助
V_T	≤ 6mL/kg(理想体重)
Pplat	≤ 30 cm H_2O
呼吸频率; pH目标	在6-35 bpm范围内调整以使pH > 7.30(如有可能)
流速	I:E = 1:1 to 1:3
氧合	55 ≤ PaO_2 ≤ 80; 88 ≤ SO_2 ≤ 95
FiO_2/PEEP	.3/5, .4/5, .4/8, .5/8, .5/10, .6/10, .7/10, .7/12, .7/14, .8/14, .9/14, .9/16, .9/18, 1.0/18, 1.0/22, 1.0/24
脱机	当FiO_2/PEEP < 0.4/8时应用PSV

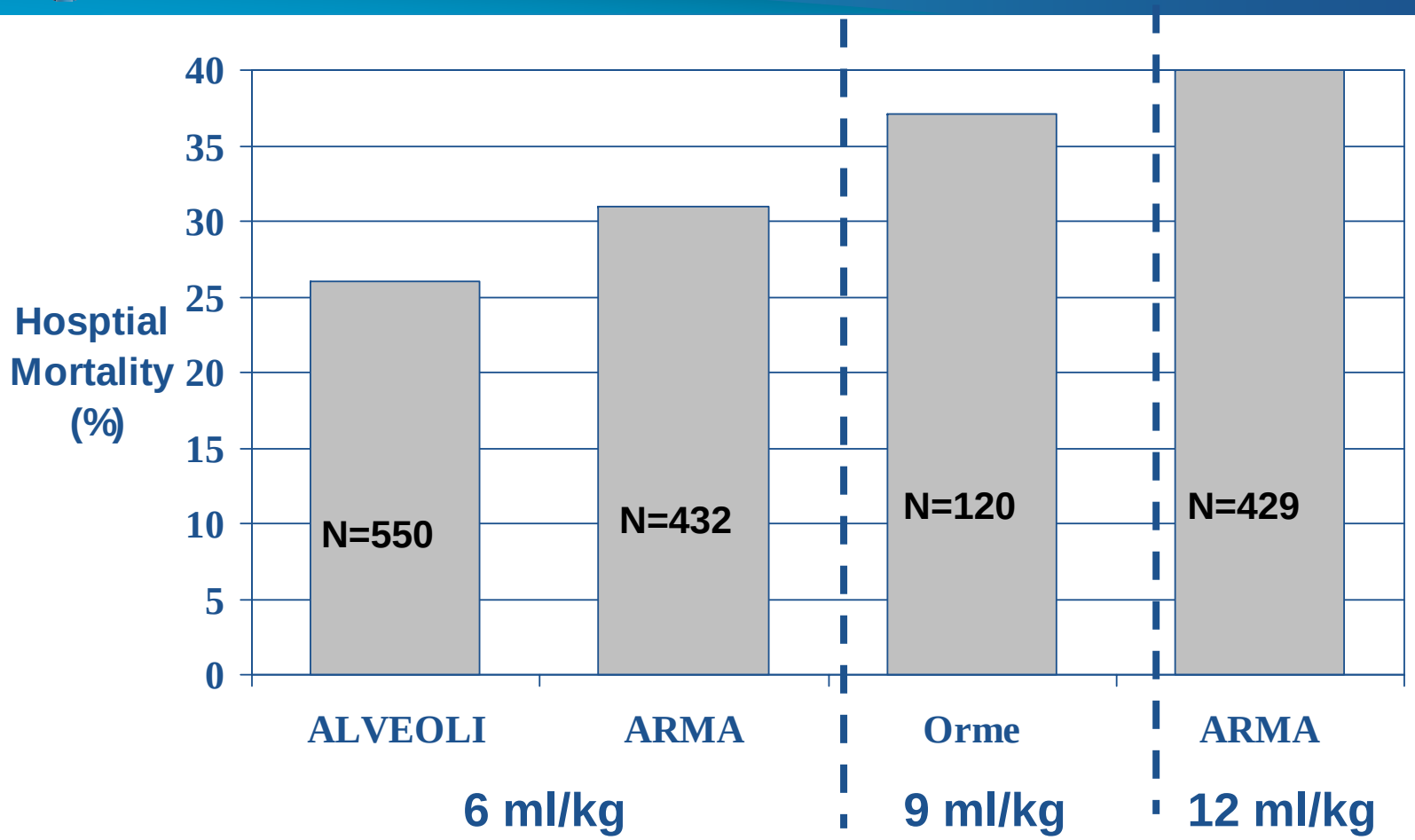
Low tidal volume ventilation: ALI/ARDS

Mortality - Low vs Traditional Tidal Volume



ARDSNet. N Eng J Med 2000;342:1301-1308.

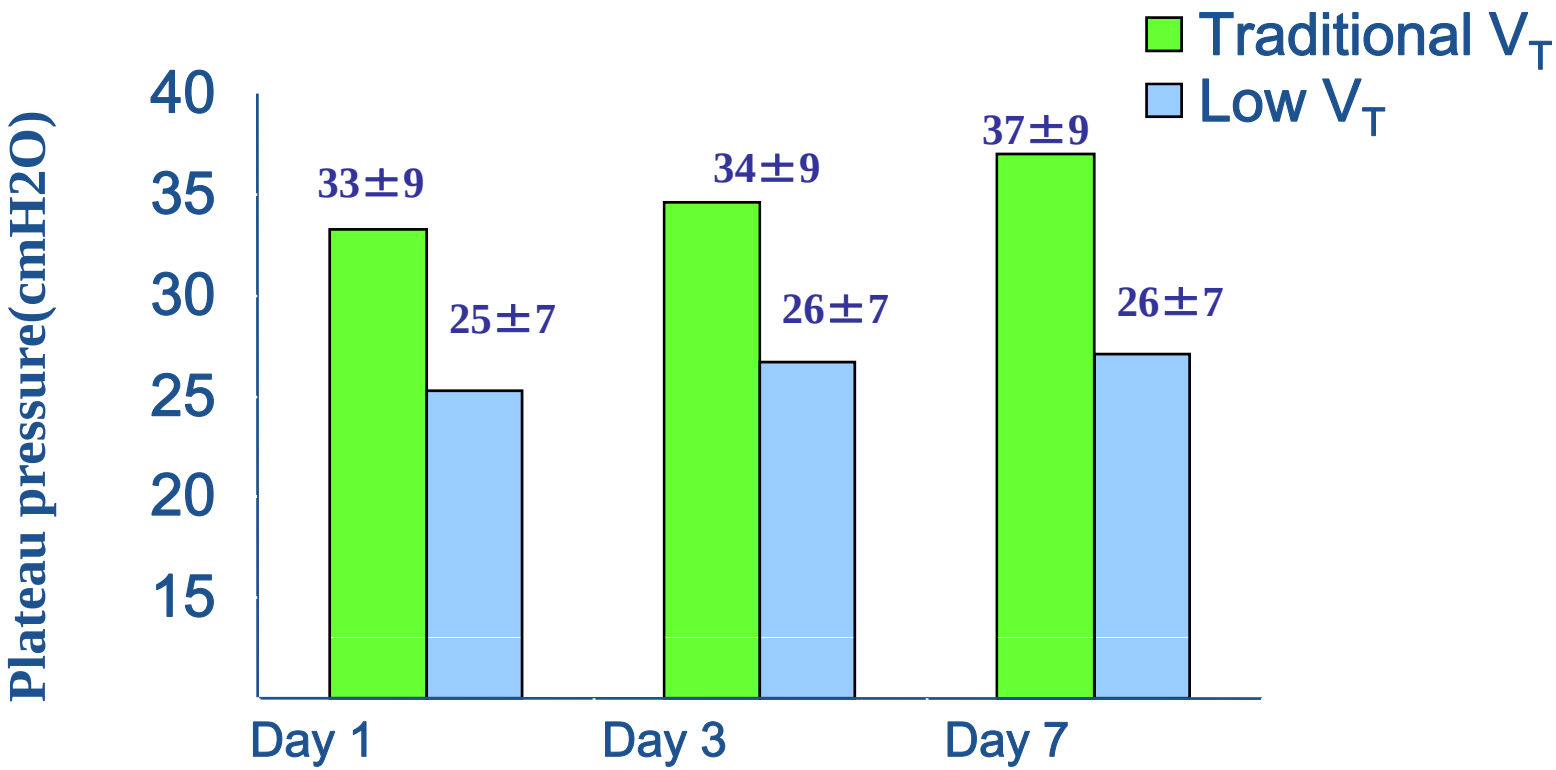
潮气量6, 9, 12 ml/kg时的住院病死率



ARMA NEJM 2000; 342:1301-1308
Orme J, LDS hospital unpublished
ALVEOLI unpublished data

平台压

Pplat- Low vs. Traditional Tidal Volume



ARDSNet. N Eng J Med 2000;342:1301-1308.

Eichacker PQ, et al. Am J Respir Crit Care Med. 2002 ; 166: 1510-1514.

Meta 分析：小潮气量通气

Critical Care Perspective

Meta-Analysis of Acute Lung Injury and Acute Respiratory Distress Syndrome Trials Testing Low Tidal Volumes

国外5组小潮气量通气的RCT研究

Am J Respir Crit Care Med Vol 166. pp 1510–1514, 2002

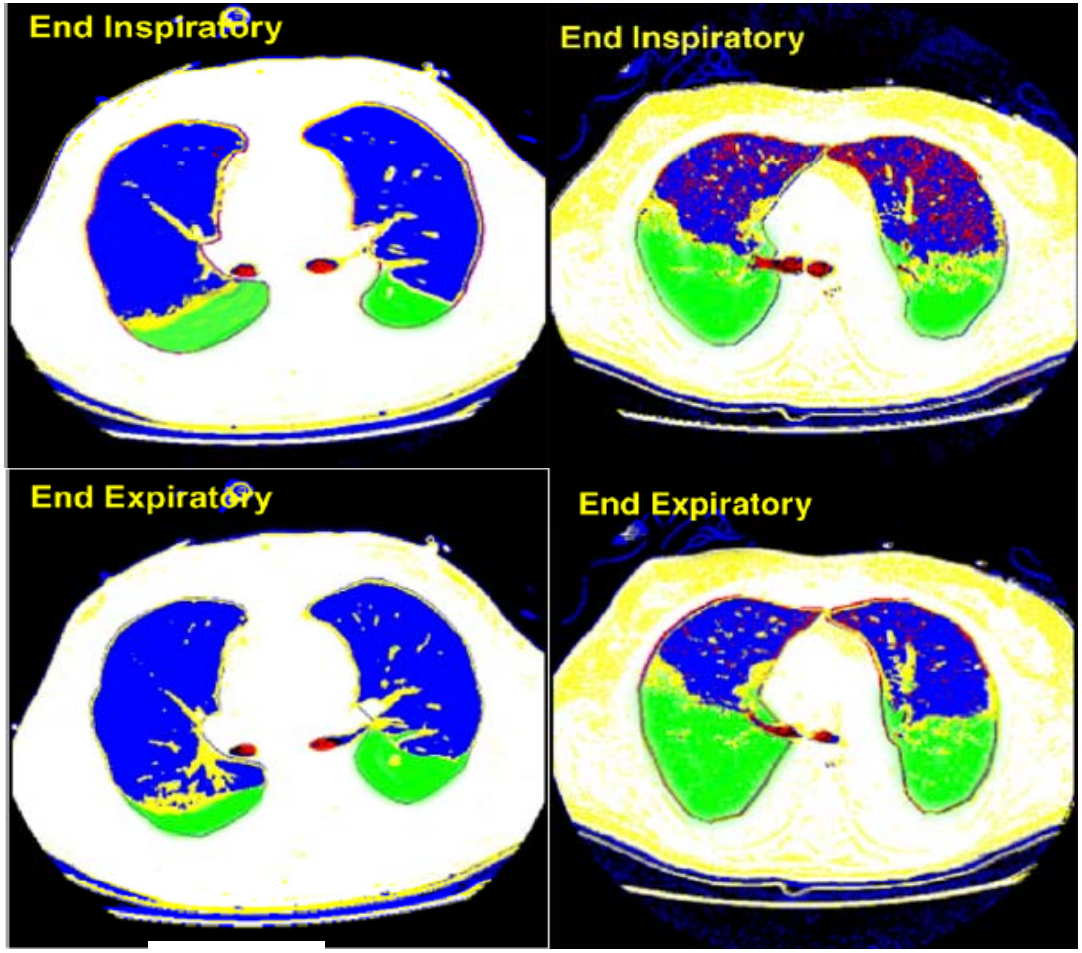
RCT研究结果汇总：2组支持小潮气量

国外有关肺保护性通气多中心研究的临床结果

	病例数	氧合指数基础值	潮气量 (ml/kg)	PEEP (cmH_2O)	气道峰压 (cmH_2O)	$PaCO_2$ (mmHg)	死亡率 (%)
Amato et al							
常规治疗	24	134±67	12	8.7±0.4	36.8±0.9	33.2±0.6	72
肺保护性通气	29	112±51	< 6*	16.4±0.4*	30.1±0.7*	55.0±1.7*	38*
Stewart et al.							
常规治疗	60	145±72	10.7±1.4	7.2±3.3	26.8±6.7	---	47
肺保护性通气	60	123±47	7.0±0.7*	8.6±3.0*	22.3±5.4*	---	50
Bronchard et al.							
常规治疗	58	155±68	10.3±1.7	10.7±2.3	31.7±6.6	41.3±7.6	38
肺保护性通气	58	144±61	7.1±1.3*	10.7±2.9	25.7±5.0*	59.5±15.0*	47
Brower et al.							
常规治疗	26	150±69	10.2±0.1	---	30.6±0.8	---	46
肺保护性通气	26	129±51	7.3±0.1*	---	24.9±0.8*	---	50
ARDSNet.							
常规治疗	429	134±58	11.8±0.8	8.6±3.6	33±9	35±8	40
肺保护性通气	432	138±64	6.2±0.9*	9.4±3.6*	25±7	40±10*	31*

*： $p<0.05$； 引自:Kopp R, et al. Intensive Care Med. 2002; 28:244-255

Terragni: 小潮气量通气时仍存在过度通气



A B

V_T: 6.0ml/kg
PEEP: 9-12cmH_2O

A: Patients of the more protected

B: Patients of the Less protected

Red: *hyperinflated (between –901 and –1,000 HU)*
Blue: *normally aerated (between –501 and –900 HU)*
Yellow: *poorly aerated (between –101 and –500 HU)*
Green: *nonaerated (between 100 and –100 HU)*

Am J Respir Crit Care Med.2007;175:160–166

小潮气量通气存在严重低氧血症

Table 5. Cointerventions and Adjunctive Therapies

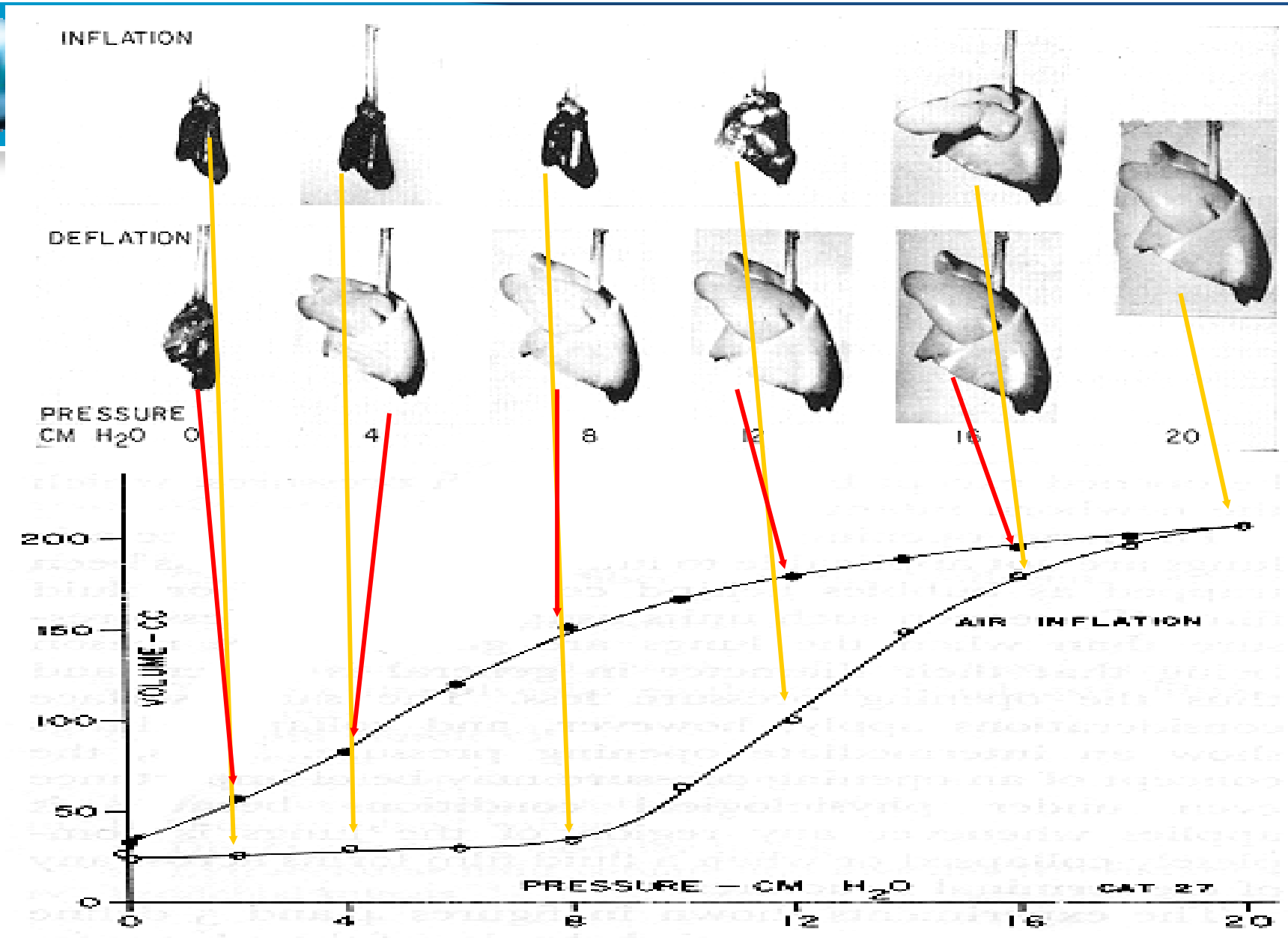
Intervention	No. (%)[a] Minimal Distension (n=382)	Increased Recruitment (n=385)	*P* Value
During the first 72 h			
Fluid loading	255 (66.8)	290 (75.3)	.01
Volume of fluids, median (IQR), L[b]	0.5 (0-1.5)	1.0 (0.1-2.2)	<.001
During the first 7 d			
Epinephrine or norepinephrine	286 (74.9)	289 (75.1)	.95
Corticosteroids	198 (51.8)	199 (51.7)	.97
Neuromuscular blockade	209 (54.7)	204 (53)	.63
Recruitment maneuvers	49 (12.8)	27 (7.0)	.007
Any therapy	132 (34.6)	72 (18.7)	<.001
Mortality in patients who received rescue therapy	62 (47.0)	37 (51.4)	.55

Received rescue therapy for severe hypoxemia 34.6% VS 18.7%（P<0.001))

JAMA. 2008;299(6):637-645.

Positive End Expiratory Pressure: PEEP

- PEEP是维持呼气末肺泡复张、促进氧合的最为有效手段
- 被认为是20世纪末临床医学十大进展之一



Respir Care . 2005; 50(5):649

PEEP = 5 cmH_2O

collapsed Area = 54.3%

collapsed Mass = 69.2%

PEEP = 19 cmH_2O
(OLA)

collapsed Area = 21.9%

collapsed Mass = 36.8%

PEEP = 25 cmH_2O
(after P_{PLAT} = 55)

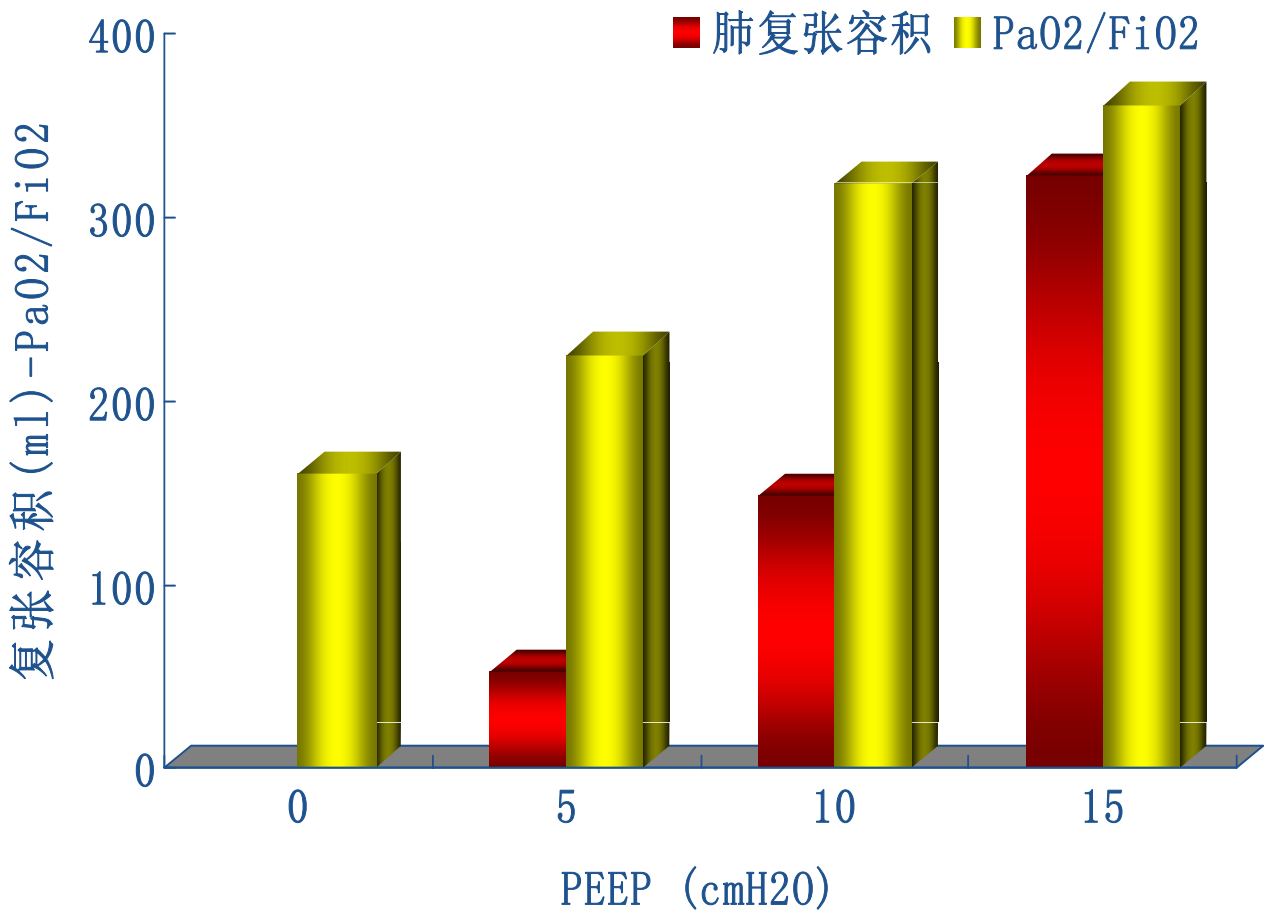
collapsed Area = 0.4%

collapsed Mass = 0.9%

随着PEEEP的增加，肺泡塌陷明显减少

Am J Respir Crit Care Med 2006，174，268–278

国内的临床研究



邱海波. 中国危重病急救医学，**2004, 16: 399.**

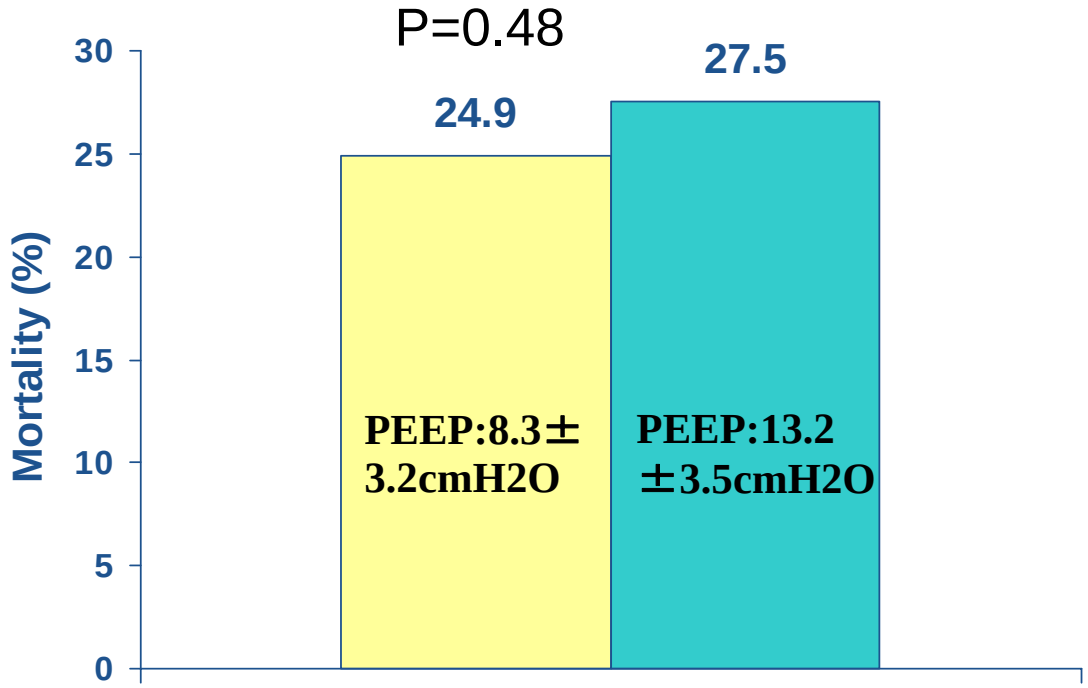
高PEEP VS 低PEEP

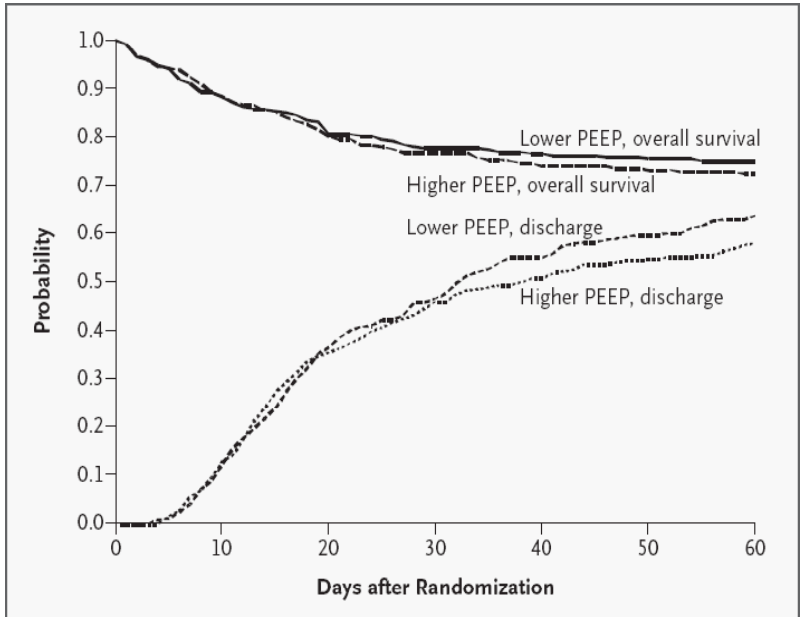
三个大规模的RCT研究

- ALVEOLI — NEJM 2004
- LOV — JAMA 2008
- Express — JAMA 2008

ALVEOLI

Mortality - Low PEEP vs. High PEEP





ARDSNet. N Eng J Med 2004;351:327-336.

LOV和Express

结论：高PEEP不会提高住院生存率，但可改善缺氧

Gattinoni认为研究对象病变严重程度不一，如果没有严重肺水肿和肺泡塌陷，高PEEP可能无效

JAMA. 2008;299 (6):637-645

JAMA. 2008;299 (6):646-655.

JAMA 2008 299（6）691-693

纲　要

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补救治疗（rescue therapy）

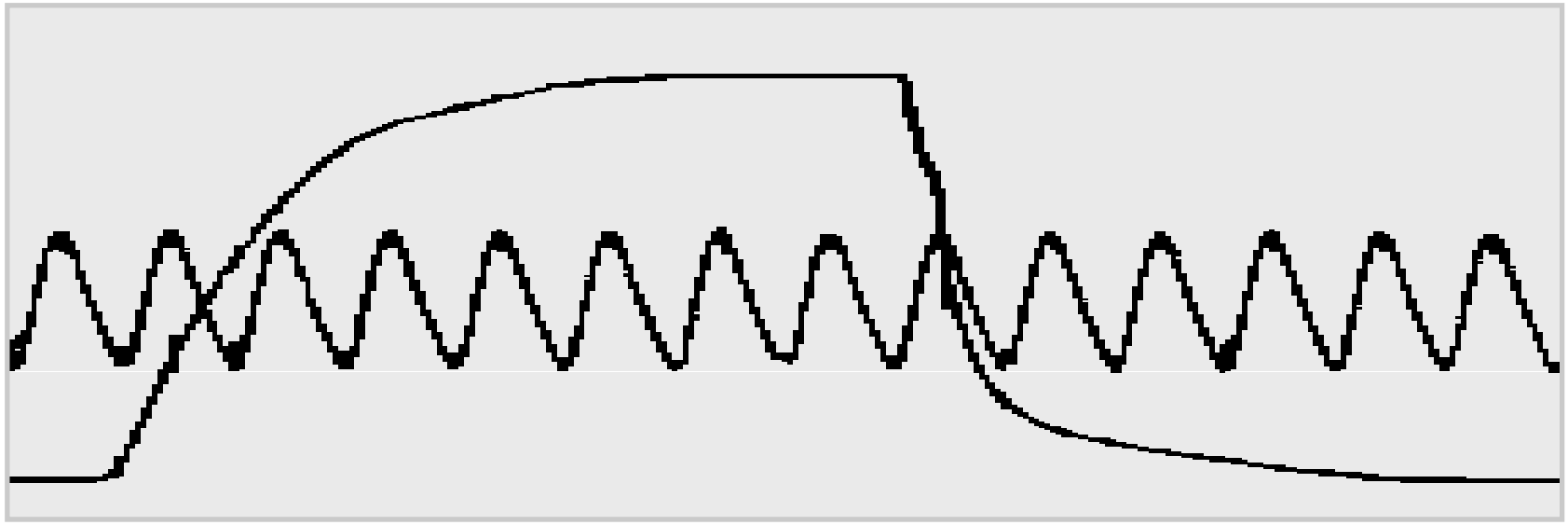
高频振荡通气

肺复张

俯卧位通气

高频振荡通气(HFOV)

HF0V 是指将低于或等于死腔的潮气容积（VT≦5ml／lg），用超过生理呼吸次数甚多的频率（60-3600／min）来供给呼吸的通气方式



高频振荡通气的RCT研究（MOAT）

High-Frequency Oscillatory Ventilation for Acute Respiratory Distress Syndrome in Adults

A Randomized, Controlled Trial

148例ARDS随机分为HFOV组(75例)和 (P—CMV) 组(73例)

30d死亡率37% vs.52%，无显著差异

30d脱机存活率36% vs.31%，无显著差异

血流动力学参数、氧合不足、通气不足、气压伤、粘液栓两组无差异

Derdak S Am J Respir Crit CareMed，2002，166：801—808

肺复张

- **Open up the lung —— RM**

短时间应用较高的气道压力打开陷闭肺区

- **keep the lung open —— PEEP**

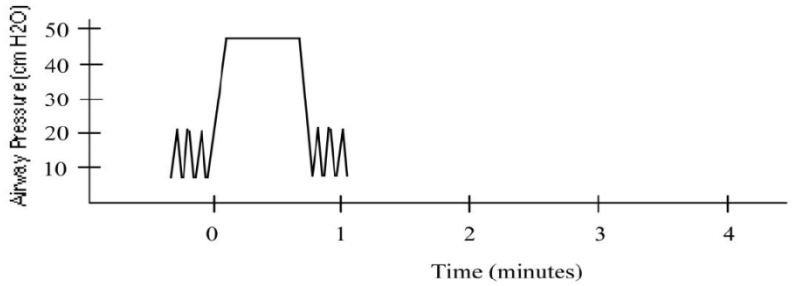
维持已复张的肺泡开放并避免其过度膨胀

Lachmann B, Intensive Care Med,1992,18:319-321

肺复张的方法

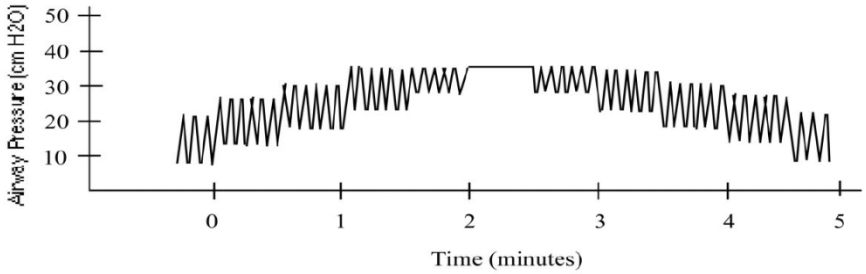
1. 控制性肺膨胀(SI)法

Sustained Inflation (SI)



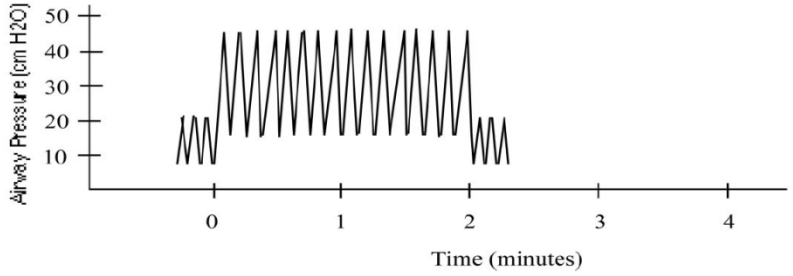
2. PEEP递增法

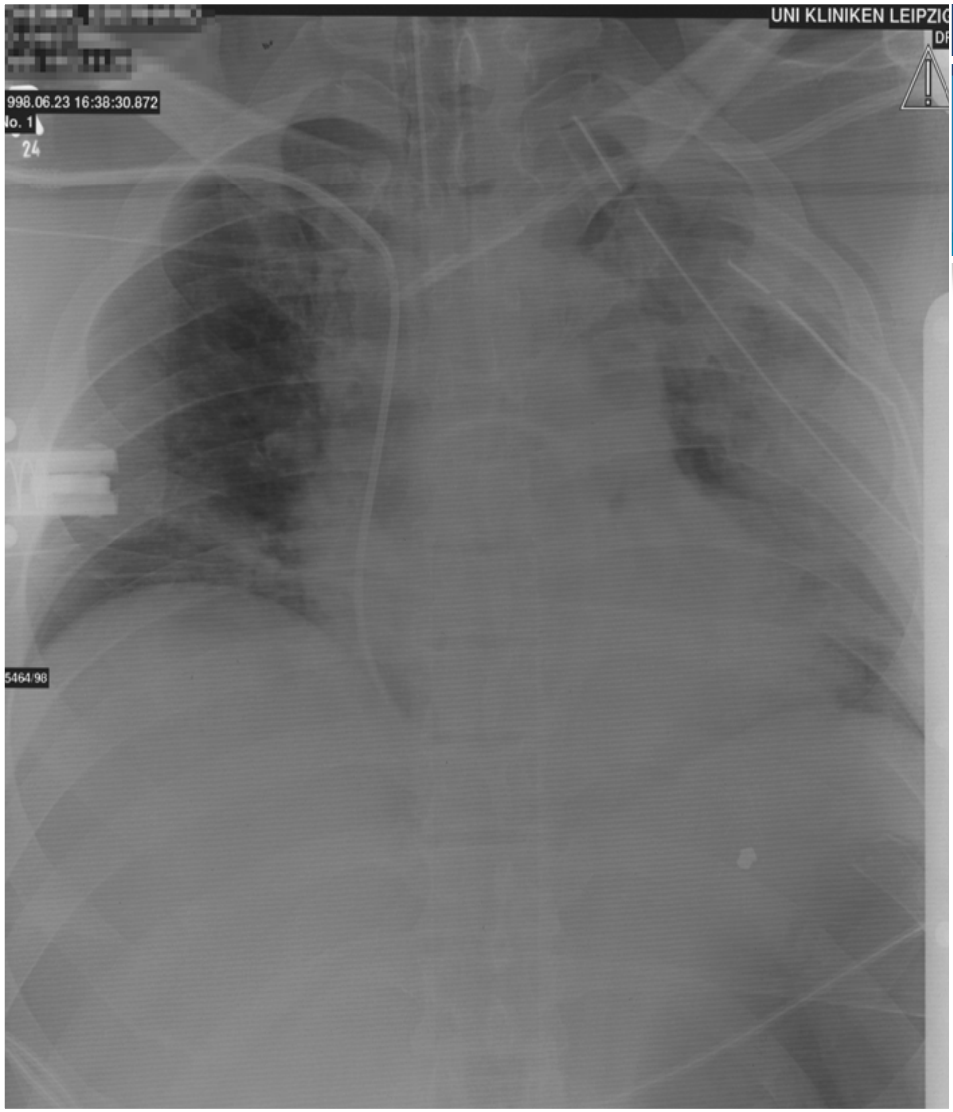
Incremental PEEP (IP)

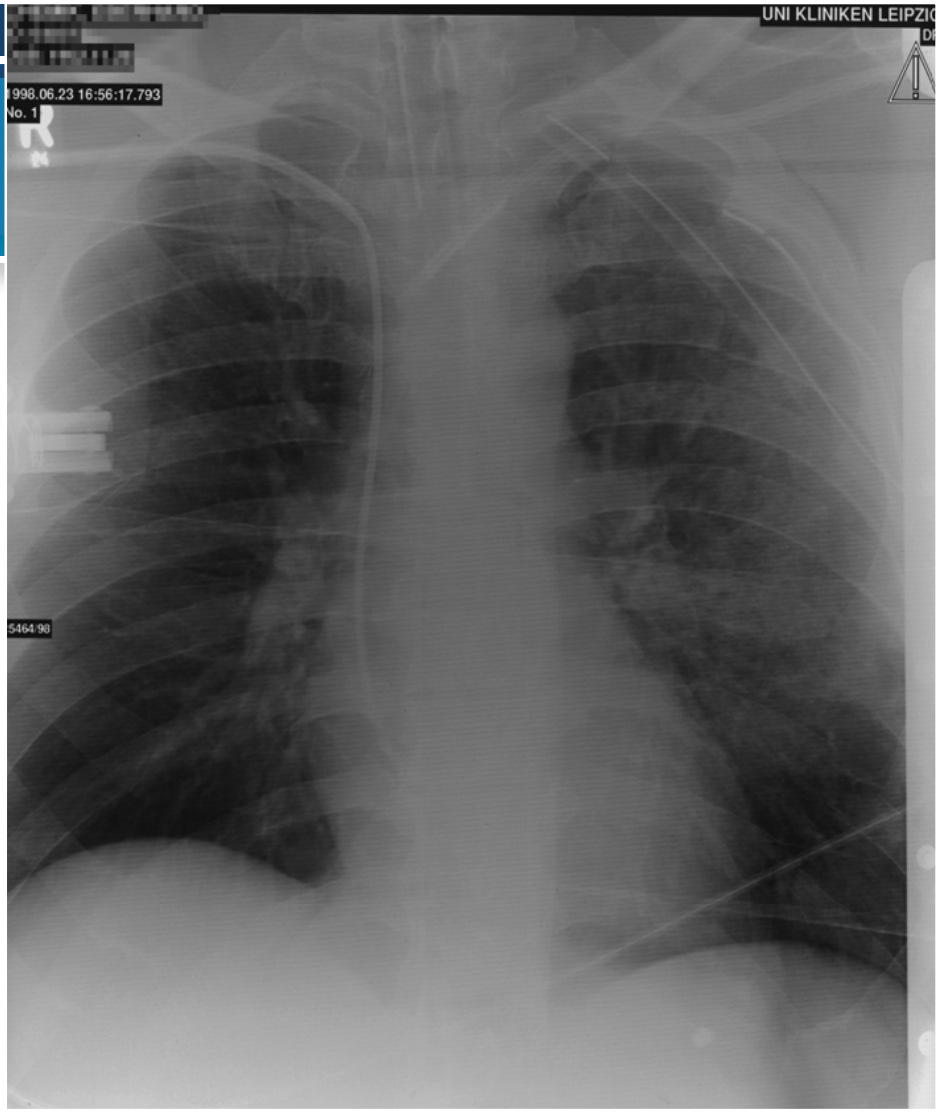


3. 压力控制(PCV)法

Pressure Control Ventilation (PCV)

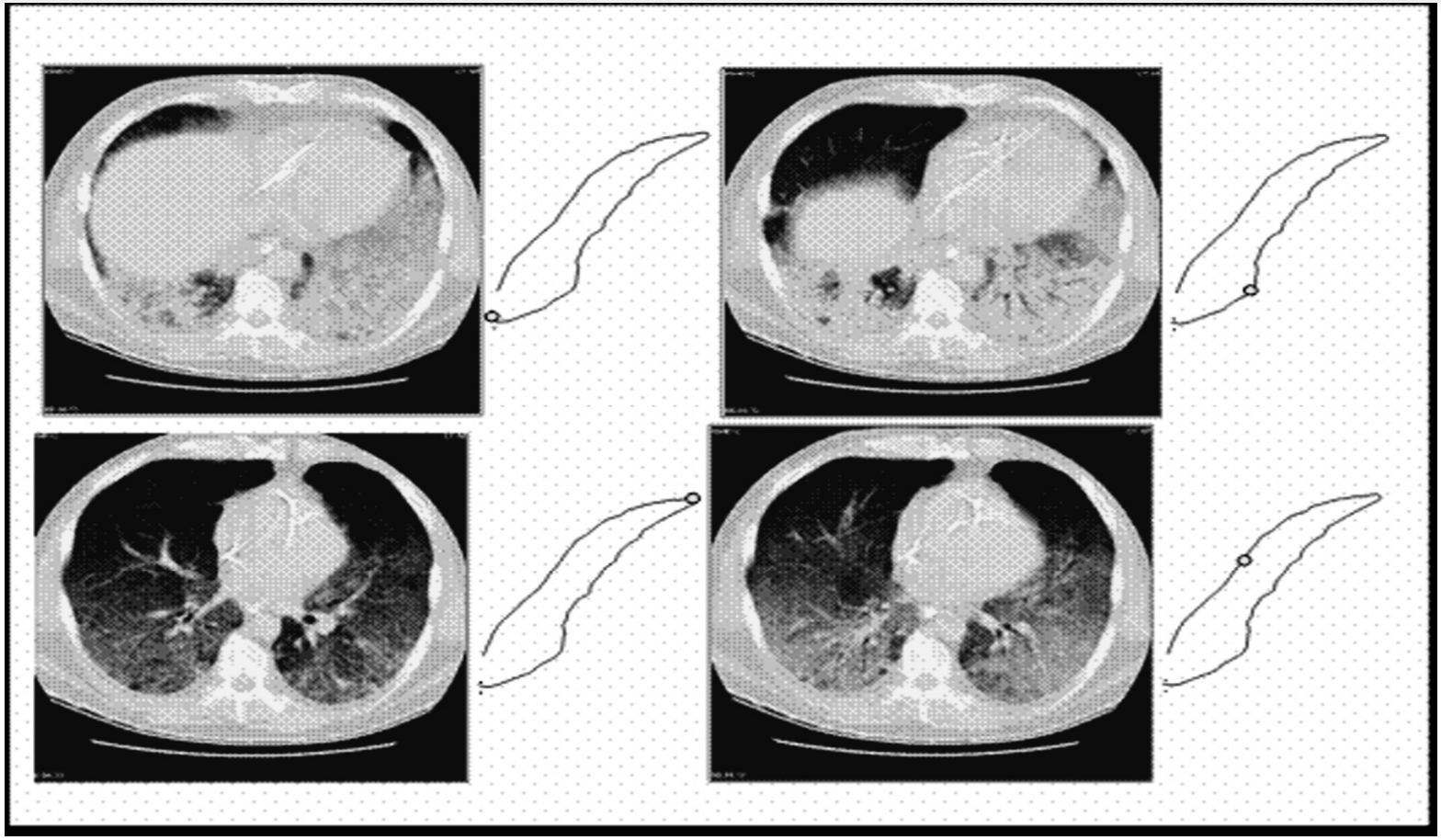






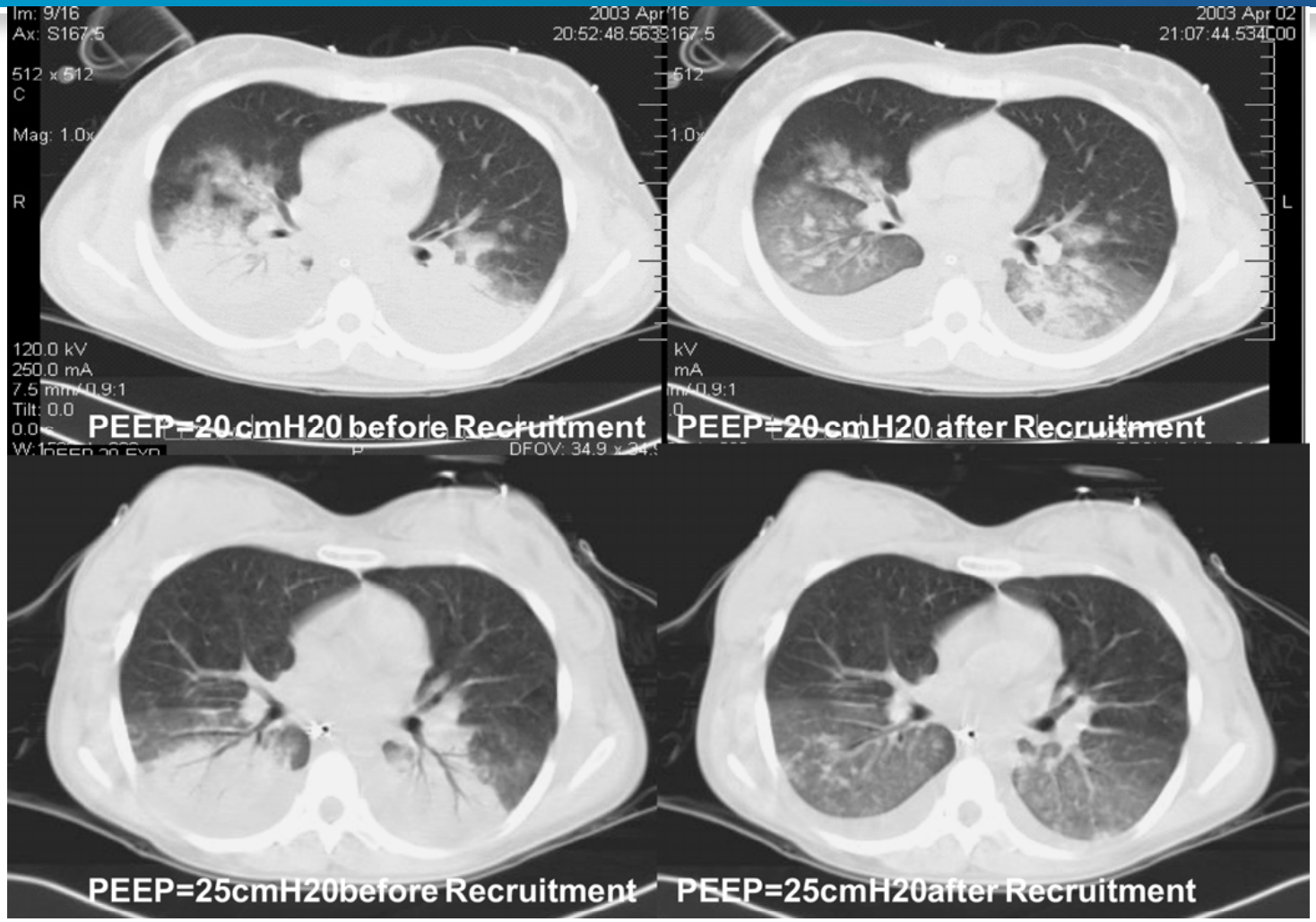
20 minutes after
start of Open Lung Management

维持肺泡稳定



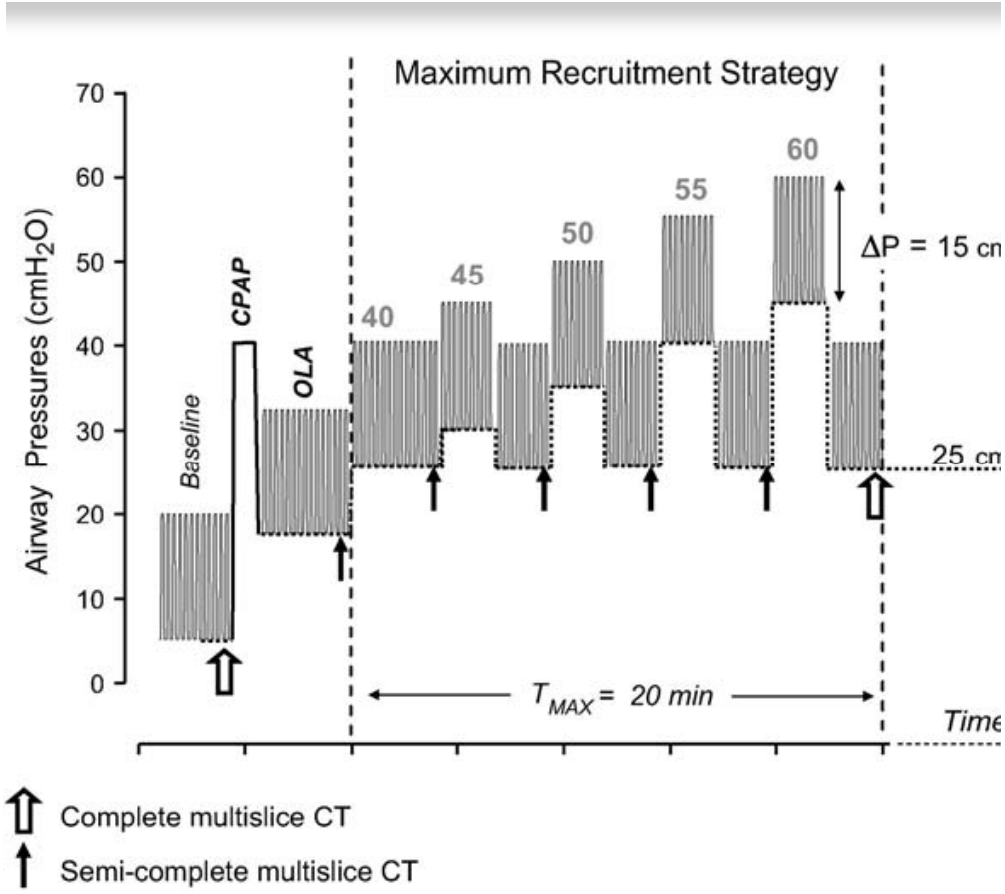
a more open and homogeneous ARDS lungs during the deflation limb of the P-V curve

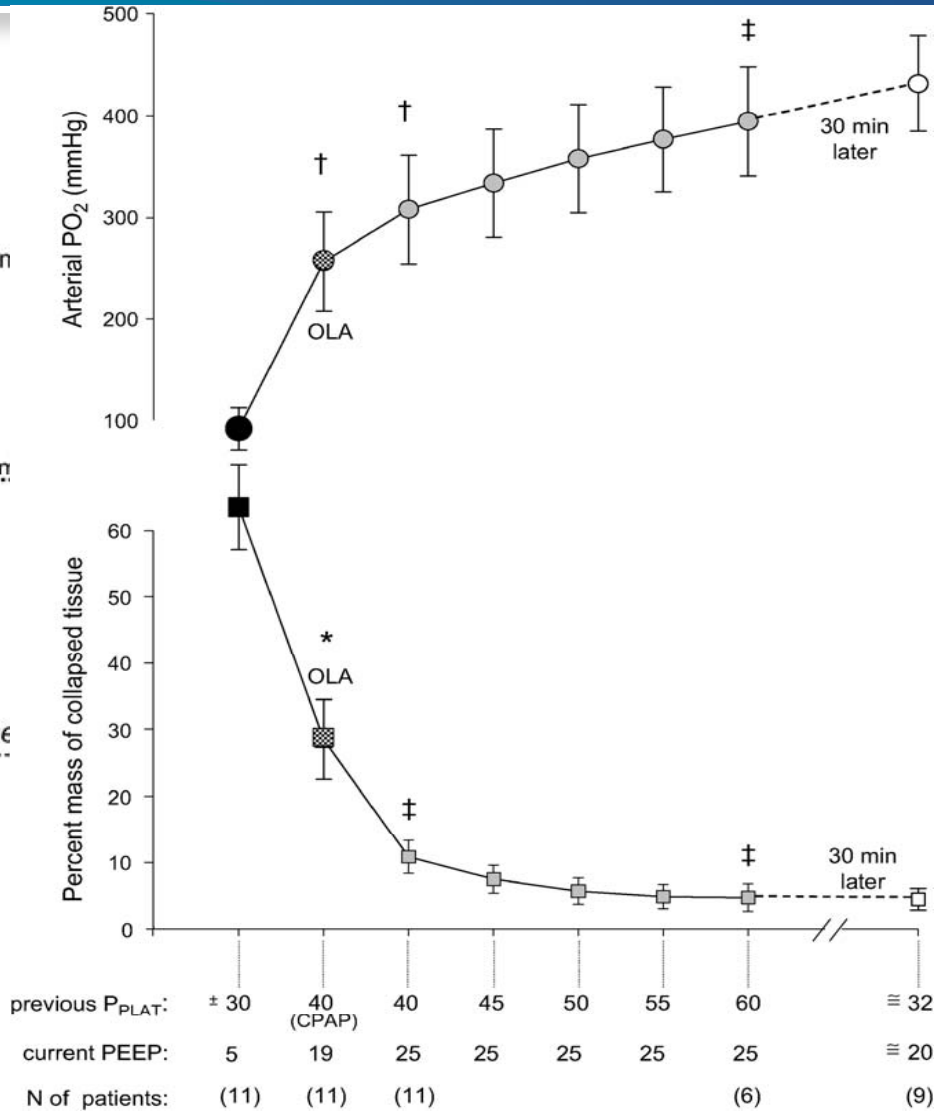
减少呼气时肺泡塌陷



Barbas CSV, et al. Current Opinion in Critical Care 2005, 11:18–28

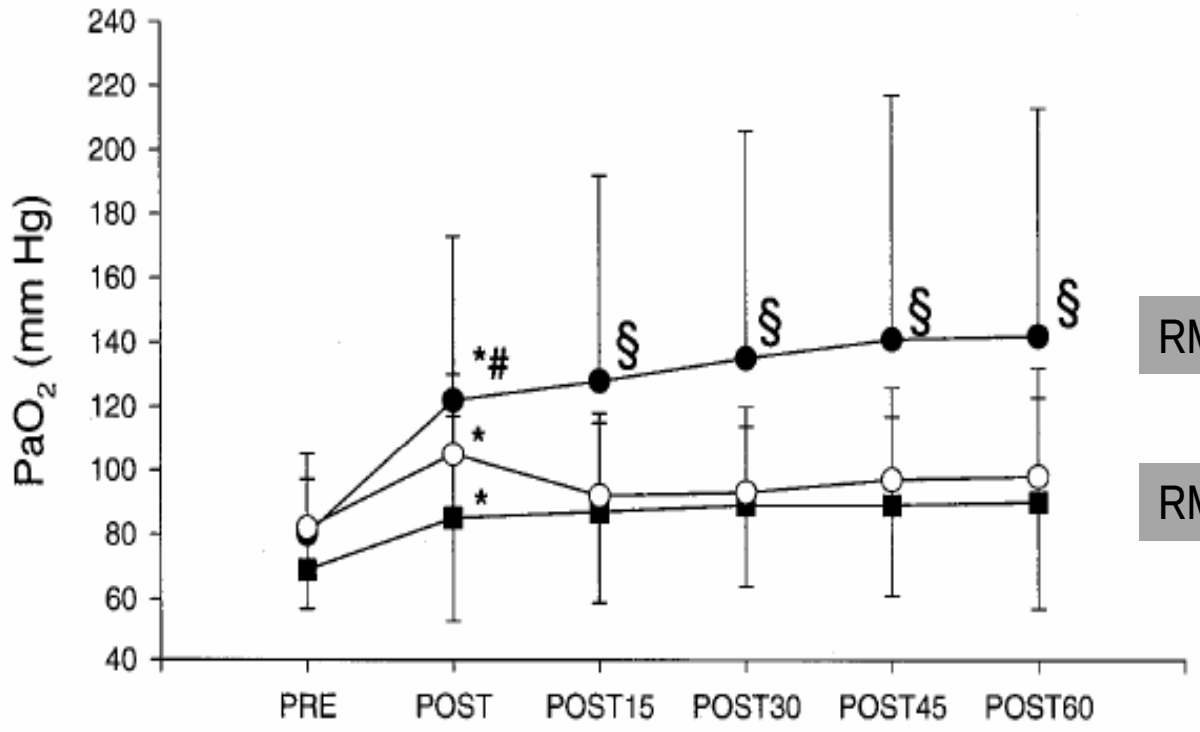
肺复张持续改善氧和





Borges JB，Am J Respir Crit Care Med 2006，174，268–278

RM + PEEP vs. RM



RM + PEEP

RM only

Figure 2. Pao_2 preintervention (*PRE*) and 5 mins postintervention (*POST*) in the ARM + PEEP group (*filled circles*), the ARM-only group (*open circles*), and the PEEP-only group (*squares*). POST15, 30, 45, and 60 denote 15, 30, 45, and 60 mins after POST. *$p < .05$ vs. PRE; #$p < .05$ vs. the PEEP-only group; §$p < .05$ vs. the ARM-only group and the PEEP-only group. *ARM*, alveolar recruitment maneuver; *PEEP*, positive end-expiratory pressure.

Lim CM, Jung H, Koh Y, Lee JS, Shim TS, Lee SD, Kim WS, Kim DS, Kim WD. Effect of alveolar recruitment maneuver in early acute respiratory distress syndrome according to antiderecruitment strategy, etiological category of diffuse lung injury, and body position of the patient. Crit Care Med 2003; 31: 411-418

Recruitment Maneuvers for Acute Lung Injury

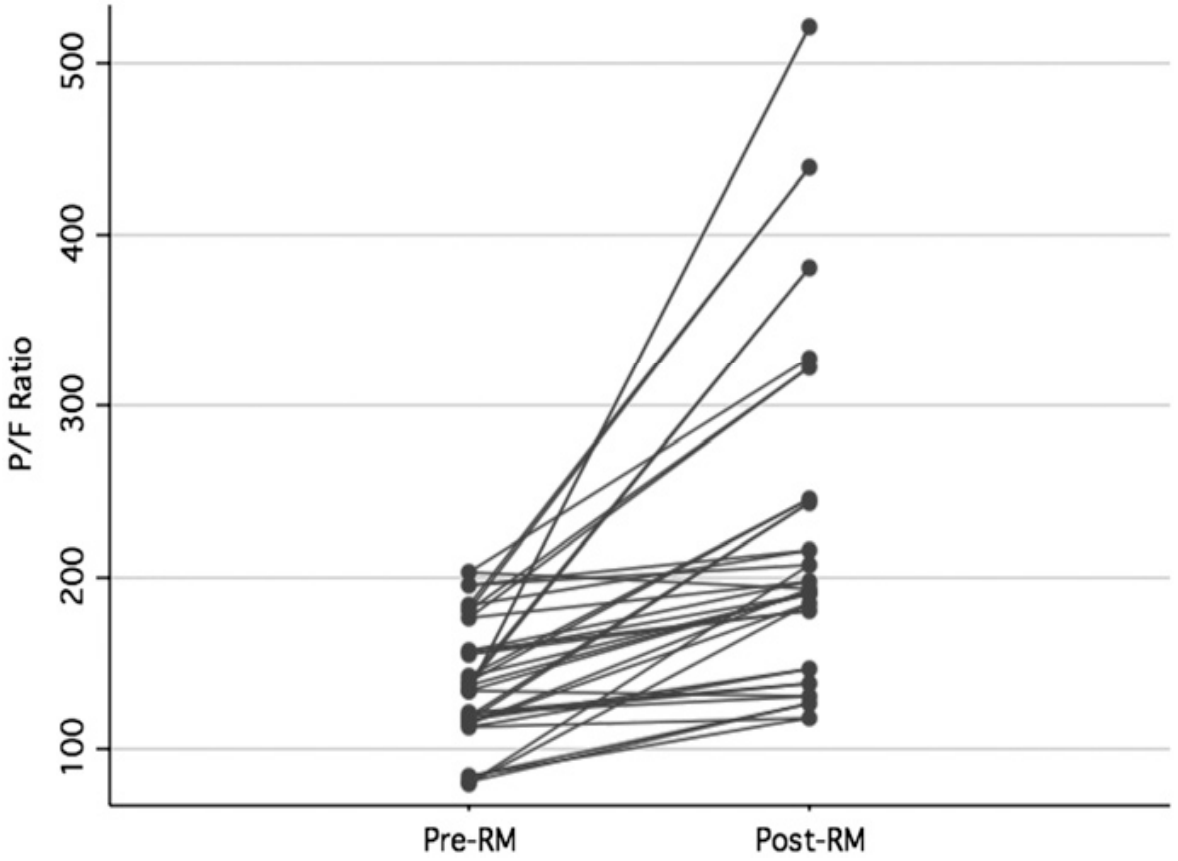
A Systematic Review

40个研究，共1185名患者

氧和明显短暂改善

无明显血流动力学影响

建议严重低氧血症患者使用



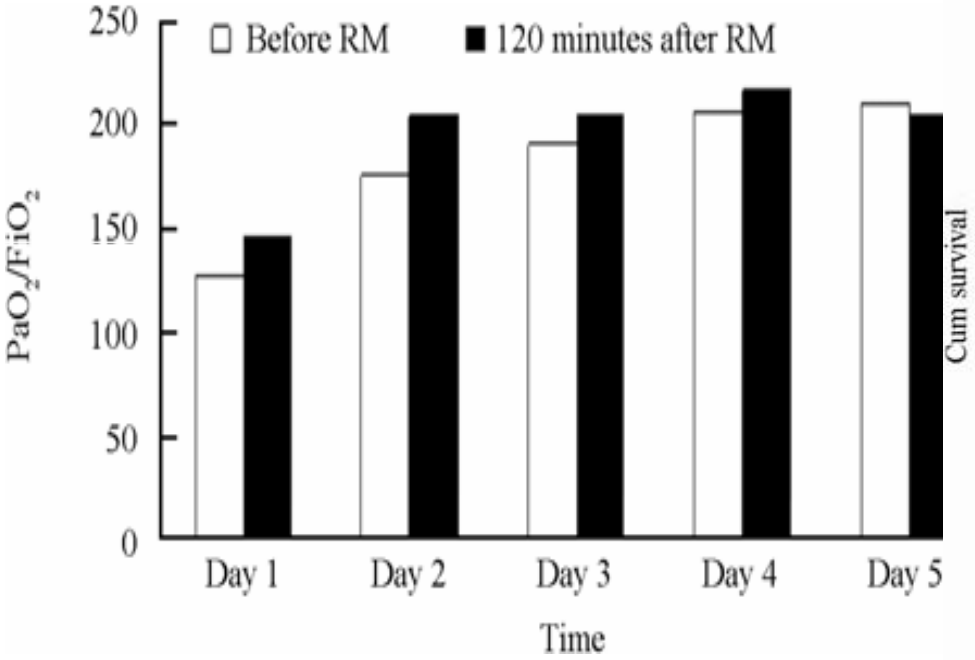
Am J Respir Crit Care Med Vol 178. pp 1156–1163, 2008

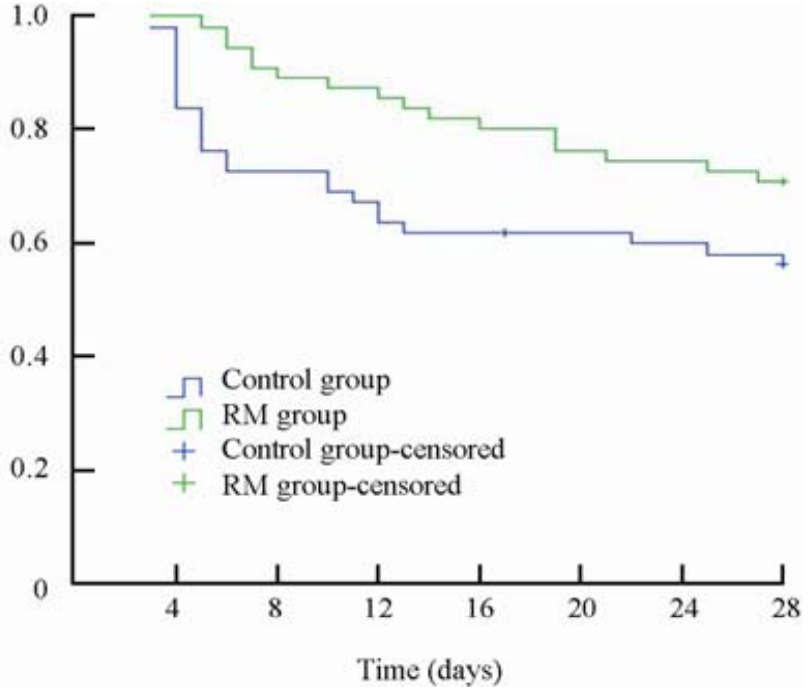
RM+ low Vt (CHINA)

Original article

Clinical efficacy and safety of recruitment maneuver in patients with acute respiratory distress syndrome using low tidal volume ventilation: a multicenter randomized controlled clinical trial

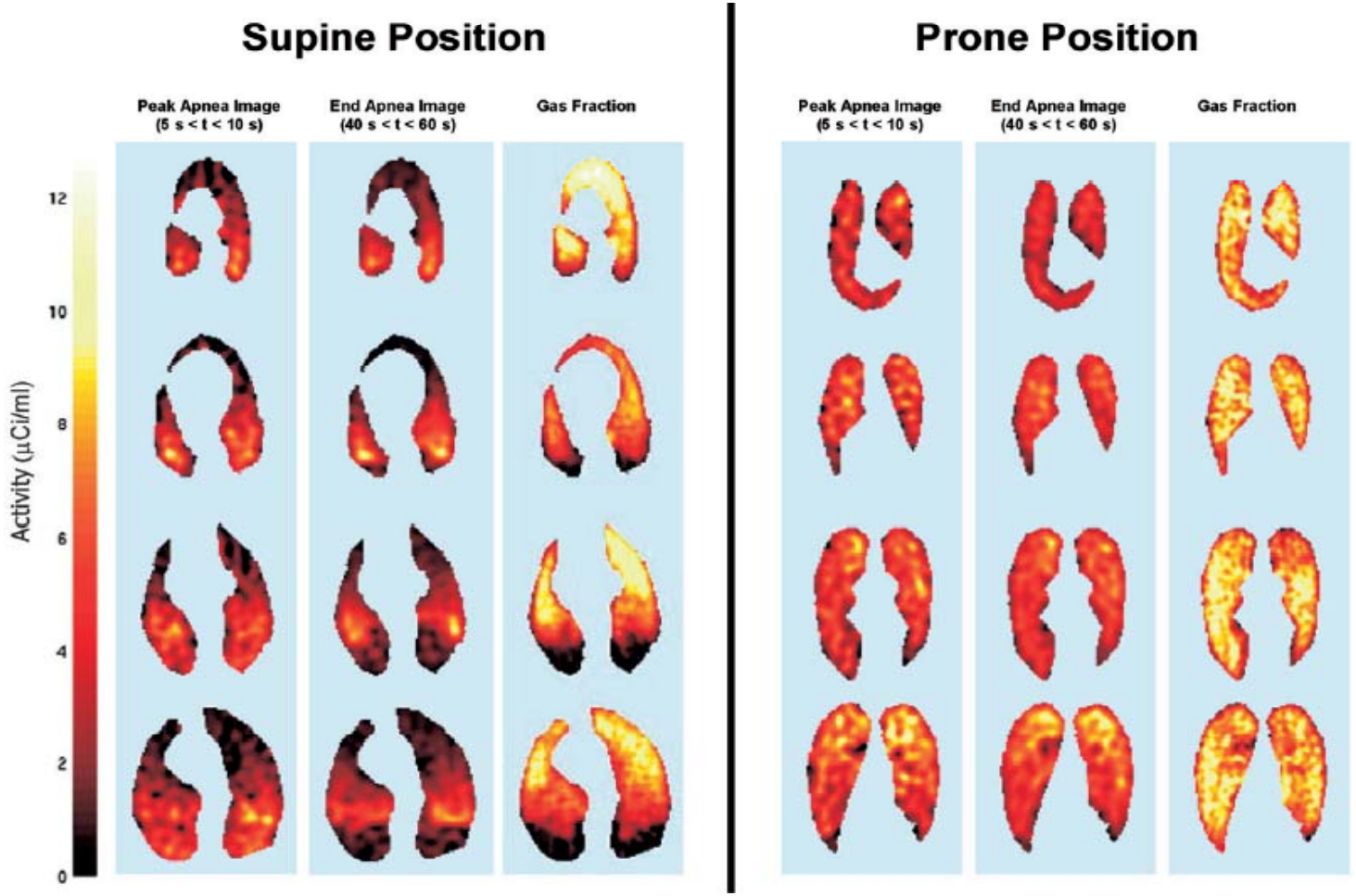
XI Xiu-ming, JIANG Li, ZHU Bo and the RM group





Chin Med J 2010;123(21):3100-3105

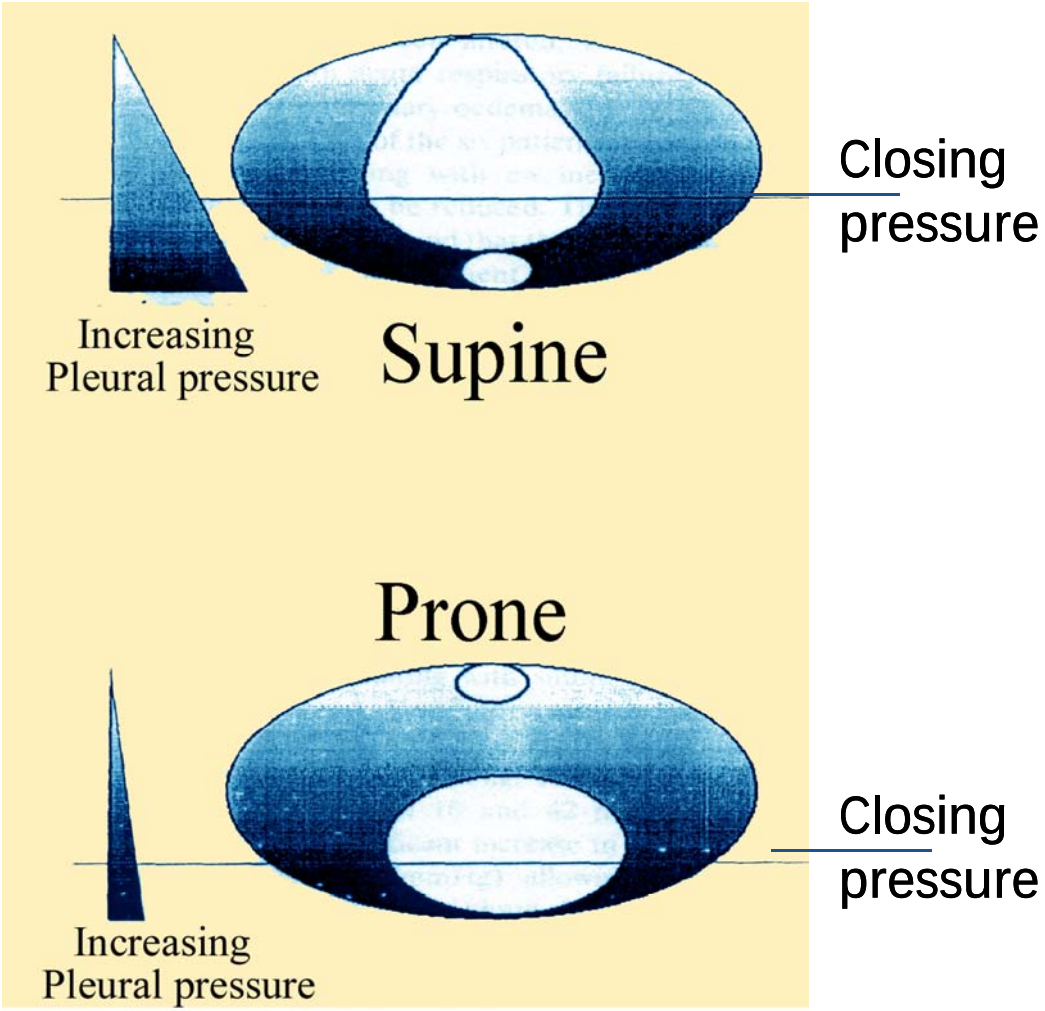
俯卧位通气（prone position）



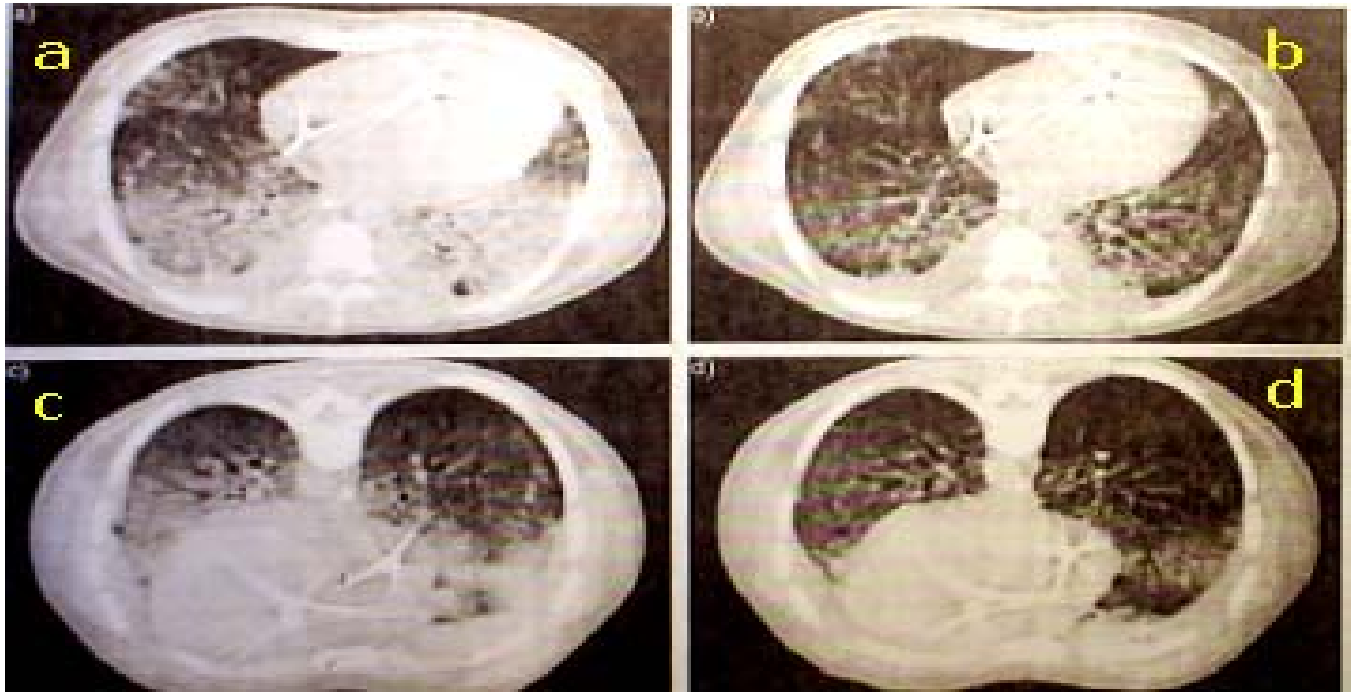
俯卧位通气的病理生理特征

改善通气过程

- ↓ 胸膜腔压力梯度
- ↓ 顺应性$_{胸壁}$
- 促进分泌物的清除



俯卧位通气



a:呼气末仰卧位，b:吸气末仰卧位
c:呼气末俯卧位，d:吸气末俯卧位

Eur Respir J. 2002; 20(4): 1017-1028.

俯卧位通气的多中心研究

Table 2 Summary of the three multicenter prospective randomized controlled trials of prone position in acute lung injury/acute respiratory distress syndrome

	Gattinoni [1]		Guérin [4•]		Mancebo [19]	
	SP	PP	SP	PP	SP	PP
No. patients analyzed	152	152	378	413	60	76
Inclusion criteria	Acute lung injury ($PaO_2/FIO_2 < 300$)		$PaO_2/FIO_2 < 300$		ARDS ($PaO_2/FIO_2 < 200$)	
Dose of PP per day						
Planned	At least 6 h		At least 8 h		20 h	
Performed	7 h		8 h		13 h	
Randomization						
Tidal volume (ml/kg)	10.3 ± 2.9 p	10.3 ± 2.7 p	8.1 ± 1.9 m	8.1 ± 2.0 m	8.6 ± 1.5 i	8.3 ± 1.7 i
PEEP (cmH_2O)	9.6 ± 3.2	9.7 ± 2.9	7.5 ± 3.2	7.9 ± 3.4	12 ± 2	12 ± 2
F_IO_2 (%)	72.7 ± 18.7	73.4 ± 18.3	65.7 ± 20.4	65.7 ± 20.9	79 ± 21	84 ± 19
PaO_2/F_IO_2	129.5 ± 49.5	125.3 ± 48.8	155 ± 59	150 ± 59	159 ± 22[a]	127 ± 34[a]
$PaCO_2$	44.2 ± 11.8	45.1 ± 11	44 ± 11	44 ± 12	43 ± 11	45 ± 9
pH	Not provided		7.38 ± 0.09	7.39 ± 0.10		
Mortality	Unchanged		Unchanged		Unchanged	
VAP incidence	Not assessed		Significantly reduced in PP group			
Oxygenation	Improved in PP group		Improved in PP group			
Duration of MV	Unchanged		Unchanged			
Side effects	More pressure sores in PP group		Pressure sores, endotracheal tube obstruction or displacement more frequent in PP group			

Current Opinion in Critical Care 2006, 12:50–54

Meta-analysis: Ventilation Strategies and Outcomes of the Acute Respiratory Distress Syndrome and Acute Lung Injury

Ann Intern Med. 2009;151:566-576.

4 RCT: lower vs higher Vt (similar PEEP) 1149 pats

3 RCT: lower vs higher PEEP(low Vt) 2299 pats

2 RCT: higher Vt+lower PEEP vs lower Vt + higher PEEP 148 pats

结论：非选择性ARDS,推荐小潮气量而非高PEEP
高PEEP可改善选择性ARDS患者的严重低氧血症

shumingpan@yahoo.com.cn