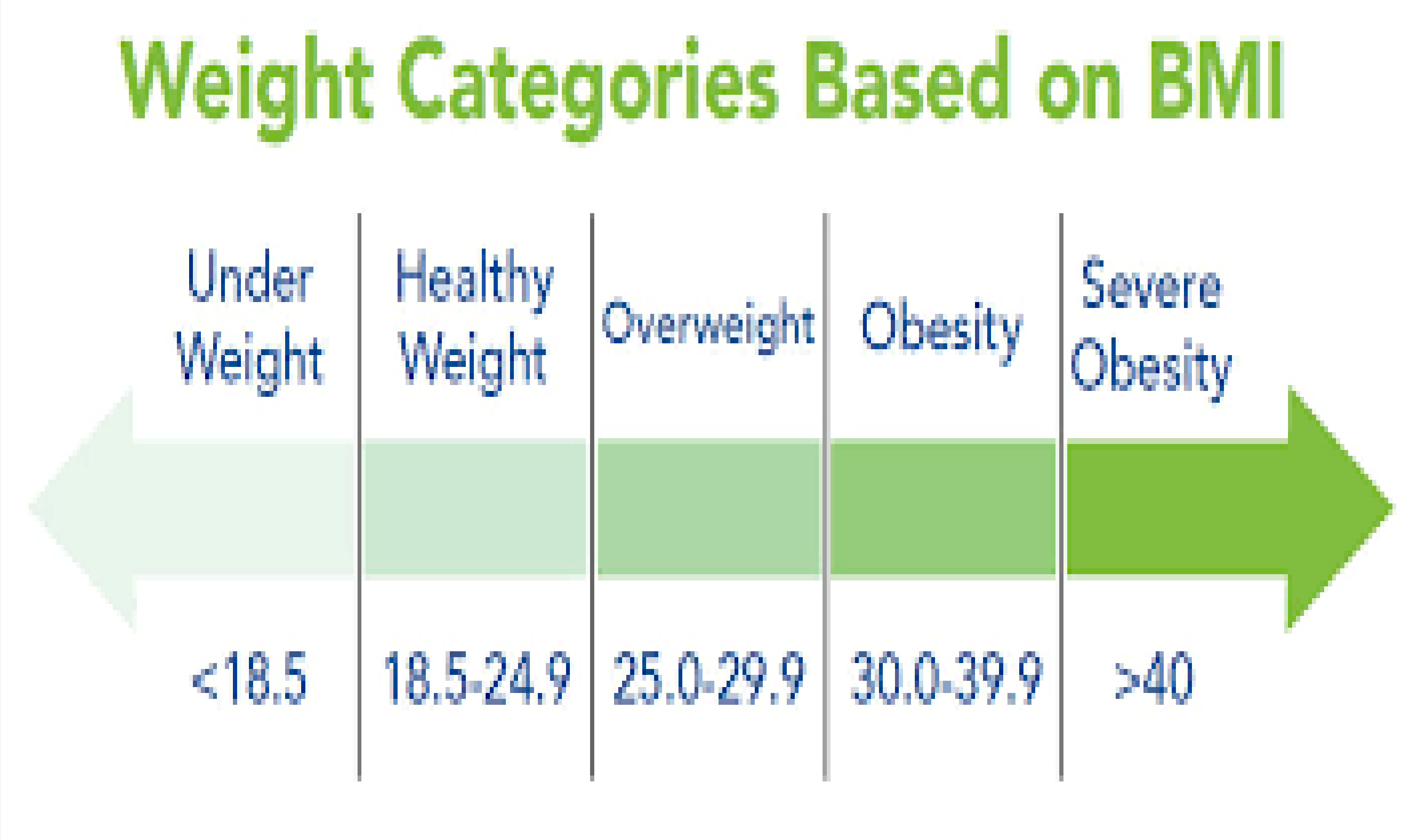
The Effects of Obesity on Lung Function

Terrence Shenfield MS, RRT-ACCS, RPFT, NPS, AE-C

Objectives

- Stats
- Prevalence of comorbidities
- Lung function
- Anatomical differences
- Airway management
- Ventilator settings
- Recruitment maneuvers
- Obesity paradox

Obesity if a problem for America


Weight Categories Based on BMI
Under Weight
Healthy Weight
Overweight
Obesity
Severe Obesity
<18.5
18.5-24.9
25.0-29.9
30.0-39.9
>40

Stats in America of obesity

- **Adults**
- Percent of adults aged 20 and over with obesity: 42.5% (2017-2018)
- Percent of adults aged 20 and over with overweight, including obesity: 73.6% (2017-2018)

- **Children and adolescents**
- Percent of adolescents aged 12-19 years with obesity: 21.2% (2017-2018)
- Percent of children aged 6-11 years with obesity: 20.3% (2017-2018)
- Percent of children aged 2-5 years with obesity: 13.4% (2017-2018)

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Recognizing Obesity in Adult Hospitalized Patients: A Retrospective Cohort Study Assessing Rates of Documentation and Prevalence of Obesity

Mohammad A. Hossain,[1,2] Ami Amin,[1] Anju Paul,[1] Huzaif Qaisar,[1] Monika Akula,[1] Alireza Amirpour,[1] Shreya Gor,[1] Sofi Giglio,[1] Jennifer Cheng,[1] Roy Mathew,[3] Tushar Vachharajani,[4] Mohamed Bakr,[1,2] and Arif Asif[1,2,*]

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Table 2

Comorbidities among patients (n = 540).

Comorbidities among Patients	Obese (n = 170)	Overweight (n = 188)	BMI < 25 (n = 182)	p Value
Hypertension	115 (68%)	116 (62%)	103 (56%)	0.079
Coronary Artery Disease	31 (18%)	52 (27%)	44 (24%)	0.148
Peripheral Vascular Disease	12 (7%)	13 (7%)	8 (4%)	0.47
Chronic Kidney Disease	29 (17%)	34 (18%)	33 (18%)	0.953
Malignancy	24 (14%)	45 (24%)	42 (23%)	0.049
Congestive Heart Failure	88 (16%)	34 (18%)	23 (12.5%)	0.258
Cerebrovascular Accident	66 (12%)	23 (12%)	22 (12%)	0.988
Diabetes Mellitus	139 (24%)	52 (27%)	28 (15%)	<0.001
COPD	113 (21%)	36 (19%)	36 (20%)	0.465
Obstructive Sleep Apnea	28 (5%)	9 (5%)	3 (2%)	0.004
Hypothyroidism	75 (14%)	28 (15%)	23 (12.5%)	0.773
Hyperlipidemia	183 (34%)	67 (35.6%)	54 (29%)	0.321

78% of COVID-19 patients hospitalized in the US overweight or obese, CDC finds

Erica Carbajal - Tuesday, March 9th, 2021 Print | Email

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Among 71,491 U.S. adults who were hospitalized with COVID-19, 27.8 percent were overweight and 50.2 were obese, according to the CDC's latest *Morbidity and Mortality Weekly Report* published March 8.

The analysis included 148,494 patients who recieved a COVID-19 diagnosis at emergency deparments or inpatient vistits between April 1 and Dec. 31 across 238 hospitals. Of those, 71,491 were hospitalized.

Those who were overweight or obese were more likely to require invasive mechanical ventilation, findings showed. Obesity was also linked to increased risk for hospitalization and death, especially among those under age 65. As BMI rose, so did the risk, the CDC found.

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Respiratory Physiology and Obesity

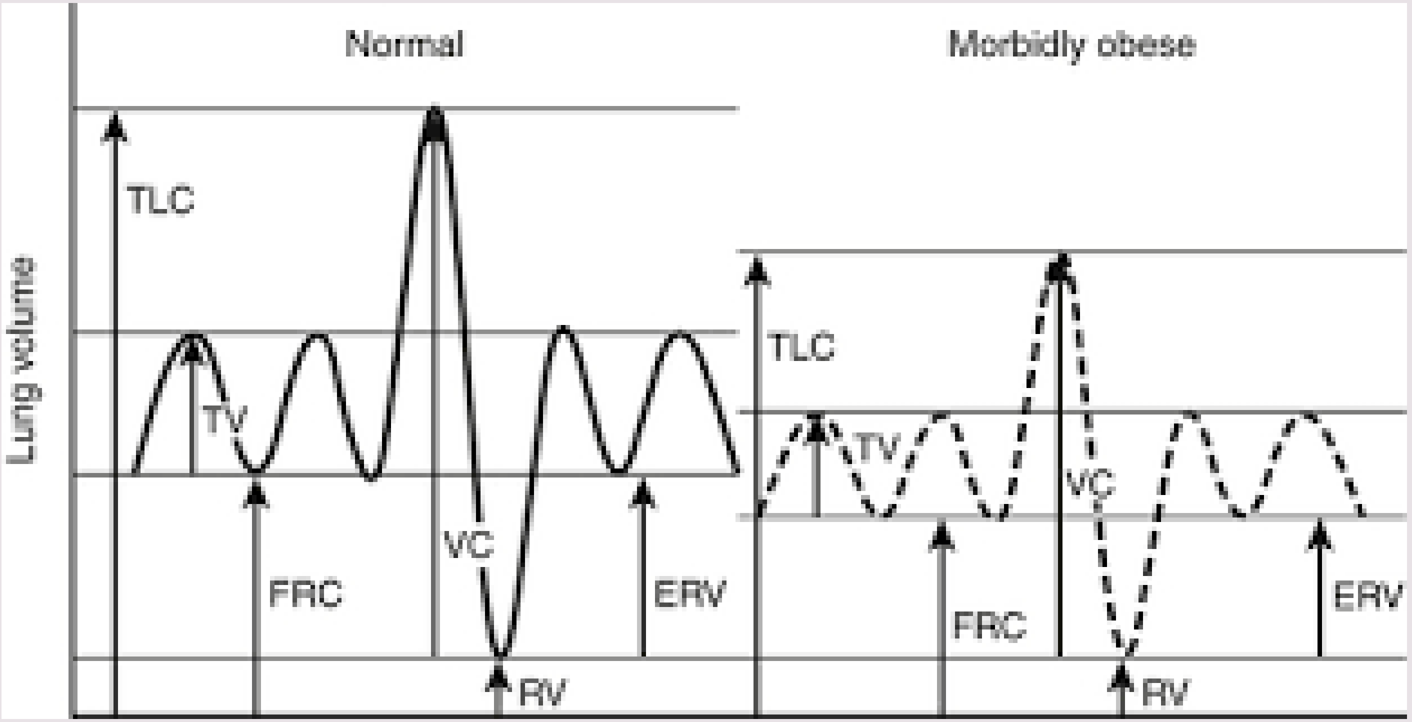
Matthew C. Miles, MD, FCCP

Assistant Professor, Pulmonary and Critical Care Medicine

Differences regarding respiratory anatomy and physiology in healthy obese compared to non-obese individuals

- Larger sagittal lung axis (sternum-to- vertebral), and shorter longitudinal axis (apex-to- base) than non-obese patients
- Adipose tissue compressing the chest wall, the diaphragm and abdomen leading to pulmonary restriction
- Reduced FRC
- Increased resistance with airway narrowing in the upper airway due to compressing adipose tissue
- In obese individuals, a reduction of the static lung volumes is caused by atelectasis of lung areas secondary to small airway closure and alveolar collapse
- Prevalence of OSA in patients with metabolic syndrome is estimated to be as high as 60%
- Impairment of right heart function specifically pulmonary hypertension is common

Lung Volumes With Obese Patients

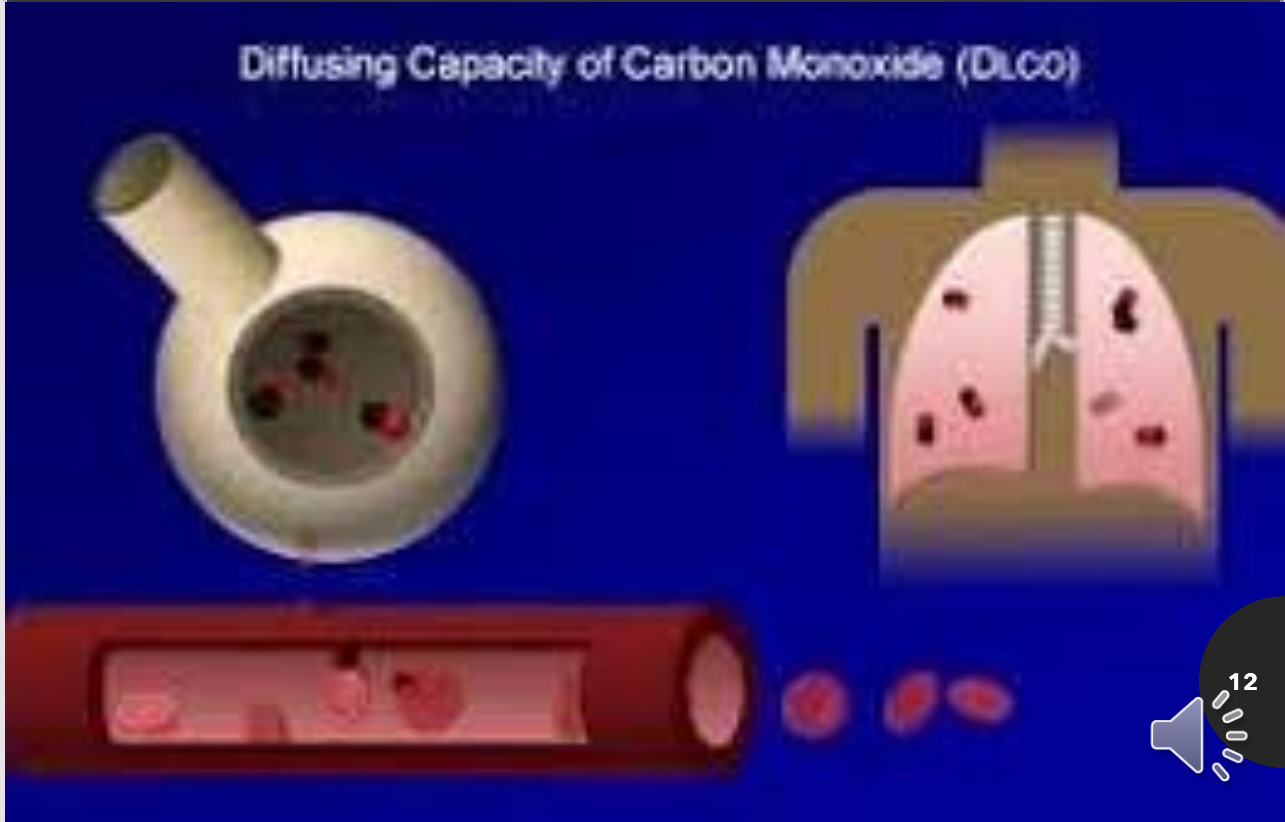


- Reduction in static lung volumes
- Small airway closure
- Alveolar collapse
- TLC, FRC, Reserve volume all decreased
- FEV1 and VC reduced
- FEV1/VC is normal

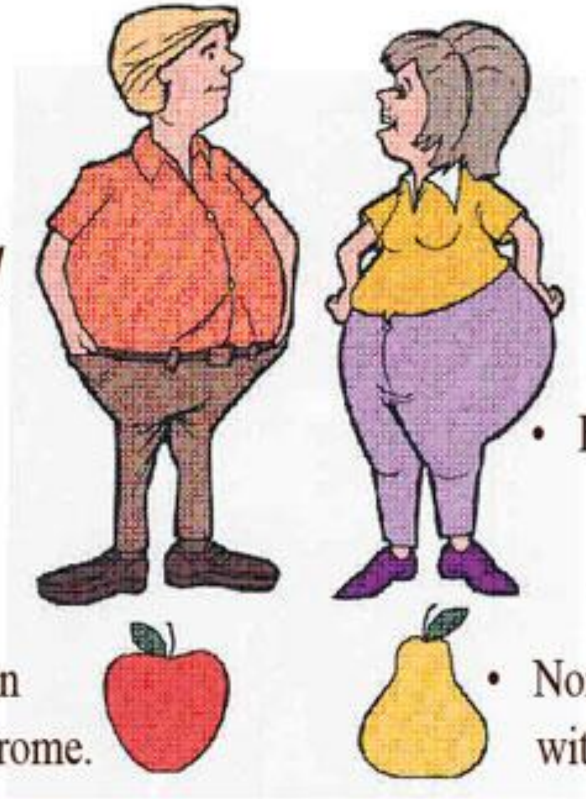
Gas exchange capacity of the lung/ DLCO

- Theoretically, obesity may lead to an increase in diffusion capacity due to an increase of total pulmonary blood volume and flow.
- Another approach hypothesizes that obesity may be associated with a decrease in gas exchange resulting from reduced alveolar surface area as well as structural changes in the interstitium due to lipid deposition.

	DLCO
Elevated:	Above 120%
Normal:	80% to 120%
Mildly reduced:	79% to 60%
Moderately reduced:	40% to 59%
Severely reduced:	Below 40%



TYPES OF OBESITY –
Are you an Apple or a Pear ??



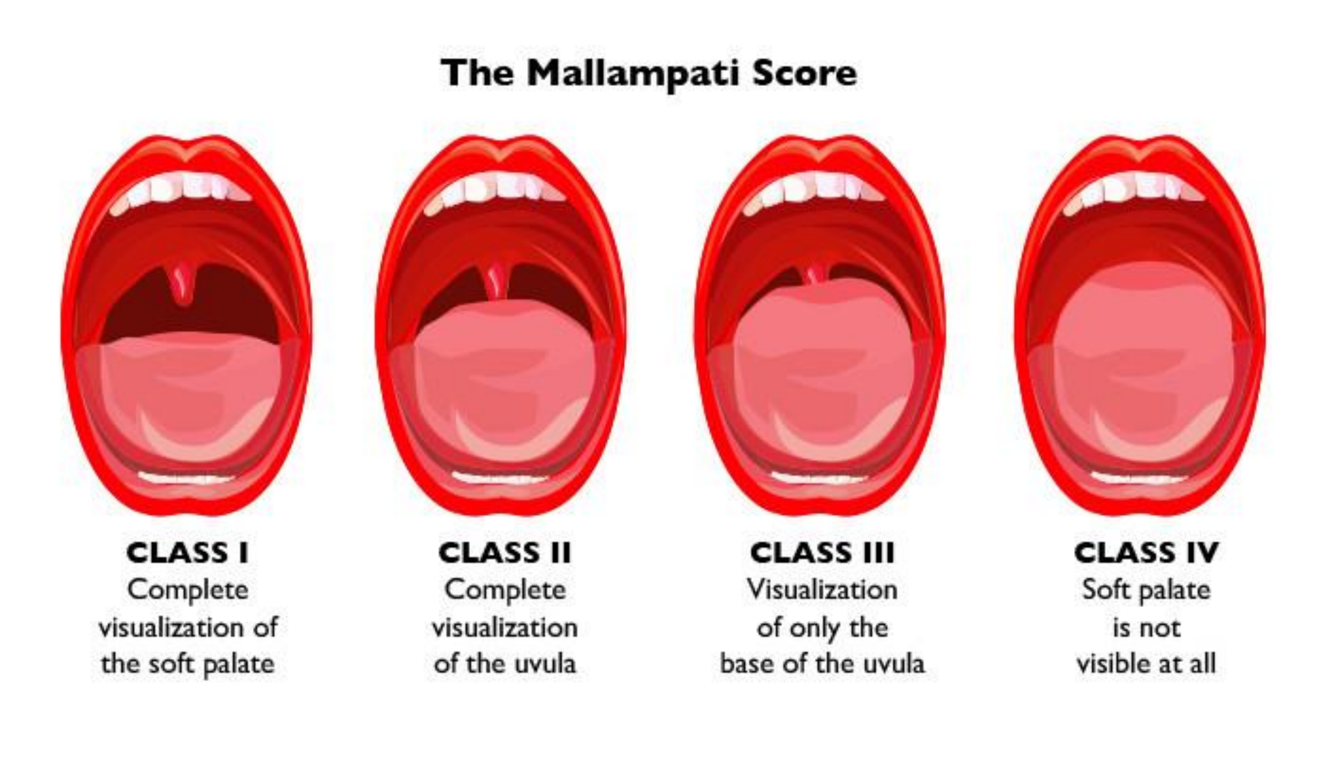
Apple/Android

- Excess Fat on the Abdomen
- Common in Men
- Significant correlation with Metabolic Syndrome.

Pear/Gynoid

- Excess Fat on the things and buttocks
- Common in Women
- Non significant correlation with Metabolic Syndrome.

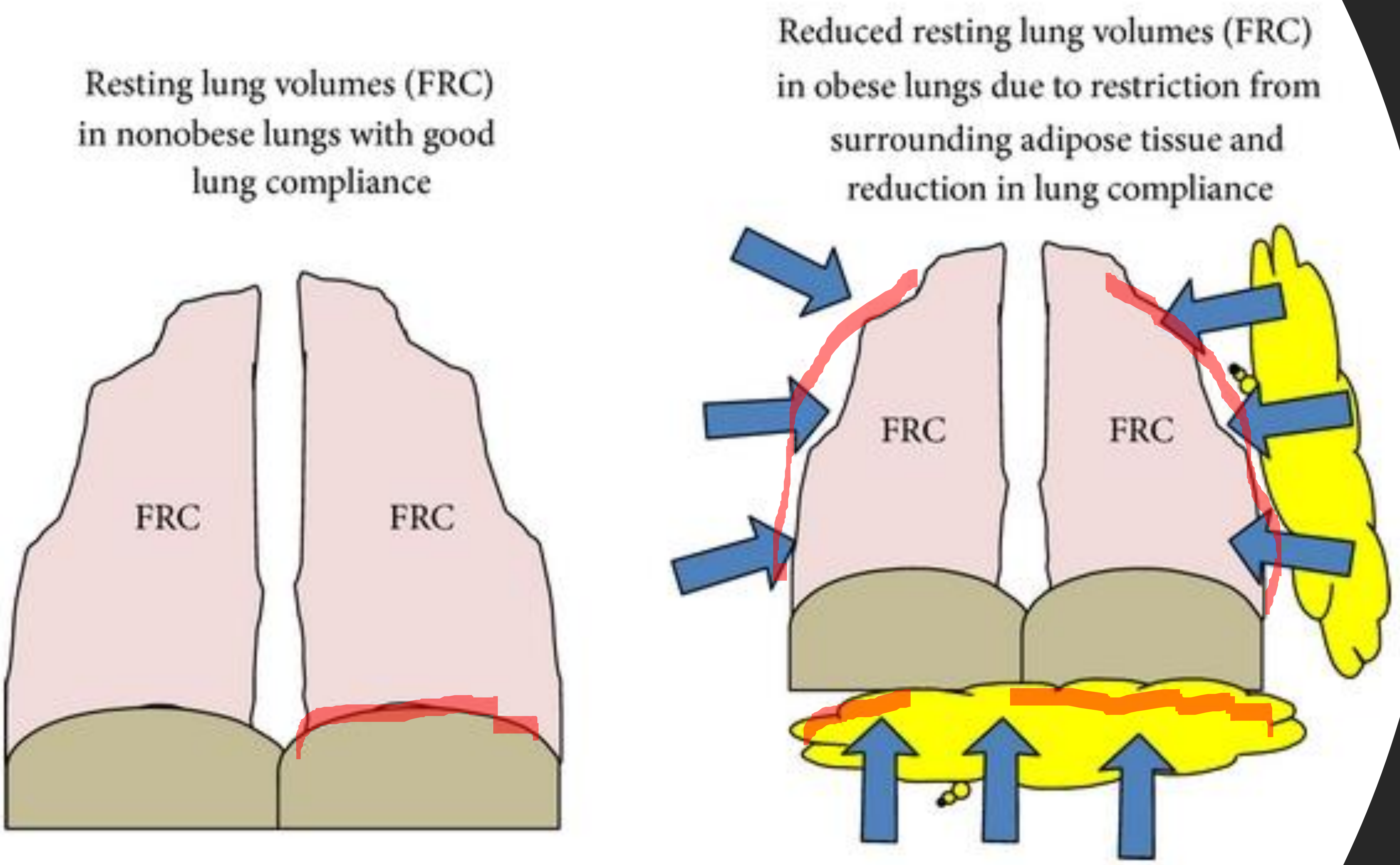
Figure 2. *Patient in ramp position prior to anesthetic induction.*



Obesity Airway Evaluation

- Neck circumference
- The single biggest predictor of problematic intubation in morbidly obese patients
- 40 cm neck circumference = 5% probability of a problematic intubation
- 60 cm neck circumference = 35% probability of a problematic intubation
- A larger neck circumference is associated with the male sex, a higher Mallampatti score, grade 3 views at laryngoscopy, and obstructive sleep apnea
- Videolaryngoscope
- Laryngeal mask airway (LMA)

Mechanical ventilation in obese patients


Resting lung volumes (FRC)
in nonobese lungs with good
lung compliance
FRC
FRC
Reduced resting lung volumes (FRC)
in obese lungs due to restriction from
surrounding adipose tissue and
reduction in lung compliance
FRC
FRC

Predicted body weight calculator

Tidal volumes for the ARMA study were based on predicted body weight (PBW). This is a calculation based on gender and height. The following are reference tables with PBW calculated for 4-8ml tidal volumes for males and females.

Formulæ: { ♂: PBW (kg) = 50 + 2.3 (height (in) – 60) | ♀: PBW (kg) = 45.5 + 2.3 (height (in) – 60) }

Mechanical ventilation protocol summary of low tidal volume used in the ALVEOLI study

Normalize tidal volume to PBW

6 mL/kg

Positioning patients with obesity in ramped or sitting positions and even early mobilization may facilitate unloading the diaphragm from increased abdominal pressure and may thereby improve aeration of dependent lung areas.

Early implementation of spontaneous breathing

Induction and intubation

Obese patients are difficult intubations

Use of sedatives/neuromuscular blockade is very important during this process

Preoxygenate (increase oxygen reserve) with 100% FiO_2

Video laryngoscopes and supraglottic devices must be readily available

Fluids and vasoactive drugs to face hemodynamic impairment

Setting up initial mechanical ventilation

- Lower FiO_2 keep spo2 > 90%
- Tidal volume based on PBW
- Target V_T to 4–6 and 6–8 ml/kg PBW in patients with and without acute respiratory distress syndrome (ARDS)
- Use volume modes or volume targeted ventilation rather that PCV
- Low-moderate PEEP of 5–8 cmH_2O

Titrating mechanical ventilation parameters

- Most obese patients can safely maintain PaO_2 55–80 mmHg and $SatO_2$ 88–94%
- Elevated respiratory rates may lead to increase intrinsic PEEP (PEEPi) due to airway closure and expiratory flow limitation
- Driving pressure (ΔP), i.e., the difference between plateau pressure (P_{plat})–PEEP limited to a maximum value of 17 cmH_2O in ARDS and 15 cmH_2O in non-ARDS obese patients to prevent VILI
- Persistent hypoxemia you should consider using higher PEEP levels

Planning rescue strategies

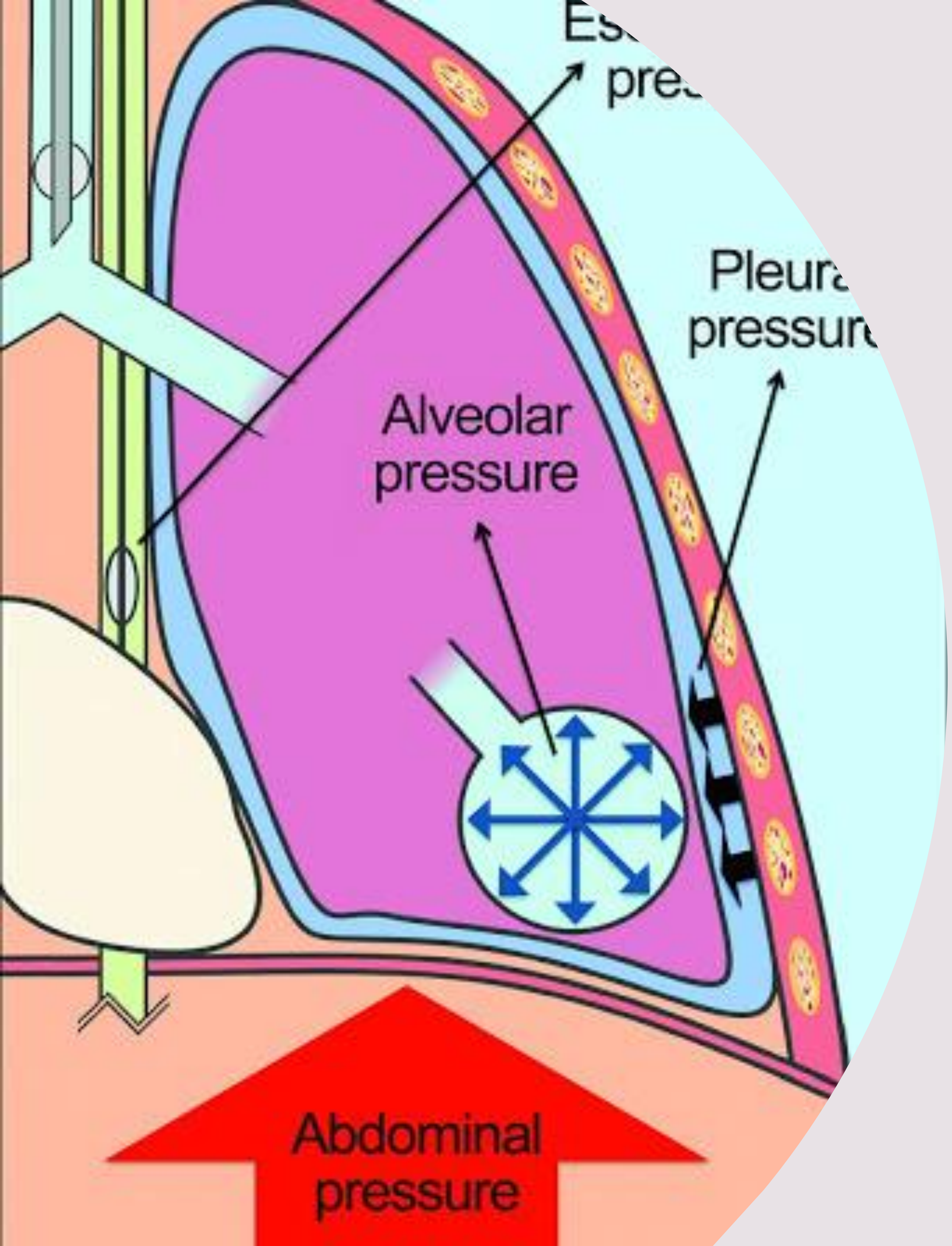
Recruitment maneuvers

Stepwise increases in PEEP

Studies have demonstrated a range of PEEP levels between 10 and 26 cmH2O With a median of 18 cmH2O

Prone positioning has an established role as a rescue therapy in ARDS patients

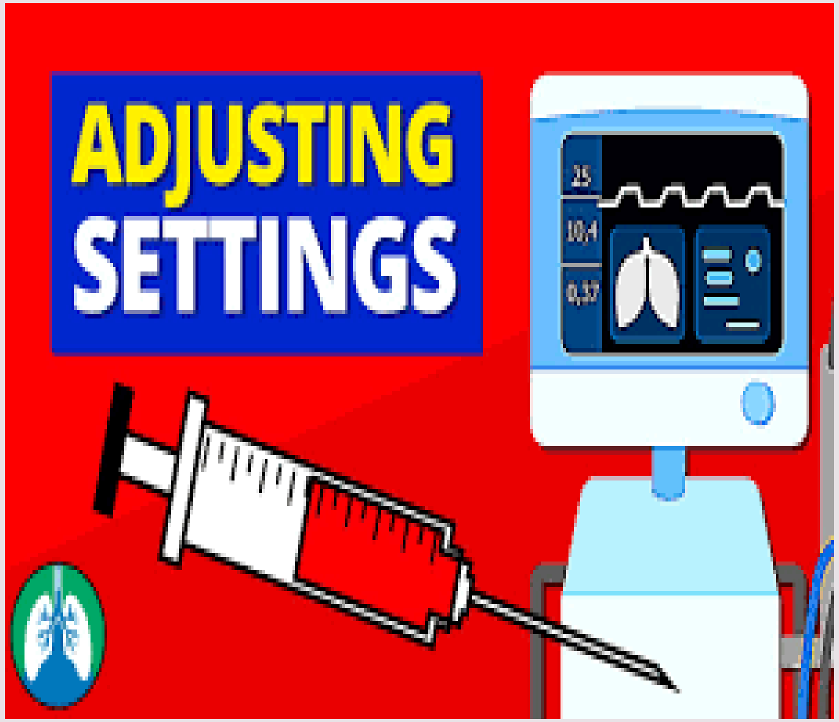
Non-invasive ventilation support can be considered following extubation



Recruitment maneuver

- Higher opening pressures of the alveolar require higher PEEP setting post RM
- Higher pleural pressures
- Esophageal Pressure Monitoring

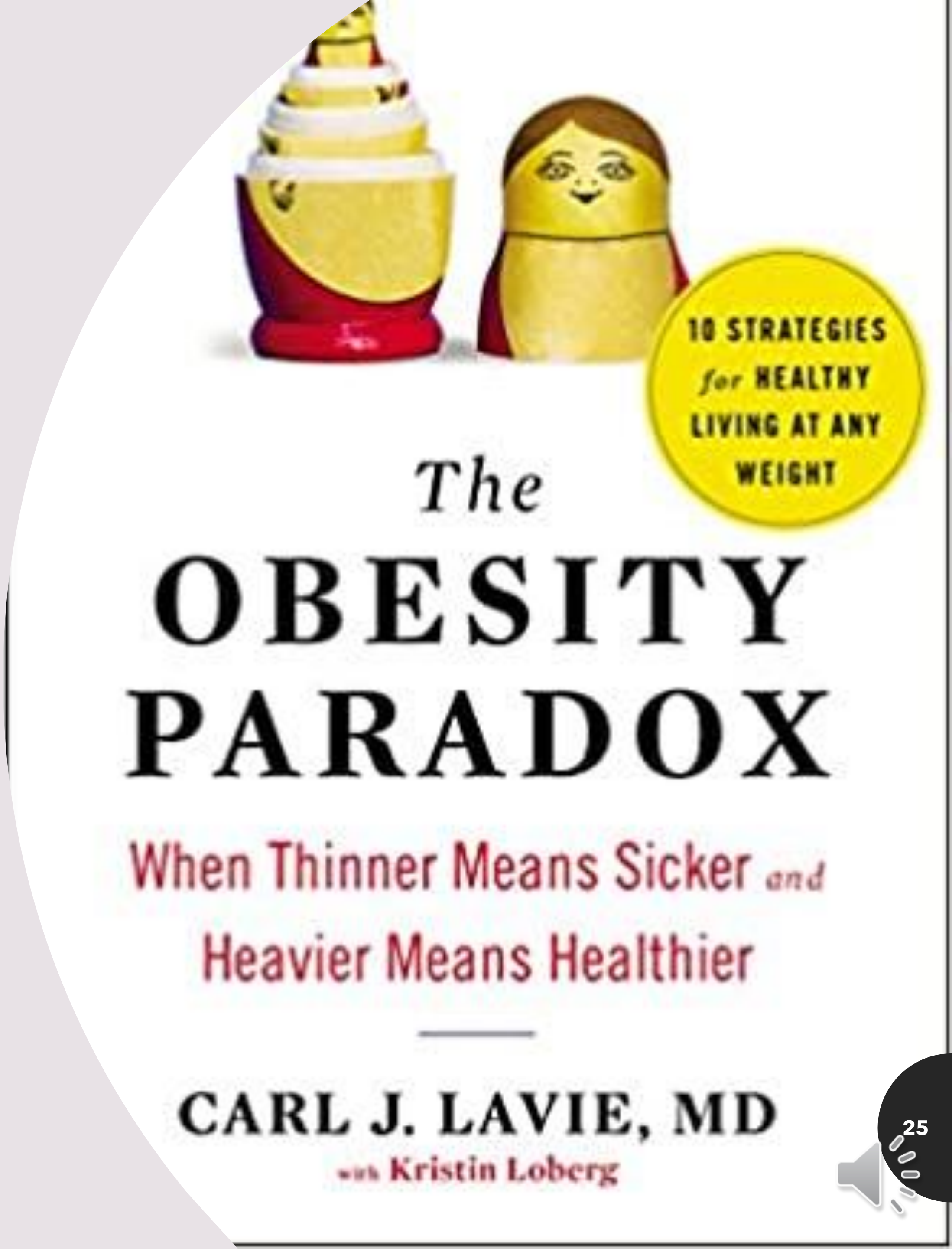
PEEP



- PEEP is used to keep alveolar pressure above the closing pressure
- PEEP avoids alveolar derecruitment
- Due to the superimposed pressure transmitted by adipose tissue on the pleural space, closing pressures in patients with obesity are higher and lungs of these patients are more prone to such complications
- Studies have demonstrated a range of PEEP levels between 10 and 26 cmH2O With a median of 18 cmH2O

Obesity paradox

- Coronary heart disease
- Chronic heart failure
- Stroke
- COPD
- ICU, patients with obesity may be more likely to develop ARDS, but their survival sometimes appeared to be better, a phenomenon called the ‘obesity paradox’
- Patients with obesity have more metabolic reserve and may, therefore, tolerate the catabolic stress of critical illness during ARDS better, because of energy stores in the form of adipose tissue



Summary

- Obese patients are more likely to develop complications during their stay
- Airway management is critical
- Once intubated- more prone to alveolar collapse
- Higher PEEP
- Recruitment maneuvers
- Use PBW to set tidal volumes

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