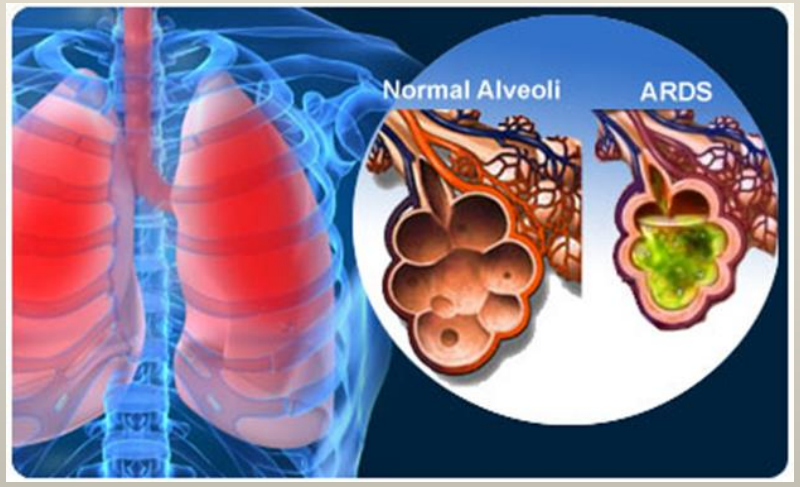
Acute Respiratory Distress Syndrome

ARDS

- Lung complication resulting in dangerously low blood oxygen
- ARDS is often a result of other health complications

Clinical Manifestations

- Related to systemic inflammatory disease
- Bilateral pulmonary infiltration
- Increased pulmonary capillary permeability
- Decreased PaO2/FiO2 ratio

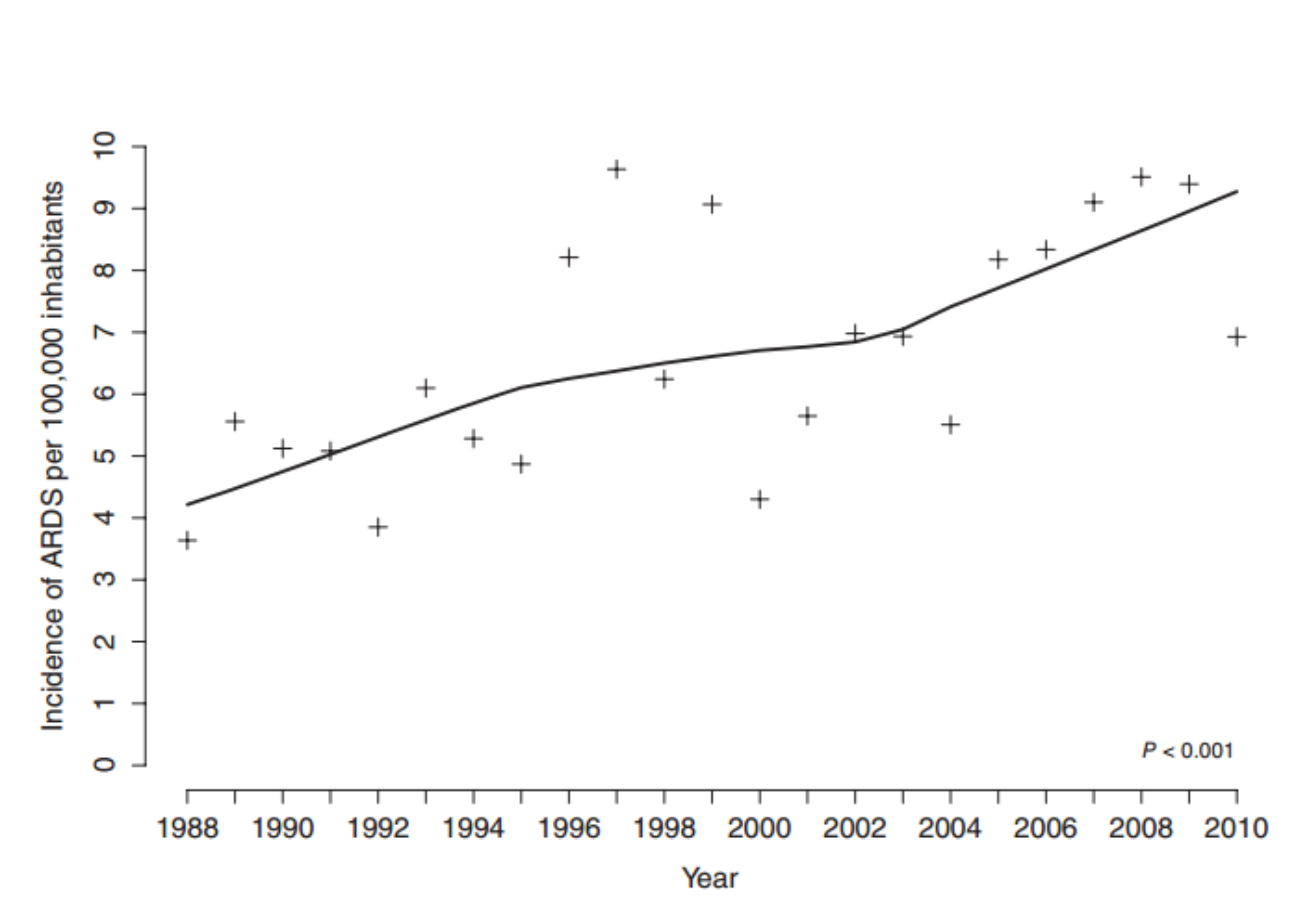


Severity Stages

- New classification system
  - Better predictor of mortality
- Three classifications:
  - Mild PaO2/FiO2 <300 mmHg
    - Acute lung injury
  - Moderate <200 mmHg
  - Severe <100 mmHg
    - 75% of cases are classified moderate or severe

Incidence

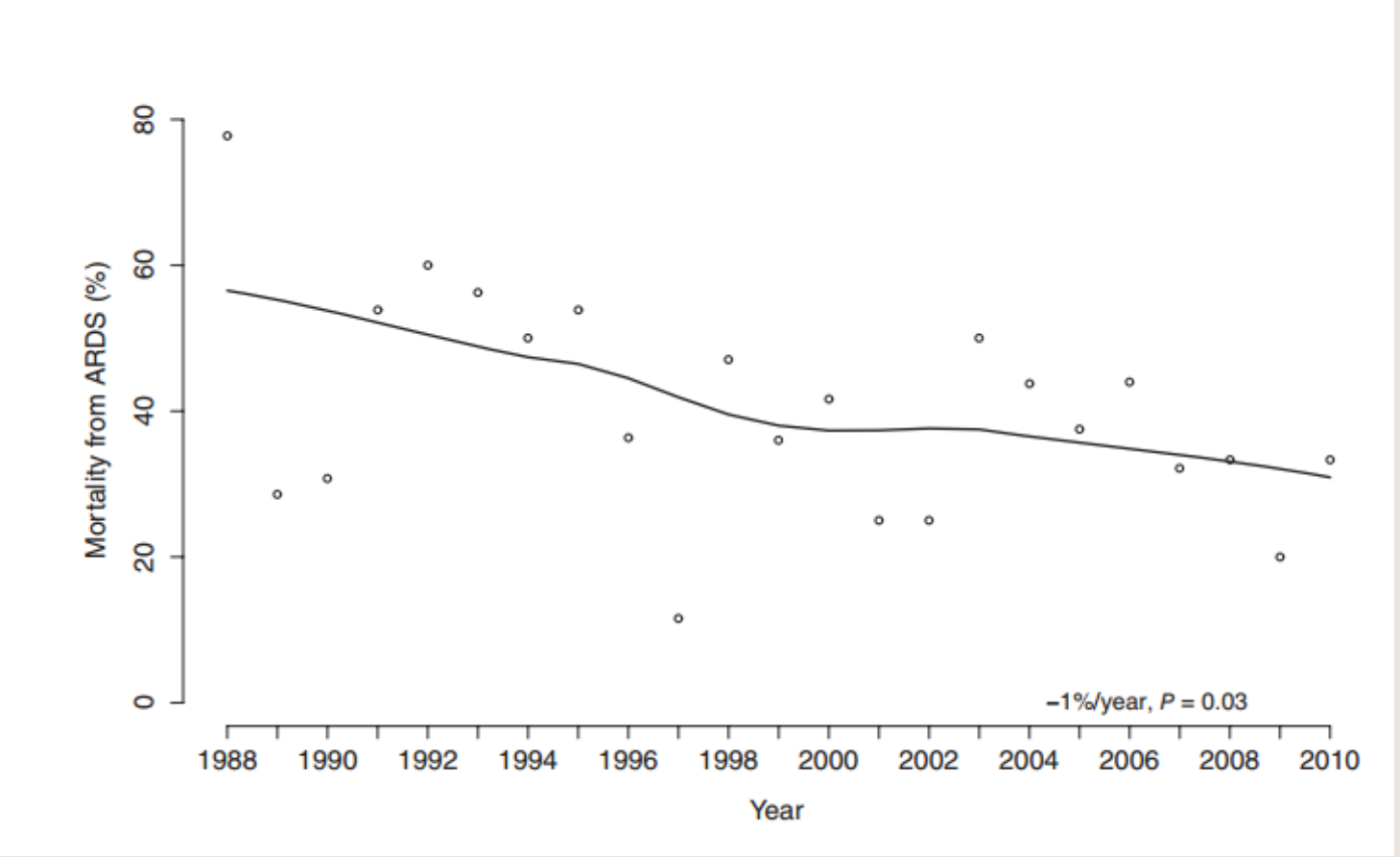
- 9% incidence of ARDS and ALL in the ICU
- United States: 64:100,000
- Europe: 4.9-13.5:100,000
- American Lung Association: 1.5-75 cases/100,000 individuals
  - 25-40% of cases end in death



Increasing Incidence of ARDS cases

Life Expectancy

- Dependent of cause of ARDS
  - Patients with fewer chronic diseases have increased survival
  - Sepsis induced ARDS has increased risk of mortality
  - Pulmonary fibrosis is found to be a major factor
- 1988: 50-70% mortality
- 2008: 25-40% mortality
- Death typically results from MODS from a lack of oxygen rather than lung failure



Decreasing mortality risk for ARDS patients

Etiology

- Direct injury:
  - Trauma
  - Aspiration
  - Inhaling Chemicals
  - Obstructed airways
- Indirect injury
  - Blood transfusion
  - Sepsis
  - Pneumonia

Signs and Symptoms

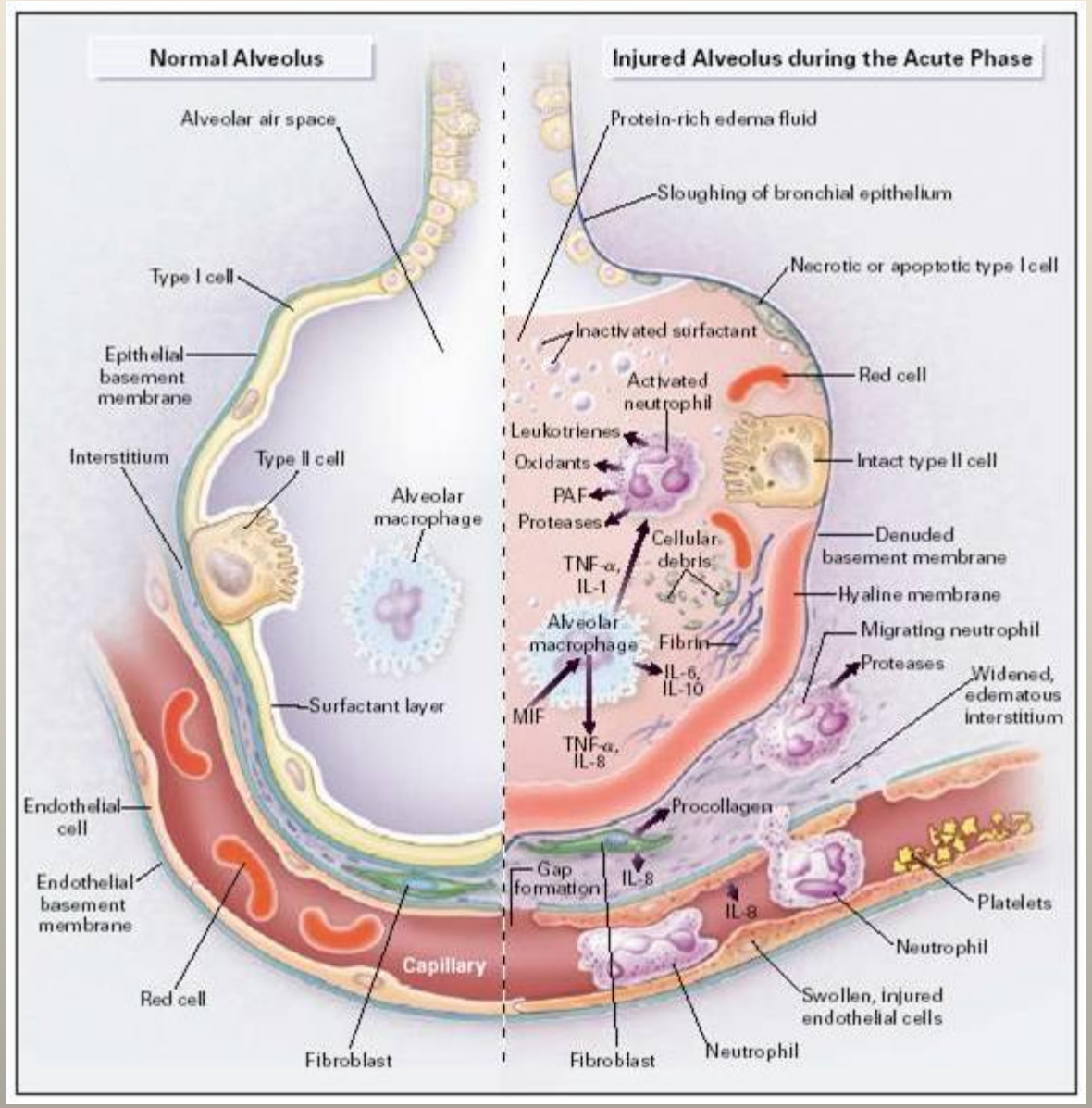
- Depending on the initial trauma specific S/S can occur
  - Ex. Pneumonia → cough
- Difficulty breathing
  - Two-pillow orthopnea: support from pillows to in order to easy breathing that occurs from the recumbent position
- Rapid breathing
- Shortness of Breath
- Low blood oxygen level

S/S continued

- **Trachea shift**: trachea shifts from its normal position because of fluid accumulation in the pleural space
- **Jugular distention**: jugular veins bulge because of increased central venous pressure
- **Bruit**: “noise” unusual sound blood makes when passing an obstruction
  - Medical professionals will look for bruit sounds to R/O other diseases

Pathophysiology

- **Early phase**: exudative (oozing)
  - Occur as a result of direct or indirect lung insults
    - Acute inflammatory stage with proinflammatory cytokines, neutrophils, and overall impaired endothelial cell barrier function
  - Barrier between the capillaries and the alveoli allow water movement into the alveoli
  - Most patients will survive this stage
- **Later phase**: fibroproliferative
  - Alveolar damage
  - Collagen deposition appears in 3 days; Fibrosis manifests within 3 weeks
  - Pulmonary fibrosis resulting in 55% of ARDS deaths


Normal Alveolus
Injured Alveolus during the Acute Phase
Alveolar air space
Type I cell
Epithelial basement membrane
Interstitium
Type II cell
Alveolar macrophage
Surfactant layer
Endothelial cell
Endothelial basement membrane
Red cell
Capillary
Fibroblast
Protein-rich edema fluid
Sloughing of bronchial epithelium
Necrotic or apoptotic type I cell
Inactivated surfactant
Activated neutrophil
Red cell
Leukotrienes
Oxidants
PAF
Proteases
Intact type II cell
Cellular debris
Denuded basement membrane
TNF-α, IL-1
Hyaline membrane
Alveolar macrophage
Fibrin
Migrating neutrophil
Proteases
IL-6, IL-10
Widened, edematous interstitium
MIF
TNF-α, IL-8
Procollagen
Gap formation
IL-8
IL-8
Platelets
Neutrophil
Swollen, injured endothelial cells
Fibroblast
Neutrophil

Chest X-ray of ARDS patient

Normal

ARDS

Risk Factors

- Old age
- Shock
- Liver failure
- Patients with diabetes have half the risk for developing ARDS compared to patients without diabetes

Quality of Life

- **Poor muscle function**
- Pulmonary function returns to normal or near normal at approx. 6 months
  - Decrease carbon monoxide diffusion capacity
- Memory loss: due to brain damage from lack of oxygen
- Fatigue
- Weakness
- Alopecia
- Pain from chest tubes
- Entrapment Neuropathy
- Heterotopic Ossification

Medical Therapy

Diagnosis

- Challenging because ARDS has nonspecific characteristics
  - 48% of patients with autopsy-prove ARDS had ARDS diagnosis in their charts

Rule out other diseases

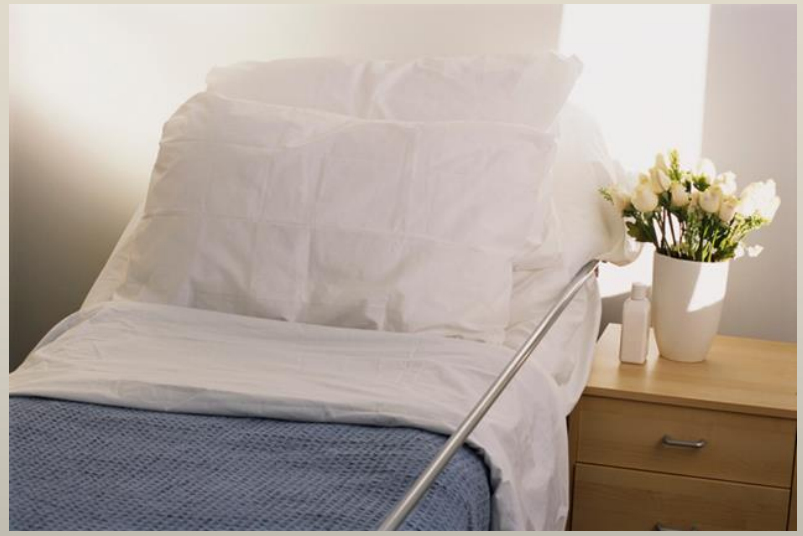
- Left heart failure
  - Check left heart function
- Acute lung injury
  - Less severe impairment of oxygen; PaO_2/FiO_2 <300 mmHg

Goals of Treatment

- Support breathing
- Treat underlying cause
- Medications to treat infections, reduce inflammation, and remove fluid from the lungs.

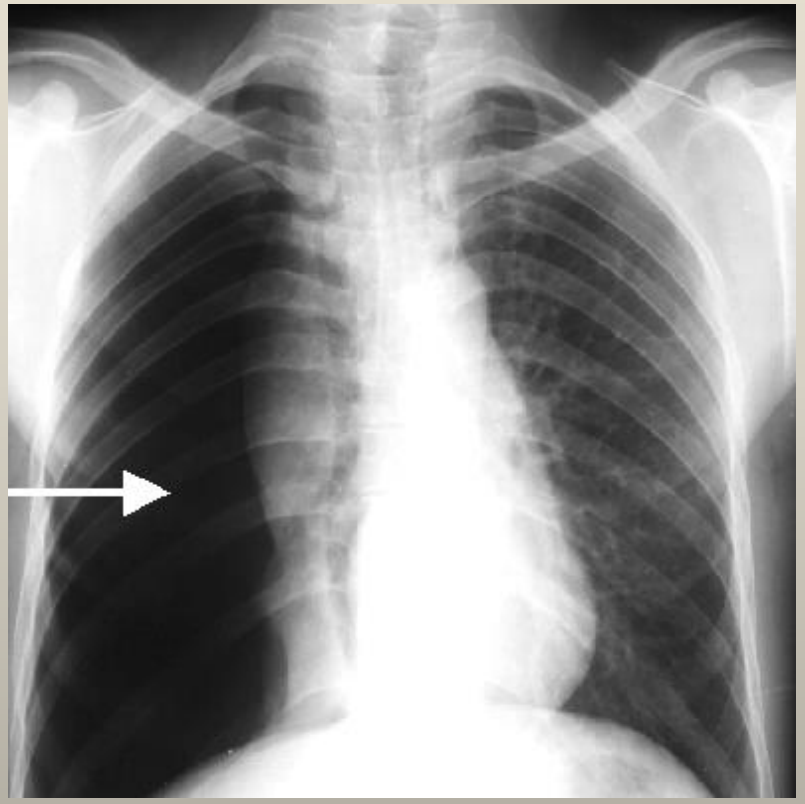
Health Impact

- 25-40% of cases are fatal
- By 7-10 days a patient has died or have been weaned off treatment



Collapsed Lung

- Pneumothorax
- Air escapes from the lung and fills the space outside the lung.
- Smokers, COPD, asthma, cystic fibrosis, tuberculosis



Collapsed Lung

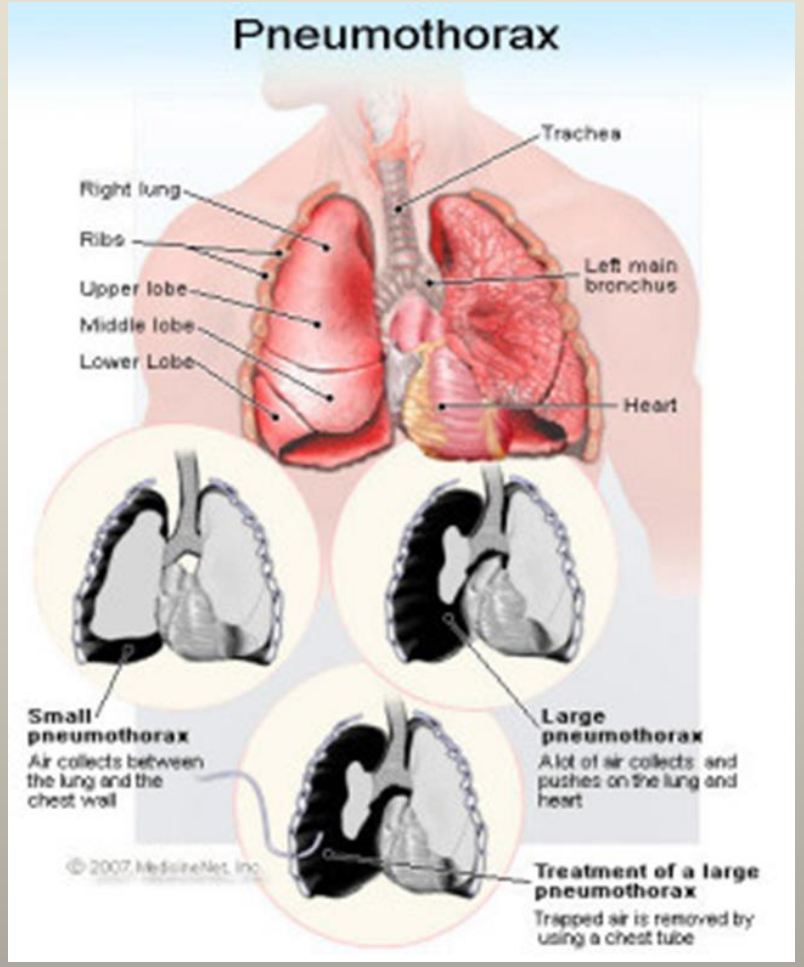
- Increased Risk
  - Smokers
  - COPD
  - Asthma
  - Cystic fibrosis
  - Tuberculosis
- Symptoms
  - Sharp chest pain
  - Shortness of breath
  - Bluish color
  - Easy fatigue
  - Rapid heart rate

Treatment

- Small pneumothorax
  - Can go away on its own
- Large Pneumothorax
  - Chest tube
  - Surgery
  - Pleurodesis

Surgery

- Treat collapsed lung
- Stop fluid buildup



Pulmonary Fibrosis

- Scarring throughout the lungs

Prevention of ARDS

- No drug has proved beneficial in prevention

Corticosteroids

- High-dose corticosteroids
  - Patients with ARDS persisting for at least 7 days had no benefit in 60 day mortality
  - Patients treated 14 days after onset had worsened mortality with corticosteroid therapy
- Methylprednisone
  - No survival advantage shown
  - short-term clinical benefits included improved oxygenation and increased ventilator-free and shock-free days
  - more likely to experience neuromuscular weakness, but the rate of infectious complications was not increased.

Corticosteroids Summary

- may be considered a form of rescue therapy
- may improve oxygenation and hemodynamics
- does not change mortality
- corticosteroids **increase** mortality in patients who have had ARDS for >14 d

Statins

- Somovstatin
  - Preadmission use of statins was associated with a reduction in 30-day and 1-year mortality of a cohort of 12,483 critically ill patients.
  - Patients under statin treatment developing MODS have a better outcome than age- and sex-matched MODS patients without statin therapy.

Table 2

Effects of statins and low-dose corticosteroids versus placebo on the ventilatory status and outcome of patients with ARDS

	Statins (80 mg/day)			Low-dose corticosteroids (1 mg/kg/day)		
Variables	**Simvastatin[95](n = 30)**	**Placebo(n = 30)**	***P***	**Methylprednisolone[96] (n = 63)**	**Placebo(n = 28)**	***P***
PaO_2/FiO_2 day 7	199 ± 76	199 ± 76	NS	256 ± 19	179 ± 21	0.006
LIS day 7	2 ± 0.78	2.1 ± 0.7	NS	2.14 ± 0.12	2.68 ± 0.14	0.004
Ventilator free days	8.2 ± 8.1	9.1 ± 8.7	NS	16.5 ± 10.1	8.7 ± 10.2	0.001
Duration of ventilation	18.6 ± 14.6	18.6 ± 14.6	NS	5 (3-8)	9.5 (6-19.5)	0.002
ICU stay				7 (6-12)	14.5 (7-20.5)	0.007
ICU survival (%)	21 (70)	21 (70)	NS	50 (79.4)	16 (57.4)	0.03
Hospital stay	51.2 ± 39.3	48 ± 37.4	NS	13 (8-21)	20.5 (10.5-40.5)	0.09
Hospital survival (%)	19 (63)	19 (63)	NS	48 (76.2)	16 (57.1)	0.07

Data are presented as mean ± SD, no. (%), and median (interquartile range).

TNF and IL-1

- Small sepsis trials suggest a potential role for antibody to tumor necrosis factor (TNF) and recombinant interleukin (IL)-1 receptor antagonist.

Prostacycline

- Prostacycline
  - Inhaled prostacycline also has not been shown to improve survival.

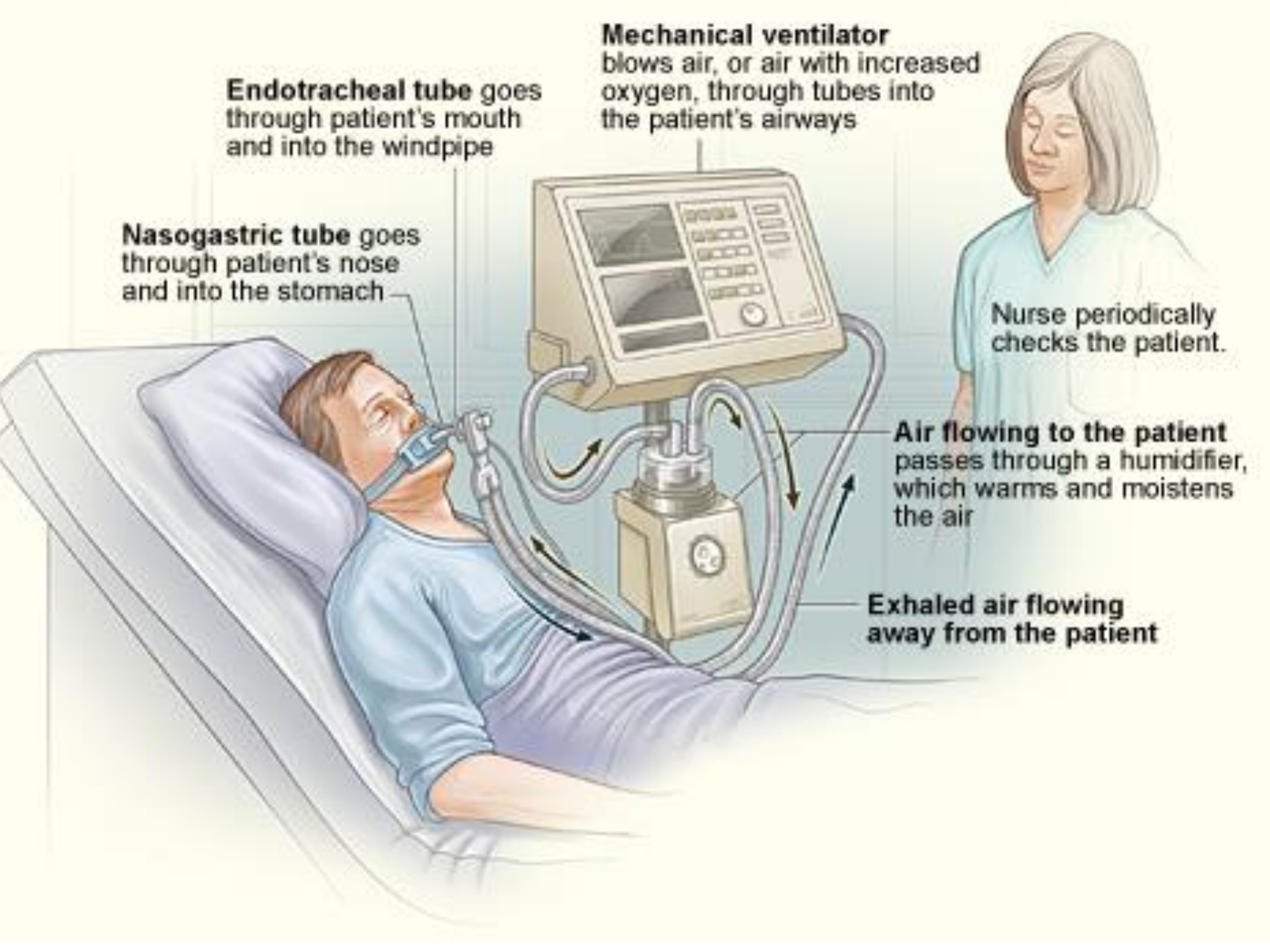
Nitric Oxide

- Inhaled nitric oxide did not change mortality rates in adults with ARDS.
- Improves transient oxygenation

Side Effects

- Short-term
- Long-term
  - Muscle wasting and weakness

Mechanical Ventilation


Mechanical ventilator blows air, or air with increased oxygen, through tubes into the patient's airways
Endotracheal tube goes through patient's mouth and into the windpipe
Nasogastric tube goes through patient's nose and into the stomach
Nurse periodically checks the patient.
Air flowing to the patient passes through a humidifier, which warms and moistens the air
Exhaled air flowing away from the patient

Ventilation

- A ventilator doesn't treat a disease or condition
- **GOAL**: provide breathing support, relieve respiratory muscles of their work

Ventilation Benefits

- Get oxygen into the lungs
- Help people breathe easier – relieve respiratory muscles
- Provide breathing support

High vs. Low Tidal Volume

High Tidal Volume

- Over-distend alveoli
- Worsen lung injury
- Inflammation

Low Tidal Volume

- Decreased ventilator-associated lung injury
- Increases survival rate

Recommended to use Low Tidal Volume for ARDS

Positive End-Expiratory Pressure (PEEP)

- Airway pressure is maintained above atmospheric pressure at the end of exhalation
- Purpose: increase volume of gas remaining in the lungs at the end of expiration
  - Decrease shunting of blood through lungs and improve gas exchange

Prone Positioning

- Supine: weight of heart and abdominal organs on lungs contribute to low compliancy
- Prone: improves oxygenation but does not improve survival
  - Higher incidence of complications (i.e. pressure sores and obstruction of the endotracheal tube)

Weaning from Mechanical Ventilation

- Those who wean successfully have less morbidity and mortality
- Spontaneous breathing trials (SBTs)
- Progressive decreases in the level of pressure support during pressure support ventilation

The Cochrane Library

- http://onlinelibrary.wiley.com.erl.lib.byu.edu/doi/10.1002/14651858.CD003844.pub4/full

- Primary outcome
  - Mortality

- Secondary Outcomes
  - Development of multiple organ failure
  - Duration of mechanical ventilation
  - Stay in ICU
  - Long term health related quality of life
  - Long-term cognitive complications

Hemolung RAS

- CO_2 removal and less invasive
- Similar to dialysis
- Uses less blood flow
- Smaller catheter
- One component system
- Active mixing
- Battery operated (patient
- can move around)

Hemolung RAS

- 2012
  - Successful pilot studies
  - Arterial pCO_2 levels reduced by 28% within 24 hours
  - lessened dyspnea
  - improved clinical status
  - effective and stable CO_2 removal on the order of 50% of metabolic production
  - No unexpected adverse events
  - All patients were able to avoid intubation
  - Still undergoing clinical trials

Medical Nutrition Therapy

Medical Nutrition Therapy

- Energy Needs:
  - Calculate with indirect calorimetry (IC)
  - Obese individuals : 11-14 kcal/kg or 60%-70% of target value

- Why: High caloric intake increases levels of $CO_{2.}$

Medical Nutrition Therapy

- Carbohydrate:
  - Been shown that concentrations of Carbohydrates not as important as calories provided
- Protein:
  - 1.5-2.0 g/kg
- Fat:
  - Give enough to provide the right amount of calories

Medical Nutrition Therapy

- What to monitor and watch closely
  - CO_2
  - Phosphate
  - Vitamin A
  - Vitamin C
  - Vitamin E
  - Meet requirements for Essential Fatty Acids

Medical Nutrition Therapy

- Enteral Nutrition
  - Helps maintain GALT
  - Less likely to overfeed
  - Reduces ICU and hospital mortality
- Parental Nutrition
  - More likely to overfeed
  - Used for patients with: Shock, Nonfunctional Gut, and Peritonitis

Medical Nutrition Therapy

- Supplementation of Omega 3 over required amounts not effective.
- Do not use RQ for substrate mix
- Consider BMI

Case Study: DH

- Age: 65
- Male
- Married – lives with wife (62)
- 4 children not living in the area
- Retired manager of local grocery chain

Anthropometrics

- Height: 5’ 4”
- Weight: 122 lbs
- BMI: 20.9
- UBW: 135 lbs
- IBW: 130 lbs
  - 8 lbs under

Case Study: DH

Biochemical

- Hemoglobin – 13.2 (14-17)
- Hematocrit – 39 (40-54)
- ABG pH – 7.2 (7.35-7.45)
- ABG pCO_2 – 65 (35-45)
- ABG CO_2 content – 35 (25-30)
- ABG pO_2 – 56 (>80)
- ABG HCO_3^- – 38 (24-28)

Clinical

- Extremities: cyanosis, 1+ pitting edema
- R femoral bruit present
- Pale skin
- Harsh inspiratory breath sounds noted over right chest – absent sounds on left
- Use accessory muscles at rest

Case Study: DH

Dietary

- General appetite: decreased over past several weeks
- Usual diet:
  - B: Egg, hot cereal, bread or muffin, hot tea (with milk and sugar)
  - L: soup, sandwich, hot tea (with milk and sugar)
  - D: small amount of meat, rice, 2-3 kinds of vegetables, hot tea (with milk and sugar)

History

- Diagnosed with emphysema more than 10 years ago
- Tobacco use: 2 PPD for 50 years
- Alcohol use: 1-2 drinks 1-2 x/week

PES Statement

Inadequate caloric intake related to increased needs from history of COPD and Acute Respiratory Distress Syndrome as evidenced by decrease appetite and weight loss.

Oxepa®

- Abbott Nutrition product for modulating Inflammation in Sepsis, ALI, and ARDS
- Benefits:
  - Improves oxygenation
  - Decrease time on ventilator
  - Decreases length of stay in ICU
- For sole-source nutrition

Sample Diet

- Oxepa – 25 kcal/kg for 24 hrs
- 55kg (122lbs) – 1375 kcals
- Protein needs: minimum 82.5 g (1.5-2.0g/kg)

	Amount	**Calories (kcal)**	**% in total Calories**
CHO	97 g	388	27
Protein	57.3 g	250.8	18
Fat	86 g	774	55
Fluid	917 ml	0	0
Total Calories/24 hours		1412	