Acute Respiratory Failure

Presented by Omar AL-Rawajfah, RN, PhD
Lecture Outlines

• Etiology and Pathophysiology
• Classification
• Assessment
• Collaborative Management
Etiology and Pathophysiology

- Acute respiratory failure: sudden and severe impairment in the lungs’ ability to maintain adequate oxygenation and ventilation
- Clinically: it is $\text{PaO}_2 < 50\ \text{mm Hg or PaCO}_2 > 50\text{mm Hg, pH: } < 7.35$ at the $\text{FiO}_2$ of 21%
- Acute Respiratory Failure may be caused by pulmonary or non-pulmonary conditions:
  - Large airway obstruction
  - Bronchial diseases
  - Parenchymal diseases
  - Cardiovascular disease
  - Muscular diseases
  - Neural disease (peripheral or central)
Classification

**Type 1 respiratory failure:**

- Defined as hypoxemia without hypercapnia, and indeed the PaCO2 may be normal or low.
- It is typically caused by a ventilation/perfusion (V/Q) mismatch; the volume of air flowing in and out of the lungs is not matched with the flow of blood to the lungs.
- The basic defect in type 1 respiratory failure is failure of oxygenation characterized by:

<table>
<thead>
<tr>
<th>PaO2</th>
<th>decreased (&lt; 60 mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaCO2</td>
<td>normal or decreased (&lt;50 mmHg)</td>
</tr>
<tr>
<td>PA-aO2</td>
<td>increased</td>
</tr>
</tbody>
</table>

PA-aO2: the difference between alveolar and arterial pressure

- PA-aO2: < 15 mmHg normal
- PA-aO2: = 20-30 mmHg mild impairment
- PA-aO2: > 15 mmHg severe pulmonary dysfunction
Classification

• **Type 1 respiratory failure:**
  - This type of respiratory failure is caused by conditions that affect oxygenation such as:
    • Low ambient oxygen (e.g. at high altitude)
    • Ventilation-perfusion mismatch (parts of the lung receive oxygen but not enough blood to absorb it, e.g. pulmonary embolism)
    • Alveolar hypoventilation (decreased minute volume due to reduced respiratory muscle activity, e.g. in acute neuromuscular disease); this form can also cause type 2 respiratory failure if severe
    • Diffusion problem (oxygen cannot enter the capillaries due to parenchymal disease, e.g. in pneumonia or ARDS)
    • Shunt (oxygenated blood mixes with non-oxygenated blood from the venous system, e.g. right-to-left shunt)
Classification

• (Type II) Hypercapnic respiratory failure: due to ventilatory failure (↑PaCO2):
  – Type 2 respiratory failure is caused by inadequate alveolar ventilation; both oxygen and carbon dioxide are affected.
  – Defined as the build up of carbon dioxide levels (PaCO₂) that has been generated by the body but cannot be eliminated:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO₂</td>
<td>decreased (&lt; 60 mmHg)</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>increased (&gt; 50 mmHg)</td>
</tr>
<tr>
<td>Pₐ-aO₂</td>
<td>Normal</td>
</tr>
<tr>
<td>pH</td>
<td>decreased</td>
</tr>
</tbody>
</table>
Classification

• Three factors for Type II:
  – Decrease respiratory drive
    • Medication
    • Brainstem lesions
    • Sleep apnea
  – Respiratory muscle fatigue or failure
    • Myasthenia gravis
    • Muscle atrophy
    • Guillain-Barre syndrome
  – Increase workload of breathing
    • COPD (increased dead space)
    • Asthma (increased airway resistance)
    • Thoracic surgery or trauma
Classification

• **Type III Respiratory Failure** (Combined Oxygenation and Ventilatory Failure): Combined respiratory failure shows features of both arterial hypoxaemia and hypercarbia (decrease in PaO2 and increase in PaCO2).

• **Assessment**
  - Increased $P_{A-a}O_2$: the difference between alveolar and arterial pressure

• **Common causes of Type III respiratory Failure:**
  - Disorders causing Type I or Type II respiratory failure can cause Type III respiratory failure.
  - Adult respiratory distress syndrome (ARDS)
  - Asthma
  - Chronic obstructive pulmonary disease
Failure of Arterial Oxygenation

- **Failure of Arterial Oxygenation**
  - Underventilated alveoli are well perfused result in V/Q mismatch (shunting)
  - Reduced PaO₂, SaO₂ or SpO₂
  - My associated with pulmonary edema, adult respiratory syndrome (ARDS), atelectasis, bronchospasm, mucus plugging

- **Failure of Oxygen Delivery**
  - Depends on O₂ content, CO, & effective circulation
  - Carbon monoxide poisoning, anemia, MI, dysrhythmias, peripheral vasoconstriction, local emboli

- **Failure of O₂ utilization**
  - May associated with conditions such as sepsis, systematic inflammatory response,
  - Decrease O₂ consumption by the cells is associated with a poor prognosis
Assessment

• History
• Physical examination
  – Neurologic system
  – Cardiovascular system
  – Pulmonary System
    • Patent airway
    • Breathing pattern
    • Chest wall abnormalities
    • Auscultation findings
    • Percussion findings
  – Other body systems
  – Psychosocial Assessment
Diagnostic Testing

• Blood gas measurement
  – Ventilation
    • Hypercapnia
    • Hypocapnia
  – Oxygenation
    • SaO2 & SpO2
    • Arterial O2 Content (CaO2) = (PaO2 x 0.003) + (1.34 x hemoglobin x SaO2)
      – Normal CaO2 = 20 Vol%
    • Venous O2 content (CvO2) = (PvO2 x 0.003) + (1.34 x hemoglobin x SvO2)
      – Normal CvO2 = 15vol%
  – Oxygen utilization
    • O2 consumption (VO2) = CvO2 – CaO2
Diagnostic Testing

• Chest Radiology (chest X-ray)
  – Areas of consolidation such as atelectasis or pneumonia
  – Effusion $\rightarrow$ costophrenic angle
    • hydrothorax $\rightarrow$ serous fluid
    • hemothorax $\rightarrow$ blood
    • pyothorax $\rightarrow$ pus

• Bronchoscopy
  – Need special perpetration such as sedation (Midazolam hydrochloride) with analgesic (Meperidine hydrochloride)
  – Close monitoring is required during & after the procedure
Chest Radiology- Pulmonary edema
Chest Radiology

Right upper lobe pneumonia

Tension pneumothorax

Pulmonary edema

Chest X-Ray with Pleural Effusion on the Left
Diagnostic Testing

- Pulmonary Function Test
- Angiography
- Drug screen
Nursing Diagnosis

- Ineffective airway clearance
- Ineffective breathing pattern
- Impaired gas exchange
- Activity intolerance
- Acute confusion
Collaborative Management

• The primary goal of the management is “to identify & treat of the precipitating condition”

• **Pharmacotherapy**
  - Bronchodilators
  - Mucolytics
  - Steroids
  - Diuretics
  - Antibiotics
  - Vasoactive drugs
Collaborative Management

- **Airway management**
  - Head tilt, chin lift or jaw thrust
  - Different types of airways are used to maintain patent airway:
    - Oropharyngeal airway
    - Nasopharyngeal airway
    - Oral endotracheal tube
    - Nasal endotracheal tube
    - Tracheostomy tube
  - Indications of endotracheal intubation:
    - Persistent airway obstruction
    - Need frequent suctioning
    - Protection of aspiration in the neurologically depressed
    - Need for mechanical ventilation
Head tilt, chin lift
Oropharyngeal airway
Nasopharyngeal airway
Oral endotracheal tube
Nasal endotracheal tube
Tracheostomy tube
Endotracheal Intubation

• Before the procedure
  – Prepare both patient & family
  – Adequate oxygenation
  – Sedation & paralytic agents

• During the procedure
  – Monitor the SpO2
  – Assist the anesthesiologist

• After the procedure
  – Assess bilateral breath sound
  – Confirm symmetrical chest movement
  – Presence of exhaled CO2
  – Chest radiography
  – Make sure that patient will not pull out the ETT
  – Cuff inflation (20-25mm Hg)
  – For long time intubation consider tracheostomy
Endotracheal Intubation
Management

• Maintain adequate arterial oxygenation
  – Use different O₂ delivery systems (see the table)
    • Low-flow system
      – Nasal cannula
      – Simple mask
      – Partial rebreathing mask
      – Nonrebreathing mask
    • High-flow system
      – Venti-mask
    • Reservoir system
      – Leak-free nonrebreathing mask
      – Face tent,
      – T-piece system
  – In all of these systems avoid O₂ toxicity
Nasal cannula
Partial rebreathing mask
Venti-mask
Face tent
oxygen T-piece system
Ambu Bag
Manual Resuscitator

- Manual Ambu-bag
  - Connected to O2
  - It can deliver 75% - 100%
  - Force of squeezing: give the appropriate TV
  - Number of hand squeezed per minute
  - Observe the chest movement during the manual resuscitation
Management

• **Mechanical Ventilation (MV)**
  - MV does not treat respiratory failure rather it supports oxygenation until appropriate treatment is applied
  - Usually, indicated for life-threatening hypoxia
  - Acute severe respiratory acidosis
  - MV setting is usually determined based on patient respiratory history & ABG results
  - In critical care settings positive-pressure ventilators are used to provide 2 types of breaths:
    • Spontaneous breaths: initiated & ended by the patient
    • Mandatory breaths: initiated & ended by the ventilator
Establishing an Artificial Airway

<table>
<thead>
<tr>
<th>Age group</th>
<th>Internal diameter of endotracheal tube</th>
<th>Suction cannula</th>
<th>Laryngoscope blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm</td>
<td>2.5-3.0</td>
<td>4-5 fr</td>
<td>0</td>
</tr>
<tr>
<td>Newborn</td>
<td>3.0</td>
<td>6 fr</td>
<td>0</td>
</tr>
<tr>
<td>1-6 months</td>
<td>3.5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>6-12 months</td>
<td>3.5-4.0</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>12-24 months</td>
<td>4.0-4.5</td>
<td>8</td>
<td>1-2</td>
</tr>
<tr>
<td>3-4 years</td>
<td>4.5-5.0</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>5-6 years</td>
<td>5.0-5.5</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>7-8 years</td>
<td>5.5-6.0</td>
<td>10</td>
<td>2-3</td>
</tr>
<tr>
<td>9-10 years</td>
<td>6.0-6.5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>11-12 years</td>
<td>6.5-7.0</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

- Adult female 8.0
- Adult male 9.0
Establishing an Artificial Airway
Intubation Procedure

- Preoxygenate with 100% oxygen to provide apneic or distressed patient with reserve while attempting to intubate.
  - Do not allow more than 30 seconds to any intubation attempt.
  - If intubation is unsuccessful, ventilate with 100% oxygen for 3-5 minutes before a reattempt.

- The depth of the tube for
  - A male patient on average is 21-23 cm at teeth
  - A female patient is 19-21 at teeth.
Intubation Procedure

• Confirm tube position:

✓ By auscultation of the chest
✓ Bilateral chest rise
✓ Tube location at teeth
✓ CO2 detector – (esophageal detection device)
Type of Ventilators
Type of Ventilators

• Volume Ventilators
  – Preset volume is delivered each time
  – Set volume depends on lung compliance

• Pressure Ventilators
  – Pressure constant and volume is changeable.
  – Pressure is constant and volume will vary with patient’s lung compliance.

• High-Frequency Ventilators
  – Used in special cases such as ARDS
  – Small TV (1 – 3 ml/Kg) at rate more than 100/min
  – Used to achieve lower peak ventilator pressure
Ventilator Settings Terminology

- **A/C**: Assist-Control
- **IMV**: Intermittent Mandatory Ventilation
- **SIMV**: Synchronized Intermittent Mandatory Ventilation
- **Bi-level/ Biphasic**: Non-inversed Pressure Ventilation with Pressure Support (consists of 2 levels of pressure)
Ventilator Settings Terminology

- **PRVC**: Pressure Regulated Volume Control
- **PEEP**: Positive End Expiratory Pressure
- **CPAP**: Continuous Positive Airway Pressure
- **Pressure**
- **PSV**: Pressure Support Ventilation
- **NI PPV**: Non-Invasive Positive Pressure Ventilation
Settings

- Trigger mode and sensitivity
- Respiratory rate
- Tidal Volume
- Positive end-expiratory pressure (PEEP)
- Flow rate
- Inspiratory time
- Fraction of inspired oxygen
**Settings**

**Trigger:** There are two ways to initiate a ventilator-delivered breath: pressure triggering or flow-by triggering

- When *pressure triggering* is used, a ventilator-delivered breath is initiated if the demand valve senses a negative airway pressure deflection (generated by the patient trying to initiate a breath) greater than the trigger sensitivity.

- When *flow-by triggering* is used, a continuous flow of gas through the ventilator circuit is monitored. A ventilator-delivered breath is initiated when the return flow is less than the delivered flow, a consequence of the patient's effort to initiate a breath.
Settings

- **Tidal volume**: is the amount of air delivered with each breath. The appropriate initial tidal volume depends on numerous factors, most notably the disease for which the patient requires mechanical ventilation.

- **Respiratory Rate**: An optimal method for setting the respiratory rate has not been established. For most patients, an initial respiratory rate between 12 and 16 breaths per minute is reasonable.
Positive End-Expiratory Pressure (PEEP)

- Applied PEEP is generally added to mitigate end-expiratory alveolar collapse. A typical initial applied PEEP is 5 cmH2O. However, up to 20 cmH2O may be used in patients undergoing low tidal volume ventilation for acute respiratory distress syndrome (ARDS)
Flow Rate

• The peak flow rate is the maximum flow delivered by the ventilator during inspiration. Peak flow rates of 60 L per minute may be sufficient (MV x 4),

• An insufficient peak flow rate is characterized by dyspnea, spuriously low peak inspiratory pressures, and scalloping of the inspiratory pressure tracing.
Inspiratory Time: Expiratory Time Relationship (I:E Ratio)

- During spontaneous breathing, the normal I:E ratio is 1:2, indicating that for normal patients the exhalation time is about twice as long as inhalation time.
- If exhalation time is too short “breath stacking” occurs resulting in an increase in end-expiratory pressure also called auto-PEEP.
- Depending on the disease process, such as in ARDS, the I:E ratio can be changed to improve ventilation.
Fraction of Inspired Oxygen

- The lowest possible fraction of inspired oxygen (FiO2) necessary to meet oxygenation goals should be used. This will decrease the likelihood that adverse consequences of supplemental oxygen will develop, such as absorption atelectasis, accentuation of hypercapnia, airway injury, and parenchymal injury.
Mechanical Ventilation

- **Basic ventilator adjustments**
  - In most settings high FIO2 is started (0.6-1.0)
  - If simple FIO2 was not enough 5 cm PEEP is added
  - Peak Flow: velocity of gas flow per unit of time
    - The rule of thumb: roughly four times that of the minute ventilation (if the MV is 15 liters, the patient requires a PF of >60 liters).
  - Pressure Limit: the highest pressure allowed in the MV
  - ABG monitoring is required for mechanically ventilated patient
  - TV is usually set at 10-15 mL/Kg
  - Patient with COPD should have the lowest possible TV
Mechanical Ventilation

- **Basic ventilator adjustments**
  - **PEEP**: Positive End Expiratory Pressure
    - PEEP can be increased up to 20 cm H2O
    - High level of PEEP may be associated with barotrauma (injury or alveolar rupture), pneumothorax,
    - Reduce PEEP if PaO2 of 80 - 100 of FiO2 less than 50%
    - Usually increase 2 - 5 cm H2O
  - **Sensitivity**:
    - Amount of patient’s effort necessary to initiate an inspiration as measured by negative inspiratory effort
Guidelines in the Initiation of Mechanical Ventilation

- Primary goals of mechanical ventilation are adequate oxygenation/ventilation, reduced work of breathing, synchrony of vent and patient, and avoidance of high peak pressures
- Set initial FIO2 on the high side, you can always titrate down
- Initial tidal volumes should be 8-10ml/kg, depending on patient’s body habitus. If patient is in ARDS consider tidal volumes between 5-8ml/kg with increase in PEEP
Guidelines in the Initiation of Mechanical Ventilation

• Use PEEP in diffuse lung injury and ARDS to support oxygenation and reduce FIO2
• Avoid choosing ventilator settings that limit expiratory time and cause or worsen auto PEEP
• When facing poor oxygenation, inadequate ventilation, or high peak pressures due to intolerance of ventilator settings consider sedation, analgesia or neuromuscular blockage
Modes of MV

• Controlled Mandatory Ventilation (CMV)
  – Fixed RR with Constant TV in specific time intervals
  – Inspiratory trigger is time
  – PEEP is often added
  – Patient efforts do not trigger a breath
  – Need sedation and paralytic (see table 17-12, important)

• Assist/Control Mode
  – The trigger is time
  – Preset of TV and minimum RR
  – Patient efforts trigger a breath with the preset TV
  – Useful for patient recovering from anesthesia
Modes of Ventilation: The Basics

- Assist-Control Ventilation Volume Control
- Assist-Control Ventilation Pressure Control
- Pressure Support Ventilation
- Synchronized Intermittent Mandatory Ventilation Volume Control
- Synchronized Intermittent Mandatory Ventilation Pressure Control
Assist Control Ventilation

- A set tidal volume (if set to volume control) or a set pressure and time (if set to pressure control) is delivered at a minimum rate
- Additional ventilator breaths are given if triggered by the patient
Synchronized Intermittent Mandatory Ventilation

Breaths are given at a set minimal rate, however if the patient chooses to breathe over the set rate no additional support is given.

One advantage of SIMV is that it allows patients to assume a portion of their ventilatory drive.

SIMV is usually associated with greater work of breathing than AC ventilation and therefore is less frequently used as the initial ventilator mode.

Like AC, SIMV can deliver set tidal volumes (volume control) or a set pressure and time (pressure control).

Negative inspiratory pressure generated by spontaneous breathing leads to increased venous return, which theoretically may help cardiac output and function.
Modes of MV

• Synchronized Intermittent Mandatory Ventilation (SIMV)
  – If the machine senses a spontaneous breath close to the mandatory one, the spontaneous breath is augmented to the preset TV
  – PEEP is often added
  – TV of spontaneous breath depends on the patient’s efforts
  – The preferred mode for short-term weaning

• Continuous Positive Airway Pressure (CPAP)
  – A spontaneous mode with a baseline pressure above zero
  – Used intermittently during long-term weaning to increase respiratory muscle strength
  – It is the final step before extubation
  – RR and TV is generated by the patient
## Advantages of Each Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assist Control Ventilation (AC)</td>
<td>Reduced work of breathing compared to spontaneous breathing</td>
</tr>
<tr>
<td>AC Volume Ventilation</td>
<td>Guarantees delivery of set tidal volume</td>
</tr>
<tr>
<td>AC Pressure Control Ventilation</td>
<td>Allows limitation of peak inspiratory pressures</td>
</tr>
<tr>
<td>Pressure Support Ventilation (PSV)</td>
<td>Patient comfort, improved patient ventilator interaction</td>
</tr>
<tr>
<td>Synchronized Intermittent Mandatory Ventilation (SIMV)</td>
<td>Less interference with normal cardiovascular function</td>
</tr>
</tbody>
</table>
## Disadvantages of Each Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assist Control Ventilation (AC)</td>
<td>Potential adverse hemodynamic effects, may lead to inappropriate hyperventilation</td>
</tr>
<tr>
<td>AC Volume Ventilation</td>
<td>May lead to excessive inspiratory pressures</td>
</tr>
<tr>
<td>AC Pressure Control Ventilation</td>
<td>Potential hyper- or hypoventilation with lung resistance/compliance changes</td>
</tr>
<tr>
<td>Pressure Support Ventilation (PSV)</td>
<td>Apnea alarm is only back-up, variable patient tolerance</td>
</tr>
<tr>
<td>Synchronized Intermittent Mandatory</td>
<td>Increased work of breathing compared to AC</td>
</tr>
<tr>
<td>Ventilation (SIMV)</td>
<td></td>
</tr>
</tbody>
</table>
Modes of MV

- **Pressure Support (PS)**
  - Augments the spontaneous breath with preset inspiratory pressure
  - TV varies according to the patient’s effort
  - Can be used alone or in conjunction with SMIV
  - It is weaning mode of long-term gentle waning

- **Pressure Control (PC) or Pressure Assist/Control (PA/C)**
  - A preset inspiratory pressure
  - TV varies according to the lung compliance
  - PEEP may be added
  - I:E timing is reversed; E time is shortened to prevent alveolar collapse
  - Patient needs sedation
  - Useful for ARDS
Modes of MV

• Noninvasive Positive-Pressure Ventilation (NIPPV)
  – Overcome some of the complication of endotracheal tube
  – Candidates:
    • Exacerbation of COPD & chronic respiratory failure for COPD
    • End-stage lung disease waiting lung transplant
    • Post op respiratory failure
    • Patient inappropriate for intubation
  – Contraindication include: hemodynamic instability, inability to clear secretion, uncooperative behavior, risk of aspiration
  – Positive pressure ventilation is provided through a form-fitting mask
  – CPAP can be used to treat sleep apnea
  – Complications include: discomfort of the fitting mask, gastric distension, self-removal of the mask
Noninvasive Positive-Pressure Ventilation
Comparison of HFOV & Conventional Ventilation

<table>
<thead>
<tr>
<th>Differences</th>
<th>CMV</th>
<th>HFOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rates</td>
<td>0 - 150</td>
<td>180 - 900</td>
</tr>
<tr>
<td>Tidal Volume</td>
<td>4 - 20 ml/kg</td>
<td>0.1 - 3 ml/kg</td>
</tr>
<tr>
<td>Alveolar Press</td>
<td>0 - &gt; 50 cmH2O</td>
<td>0.1 - 5 cmH2O</td>
</tr>
<tr>
<td>End Exp Volume</td>
<td>Low</td>
<td>Normalized</td>
</tr>
<tr>
<td>Gas Flow</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
Complications of MV

• Artificial airway
  – Laryngeal spasm or edema on extubation
  – Self-extubation
  – Uncomfortable
  – High risk of aspiration

• Ventilator management
  – Barotrauma as result of inappropriate pressure settings
  – Iatrogenic respiratory acidosis or alkalosis
  – Power failure
  – Patient comfort and anxiety in relation to MV mode
Complications of MV

- Ventilator associated pneumonia
- Water imbalance: release of ADH
- Complications associated with immobility
- Gastrointestinal problems
- Muscle weakness
Weaning of MV

• Guidelines for weaning
  – Readiness criteria
    • Hemodynamically stable
    • SaO2 > 92% on FiO2 < 40%
    • CxR findings
    • Metabolic indicators such as pH, electrolytes
    • Adequate management of pain, anxiety and agitation
  – Neurological assessment
  – Cardiovascular stability
  – Nutritional status
  – Psychological readiness
Weaning of MV

- **Weaning process**
  - Start reducing FIO2 based on ABG and SpO2
  - PEEP reduction until less than 5cm
  - When FIO2 weaned less than 0.4 & PEEP < 5cm, then the actual weaning may begin
  - Graduate support in SIMV and PS
  - When SIMV rate reach 4-6 → change to CPAP
  - Change to CPAP mode or T-tube
  - Continue to assess the patient physical & psychological response
  - Monitor patient spontaneous breathings for rate & adequate TV
  - PS is good weaning mode for those with neuromuscular dysfunction, COPD, limited cardiac reserve
Weaning of MV

• **Weaning outcome**
  - Successful weaning is being 24 hrs without distress
  - After successful weaning close monitoring is required for:
    • Airway patency
    • Oxygenation & ventilation
  - Long-term full ventilatory support
    • Prepare both patient & family for long-term care
Mechanical Ventilation in Critical Care

- Introduction
- What is a mechanical ventilator?
- How are mechanical ventilators classified?
- Why are there so many different ways to ventilate a patient?
- What is the difference between PEEP and CPAP?
- What do I need to know about volume-controlled ventilators?
- What is volume assist-control ventilation?
- What is (synchronized) intermittent mandatory ventilation (IMV / SIMV)?
Questions and answers