I believe…

- we are responsible for preparing and learning.
- we learn best by interacting & discussing collegially.
- we must respect everyone.
- we are continually learning – building on previously learned concepts.
- in an open environment in which questions & observations are welcome.
- I do not have all of the answers
- I will always find the answer, rationale, reason
- everyone has potential to become more than they are today
Interferences with Ventilation

Objectives

- Discuss assessment—breath sounds
- Describe diagnostic tests for pulmonary function
- Discuss acid-base balance
- Examine signs, symptoms, pathophysiology, treatments, and nursing care of respiratory distress syndromes
- Discuss nursing interventions – mechanical ventilation, tracheostomy, postural drainage
- Discuss pulmonary accidents—chest trauma, aspiration
Content Approach

- Anatomy & Physiology Review
- Demographics/occurrence
- Pathophysiology
- Clinical Picture
- Medical Management
- Nursing Process (APIE)

Assessment - Nursing Actions - Education
Interferences with Ventilation
Respiratory Anatomy & Physiology

- **Anatomy**
  - **Structure of the Chest Wall**: Ribs, pleura, muscles of respiration
  - **Upper Respiratory**: nose, pharynx, adenoids, tonsils, epiglottis, larynx, and trachea
  - **Lower Respiratory**: bronchi, bronchioles, alveolar ducts, and alveoli

- **Physiology**
  - **Ventilation**: inspiration and expiration
  - **Elastic Recoil**: elastin fibers that recoil after expansion
  - **Diffusion**: Exchange of oxygen and carbon dioxide
  - **Arterial Blood Gases / Oximetry**
Lungs
A & P Review

- Trachea ("wind pipe")
- Lung apices
- Right upper lobe
- Pleura
- Pleural cavity
- Three right lobar bronchi
- Right middle lobe
- Alveolar ducts and alveoli
- Right lower lobe
- Cartilaginous rings
- Left upper lobe
- Right and left mainstem bronchi
- Subsegmental bronchi
- Segmental bronchi
- Carina
- Two left lobar bronchi
- Bronchioles
- Lungs
- Lung bases
- Left lower lobe
- Diaphragm
Respiratory Assessment
A&P Review
Thorax
Anatomical Landmarks

- Right middiavicular line
- Thyroid cartilage
- Larynx
- Trachea
- Suprasternal notch
- First rib
- Angle of Louis
- Left upper lobe
- Left lower lobe

- Right anterior axillary line
- Midsternal line
- Vertebral line
- Spinal processes
- Left upper lobe
- Left lower lobe

- Right upper lobe
- Right lower lobe
- Scapular line
Interferences with Ventilation

Alveolar Gas Exchange
Interferences with Ventilation

Assessment

- **History**

- **Cues to Respiratory Problems:**
  - Shortness of breath – dyspnea
    - Orthopnea / Nocturnal dyspnea
  - Wheezing
  - Cough / sputum production
  - Hemoptysis
  - Voice change
  - Fatigue
Interferences with Ventilation

Assessment

Thorax & Lungs

- **Inspection:**
  - Posture, chest movement, abnormalities of sternum
  - Respiratory rate, depth, rhythm

- **Palpation:**
  - Equality of chest expansion
  - Tactile Fremitus

- **Percussion:**
  - Hyperresonance
  - Dullness

- **Auscultation:**
  - Discontinuous: fine crackles/rales / coarse crackles / rales
  - Continuous: Wheeze, Rhonchi
  - Pleural friction rub
<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonance</td>
<td>Low-pitched sound heard over normal lungs</td>
</tr>
<tr>
<td>Hyperresonance</td>
<td>Loud, lower-pitched sound than normal resonance heard over hyperinflated lungs, such as in chronic obstructive lung disease and acute asthma</td>
</tr>
<tr>
<td>Tympany</td>
<td>Drumlike, loud, empty quality heard over gas-filled stomach or intestine, or pneumothorax</td>
</tr>
<tr>
<td>Dull</td>
<td>Medium-intensity pitch and duration heard over areas of “mixed” solid and lung tissue, such as over the top area of the liver, partially consolidated lung tissue (pneumonia), or fluid-filled pleural space</td>
</tr>
<tr>
<td>Flat</td>
<td>Soft, high-pitched sound of short duration heard over very dense tissue where air is not present</td>
</tr>
</tbody>
</table>
Larynx

Anatomical Landmarks

Epiglottis
Hyoid bone
Thyrohyoid membrane
Thyroid notch
Arytenoid cartilages
Thyroid cartilage (Adam's apple)
Cricothyroid membrane
Cricoid cartilage
Trachea

ANTERIOR

POSTERIOR
# Respiratory Assessment

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>INSPECTION</th>
<th>PALPATION</th>
<th>PERCUSSION</th>
<th>AUSCULTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic bronchitis</td>
<td>Barrel chest; cyanosis</td>
<td>↓ Movement</td>
<td>Hyperresonant or dull if consolidation</td>
<td>Crackles; rhonchi; wheezes</td>
</tr>
<tr>
<td>Emphysema</td>
<td>Barrel chest; tripod position; use of accessory muscles</td>
<td>↑ Fremitus</td>
<td>Hyperresonant or dull if consolidation</td>
<td>Crackles; rhonchi; diminished if no exacerbation</td>
</tr>
<tr>
<td>Asthma</td>
<td>Prolonged expiration; tripod position; pursed lips</td>
<td>↓ Movement</td>
<td>Hyperresonance</td>
<td>Wheezes; ↓ breath sounds ominous sign if no improvement (severely diminished air movement)</td>
</tr>
<tr>
<td>In exacerbation</td>
<td></td>
<td>↓ Fremitus if hyper-inflation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not in exacerbation</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Tachypnea; use of accessory muscles; duskeness or cyanosis</td>
<td>Unequal movement if lobar involve- ment; ↑ fremitus over affected area</td>
<td>Dull over affected areas</td>
<td>Early: Bronchial sounds Later: Crackles; rhonchi</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>No change unless involves entire segment, lobe</td>
<td>If small, no change If large, ↓ movement; ↑ fremitus</td>
<td>Dull over affected areas</td>
<td>Crackles (may disappear with deep breaths); absent sounds if large Fine or coarse crackles</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>Tachypnea; labored respirations; cyanosis</td>
<td>↓ Movement or normal movement</td>
<td>Dull or normal depending on amount of fluid</td>
<td></td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>Tachypnea; use of accessory muscles</td>
<td>↓ Movement</td>
<td>Dull</td>
<td>Diminished or absent over effusion; egophony over effusion</td>
</tr>
</tbody>
</table>
Respiratory Assessment

Ascultation Landmarks
Respiratory Assessment
Breath Sounds
# Respiratory Assessment

## Normal Breath Sounds

<table>
<thead>
<tr>
<th></th>
<th>Pitch</th>
<th>Amplitude</th>
<th>Duration</th>
<th>Quality</th>
<th>Normal Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchial (tubular, tracheal)</td>
<td>High</td>
<td>Loud</td>
<td>Inspiration &lt; Expiration</td>
<td>Harsh, hollow, tubular, blowing</td>
<td>Trachea and larynx</td>
</tr>
<tr>
<td>Bronchovesicular</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Inspiration = Expiration</td>
<td>Mixed</td>
<td>Over major bronchi where fewer alveoli are located: posterior, between scapulae (especially on right); anterior, around upper sternum in first and second intercostal spaces</td>
</tr>
<tr>
<td>Vesicular</td>
<td>Low</td>
<td>Soft</td>
<td>Inspiration &gt; Expiration</td>
<td>Rustling, like the sound of the wind in the trees</td>
<td>Over peripheral lung fields where air flows through smaller bronchioles and alveoli</td>
</tr>
</tbody>
</table>
# Respiratory Assessment

## Adventitious Breath Sounds

<table>
<thead>
<tr>
<th>Adventitious Sound</th>
<th>Occurrence in the Respiratory Cycle</th>
<th>Character</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DISCONTINUOUS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine crackles</td>
<td>Either early or late inspiration</td>
<td>Popping, discontinuous sounds caused by air moving into previously deflated airways; sounds like hair being rolled between fingers near the ear</td>
<td>Asbestosis</td>
</tr>
<tr>
<td>Fine rales</td>
<td></td>
<td>“Velcro” sounds late in inspiration usually associated with restrictive disorders</td>
<td>Atelectasis</td>
</tr>
<tr>
<td>High-pitched rales</td>
<td></td>
<td></td>
<td>Interstitial fibrosis</td>
</tr>
<tr>
<td><strong>Coarse crackles</strong></td>
<td>More common on expiration but may be present early in inspiration</td>
<td>Lower pitched, coarse, discontinuous rattling sounds caused by fluid or secretions in large airways; likely to change with coughing or suctioning</td>
<td>Bronchitis</td>
</tr>
<tr>
<td>Low-pitched crackles</td>
<td></td>
<td></td>
<td>Pneumonia</td>
</tr>
<tr>
<td><strong>CONTINUOUS</strong></td>
<td></td>
<td></td>
<td>Chronic pulmonary diseases</td>
</tr>
<tr>
<td>Wheeze</td>
<td>Audible during either inspiration, expiration, or both</td>
<td>Squeaky, musical, continuous sounds associated with air rushing through narrowed airways; may be heard without a stethoscope</td>
<td>Bronchitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arise from the small airways</td>
<td>Edema</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usually do not clear with coughing</td>
<td>Secretions</td>
</tr>
<tr>
<td><strong>Rhonchus (rhonchi)</strong></td>
<td>Audible during both inspiration and expiration, but commonly more prominent on expiration</td>
<td>Lower-pitched, coarse, continuous snoring sounds</td>
<td>Pulmonary vessel engorge-ment (as in cardiac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arise from the large airways</td>
<td>“asthma”)</td>
</tr>
<tr>
<td><strong>PLEURAL FRICION</strong></td>
<td>Heard during both inspiration and expiration, generally at the end of inspiration and the beginning of</td>
<td>Loud, rough, grating, scratching sounds caused by the inflamed surfaces of the pleura rubbing together; often associated with pain on deep inspirations</td>
<td>Thick, tenacious secretions</td>
</tr>
<tr>
<td><strong>RUB</strong></td>
<td></td>
<td></td>
<td>Sputum production</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Obstruction by foreign body</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tumors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pleurisy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tuberculosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pulmonary infarction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pneumonia</td>
</tr>
</tbody>
</table>
# Respiratory Assessment

<table>
<thead>
<tr>
<th><strong>Inspection</strong></th>
<th><strong>Definition</strong></th>
<th><strong>Clinical Picture</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pursed-lip breathing</td>
<td>Exhalation through mouth with lips pursed together to slow exhalation.</td>
<td>COPD, asthma. Suggests ↑ breathlessness. Strategy taught to slow expiration, ↓ dyspnea.</td>
</tr>
<tr>
<td>Tripod position; inability to lie flat</td>
<td>Learning forward with arms and elbows supported on overbed table.</td>
<td>COPD, asthma in exacerbation, pulmonary edema. Indicates moderate to severe respiratory distress.</td>
</tr>
<tr>
<td>Accessory muscle use; intercostal retractions</td>
<td>Neck and shoulder muscles used to assist breathing. Muscles between ribs pull in during inspiration.</td>
<td>COPD, asthma in exacerbation, secretion retention. Indicates severe respiratory distress, hypoxemia.</td>
</tr>
<tr>
<td>Splinting</td>
<td>Voluntary ↓ in tidal volume to ↓ pain on chest expansion.</td>
<td>Thoracic or abdominal incision. Chest trauma, pleurisy.</td>
</tr>
<tr>
<td>↑ AP diameter</td>
<td>AP chest diameter equal to lateral. Slope of ribs more horizontal (90 degrees) to spine.</td>
<td>COPD, asthma, cystic fibrosis. Lung hyperinflation. Advanced age.</td>
</tr>
<tr>
<td>Tachypnea</td>
<td>Rate &gt;20 breaths/min; &gt;25 breaths/min in elderly.</td>
<td>Fever, anxiety, hypoxemia, restrictive lung disease. Magnitude of ↑ above normal rate reflects increased work of breathing.</td>
</tr>
<tr>
<td>Kussmaul’s respirations</td>
<td>Regular, rapid, and deep respirations.</td>
<td>Metabolic acidosis; ↑ in rate aids body in ↑ CO₂ excretion.</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>Bluish color of skin best seen in earlobes, under the eyelids, or nail beds.</td>
<td>↓ Oxygen transfer in lungs, ↓ cardiac output. Nonspecific, unreliable indicator.</td>
</tr>
<tr>
<td>Abdominal paradox</td>
<td>Inward (rather than normal outward) movement of abdomen during inspiration.</td>
<td>Inefficient and ineffective breathing pattern. Nonspecific indicator of severe respiratory distress.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Palpation</strong></th>
<th><strong>Definition</strong></th>
<th><strong>Clinical Picture</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheal deviation</td>
<td>Leftward or rightward movement of trachea from normal midline position.</td>
<td>Nonspecific indicator of change in position of mediastinal structures. Medical emergency if...</td>
</tr>
</tbody>
</table>
Interferences with Ventilation

Diagnostic Studies

- **Blood Studies:** Hgb, Hct, ABGs
- **Sputum Studies:** C&S, Gram Stain, Acid-fast smear; Cytology
- **Radiology:**
  - Chest x-ray -- posterior-anterior / lateral
  - Computed tomography (CT) – cross sections of the lung with and without contrast – used often
  - Magnetic resonance imaging (MRI) – images of pulmonary structures – limited use
  - Pulmonary angiogram – x-rays after injection of radiopaque dye – used to dx pulmonary embolism
  - Positron emission tomography (PET) – IV glucose administration – malignant tumors show increased uptake of glucose
  - Ventilation-Perfusion Scan – Perfusion: isotope administration which outlines pulmonary vasculature; Vent: inhalation of radioactive gas which outlines the alveoli – dx pulmonary emboli
Interferences with Ventilation

Diagnostic Studies

➢ Endoscopic Exams (done in x-ray or OR):
   - Bronchoscopy – fiberoptic visualization of bronchi – biopsy; also used to remove mucous plugs, foreign bodies, obstructions
   - Mediastinoscopy – scope through a small incision in the suprasternal notch – visualize mediastinum for tumors, lymph nodes, infections, sarcoidosis

➢ Biopsy: Transbronchial or open lung biopsy – done in x-ray or OR

➢ Thoracentesis – insertion of a needle into the pleural space – pleural fluid, install medication - done at bedside

➢ Pulmonary Function Testing – tests to measure lung volumes and used to dx pulmonary disease, monitor progress, evaluate disability, evaluate response to bronchodilators – done in pulmonary lab

➢ Skin Testing – intradermal planning of test dose to assess skin reaction by measuring mm induration – TB, various lung diseases
Pulmonary Function Test
Relationship of Lung Volumes & Capacities

Maximal inhalation

VC (4500 ml)
ICA (3500 ml)
IRV (3000 ml)
TLC (6000 ml)

Maximal exhalation

FRC (2500 ml)
ERV (1000 ml)
RV (1500 ml)
TV (500 ml)
Respiratory Diagnostic Testing
Fiberoptic Bronchoscopy
Diagnostic Lung Tests
Thoracentesis
Pair Share – Critical Thinking

- Upon performing a lung sound assessment of the anterior chest, the nurse hears moderately loud sounds on inspiration that are equal in length with expiration. Where in the airway would this lung sound be considered normal?

  a. Trachea
  b. Primary bronchi
  c. Lung fields
  d. Larynx
Pair Share – Critical Thinking

- The name that describes the particular lung sound in the previous questions is which of the following?

- a. Bronchial
- b. Bronchovesicular
- c. Vesicular
- d. Basilar
Interferences with Ventilation
Regulation of Acid-Base Balance
Review

- Acid – contributes hydrogen ion

  - Two types:
    - **Volatile respiratory acid**
      - Dehydrates and excreted in the form of a gas
    - **Nonvolatile metabolic acid**
      - Metabolized and excreted in the form of body fluids
Interferences with Ventilation
Regulation of Acid-Base Balance

Review

- **Base** – accepts or removes hydrogen ion
  - **Buffer** - controls the hydrogen ion concentration:
    - Absorbing hydrogen ions when an acid is added OR
    - Releasing hydrogen ions when base is added.

- **Three Buffer Systems:**
  - Bicarbonate – operates in lungs & kidneys
  - Phosphate – renal tubules
  - Protein – Hgb, plasma proteins, & intracellular protein
Factors to remember:

- Lungs – Eliminate or retain carbon dioxide $\text{CO}_2$
- Kidneys – excrete or form bicarbonate $\text{HCO}_3^-$

Food – converted by the body – $\text{H}_2\text{O} + \text{CO}_2 + \text{energy}$

Lung + Kidney

$\text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3 = \text{HCO}_3^- + \text{H}^+$
Interferences with Ventilation
Normal Acid-Base Balance

- pH
  - 6.8: Death
  - 7.35: Acidosis
  - 7.45: Normal
  - 8.0: Alkalosis

- Balance:
  - 1 part carbonic acid ($H_2CO_3$)
  - 20 parts bicarbonate ($HCO_3^-$)
Interferences with Ventilation
Regulation of Acid-Base Balance

Lungs/Respiratory System

- Increase or decrease hydrogen ion concentration
  - Through respiratory rate and depth
  - Result: C02 is either retained or eliminated
- Changes can occur within minutes
- Controlled in the medulla oblongata—respiratory center

$> = \text{increased}; < = \text{decreased}$

- $<\text{pH causes} > \text{respirations} = <\text{C02} + \text{correcting pH}$
- $>\text{pH causes} < \text{respirations} = >\text{C02} + \text{correcting pH}$
Interferences with Ventilation

Regulation of Acid-Base Balance

> Renal System

- Reabsorb and conserve bicarbonate
- Can generate additional bicarbonate and eliminate excess hydrogen ions as compensation for acidosis
- Three mechanisms:
  - Secretion of small amounts of free hydrogen into the renal tubule
  - Combination of hydrogen ions with ammonium to form ammonium
  - Excretion of weak acids
  - Urine pH 4 – 8
### Interferences with Ventilation

**Regulation of Acid-Base Balance**

$> =$ increased; $<=$ decreased

<table>
<thead>
<tr>
<th>ABG</th>
<th>Condition</th>
<th>Respiratory process</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&gt;\text{PCO}_2$</td>
<td>Respiratory acidosis</td>
<td>$&lt; \text{PCO}_2$ elimination by the lungs -- hypoventilation</td>
</tr>
<tr>
<td>$&lt;\text{PCO}_2$</td>
<td>Respiratory Alkalosis</td>
<td>$&gt;\text{PCO}_2$ elimination by the lungs - hyperventilation</td>
</tr>
</tbody>
</table>
Respiratory Alkalosis

- 0.6 part carbonic acid ($H_2CO_3$)

Respiratory Acidosis

- 2 parts carbonic acid ($H_2CO_3$)

- 20 parts bicarbonate ($HCO_3^-$)

B
Acid-Base Imbalance
Respiratory Acidosis

- Hypoventilation from primary lung problem
  - Atelectasis
  - Pneumonia
  - Respiratory failure
  - Airway obstruction
  - Chest wall injury
  - Cystic fibrosis

- Hypoventilation from other factors
  - Drug overdose
  - Head injury
  - Paralysis of respiratory muscles
  - Obesity
Acid-Base Imbalance

Respiratory Alkalosis

- Hyperventilation from primary lung problem
  - Asthma
  - Pneumonia
  - Inappropriate ventilator settings

- Hyperventilation from other factors
  - Anxiety
  - Disorders of the central nervous system
  - Salicylate overdose
Interferences with Ventilation

Regulation of Acid-Base Balance

Respiratory Function

<table>
<thead>
<tr>
<th>pH</th>
<th>PC02</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased</td>
<td>Increased</td>
<td>Respiratory acidosis</td>
</tr>
<tr>
<td>Increased</td>
<td>Decreased</td>
<td>Respiratory alkalosis</td>
</tr>
</tbody>
</table>
Pair Share – Critical Thinking

- What acid-base imbalance would you suspect for the patient having respiratory problems with respiratory rate: 28/min and expiratory wheezing?
What acid-base imbalance would you suspect for the post-operative patient with respiratory rate 10/min, difficulty to arouse, but arouses with verbal stimuli.
### Interferences with Ventilation

**Regulation of Acid-Base Balance**

> = increased; < = decreased

<table>
<thead>
<tr>
<th>ABG</th>
<th>Condition</th>
<th>Metabolic process</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;PCO2</td>
<td>Metabolic acidosis</td>
<td>&lt; HCO3- elimination by the kidneys – increased acid</td>
</tr>
<tr>
<td>&lt;PCO2</td>
<td>Metabolic Alkalosis</td>
<td>&gt;HCO3- elimination by the kidneys – increased base</td>
</tr>
</tbody>
</table>
Acid-Base Imbalance
Metabolic Acidosis

- Starvation
- Diabetic ketoacidosis
- Renal failure
- Lactic acidosis from heavy exercise
- Use of drugs (ASA, methanol, ethanol)
- Acute renal tubular necrosis
- Diarrhea
Acid-Base Imbalance
Metabolic Alkalosis

- Excessive vomiting
- Prolonged nasogastric suctioning
- Hypokalemia or hypercalcemia
- Excess aldosterone
- Use of drugs (steroids, sodium bicarbonate, diuretics)
### Interferences with Ventilation

**Regulation of Acid-Base Balance**

**Metabolic Function**

<table>
<thead>
<tr>
<th>pH</th>
<th>HC03</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased</td>
<td>Decreased</td>
<td>Metabolic acidosis</td>
</tr>
<tr>
<td>Increased</td>
<td>Increased</td>
<td>Metabolic alkalosis</td>
</tr>
</tbody>
</table>
Interferences with Ventilation
Regulation of Acid-Base Balance

- Normal Values:

<table>
<thead>
<tr>
<th>pH</th>
<th>PCO2</th>
<th>HCO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.35 – 7.45</td>
<td>35 – 45 mm Hg</td>
<td>22 – 26 mEq / L</td>
</tr>
</tbody>
</table>
Interferences with Ventilation
Regulation of Acid-Base Balance
Arterial Blood Gas Interpretation

> = increased; < = decreased

➢ **Step 1: Evaluate the pH**
  - pH <7.35 = acidosis
  - pH >7.45 = alkalosis

➢ **Step 2: Evaluate Respiratory Function**
  - Paco2 >45 mm HG = ventilatory failure & respiratory acidosis
  - Paco2 <35 mm HG = hyperventilation & respiratory alkalosis
Interferences with Ventilation
Regulation of Acid-Base Balance
Arterial Blood Gas Interpretation

> = increased; < = decreased

Step 3: Evaluate Metabolic Processes
- Serum bicarbonate HCO₃ <22 mEq/L = metabolic acidosis
- Serum bicarbonate HCO₃ >26 mEq/L = metabolic alkalosis

Step 4: Determine the Primary Disorder
- When Paco₂ & HCO₃ are both abnormal:
  - Determine which follows the deviation from the pH and
  - Deviates the most from normal
### Interferences with Ventilation

#### Regulation of Acid-Base Balance

#### Arterial Blood Gas Interpretation

- **Respiratory Acidosis:**

<table>
<thead>
<tr>
<th>Normal Values</th>
<th>pH</th>
<th>HCO3-</th>
<th>Paco2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.35–7.45</td>
<td>22-26 mEq/L</td>
<td>35-45mm HG</td>
</tr>
</tbody>
</table>

- **Respiratory Acidosis:**

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>HCO3-</th>
<th>Paco2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Acidosis</td>
<td>7.15</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

- **Compensated:**

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>HCO3-</th>
<th>Paco2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensated</td>
<td>7.37</td>
<td>34</td>
<td>66</td>
</tr>
</tbody>
</table>
## Interferences with Ventilation

### Regulation of Acid-Base Balance

#### Arterial Blood Gas Interpretation

- **Respiratory Alkalosis:**

<table>
<thead>
<tr>
<th>Normal Values</th>
<th>pH</th>
<th>HCO3-</th>
<th>Paco2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.35-7.45</td>
<td>22-26 mEq/L</td>
<td>35-45mm HG</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respiratory Alkalosis</th>
<th>7.6</th>
<th>24</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensated</td>
<td>7.54</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>
## Respiratory Assessment

### Relationship between PaO2 & SpO2

<table>
<thead>
<tr>
<th>PaO2 (%)</th>
<th>SpO2 (%)</th>
<th>CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥70</td>
<td>≥94</td>
<td>Adequate unless patient is hemodynamically unstable or has O2-unloading problem. With a low cardiac output, arrhythmias, a leftward shift of the oxyhemoglobin dissociation curve, or carbon monoxide inhalation, higher values may be desired. Benefits of a higher blood O2 value need to be balanced against the risk of O2 toxicity.</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
<td>Adequate in almost all patients. Values are at steep part of O2-hemoglobin dissociation curve. Provides adequate oxygenation but with less margin of error than above.</td>
</tr>
<tr>
<td>55</td>
<td>88</td>
<td>Adequate for patients with chronic hypoxemia if no cardiac problems occur. These values are also used as criteria for prescription of continuous O2 therapy.</td>
</tr>
<tr>
<td>40</td>
<td>75</td>
<td>Inadequate but may be acceptable on a short-term basis if the patient also has CO2 retention. In this situation, respirations may be stimulated by a low PaO2. Thus the PaO2 cannot be raised rapidly. O2 therapy at a low concentration (24%-28%) will gradually increase the PaO2. Monitoring for arrhythmias is necessary.</td>
</tr>
<tr>
<td>&lt;40</td>
<td>&lt;75</td>
<td>Inadequate. Tissue hypoxia and cardiac arrhythmias can be expected.</td>
</tr>
</tbody>
</table>
Respiratory Assessment
Pulse Oximetry
### Arterial Blood Gas Interpretation

#### Metabolic Acidosis:

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>HCO3-</th>
<th>Paco2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Values</td>
<td>7.35 – 7.45</td>
<td>22-26 mEq/L</td>
<td>35-45mm HG</td>
</tr>
<tr>
<td>Metabolic Acidosis</td>
<td>7.20</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>Compensated</td>
<td>7.28</td>
<td>9</td>
<td>23</td>
</tr>
</tbody>
</table>
### Interferences with Ventilation

**Regulation of Acid-Base Balance**

**Arterial Blood Gas Interpretation**

- **Metabolic Alkalosis**

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<th>HCO3-</th>
<th>Paco2</th>
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<tr>
<td></td>
<td>7.35 – 7.45</td>
<td>22-26 mEq/L</td>
<td>35-45mm HG</td>
</tr>
</tbody>
</table>

| Metabolic Alkalosis | 7.54 | 36 | 44 |

| Compensated | 7.42 | 31 | 50 |
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

pH - 7.50
Paco2 – 28
HCO3- - 25
Pao2 - 88
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

- Medical Dx: Acute exacerbation of asthma
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

pH -7.28
Paco2 – 52
HCO3- - 26
Pao2 - 68
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

Medical Dx: Acute exacerbation of emphysema
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

pH - 7.30
Paco2 – 37
HCO3- - 18
Pao2 - 90
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

- Medical Dx: Renal Failure
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

pH – 7.48
Paco2 – 45
HCO3- - 32
Pao2 – 98
Pair Share – Critical Thinking
Arterial Blood Gas Interpretation

Medical Dx: postop patient with NG with large amount of NG output
Interferences with Ventilation
Classification of Resp Failure

Hypoxemic PaO2 <= 60 mmHg on 60% O2

- Acute Respiratory Distress Syndrome
  - Direct lung injury: aspiration; severe, disseminated pulmonary infection; near-drowning; toxic gas inhalation; airway contusion
  - Indirect lung injury: sepsis/septic shock; severe non-thoracic trauma, cardiopulmonary bypass

- Pathophysiology –
  - Fluid enters interstitial space and alveoli—impaired gas exchange
  - < PaO2 and > PaCO2.
  - Ischemia to pulmonary capillaries
  - < integrity of the alveolar-capillary membrane
Interferences with Ventilation Respiration Failure – Medical Tx Goals

- Maintain adequate oxygenation & ventilation
  - Oxygen therapy
  - Mobilization of secretions
    - Effective coughing and positioning
    - Hydration & humidification
  - Chest physical therapy
  - Airway suctioning
  - Positive pressure ventilation
  - Relief of bronchospasm
  - Reduction of airway inflammation
  - Reduction of pulmonary congestion
  - Treatment of pulmonary infections
  - Reduction of severe anxiety, pain, and agitation
  - Treat underlying cause
  - Maintain adequate cardiac output
  - Maintain adequate hemoglobin concentration
Interferences with Ventilation

Nursing Diagnosis

66-year old man with shortness of breath, dyspnea, orthopnea, profuse perspiration, feeling like he can’t catch his breath. You observe him to have prolonged expiration.

Breath sounds: expiratory wheezing – upper lung fields bilaterally; rhonchi hear in right lung field

ABGs:
- pH -7.28
- Paco2 – 50
- HCO3- - 26
- Pao2 – 66

Pulse Oximetry: 89

B/P: 160/90 HR: 110 Resp: 14

Priority Nsg Actions?
Top Three Nsg Dx?
Interferences with Ventilation

Nursing Diagnosis

- Ineffective airway clearance
- Ineffective breathing pattern
- Risk for imbalanced fluid volume
- Anxiety
- Impaired gas exchange
- Imbalanced nutrition: less than body requirements
Interferences with Ventilation
Classification of Resp Failure

- **Hypercapnic PaCO2 > 45 and pH < 7.35**
  - Imbalance between ventilatory supply and ventilatory demand
    - **Supply**: maximum ventilation that the pt. can sustain without developing respiratory muscle fatigue
    - **Demand**: The amount of ventilatory needed to keep the PaCO2 within normal limits
  - Normally: supply > demand
  - Hypercapnia – ventilatory failure – inability of the respiratory system to ventilate out sufficient CO2 to maintain a normal PaCO2
Interferences with Ventilation
Respiratory Failure

Causes of hypercapnic respiratory failure

- **Airways & alveoli**
  - Asthma, emphysema, chronic bronchitis, cystic fibrosis

- **Central nervous system**
  - Problems that suppress the drive to breathe – drug overdose, brainstem infarction, severe head injury, spinal cord injuries

- **Chest wall**
  - Flail chest, fractures, kyphoscoliosis, massive obesity

- **Neuromuscular conditions**
  - Guillain-Barre syndrome, muscular dystrophy, multiple sclerosis, myasthenia gravis, ALS
Interferences with Ventilation
Nursing Management
Tracheostomy Care

- **Indications for Tracheostomy**
  - Bypass an upper airway obstruction
  - Cases of prolonged intubation & mechanical ventilation
  - Facilitate removal of secretions
  - Permit oral intake & speech in a patient who requires long-term mechanical ventilation
Interferences with Ventilation
Nursing Management
Tracheostomy Care

Types of Tracheostomy Tubes

- Shiley & Portex fenestrated tracheostomy tube with cuff, inner cannula, decannulation plugs & pilot balloon
  - **Fenestrated**: openings on the surface of the outer cannula that permit air from the lungs to flow over the vocal cords
    - Allows the patient to breathe spontaneously, speak, & cough up secretions
    - Used by the patient who can swallow without risk of aspiration but requires suctioning for secretion removal.
    - Used by the patient who requires mechanical ventilation for fewer than 24 hours a day

- Bivona (Fome) tracheostomy tube with foam cuff and obturator
Interferences with Ventilation
Nursing Management
Tracheostomy Care

- Inserting trach tube
  - Removing obturator

- **Trach tube maintenance**
  - Cuff – deflated versus inflated

- **Trach suctioning**
  - Sterile procedures
  - *Use only Normal sterile saline* (NO Water)
  - Apply suction as catheter is withdrawn

- **Cleaning procedure**
  - Disposable inner cannula
  - Skin care; Changing trach ties
Interferences with Ventilation
Nursing Management
Patient with a ET Tube or Trach

- **Maintain correct tube placement**
  - Breath sounds

- **Maintain proper cuff inflation**
  - Cuff pressure 20-25 mm Hg (capillary perfusion 30 mm Hg)

- **Monitor Oxygenation & Ventilation**
  - ABGs; pulse oximetry;
  - PETCO2 (partial pressure of end-tidal CO2)
  - Respiratory rate assessment
Interferences with Ventilation
Nursing Management
Patient with a ET Tube or Trach

- **Maintain tube patency**
  - Closed and open suctioning
  - Assess patient:
    - Visible secretions
    - Sudden onset of respiratory distress
    - Suspected aspiration
    - Increase in peak airway pressure
    - Auscultation of adventitious breath sounds
    - Increased respiratory rate / increased cough
    - Sudden or gradual decrease in Pao2 and/or SpO2
Interferences with Ventilation
Nursing Management
Patient with a ET Tube or Trach

- **Providing Oral Care and Maintaining Skin Integrity**
  - Lips, mouth, teeth, tongue, oropharynx q2hr
  - Prevent pressure from ET tube
    - Ensure ET or Trach is secured properly
    - Change securing tapes qd & prn

- **Fostering Comfort and Communication**
  - Position of comfort
  - Include family in care as appropriate
  - Pain relief
  - Methods of communication: pictures, word chart
Interferences with Ventilation

**Nursing Management**

**Patient with a Trach**

- **Nursing Diagnoses:**
  - Ineffective airway clearance
  - Impaired verbal communication
  - Risk for infection
  - Imbalanced nutrition
  - Impaired swallowing
  - Ineffective therapeutic regimen management
  - Potential complication—hypoxemia related to misplaced or properly functioning trach tube
Anatomy of the Tracheostomy Tube

Valve used for cuff inflation, deflation, and pressure measurement

- Face plate
- Slots for tube ties
- Pilot balloon
- Outer cannula
- Cuff (inflated)
- Disposable inner cannula
- Obturator
Fenestrated Tracheostomy Tube
Tracheostomy Suctioning

Fig. 26-7  Suctioning a tracheostomy. Using sterile technique, the suction catheter is being withdrawn from the airway while suction is applied. The pilot balloon tubing may be seen lying on the patient’s chest.
Humidification of the air is essential for the patient with an artificial airway because humidification helps do which of the following?

- Prevent tracheal damage
- Promote thick secretions
- Dry out the airways
- Liquefy the secretions
Interferences with Ventilation
Nursing Management
Care of the Patient
Requiring Mechanical Ventilation

- Types of mechanical ventilation
- Settings
- Modes of volume ventilation
- Complications
- Nutritional therapy
- Weaning from positive pressure ventilation & extubation
- Home mechanical ventilation
Interferences with Ventilation
Nursing Management
Care of the Patient Requiring
Mechanical Ventilation

Types of mechanical ventilation

- Controlled mandatory ventilation (CMV) – breaths are delivered at a set rate and volume independent of the patient’s respirations
- Assist-control mechanical ventilation – delivered preset volume & frequency; when pt. initiates a spontaneous breath, a full volume is delivered
- Synchronized intermittent mandatory ventilation – prevent volume at a frequency synchronized with patient’s respirations – most common form used
- Pressure support ventilation – preset level of positive airway pressure is set. Volume delivered depends on pressure level & airway compliance
- Pressure-controlled inverse ratio ventilation – I/E ratio – ratio of duration of inspiration/expiration
Interferences with Ventilation
Nursing Management
Care of the Patient Requiring
Mechanical Ventilation

Other Ventilatory Maneuvers:

- Positive end-expiratory pressure (PEEP) -- + pressure applied during expiration – increases functional residual capacity – prevents alveoli collapse
- Continuous positive airway pressure (CPAP) – prevents patients airway pressure from falling to zero – Used for sleep apnea
- High-frequency ventilation – delivery of small tidal volume at a rapid respiratory rate – maintains lung volume and reduces intrapulmonary shunting
Interferences with Ventilation
Nursing Management
Complications of Mechanical Ventilation

- Pulmonary
  - Barotrauma
  - Volu - pressure trauma
  - Alveolar hypoventilation
  - Alveolar hyperventilation
  - Ventilator-assisted pneumonia
- Sodium & Water Imbalance – Na+ & fluid retention
- Neurologic – impaired cerebral blood floor
- Gastrointestinal – stress ulcer/GI bleed
- Musculoskeletal – contractures, pressure ulcers, footdrop, complications of immobility
- Psychosocial = pain, fear, isolation, anxiety, dependency
- Mechanical Disconnection or Malfunction – Alarm Alert
Establish a nutritional program if the pt is to be without food for 3-5 days

- Total parenteral nutrition
- Enteral feedings
  - Concern:
    - Aspiration
    - Increased carbohydrates = increases CO2 levels
Interferences with Ventilation
Nursing Management
Weaning the Pt. from Mechanical Ventilation & Extubation

Weaning: reducing ventilator support & resuming spontaneous ventilation

- **Pre-weaning** – assessing Pt respiratory effort
  - Muscle strength; PEEP; TV; VC; clear lungs

- **Weaning** – SIMV – synchronized intermittent mandatory ventilation; CPAP; humidified T-piece

- **Outcome Phase** – extubation after hyperoxygenation & suctioning prior to removal; supplemental oxygen, monitoring, need for re-intubation
Interferences with Ventilation
Nursing Management
Home Mechanical Ventilation

- Negative & positive pressure ventilators
  - Settings and alarms
- Home Health / Family participation in care
- Decreased risk for nosocomial infection

Concerns:
- Reimbursement: home health, disposable products may be nonreimbursable
- Family – respite care
A 72-year old female brought to the ER following a head-on car accident. She has blunt injury to the chest—difficulty breathing, cyanosis; receiving O₂ 4l/min NC.

Assessment priority?

Immediate nursing actions