CCRN Review - Pulmonary

ABG Interpretation

- Is the pH normal?
- Is the CO₂ normal?
- Is the HCO₃ normal?
- Are the PaO₂ and the O₂ sat normal?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.35 - 7.45</td>
</tr>
<tr>
<td>PCO₂</td>
<td>35 - 45</td>
</tr>
<tr>
<td>PaO₂</td>
<td>80 - 100</td>
</tr>
<tr>
<td>O₂ saturation</td>
<td>90% - 100%</td>
</tr>
<tr>
<td>HCO₃</td>
<td>22 - 26</td>
</tr>
<tr>
<td>Base Excess</td>
<td>-2 to +2</td>
</tr>
</tbody>
</table>
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Practice # 1
- pH 7.20
- pCO₂ 45
- paO₂ 88
- SaO₂ 95%
- HCO₃ 17

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Practice # 2
- pH 7.29
- pCO₂ 55
- paO₂ 75
- SaO₂ 93%
- HCO₃ 26

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Practice # 3
- pH 7.51
- pCO₂ 32
- paO₂ 106
- SaO₂ 98%
- HCO₃ 25
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Practice # 4
- pH: 7.49
- pCO₂: 40
- paO₂: 95
- SaO₂: 97%
- HCO₃: 29

Practice # 5
- pH: 7.20
- pCO₂: 25
- paO₂: 92
- SaO₂: 96%
- HCO₃: 9

Practice # 6
- pH: 7.42
- pCO₂: 18
- paO₂: 178
- SaO₂: 99%
- HCO₃: 11
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Practice # 7
- pH 7.35
- pCO₂ 60
- paO₂ 92
- SaO₂ 96%
- HCO₃ 32

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Practice # 8
- pH 7.37
- pCO₂ 33
- paO₂ 86
- SaO₂ 96%
- HCO₃ 18

CCRN Review - Pulmonary

COPD
- Definition
  - continual increased resistance to expiratory airflow
  - chronic bronchitis: inflammation of lower airways → ↑ secretions, cough & dyspnea
  - emphysema: alveolar destruction
COPD
- Pathophysiology
  - Bronchitis: excessive mucus secretion & chronic infection
  - Emphysema: increase in size of airspaces distal to bronchioles - loss of recoil
  - overlapping conditions in end-stage disease

COPD
- Etiology - COPD
  - cigarette smoking
  - air pollution, occupational exposure
  - allergy, autoimmunity
  - infection
  - genetic predisposition, aging

COPD
- Clinical Presentation
  - Chronic Bronchitis
    - productive cough
    - thick sputum
    - wheezing & dyspnea
**CCRN Review - Pulmonary**

- **COPD**
  - Clinical Presentation
    - Emphysema
    - dyspnea
    - ↓ exercise tolerance
    - cough
    - sputum (mild)
    - barrel chest

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- **COPD**
  - Diagnostics
    - PFT
    - ABGs
    - Chest x-ray

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- **COPD**
  - Management
    - smoking cessation
    - bronchodilators
    - corticosteroids
    - antimicrobials
    - chest physiotherapy
    - supplemental oxygen
COPD
- Respiratory failure
- Pneumonia
- Right heart failure
- Dysrhythmias
- Depression
- Skeletal muscle dysfunction

Asthma
- Definition
  - Chronic inflammatory airway disorder
  - Episodic inflammation
  - Produces wheezing, breathlessness, chest tightness, coughing & airway hyperreactivity

Asthma
- Pathophysiology
  - Constriction of smooth muscles in airway & hypersecretion of mucus
  - Triggers IgE which causes degranulation of mast cell (histamine)
  - Bronchoconstriction, mucus secretion, vasodilation & increased permeability
**CCRN Review - Pulmonary**

**Asthma**
- **Clinical Presentation**
  - episodes of coughing
  - wheezing
  - dyspnea
  - feeling of chest tightness

**CCRN Review - Pulmonary**

**Asthma**
- **Diagnostics**
  - change in peak flow
  - chest x-ray to rule out other lung diseases

**CCRN Review - Pulmonary**

**Asthma**
- **Management**
  - quick relief meds
  - inhalers
  - anticholinergics
  - corticosteroids
  - β-agonists
Asthma

Management

- Long-term
  - inhaled steroids
  - β-agonists (long-acting)
  - leukotriene modifiers
  - oral steroids
  - methylxanthines

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Asthma

- Management
  - environmental control
  - nursing care: relief of dyspneic breathing, relieving anxiety, patient teaching

CCRN Review - Pulmonary

Asthma

- Complication
  - status asthmaticus
Status Asthmaticus
- Definition
  - severe form of asthma
  - airway obstruction is unresponsive to usual therapy

Contributing Factors
- infection
- air pollutants & allergens
- noncompliance
- ASA
- aspiration of gastric acid

Clinical Presentation
- tachypnea
- suprasternal retractions
- diminished breath sounds
- s/s CO₂ retention
**Status Asthmaticus**

- **Clinical Presentation**
  - anxiety, irritability, fatigue, headache
  - tachycardia, ↑ BP
  - heart failure

**Management**

- monitor RR & SaO₂
- administer aerosol medications
- monitor IV therapy
- continuous humidified O₂

**Pneumonia**

- **Definition**
  - inflammatory process
  - involves terminal airways & alveoli
  - due to infectious agent
Pneumonia

Pathophysiology
- Organisms gain access to lungs by:
  - aspiration of secretions
  - inhalation of secretions
  - bloodstream
  - direct spread during trauma or surgery

Clinical Presentation
- sudden onset: shaking chill & fever (39.5°F to 40°F)
- productive cough
- pleuritic chest pain
- dyspnea, tachypnea, signs of respiratory distress
- rapid bounding pulse

Diagnostics
- chest x-ray
- gram stain of culture & sensitivity
- blood culture
Pneumonia

Management
- antimicrobials
- O2 therapy
- nursing: improve gas exchange, enhance airway clearance, relieve pleuritic pain, monitor for complications

Complication
- pleural effusion
- sustained hypotension & shock
- superinfection
- delirium
- atelectasis

Aspiration Pneumonia

Definition
- oropharyngeal secretions &/or stomach contents
- acute form of pneumonia
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Aspiration Pneumonia
- Pathophysiology
  - particulate matter
  - anaerobic bacterial aspiration
  - gastric juice

Aspiration Pneumonia
- Etiology
  - loss of protective airway
  - nasogastric tube feedings
  - obstetric patients
  - GI conditions

Aspiration Pneumonia
- Clinical Presentation
  - tachycardia, fever
  - dyspnea, cough, tachypnea
  - cyanosis
  - crackles, rhonchi, wheezing
  - pink, frothy sputum
Aspiration Pneumonia

Diagnosis
- Imaging - chest x-ray

Management
- Clear obstructed airway
- Fluid volume replacement
- Laryngoscopy / bronchoscopy

Antimicrobial therapy
- Correction of acidosis
- Supplement O₂ & mechanical ventilation
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Aspiration Pneumonia

- Complications
  - lung abscess: empyema
  - necrotizing pneumonia

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Acute Respiratory Failure

- Definition
  - \( \text{PaO}_2 < 60 \text{ mm Hg} \)
  - \( \text{PaCO}_2 > 50 \text{ mm Hg} \)
  - \( A - a \text{DO}_2 \) (5 - 10 on RA; 50 on 100%)
  - \( \text{PaO}_2/\text{FiO}_2 \) ratio < 250

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Acute Respiratory Failure

- Definition
  - hypoxemia associated with a normal \( A - a \text{DO}_2 \) indicates that the cause of hypoxemia is alveolar hypoventilation
Acute Respiratory Failure
- Definition
  - P/F ratio
  - Estimation of shunt
  - Normal > 300; respiratory failure < 250; ARDS < 200
  - \( \text{PaO}_2 \) 78, \( \text{FiO}_2 \) 40% so 78/.40 = 195

Types
- Hypoxemia without hypercapnia
- V/Q mismatch
  - Most common cause of hypoxemia
  - COPD, pneumonia, CHF

Right-to-left shunt
- Pulmonary edema
- Atelectasis
- Airway occlusion
Acute Respiratory Failure
- Diffusion Defect
  - interstitial fibrosis
  - sarcoidosis

Low Cardiac Output
- treat underlying cause
- diminished cardiac function
- diminished circulating volume

Hypoxemia with Hypercapnia
- ↓ RR
- ↑ physiologic deadspace
- ↓ tidal volume
- ↓ pulmonary compliance
- ↓ chest wall compliance
- Neuromuscular disorders
- ↑ CO₂ production
Acute Respiratory Failure
- Management
  - $\text{PaO}_2 > 60$ & $\text{SaO}_2 > 90$
  - treat underlying cause
  - PEEP or CPAP
  - antibiotics
  - diuretics

Acute Respiratory Failure
- Management
  - improve ventilation
  - responds to $O_2$
  - mechanical ventilation
  - low - flow $O_2$

Acute Respiratory Distress Syndrome
- diffuse lung injury resulting in noncardiogenic pulmonary edema due to increase in capillary permeability
**ARDS**
- **Definition**
  - noncardiogenic pulmonary edema
  - severe hypoxemia
  - ↓ lung compliance
  - mortality 50% to 60%

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**Pathophysiology**
- Pulmonary or nonpulmonary insult to alveolar – capillary membrane
- Fluid leakage
- V/Q mismatch related to shunting

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**Etiology**
- pneumonia
- infections
- shock
- trauma
CCRN Review - Pulmonary

**Etiology**
- metabolic
- inhaled toxins
- major surgery
- fat or air embolism

**CCRN Review - Pulmonary**

- refractory hypoxemia
- diminished compliance
- diffuse infiltrates on chest x-ray
- normal PAOP
- PaO\(_2\) / FiO\(_2\) ratio < 200

**CCRN Review - Pulmonary**

- Phase I & II
  - subclinical respiratory distress
  - ABGs (respiratory alkalosis)
  - hyperventilating
Phase III
- established respiratory distress
- pulmonary shunt > 10% above baseline
- chest x-ray shows infiltrates
- crackles in lung bases

Phase IV
- severe respiratory failure
- rising pCO₂
- rising physiologic shunt
- white-out on chest x-ray

ARDS
- Diagnostics
  - ABG
  - chest x-ray
  - PAOP < 18 mm Hg
  - diminished lung compliance
Management
- establish patent airway
- restore arterial O₂ level

Mechanical Ventilation
- PC / IRV
- HFJV
- conventional with PEEP

Sedation
- control anxiety & physical activity
- may require addition of neuromuscular blocker
- suggestions:
  - propofol
  - versed
**Fluid Management**
- maintain adequate perfusion
- isotonic solutions
- fluid restriction
- consider diuretics

**Pharmacologic Therapy**
- corticosteroids
- antimicrobials
- non-steroidal anti-inflammatory agents
- anti-pyretic

**O₂ Therapy**
- > 60% FiO₂ < 60 minutes
- complications
  - absorption atelectasis
  - free radicals
  - pulmonary fibrosis
  - nosocomial pneumonia

**Complications**
- absorption atelectasis
- free radicals
- pulmonary fibrosis
- nosocomial pneumonia
CCRN Review - Pulmonary

- **Positioning**
  - "good lung" in dependent position
  - both lungs are equally injured
  - beneficial positions include:
    - prone
    - right lung down

- **Nutritional Support**
  - often overlooked in ARDS
  - ingredients required:
    - stress amino acid
    - trace elements
    - omega 3 / omega 6
    - Oxepa or Impact

- **Complications**
  - infection
  - respiratory complications
  - GI complications
  - cardiac complications
  - renal failure, DIC
Pulmonary Embolus

**Definition**
- obstruction of one or more pulmonary arteries by a thrombus
- thrombi from heart or lower extremities
- infarction can occur

Hypercoagulability
- ATIII deficiency
- dehydration
- malignancy
- fever
- oral contraceptive use
- sepsis
- sickle cell disease
- thrombocytopenia
- pregnancy

Vessel Injury
- trauma
- IV drug use
- aging process
- vasculitis
- varicose veins
- IIR
- atherosclerosis
- diabetes mellitus
**CCRN Review - Pulmonary**

**Venous Stasis**
- immobilization
- advanced age
- pregnancy
- MI
- dysrhythmia
- cardioversion
- recent surgery

**Diagnostic Indicators**
- Small to Medium Embolus
  - tachypnea
  - tachycardia
  - dyspnea
  - anxiety
  - chest pain
  - cough
  - accentuated $P_2$
  - right-sided $S_3$ or $S_4$

**Diagnostic Indicators**
- Large to Massive
  - all symptoms as in small to medium
  - hypotension
  - sudden shock
  - cyanosis
  - mental clouding
  - RV failure
  - PEA
Pulmonary Infarction
- fever
- pleuritic chest pain
- hemoptysis
- pleural friction rub

Diagnostics
- ABGs
  - PaO₂, SaO₂, PaCO₂ decreased
  - respiratory alkalosis
  - metabolic acidosis
  - respiratory acidosis

Diagnostics
- Chest x-ray
  - initially normal
  - @ 24 hours - small infiltrates; elevated hemidiaphragm; decreased vascularity
  - infarction = infiltrates; ? effusion
  - rule out other abnormalities
CCRN Review - Pulmonary

- **Diagnostics**
  - Pulmonary Angiography
    - definitive diagnostic
    - shows cutoff of vessel within 24 - 72 hours from symptom onset

- **Management**
  - oxygen
  - pain & anxiety management
  - anticoagulation
  - surgery: IVC filter; embolectomy

- **Complications**
  - respiratory failure
  - complications of therapy (bleeding, $O_2$ toxicity)
Fat Embolism
- **Definition**
  - small fat globules
  - long bone fracture & pelvic fracture
  - 24 to 48 hours after injury
  - also seen with pancreatitis

- **Clinical Presentation**
  - sudden onset shortness of breath
  - tachycardia
  - hypoxemia
  - petechiae
  - altered LOC

- **Diagnosis - Lab**
  - ABG (hypoxemia)
  - CBC (thrombocytopenia)
  - ECG right sided failure
  - Chest bilateral diffuse infiltrates
**Fat Embolism**
- Management
  - 100% O₂
  - mechanical ventilation
  - IV fluids
  - vasopressors &/or inotropic support

**Thoracic Trauma**
- Definition
  - CV system
  - respiratory system
  - chest wall & rib cage
  - CNS
  - GI

**Thoracic Trauma - Rib fractures**
**CCRN Review - Pulmonary**

- Thoracic Trauma - Flail Chest

**CCRN Review - Pulmonary**

- Thoracic Trauma - Flail Chest

**CCRN Review - Pulmonary**

- Thoracic Trauma - Pneumothorax
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- Thoracic Trauma - Open Pneumothorax

- Thoracic Trauma - Tension Pneumothorax

- Thoracic Trauma - Hemothorax
Thoracic Trauma - Pulmonary Contusion

- thoracic surgery:
  - thoracotomy, lobectomy, pneumonectomy, segmental resection & wedge resection

Thoracic Surgery

- lobectomy:
  - bronchogenic carcinoma
  - giant emphysematous blebs
  - benign tumors
  - metastatic malignant tumors
  - bronchiectasis
  - fungal infections
CCRN Review - Pulmonary

**Thoracic Surgery**  
- Pneumonectomy  
  - carcinoma  
  - lung abscess  
  - bronchiectasis  
  - extensive tuberculosis

**Thoracic Surgery**  
- Segmental Resection  
  - bronchiectasis  
  - patients with preexisting cardiopulmonary compromise

**Thoracic Surgery**  
- Wedge Resection  
  - random lung biopsy  
  - small peripheral nodules
Thoracic Surgery
- Preoperative Management
  - stop smoking
  - teach effective cough
  - humidify air
  - bronchodilators
  - antimicrobials

Thoracic Surgery
- Preoperative Management
  - antimicrobials
  - deep breathing
  - evaluate CV status
  - correct anemia, dehydration, hypoproteinemia
  - anticoagulant therapy

Thoracic Surgery
- Postoperative Management
  - mechanical ventilation
  - assessment
  - monitor ABGs
  - monitor & manage chest tube drainage
Thoracic Surgery
- Complications
  - hypoxia
  - postoperative bleeding
  - pneumonia
  - bronchopleural fistula
  - cardiac dysrhythmias, MI or heart failure

Practice #9a
- pH 7.48
- pCO₂ 30
- HCO₃ 24
- paO₂ 58
- FiO₂ .60
- P/F ratio 97
- PEEP 10

CO 7.0
SvO₂ 75%

Practice #9b
- pH 7.46
- pCO₂ 33
- HCO₃ 24
- paO₂ 88
- FiO₂ .60
- P/F ratio 147
- PEEP 15

CO 3.8
SvO₂ 70%
CCRN Review - Pulmonary

**Ventilators**
- Low Pressure Alarm
- High Pressure Alarm

**Complications**