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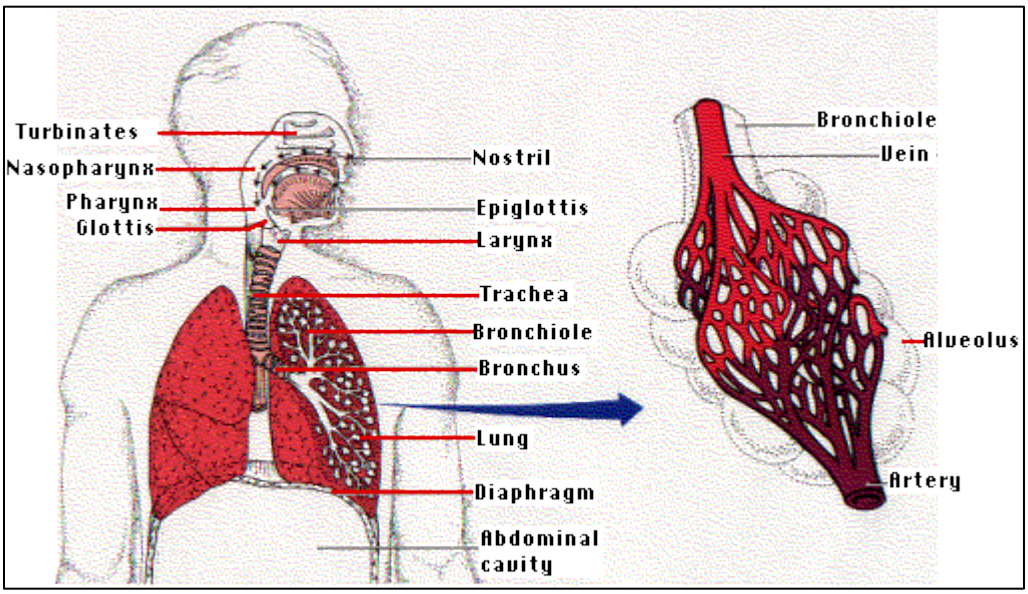
ICON

Respiratory failure*

RESPIRATORY FAILURE

1. Definition:

Respiratory failure is an alteration in the function of the respiratory gas exchange system that causes the arterial oxygen (PaO_2) level to fall below 60 mm Hg (hypoxemia) and/or the arterial carbon dioxide ($PaCO_2$) level to rise above 50 mm Hg (hypercapnia), as determined by arterial blood gas (ABG) analysis. Respiratory failure is classified as acute, chronic, or combined acute and chronic.



Respiratory failure

2. Classification:

a. Acute Respiratory Failure

- Characterized by hypoxemia (PaO_2 less than 50 mm Hg) and/or hypercapnia ($PaCO_2$ greater than 50 mm Hg) and acidosis (pH less than 7.35).
- Occurs rapidly, usually in minutes to hours or days.

b. Chronic Respiratory Failure

- Characterized by hypoxemia (decreased PaO_2) and/or hypercapnia (increased $PaCO_2$) with a normal pH (7.35 to 7.45).
- Occurs over a period of days to months to years, allowing for activation of compensatory mechanisms, including bicarbonate retention with normalization of pH.

c. Combined Acute and Chronic Respiratory Failure

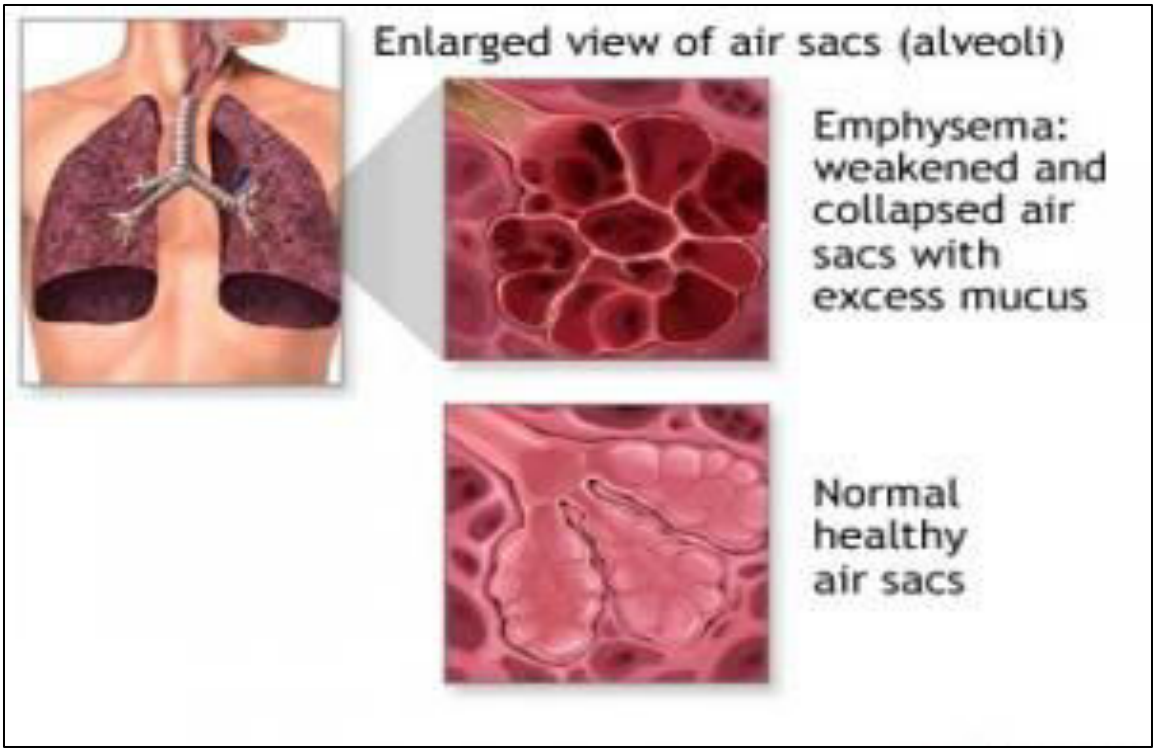
- Characterized by an abrupt increase in the degree of hypoxemia and/or hypercapnia in patients with preexisting chronic respiratory failure.
- May occur after an acute upper respiratory infection, pneumonia, or exacerbation or without obvious cause.
- Extent of deterioration is best assessed by comparing the patient's present ABG levels with previous ABG levels (patient baseline).

3. Etiology;

A. Hypoxemic Respiratory Failure

Characterized by a decrease in PaO_2 and normal or decreased $PaCO_2$.

- Cardiogenic pulmonary edema (left-sided heart failure; mitral stenosis).
- Acute respiratory distress syndrome (ARDS). Underlying causes of ARDS include shock of any etiology; infectious causes, such as gram-negative sepsis, viral pneumonia, bacterial pneumonia; trauma, such as fat emboli, head injury, lung trauma; aspiration of gastric fluid, near drowning; inhaled toxins, such as oxygen in high concentrations, smoke, corrosive chemicals; hematologic conditions, such as massive transfusions, postcardiopulmonary bypass; and metabolic disorders, such as pancreatitis, uremia.



Emphysema causing respiratory failure:

b. Ventilatory Failure with Normal Lungs

Characterized by a decrease in PaO_2, increase in $PaCO_2$, and a decrease in pH.

- Insufficient respiratory center activity (drug intoxication, such as opioid overdose, general anesthesia; vascular disorders, such as cerebral vascular insufficiency, brain tumor; trauma, such as head injury, increased intracranial pressure).
- Insufficient chest wall function (neuromuscular disease, such as Guillain-Barré syndrome, myasthenia gravis, amyotropic lateral sclerosis, poliomyelitis; trauma to the chest wall resulting in multiple fractures; spinal cord trauma; kyphoscoliosis).

c. Ventilatory Failure with Intrinsic Lung Disease

Characterized by a decrease in PaO_2, increase in $PaCO_2$, and decreased pH.

- Chronic obstructive pulmonary disease (COPD) (chronic bronchitis, emphysema).
- Severe asthma.
- Cystic fibrosis.

4. **Pathophysiology:**

A. Hypoxemic Respiratory Failure

Characterized by a decrease in PaO_2 and normal or decreased $PaCO_2$.

- Primary problem is inability to adequately oxygenate the blood, resulting in hypoxemia.
- Hypoxemia occurs because damage to the alveolar-capillary membrane causes leakage of fluid into the interstitial space or into the alveoli and slows or prevents movement of oxygen from the alveoli to the pulmonary capillary blood.
    - Typically, this damage is widespread, resulting in many areas of the lung being poorly ventilated or non-ventilated.
    - Consequences are severe ventilation-perfusion imbalance and shunt.
- Hypocapnia may result from hypoxemia and decreased pulmonary compliance. Fluid within the lungs makes the lung less compliant or stiffer.
    - Change in compliance reflexively stimulates the increased ventilation.
    - Ventilation is also increased as a response to hypoxemia.
    - Ultimately, if treatment is unsuccessful, $PaCO_2$ will increase, and the patient will experience both an increase in $PaCO_2$ and a decrease in PaO_2.

b. Ventilatory Failure with Normal Lungs

Characterized by a decrease in PaO_2, increase in $PaCO_2$, and a decrease in pH.

- Primary problem is insufficient respiratory center stimulation or insufficient chest wall movement, resulting in alveolar hypoventilation.
- Hypercapnia occurs because impaired neuromuscular function or chest wall expansion limits the amount of carbon dioxide removed from the lungs.
    - Primary problem is not the lungs. The patient's minute ventilation (tidal volume [VT] times the number of breaths per minute) is insufficient to allow normal alveolar gas exchange.
- The carbon dioxide (CO_2) not excreted by the lungs combines with water (H_2O) to form carbonic acid (H_2CO_3). This predisposes to acidosis and a fall in pH.
- Hypoxemia occurs as a consequence of inadequate ventilation and hypercapnia. When $PaCO_2$ rises, PaO_2 falls unless increased amounts of oxygen are added to the inspired air.

c. Ventilatory Failure with Intrinsic Lung Disease

Characterized by a decrease in PaO_2, increase in $PaCO_2$, and decreased pH.

- Primary problem is acute exacerbation or chronic progression of previously existing lung disease, resulting in CO_2 retention.
- Hypercapnia occurs because damage to the lung parenchyma and/or airway obstruction limits the amount of CO_2 removed by the lungs.
    - Primary problem is preexisting lung disease—usually chronic bronchitis, emphysema, or severe asthma. This limits CO_2 removal from the lungs.

- The CO_2 not excreted by the lungs combines with H_2O to form H_2CO_3. This predisposes to acidosis and a fall in pH.
- Hypoxemia occurs as a consequence of hypoventilation and hypercapnia. In addition, damage to the lung parenchyma and/or airway obstruction limits the amount of oxygen that enters the pulmonary capillary blood.

5. Clinical Manifestations:

- Hypoxemia—restlessness, agitation, dyspnea, disorientation, confusion, delirium, loss of consciousness
- Hypercapnia—headache, somnolence, dizziness, confusion
- Tachypnea initially; then, when no longer able to compensate, bradypnea
- Accessory muscle use
- Asynchronous respirations

6. Diagnostic Evaluation:

ABG analysis—shows changes in PaO_2, $PaCO_2$, and pH from patient's normal; or PaO_2 less than 50 mm Hg, $PaCO_2$ greater than 50 mm Hg, pH less than 7.35.

- Pulse oximetry—decreasing SaO_2.
- End tidal CO_2 monitoring—elevated.
- Complete blood count, serum electrolytes, chest X-ray, urinalysis, electrocardiogram (ECG), blood and sputum cultures—to determine underlying cause and patient's condition.

7. Management:

- Oxygen therapy to correct the hypoxemia.
- Turn patient regularly and mobilize when clinically stable to improve ventilation and oxygenation.
- Bronchodilators and possibly corticosteroids to reduce bronchospasm and inflammation.
- Diuretics for pulmonary vascular congestion or pulmonary edema.
- Mechanical ventilation as indicated. Non-invasive positive-pressure ventilation using a face mask may be a successful option for short-term support of ventilation.

8. Complications:

- Oxygen toxicity if prolonged high FiO_2 required
- Barotrauma from mechanical ventilation intervention

9. Nursing management:

Nursing Assessment

- Note changes suggesting increased work of breathing (dyspnea, tachypnea, diaphoresis, intercostal muscle retraction, fatigue) or pulmonary edema (fine, coarse crackles or rales, frothy pink sputum).
- Assess breath sounds.
    - Diminished or absent sounds suggest inability to ventilate the lungs sufficiently to prevent atelectasis.
    - Crackles may indicate ineffective airway clearance, fluid in the lungs.
    - Wheezing indicates narrowed airways and bronchospasm.
    - Rhonchi and crackles suggest ineffective secretion clearance.
- Assess level of consciousness (LOC) and ability to tolerate increased work of breathing.
    - Confusion, lethargy, rapid shallow breathing, abdominal paradox (inward movement of abdominal wall during inspiration), and intercostal retractions suggest inability to maintain adequate minute ventilation.
- Assess for signs of hypoxemia and hypercapnia.
- Analyze ABG and compare with previous values.
    - If the patient cannot maintain a minute ventilation sufficient to prevent CO_2 retention, pH will fall.
    - Mechanical ventilation or non-invasive ventilation may be needed if pH falls to 7.30 or below.
- Determine vital capacity (VC) and respiratory rate and compare with values indicating need for mechanical ventilation:
    - VC < 15 mL/kg.
    - Respiratory rate > 30 breaths/minute.
    - Negative inspiratory force < -15 to -25 cm H_2O.
    - Refractory hypoxia
- Determine hemodynamic status (blood pressure [BP], heart rate, pulmonary wedge pressure, cardiac output, SvO_2) and compare with previous values. If patient is on mechanical ventilation with positive end-expiratory pressure (PEEP), venous return may be limited, resulting in decreased cardiac output.

Nursing Diagnoses

- Impaired Gas Exchange related to inadequate respiratory center activity or chest wall movement, airway obstruction, and/or fluid in lungs
- Ineffective Airway Clearance related to increased or tenacious secretions

Nursing Interventions

Improving Gas Exchange

- Administer oxygen to maintain PaO_2 of 60 mm Hg or SaO_2 greater than 90% using devices that provide increased oxygen concentrations (aerosol mask, partial rebreathing mask, nonrebreathing mask).
- Administer antibiotics, cardiac medications, and diuretics as ordered for underlying disorder.
- Monitor fluid balance by intake and output measurement, daily weight, and direct measurement of pulmonary capillary wedge pressure to detect presence of hypovolemia or hypervolemia.
- Provide measures to prevent atelectasis and promote chest expansion and secretion clearance, as ordered (incentive spirometer, nebulization, head of bed elevated 30 degrees, turn frequently, out of bed when clinically stable).
- Monitor adequacy of alveolar ventilation by frequent measurement of SpO_2, ABG levels, respiratory rate, and VC.
- Compare monitored values with criteria indicating need for mechanical ventilation (see section titled "Nursing Assessment"). Report and prepare to assist with noninvasive ventilation or intubation and initiation of mechanical ventilation, if indicated.

STANDARDS OF CARE GUIDELINES

Respiratory Compromise

When caring for patients at risk for respiratory compromise, consider the following assessments and interventions:

- Be aware of the status of the patient when assuming care so comparison can be made with subsequent assessments.
- Perform thorough systematic assessment, including mental status, vital signs, respiratory status, and cardiovascular status.
- Document patient's condition to provide a record for continuity of care.
- Evaluate for signs of hypoxia when anxiety, restlessness, confusion, or aggression of new onset are noted. Do not administer sedatives unless hypoxia has been ruled out by performing respiratory assessment.
- Notify appropriate health care provider of significant findings of hypoxia—cyanosis, circumoral pallor, rapid and shallow respirations, abnormal breath sounds, change in behavior or level of consciousness (LOC). Request assessment and intervention by health care provider as indicated.
- Use extreme caution in administering sedatives and opioids to patients at risk for respiratory compromise.

This information should serve as a general guideline only. Each patient situation presents a unique set of clinical factors and requires nursing judgment to guide care, which may include additional or alternative measures and approaches.

Maintaining Airway Clearance

- Administer medications to increase alveolar ventilation—bronchodilators to reduce bronchospasm, corticosteroids to reduce airway inflammation.
- Teach slow, pursed-lip breathing to reduce airway obstruction and improve oxygen levels. Chest physiotherapy may be considered to remove mucus.
- Suction patient, as needed, to assist with removal of secretions.
- If the patient becomes increasingly lethargic, cannot cough or expectorate secretions, cannot cooperate with therapy, or if pH falls below 7.30, despite use of the above therapy, report and prepare to assist with intubation and initiation of mechanical ventilation.

Patient Education and Health Maintenance

- Instruct patient with preexisting pulmonary disease to seek early intervention for infections to prevent acute respiratory failure, pneumonia, and exacerbations.
- Teach patient about medication regimen.
    - Proper technique for inhaler use
    - Dosage and timing of medications
    - Monitoring for adverse effects of corticosteroids to report to health care provider: weight gain due to fluid retention, polyuria and polydipsia due to hyperglycemia, mood changes, insomnia, bruising, fragile skin; vision changes due to cataracts or glaucoma.

Community and Home Care Considerations

- Encourage patients at risk, especially the elderly and those with preexisting lung disease, to get pneumococcal pneumonia and yearly influenza immunizations.
    - Pneumococcal vaccine is 60% to 70% effective in preventing bacteremic pneumococcal infections in adults and children at least age 2.
    - If a person received their first pneumococcal vaccination before age 65, they should be revaccinated after age 65, if more than 5 years have elapsed since the previous dose.
- Vaccinate children under age 2 and those over age 2 with the following conditions, which increase risk for pneumococcal pneumonia or severe complications, as recommended by the Centers for Disease Control and Prevention (CDC):
    - Chronic cardiovascular disease (including heart failure).

    - Chronic pulmonary disease (eg, emphysema).
    - Diabetes.
    - Alcoholism.
    - Chronic liver disease (including cirrhosis).
    - Cerebrospinal fluid leaks.
    - Asplenia (including functional asplenia such as sickle cell disease).
    - Immunocompromised people (including human immunodeficiency virus [HIV]).
    - People living in environments at higher risk for pneumococcal disease (Alaskan natives, certain American Indian populations, and residents of nursing homes and long-term care facilities).
- Immunize annually for influenza in the following groups, according to the CDC:
    - People age 50 and older
    - Immunocompromised patients
    - Residents of nursing homes or chronic care facilities
    - People with cardiovascular disease
    - People with diabetes mellitus
    - Patients receiving long-term aspirin therapy
    - Pregnant women who will be in the second or third trimester of pregnancy during flu season
    - Health care workers
    - Household contacts of those at risk for influenza.
- Inactivated influenza vaccine should be given to people age 6 months to 5 years and in those age 50 and older.
- Intranasal live attenuated vaccine is an alternative for people ages 5 to 49 without chronic conditions, HIV, or asthma.

Evaluation: Expected Outcomes

- ABG values within patient's normal limits
- Decreased secretions; lungs clear

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