<table>
<thead>
<tr>
<th><strong>Oxygenation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adventitious breath sounds</strong></td>
</tr>
<tr>
<td><strong>Apnea</strong></td>
</tr>
<tr>
<td><strong>Atelectasis</strong></td>
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<tr>
<td><strong>Biot's (cluster) respirations</strong></td>
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<tr>
<td><strong>Bradypnea</strong></td>
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<tr>
<td><strong>Cheyne-Stokes respirations</strong></td>
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<tr>
<td><strong>Cyanosis</strong></td>
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<tr>
<td><strong>Diffusion</strong></td>
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<tr>
<td><strong>Dyspnea</strong></td>
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<tr>
<td><strong>Emphysema</strong></td>
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<tr>
<td><strong>Erythrocytes</strong></td>
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<tr>
<td><strong>Eupnea</strong></td>
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<tr>
<td><strong>Expectorate</strong></td>
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<tr>
<td><strong>Hematocrit</strong></td>
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<tr>
<td><strong>Hemoglobin</strong></td>
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<tr>
<td><strong>Humidifiers</strong></td>
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<tr>
<td><strong>Hypercapnia / Hypercarbia</strong></td>
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<tr>
<td><strong>Hypoxemia</strong></td>
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<tr>
<td><strong>Hypoxia</strong></td>
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<tr>
<td><strong>Hypoxemic hypoxia</strong></td>
</tr>
<tr>
<td><strong>Circulatory hypoxia</strong></td>
</tr>
<tr>
<td>Term</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>pressure of O2 is reduced, but PaO2 remains normal.</td>
</tr>
<tr>
<td>Anemic hypoxia</td>
</tr>
<tr>
<td>Histotoxic hypoxia</td>
</tr>
<tr>
<td>Incentive spirometers</td>
</tr>
<tr>
<td>Intrapleural pressure</td>
</tr>
<tr>
<td>Intrapulmonary pressure</td>
</tr>
<tr>
<td>Kussmaul's breaths</td>
</tr>
<tr>
<td>Lung compliance</td>
</tr>
<tr>
<td>Lung recoil</td>
</tr>
<tr>
<td>Orthopnea</td>
</tr>
<tr>
<td>Oxyhemoglobin</td>
</tr>
<tr>
<td>Partial pressure</td>
</tr>
<tr>
<td>Postural drainage</td>
</tr>
<tr>
<td>Respiratory membrane</td>
</tr>
<tr>
<td>Sputum</td>
</tr>
<tr>
<td>Stridor</td>
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<tr>
<td>Surfactant</td>
</tr>
<tr>
<td>Tachypnea</td>
</tr>
<tr>
<td>Tidal volume</td>
</tr>
<tr>
<td>Torr</td>
</tr>
</tbody>
</table>
vibration

A series of vigorous quiverings produced by hands that are placed flat on a client's chest wall. Used to increase turbulence of exhaled and thus loosen thick secretions.

Inhaled atmospheric air is approximately 21% Oxygen (O2)
**Process of Respiration**

1. Pulmonary ventilation (breathing) → movement of air between the atmosphere & the alveoli of the lungs
2. Gas exchange → diffusion of oxygen & carbon dioxide between alveoli & pulmonary capillaries
3. Transport of oxygen from the lungs to the tissues and of carbon dioxide from the tissues to the lungs

**Respiratory System Structure**

Upper respiratory system = the mouth, nose, pharynx and larynx

Lower respiratory system = trachea and lungs (lungs include bronchi, bronchioles, alveoli, pulmonary capillary network, and pleural membranes.)
The respiratory zone of the lungs include the respiratory bronchioles, which have scattered air sacs in their walls, the alveolar ducts and the alveoli. (pg 1358 in Kozier)

**The Cough Reflex** (pg 1358 Kozier)

- Nerve impulses are sent through the vagus nerve to the medulla
- a large inspiration of approximately 2.5 L occurs
- The epiglottis and glottis (vocal cords) close
- A strong contraction of abdominal and internal intercostal muscles dramatically raises the pressure in the lungs
- The epiglottis and glottis open suddenly
- Air rushes outward with great velocity
- Mucus and any foreign particles are dislodged from the lower respiratory tract and are propelled up and out

**Pulmonary Ventilation**

Adequate ventilation depends on several factors

1. clear airways
   - maintained by many mechanisms, such as ciliary action (the mucous elevator!) and the cough reflex
2. an intact central nervous system and respiratory center
   - the respiratory centers of the medulla and pons in the brain stem control breathing
3. intact thoracic cavity capable of expanding and contracting
   - if it's not intact, it's holy and that won't work!!!!!
4. adequate pulmonary compliance and recoil
   - expansion and recoil of lungs occurs passively in response to changes in pressure within the thoracic cavity & lungs
   - intrapleural pressure should always be slightly negative in relation to atmospheric pressure, this is what causes the lungs to “stick” to the chest cage → like sucking on a condom will make the condom conform to the inside of your mouth. The lungs conform to the inside of the chest cavity because of the negative pressure
   - intrapulmonary pressure always equalizes with atmospheric pressure. Therefore when the diaphragm contracts, the expanding lungs creates a pressure that is lower than the atmosphere, and atmosphere air rushes in to equalize the pressure. Conversely, when the diaphragm relaxes intrapulmonary pressure increases and the air is expelled

**Gas Exchange**

Once the air has entered the alveoli, gas exchange can occur via diffusion. (See the definitions above!) Diffusion occurs because of the differences in partial pressure of O2 and CO2.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Partial Pressure in Blood</th>
<th>Action</th>
<th>Partial Pressure in Alveolar Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>45 mm Hg</td>
<td>Exit ==&gt;</td>
<td>40 mm Hg</td>
</tr>
<tr>
<td>Oxygen</td>
<td>40 mm Hg</td>
<td>&lt;= enter blood</td>
<td>Approx 100 mm Hg</td>
</tr>
</tbody>
</table>

When referring to partial pressure in arterial blood, use the prefix Pa (such as PaO2 or PaCO2). When referring to partial pressure in venous blood, drop the a (such as PO2 or PCO2).
Transport of Oxygen & Carbon Dioxide

As the oxygen diffuses into the blood, 97% of it combines loosely with hemoglobin (forming oxyhemoglobin). The rest dissolves into the plasma.

Factors that affect rate of O2 transport

1. Cardiac output
   - any condition that decreases cardiac output diminishes the amount of O2 delivered to tissues
   - increased heart rate may or may not be able to compensate for the decreased O2 delivery

2. Number of erythrocytes & blood hematocrit
   - excessive increases in blood hematocrit raise the viscosity of the blood, in turn reducing cardiac output
   - excessive reductions in blood hematocrit (e.g. anemia) reduces O2 transport

3. Exercise
   - well-trained athletes can have up to 20 times the normal rate for O2 transport, partly due to increased cardiac output, and partly due to rapid oxygen use by cells

Carbon dioxide is transported in three ways

- 65% is carried inside RBCs as bicarbonate (HCO3-)
- 30% combines with hemoglobin as carboxyhemoglobin (or carbaminohemoglobin)
- 5% is transported in solution as carbonic acid (CO2 + H2O) in the blood plasma

Respiratory Regulation

- Regulation includes both neural and chemical controls
- The “respiratory center” is a number of groups of neurons located in the medulla oblongata and pons of the brain
**Particular to the Medulla Oblongata**

- there is a highly responsive chemosensitive center in the medulla oblongata that responds to
  - blood CO2.
  - hydrogen ion concentration in the blood
- the Medulla Oblongata can influence other respiratory centers to increase the activity of the inspiratory center and the rate and depth of respirations

Special neural sensors in the carotid (right above where they split in the neck) and aortic body (right in the aortic arch) are sensitive to decreases in O2 concentration. Decreases in arterial oxygen concentrations stimulate chemoreceptors, and they stimulate the respiratory center to increase ventilations.

While O2, Hydrogen Ions, and CO2 can all affect respirations, CO2 has the strongest effect.

Individuals with chronic lung ailments (Emphysema, COPD, etc) “burn out” their CO2 chemoreceptors! Ventilation rate depends mostly on blood O2 levels instead.

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**Clinical Alert (pg 1361 Kozier)**

In clients with chronic obstructive lung disease, administering too much supplemental oxygen can actually cause the client to stop breathing.

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**Factors Affecting Respiratory Function**

- **Age**
  - developmental factors (babies lungs don't reach full expansion until 2 weeks of age!)
  - chest wall and airways lose elasticity
  - amount of exchanged air decreases
  - cough reflex and cilia action are decreased
  - mucous membranes become drier and more fragile
  - muscle strength and endurance decrease
  - if osteoporosis is present, adequate lung expansion may be compromised
  - immune system efficiency decreases
  - gastroesophageal reflux increases with age and increases risk of aspiration, causing inflammatory responses
- **Environment**
  - altitude → the higher the altitude, the lower the PO2 in the atmosphere, the lower the PO2 in the alveolus, and less diffusion across the respiratory membrane occurs. To compensate a person at high altitudes has increased respiratory and cardiac rates
  - heat
  - cold
  - air pollution
- **Lifestyle**
  - physical exercise or activity increases the rate and depth of respirations
  - occupations can predispose an individual to certain disease
    - silicosis → seen in people who work with sandstone and pottery
    - anthracosis → seen in coal miners
- organic dust disease → seen in farmers or people who work with moldy hay
- asbestosis → seen in asbestos workers

- Health status
  - diseases of the respiratory system can adversely affect oxygenation of the blood

- Medications
  - medications can decrease rate and depth of respirations. Such as:
    - benzodiazepine sedative-hypnotics and antianxiety drugs (e.g. diazepam [Valium], flurazepam [Dalmane], midazolam [Versed])
    - narcotics (morphine and meperidine hydrochloride [Demerol])

- Stress
  - psychological and physiologic responses can affect oxygenation
    - hyperventilation due to stress
      - arterial PO2 rises and PCO2 falls.
      - The person may be light-headed and feel numbness & tingling of fingers, toes and around the mouth
    - the sympathetic nervous system (Fight or Flight!) is stimulated and epinephrine is released
      - epinephrine causes the bronchioles to dilate, increases blood flow and oxygen delivery to active muscles.
      - if this occurs continually, it can be destructive and increase the risk of cardiovascular disease.

### Lifespan Considerations – Respiratory Development (pg 1363 Kozier)

<table>
<thead>
<tr>
<th>Infants</th>
<th>Respiratory rates are highest &amp; most variable in newborns. The respiratory rate of a neonate is 40-80 breaths per minute.</th>
<th>Infant respiratory rates average about 30 per minute.</th>
<th>Because of rib cage structure, infants rely almost exclusively on diaphragmatic movement for breathing. This is seen as abdominal breathing, as the abdomen raises and falls with each breath.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>The respiratory rate gradually decreases, averaging around 25 breaths per minute in the preschooler and reaching the adult rate of 12 to 18 per minute by late adolescence.</td>
<td>During infancy and childhood, upper respiratory infections are common.</td>
<td>Infants &amp; preschoolers are also at risk for airway obstruction by foreign objects such as coins 7 small toys. Cystic fibrosis (a congenital disorder that affects the lungs, causing them to become congested with thick, tenacious mucus) can affect children. Asthma is typically identified during this stage.</td>
</tr>
<tr>
<td>Elders</td>
<td>Are at increased risk for acute respiratory diseases such as pneumonia.</td>
<td>Are at increased risk for chronic diseases such as emphysema and chronic bronchitis. COPD may affect elders, particularly after years of exposure to cigarette smoke or pollutants.</td>
<td>Pneumonia may not be present with the usual symptoms of a fever, but will present with atypical symptoms, such as confusion, weakness, loss of appetite, and increase in heart rate and respirations.</td>
</tr>
</tbody>
</table>
Nursing interventions should be directed toward achieving optimal respiratory effort and gas exchange:

- always encourage wellness and prevention of disease by reinforcing the need for good nutrition, exercise and immunizations
- Increase fluid intake, if not contraindicated by other problems
- Proper positioning and frequent changing of positions allow for better lung expansion and better air & fluid movement
- Teach the client to use breathing techniques for better air exchange
- Pace activities to conserve energy
- Encourage client to eat more frequent, smaller meals to decrease gastric distention, which can cause pressure on the diaphragm.
- Teach the client to avoid extreme hot or cold temperatures that will further tax the respiratory system.
- Teach actions and side effects of drugs, inhalers, and treatments.

Alterations in Respiratory Function
Respiratory function can be altered by conditions that affect:
- movement of air into or out of lungs
- diffusion of oxygen and/or carbon dioxide between the alveoli & pulmonary capillaries
- the transport of oxygen and/or carbon dioxide via the blood

Hypoxia → a condition of insufficient oxygen anywhere in the body
          → it can be related to any parts of respiration [[ventilation, diffusion of gases or transportation]]
          → it can be caused by any condition that alters one or more parts of the respiratory process

Clinical Manifestations of Hypoxia (pg 1363 Kozier)

- Rapid pulse
- rapid, shallow respirations & dyspnea
- increased restlessness or light-headedness
- flaring of the nares
- substernal or intercostal retractions
- cyanosis

→ can be caused by hypoventilation [[may occur because of diseases of the respiratory muscles, drugs or anesthesia, and can also lead to hypercarbia/hypercapnia]]

Hypoxemia → specifically refers to hypoxia of the blood
          → characterized by low PaO2 levels or by low hemoglobin saturation
          → cyanosis may present during low blood O2 levels. Blood must contain about 5g or more unoxyenated hemoglobin per 100 mL of blood and the surface blood capillaries must be dilated to get the bluish discoloration. Factors that interfere with those conditions eliminate cyanosis as a sign of hypoxemia even if the client is hypoxic.
• Cerebral functioning can be permanently damaged if hypoxia lasts more than 3 to 5 minutes
  ◦ an individual who is acutely hypoxic usually appears anxious, tired and drawn
    ■ they usually sit up and lean forward slightly to aid in thoracic expansion
  • an individual who is chronically hypoxic often appears fatigued and lethargic
    ■ fingers and toes may be clubbed as a result of long-term lack of oxygen (the base of the
    nail becomes swollen and the ends of the fingers & toes increase in size)

**Altered Breathing Patterns**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apnea</strong></td>
<td>Cessation of respirations</td>
</tr>
<tr>
<td><strong>Biot's (cluster) respirations</strong></td>
<td>Shallow breaths interrupted by apnea; may be seen in clients with</td>
</tr>
<tr>
<td></td>
<td>central nervous system disorders</td>
</tr>
<tr>
<td><strong>Bradypnea</strong></td>
<td>Low respiration rate (&lt;12 breaths per minute)</td>
</tr>
<tr>
<td><strong>Cheyne-Stokes respirations</strong></td>
<td>Marked rhythmic waxing and waning of respiration from very deep</td>
</tr>
<tr>
<td></td>
<td>to very shallow breathing and temporary apnea; common causes</td>
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<tr>
<td></td>
<td>include congestive heart failure, increased intracranial pressure, and</td>
</tr>
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<td></td>
<td>overdose of certain drugs</td>
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<tr>
<td><strong>Dyspnea</strong></td>
<td>Difficult or uncomfortable breathing</td>
</tr>
<tr>
<td><strong>Eupnea</strong></td>
<td>Normal respiration</td>
</tr>
<tr>
<td><strong>Kussmaul's breathing</strong></td>
<td>A particular type of hyperventilation; deep rapid breathing caused by</td>
</tr>
<tr>
<td></td>
<td>metabolic acidosis. The body attempts to give off excess body acids</td>
</tr>
<tr>
<td></td>
<td>by blowing off carbon dioxide</td>
</tr>
<tr>
<td><strong>Orthopnea</strong></td>
<td>Inability to breathe except in an upright or standing position</td>
</tr>
<tr>
<td><strong>Tachypnea</strong></td>
<td>Rapid, shallow respirations</td>
</tr>
</tbody>
</table>

**Obstructed Airway**

Complete or partially obstructed airways can occur in either the upper or lower respiratory system:

**Upper respiratory system**  
→ in the nose, pharynx or larynx  
→ can occur because of a foreign object  
→ can be the tongue during unconsciousness  
→ can be secretions collecting in the passageways. These will sound gurgly or bubbly as the air attempts to pass through the secretions  
→ partial obstruction of upper airway passages is indicated by a low-pitched snoring sound during inhalation  
→ complete obstruction is indicated by extreme inspiratory effort with no chest movement, an inability to cough or speak (choking!)

**Lower respiratory system**  
→ obstruction involving partial or complete occlusion is most often due to increased accumulation of mucus or inflammatory exudate  
→ stridor may be heard during inspiration  
→ individual may have altered arterial blood gas levels, restlessness, dyspnea and adventitious breath sounds
Nursing Management

Nursing Assessment needs to include history, physical examination & review of relevant diagnostic data.

History be sure to obtain:
- history relevant to oxygenation
- current & past respiratory problems
- lifestyle
- presence of cough
- sputum
- pain
- medications for breathing
- presence of risk factors for impaired oxygenation (such as smoking)

Physical Examination
- use all four physical examination techniques
  - inspection
    - first observe the rate, depth, rhythm & quality of respirations, noting the position the client assumes for breathing
    - also observe shape of thorax → it can be indicative of chronic conditions
  - palpation
    - palpate the thorax for bulges, tenderness or abnormal movements
    - can be used to detect vocal fremitus
  - percussion
    - thorax can be percussed for diaphragmatic excursion (the movement of diaphragm during maximal inspiration and expiration)
  - auscultation
    - listen for adventitious breath sounds

Diagnostic Studies
- the primary care provider or attending physician may order labs or diagnostic tests to assess respiratory status, function & oxygenation
- specialty nurses can draw blood from the femoral, radial or brachial arteries. If this is done, pressure needs to be applied to the site for about 5 minutes after removing the needle to prevent hemorrhage.
- Frequently a pulse oximeter is sufficient to obtain a measurement of oxygenation of the arterial blood.

Pulmonary functions tests can measure lung volume & capacity. They are typically rendered by a Respiratory Therapist. Patient must be aware, cooperative and have had-eye coordination for the test to be effective.
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal Volume (VT)</td>
<td>Volume inhaled &amp; exhaled during normal quiet breathing</td>
</tr>
<tr>
<td>Inspiratory reserve volume (IRV)</td>
<td>Maximum amount of air that can be inhaled over and above a normal breath</td>
</tr>
<tr>
<td>Expiratory reserve volume (ERV)</td>
<td>Maximum amount of air that can be exhaled following a normal exhalation</td>
</tr>
<tr>
<td>Residual volume (RV)</td>
<td>The amount of air remaining in the lungs after maximal exhalation</td>
</tr>
<tr>
<td>Total lung capacity (TLC)</td>
<td>The total volume of the lungs at maximum inflation; calculated by adding the VT, IRV, ERV, RV</td>
</tr>
<tr>
<td>Vital capacity (VC)</td>
<td>Total amount of air that can be exhaled after a maximal inspiration; calculated by adding the VT, IRV, ERV</td>
</tr>
<tr>
<td>Inspiratory capacity</td>
<td>Total amount of air that can be inhaled following normal quiet exhalation; calculated by adding the VT and IRV</td>
</tr>
<tr>
<td>Functional residual capacity (FRC)</td>
<td>The volume left in the lungs after normal exhalation; calculated by adding the ERV and RV</td>
</tr>
<tr>
<td>Minute volume (MV)</td>
<td>The total volume or amount of air breathed in 1 minute</td>
</tr>
</tbody>
</table>
Diagnosing

- **Ineffective Airway Clearance** – the inability to clear secretions or obstructions from the respiratory tract
- **Ineffective Breathing Pattern** – Inspiration and/or expiration does not provide adequate ventilation
- **Impaired Gas Exchange** – Excess or deficit in oxygenation and/or carbon dioxide elimination at the alveolar-capillary membrane
- **Activity Intolerance** – Insufficient physiological or psychological energy to endure or complete required or desired daily activities

Planning

The overall outcomes/goals for a client with oxygenation problems are:

I. Maintain a patent airway
II. Improve comfort & ease of breathing
III. Maintain or improve pulmonary ventilation & oxygenation
IV. Improve ability to participate in physical activities
V. Prevent risks associated with oxygenation problems, such as:
   ➔ skin & tissue breakdown
   ➔ syncope
   ➔ acid-base imbalances
   ➔ feelings of hopelessness
   ➔ social isolation

Intervention & Home Care

➢ Assess the client & family's knowledge & abilities for self-care
➢ Consider financial resources
➢ Evaluate the need for referrals
➢ Evaluate the need for home health services

Client Teaching – Promoting Healthy Breathing (Kozier pg 1367)

- Sit straight & stand erect to permit full lung expansion
- Exercise regularly
- Breathe through the nose
- Breathe in to expand the chest fully
- Do not smoke cigarettes, cigars or pipes
- Eliminate or reduce the use of household pesticides & irritating chemical substances
- Use building materials that do not emit vapors
- Make sure furnaces, ovens & wood stoves are correctly ventilated
- Support a pollution-free environment

The semi-fowler's or high fowler's position allows maximum chest expansion. Dyspneic clients often will sit in bed or in a chair and lean over the over bed table. The patient can use the table to help exhalation & it also ensures the abdominal organs are not pressing on the diaphragm.
Breathing Techniques

**Abdominal (diaphragmatic) breathing**
- permits deep full breaths with little effort

**Pursed lip breathing**
- helps client develop control over breathing
- pursed lips create a resistance to air flowing out of the lungs
- it helps to maintain positive pressure

### Client Teaching – Abdominal (Diaphragmatic) & Pursed-Lip Breathing (Kozier pg 1368)

- Assume a comfortable semi-sitting position
- Flex knees to relax muscles of the abdomen
- Place one or both hands on your abdomen, just below the ribs
- Breathe in deeply through the nose, keeping the mouth closed
- Concentrate on feeling abdomen rise (expand) as far as possible; stay relaxed & avoid arching your back.
- Purse the lips as if about to whistle
- Breathe out slowly and gently, making a slow “whooshing” sound without puffing out the cheeks
- Concentrate on feeling the abdomen fall or sink. Tighten (contract) the abdominal muscles while breathing out to enhance effective exhalation. Count to 7 during exhalation.
- Use this exercise whenever feeling short of breath. Increase gradually to 5 to 10 minutes four times per day.
- Practice will help make this an unconscious exercise.

### Client Teaching – Controlled & Huff Coughing (Kozier pg 1369)

- After using a bronchodilator treatment (if prescribed), inhale deeply & hold breath for a few seconds
- Cough twice. The first cough loosens the mucus; the second expels secretions
- For huff coughing, lean forward and exhale sharply with a “huff” sound. This technique helps keep airways open while moving secretions up and out of lungs
- Inhale by taking rapid short breaths in succession (“sniffing) to prevent mucus from moving back to into smaller airways
- Rest
- Try to avoid prolonged episodes of coughing because these may cause fatigue and hypoxia
**Medications**

Different medications that can help individuals with O2 problems

- Bronchodilators
- Anti-inflammatory drugs
- Leukotriene modifiers
- Expectorants
- Cough suppressants

**Sympathomimetics – Albuterol (Proventil, Ventolin) (pg 1369 Kozier)**

The beta-2 adrenergic agonists are called sympathomimetic drugs because they “mimic” the action of sympathetic stimulation to the beta-2 receptors in the smooth muscle of the lung. At the therapeutic levels these drugs promote bronchodilation & so relieve bronchospasm.

Sympathomimetic agents are useful in the treatment of bronchospams in reversible obstructive airway diseases such as asthma and bronchitis. They are also useful in preventing exercise-induced bronchospam.

<table>
<thead>
<tr>
<th>Nursing Responsibilities</th>
<th>Client &amp; Family Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Most inhaled sympathomimetics have very rapid onset &amp; short duration of action, so they are useful for relief of acute attacks, but not for prophylaxis&lt;br&gt;- Monitor the client's respiraotyr status while administer sympathomimetics. This includes respiratory rat, lung sounds, oxygen saturation &amp; subjective symptoms&lt;br&gt;- These medications should be used with caution in clients with conditions such as cardiac disease, vascular disease, hypertension, hyperthyroidism, and pregnancy.&lt;br&gt;- Monitor the client for common side effects including increased heart rate &amp; tremors&lt;br&gt;- Monitor for other side effects that occur with excessive dosing which may include central nervous system stimulation, gastrointestinal upset, hypertension &amp; sweating.</td>
<td>- Caution the client to use the least amount of medication needed to get relief for the shortest time period necessary. This will help prevent adverse effects.&lt;br&gt;- Counsel the client to report immediately any chest pain and/or changes in heart rate or rhythm.&lt;br&gt;- Teach the client and/or family how to use the delivery system. This will most often be a meter-dose inhaler (MDI) or dry powder inhaler (DPI) or nebulizer.&lt;br&gt;- Teach the client to record the frequency and intensity of symptoms.</td>
</tr>
</tbody>
</table>
**Glucocorticoids** – Inhaled: Beclomethason / Orally: Prednisone (pg 1370 Kozier)

Glucocorticoids are administered to clients with oxygenation problems to suppress inflammation. They can be administered either by inhalation, orally, or intravenously. The route of administration depends on the severity of the client's disorder and the individual's response. Glucocorticoids (steroids) are well absorbed from the respiratory tract so giving them by inhalation is often effective. Steroids suppress the inflammatory response in the airways by decreasing synthesis and release inflammatory mediators, decreasing activity of inflammatory cells, and decreasing edema.

<table>
<thead>
<tr>
<th>Nursing Responsibilities</th>
<th>Client &amp; Family Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Glucocorticoids are intended for preventive therapy. They will not be useful in an acute attack.</td>
<td>• Caution the client to use the least amount needed to get relief for the shortest time period necessary. This will help prevent adverse effects. Alternate day therapy may be recommended to decrease adrenal suppression.</td>
</tr>
<tr>
<td>• If the client is also taking a sympathomimetic medication, delivery of the glucocorticoid to the respiratory tract may be enhanced by administering the sympathomimetic first. Wait 3 to 5 minutes before administering the glucocorticoid.</td>
<td>• Make sure the client understands that these drugs are NOT for acute attacks. They are intended for preventive therapy.</td>
</tr>
<tr>
<td>• It is important to monitor the client's respiratory status while administering glucocorticoids. This includes respiratory rate, lung sounds, oxygen saturation, and subjective symptoms.</td>
<td>• Teach the client and/or family how to use the delivery system. This will most often be a metered-dose inhaler (MDI) or dry powder inhaler (DPI) or nebulizer.</td>
</tr>
<tr>
<td>• These medications should be used with caution or not at all in clients with conditions such as allergy, pregnancy, lactation and systemic infections.</td>
<td>• Counsel the client to report adverse effects such as sore throat, hoarseness, and pharyngeal &amp; laryngeal fungal infections</td>
</tr>
<tr>
<td>• Monitor the client for side effects of the medications. Most commonly this could be an increase in heart rate &amp; tremors.</td>
<td>• Teach the client to record the frequency and intensity of symptoms.</td>
</tr>
<tr>
<td>• The client should be monitored for other side effects which will usually only occur with excessive dosing &amp; may include central nervous system stimulation, gastrointestinal upset, hypertension, &amp; sweating.</td>
<td></td>
</tr>
</tbody>
</table>

**Client Teaching – Using Cough Medications**

- Do not take cough medications in excessive amounts because of adverse side effects.
- If you have diabetes mellitus, avoid cough syrups that contain sugar or alcohol; these can disturb metabolism.
- When a cough medicine does not act as expected, consult a health care professional.
- Be aware of side effects (e.g. drowsiness) that can make operation of machinery dangerous.
Incentive Spirometry

- also known as Sustained Maximal Inspiration Devices (SMIs)
- improves pulmonary ventilation
- counteracts the effects of anesthesia or hypoventilation
- loosens respiratory secretions
- facilitates respiratory gaseous exchange
- expands collapse alveoli

Client Teaching – Using an Incentive Spirometer

- Hold or place the spirometer in an upright position
- Exhale normally
- Seal the lips tightly around the mouthpiece
- Take in a slow, deep breath to elevate the balls or cylinder, and then hold the breath for 2 seconds initially, increasing to 6 seconds, to keep the balls or cylinder elevated if possible
- if you have difficulty breathing only through the mouth, a nose clip can be used
- remove the mouthpiece and exhale normally
- Cough after the incentive effort. Deep ventilation may loosen secretions, and coughing can facilitate their removal.
- Relax and take several normal breaths before using the spirometer again.
- Repeat the procedure several times & then four or five times hourly. Practice increases inspiratory volume, maintains alveolar ventilation, and prevents atelectasis
- clean the mouthpiece with water and shake it dry

Percussion, Vibration & Postural Drainage

Percussion → aka clapping; forceful striking of the skin with cupped hands. Mechanical percussion cups & vibrators are also available. Percussion over congested areas can dislodge tenacious secretions.

To percuss a client's chest:
- Cover the area with a towel or gown (ensure for privacy)
- Ask the client to breathe slowly & deeply (relax)
- Alternately flex and extend the wrists rapidly to slap the chest
- Percuss each affected lung segment for 1 to 2 minutes.

Vibration → a series of vigorous quiverings produced by hands that are placed flat against the client's chest wall. Often done alternately with percussion to increase turbulence of the exhaled air & further loosen thick secretions.

To vibrate a client's chest:
- Place hands, palms down, on the chest area, one hand over the other with fingers together & extended.
- Ask client to inhale deeply and exhale slowly through the nose or pursed lips during exhalation, tense all the hand and arm muscles & using mostly the heel of the hand, vibrate the hands, moving them downward. Stop vibrating during inhalation.
- Vibrate during five exhalations over each affected lung segment
- After each vibration, encourage the client to cough and expectorate secretions into a sputum container.
• Oscillation Vests are now available, and have proven to be more effective than manual vibration. It is gentler & acts on all lobes of the lung simultaneously. The vest is applied to the pt and uses air pulses to compress the chest wall 8-18 times/sec.

• Postural Drainage → drainage by gravity of secretions from various lung segments. See pg 26 for positions

**Oxygen Therapy**

- O2 therapy is prescribed by the primary care provider
- PCP specifies the concentration, method of delivery and depending on the method, liter flow per minute
- **Concentration** is more important than the liter flow per minute.
- **Emergency measures** – a nurse may administer oxygen without a primary care provider's order
- **Low flow systems are essential for clients with COPD**
- in hospitals & long-care facility, O2 is usually piped through the walls & is readily available
- tanks & cylinders under pressure can also be used
- small cylinders are practical for home use
- O2 administered from a cylinder or wall outlet system is dry. Humidifiers can add water vapor to inspired air to prevent dehydrating respiratory membranes.
- Very low liter flows (e.g. 1 – 2 L per minute by nasal cannula) do not require humidification. Enough atmospheric air is inspired at the same time, and atmospheric air has enough water vapor to prevent mucosal drying.

**To use an oxygen wall outlet:**

1. Attach the flow meter to the wall outlet, exerting firm pressure. The flow meter should be in the off position.
2. Fill the humidifier bottle with distilled or tap water in accordance with agency protocol. Some humidifier bottles come prefilled by the manufacturer.
3. Attach the humidifier bottle to the base of the flow meter
4. Attach the prescribed oxygen tubing & delivery device to the humidifier
5. Regulate the flow meter to the prescribed level. The line for the prescribed flow rate should be in the middle of the ball of the flow meter.

**Oxygen Delivery Systems**

- The system utilized depends on the client's oxygen needs, comfort & developmental considerations.
- Many systems O2 delivered is mixed with room air before being inspired. Precise regulation of the percentage of inspired O2 is impossible with these systems, so the amount of O2 delivered is determined by regulating its flow rate (e.g. 2 to 6 L per minute).
**Cannula**
- Easy to apply
- Does not interfere with ability to eat or talk
- permits freedom of movement
- delivers relatively low concentrations of oxygen (24% to 45% at flow rates of 2 to 6 L per minute
- above 6 L per minute, the client tends to swallow air instead
- limited by its inability to deliver higher concentrations of oxygen
- can be drying & irritating to mucous membranes

**Face Mask**
- face masks that cover the client's nose & mouth may be used for oxygen inhalation
- exhalation ports on the sides of the mask allow exhaled CO2 to escape
- masks can be limited by size available
- usually smaller sizes are available for children
- some clients may complain of feeling hot or smothered
- the facial skin must be kept dry
- there are different types of face masks. In order from top to bottom:
  - **Simple Mask**
    - delivers oxygen concentrations from 40%-60% at liter flows of 5 to 8 L per minute.
  - **Partial Rebreather Mask**
    - delivers oxygen concentrations of 60%-90% at liter flows of 6 to 10 L per minute.
    - the bag allows the client to rebreathe the first third of exhaled air
    - the bag must not totally deflate during inspiration to avoid carbon dioxide buildup
    - if the bag deflates during inspiration, increasing liter flow can prevent deflation.
  - **Nonrebreather Mask (looks almost identical to a partial rebreather mask)**
    - delivers the highest O2 concentration possible – 95% to 100% - by means other than intubation or mechanical ventilation, at liter flows of 10 to 15 L per minute.
    - One-way valves on the mask & between the reservoir bag & mask prevent room air and the client's exhaled breather from entering the bag. This allows the client to only inspire O2 provided.
    - the bag must not totally deflate during inspiration to avoid carbon dioxide buildup
    - if the bag deflates during inspiration, increasing liter flow can prevent deflation.
- **Venturi Mask**
  - delivers O2 concentration varying from 24% to 40% or 50% at liter flows of 4 to 10 L per minute
  - has wide-bore tubing & color-coded jet adapters that correspond to precise oxygen concentration and liter flow.

- **Face Tent**
  - can replace O2 masks when they are poorly tolerated by clients
  - they provide varying concentrations of O2 – 30% to 50% concentration of O2 at 4 to 8 L per minute
  - frequently inspect the client's facial skin for dampness or chafing – dry & treat as needed
  - like the face mask, the skin must be kept dry

### Oxygen Administration Devices (Brunner 637)

<table>
<thead>
<tr>
<th>Device</th>
<th>Suggested Flow Rate (L/min)</th>
<th>O2 Percentage Setting</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low-flow Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannula</td>
<td>1-2</td>
<td>23-30</td>
<td>Lightweight, comfortable, inexpensive, continuous use with meals &amp; activity</td>
<td>Nasal mucosal drying, variable FiO2</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td>30-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oropharyngeal catheter</td>
<td>1-6</td>
<td>23-42</td>
<td>Inexpensive, does not require a tracheostomy</td>
<td>Nasal mucosa irritation; catheter should be changed frequently to alternate nostril</td>
</tr>
<tr>
<td><em>this is rarely used, but can be prescribed for short-term therapy</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mask, simple</td>
<td>6-8</td>
<td>40-60</td>
<td>Simple to use, inexpensive</td>
<td>Poor fitting, variable FiO2, must remove to eat</td>
</tr>
<tr>
<td>Oxygen Delivery System</td>
<td>Flow Rate</td>
<td>Oxygen Concentration</td>
<td>Description</td>
<td>Additional Information</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Partial rebreather</td>
<td>8-11</td>
<td>50-75</td>
<td>Moderate O2 concentration</td>
<td>Warm, poorly fitting, must remove to eat</td>
</tr>
<tr>
<td>Non-rebreather</td>
<td>12</td>
<td>80-100</td>
<td>High O2 concentration</td>
<td>Poorly fitting, must remove to eat</td>
</tr>
<tr>
<td><strong>High-Flow Systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transtracheal catheter</td>
<td>1/4-4</td>
<td>60-100</td>
<td>More comfortable, concealed by clothing, less O2 liters per minute needed than nasal cannula</td>
<td>Requires frequent and regular cleaning, requires surgical intervention</td>
</tr>
<tr>
<td>Mask, Venturi</td>
<td>4-6</td>
<td>24, 26, 28</td>
<td>Provides low levels of supplemental O2, precise FiO2, additional humidity available</td>
<td>Must remove to eat</td>
</tr>
<tr>
<td></td>
<td>6-8</td>
<td>30, 35, 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mask, aerosol</td>
<td>8-10</td>
<td>30-100</td>
<td>Good humidity, accurate FiO2</td>
<td>Uncomfortable for some</td>
</tr>
<tr>
<td>Tracheostomy collar</td>
<td>8-10</td>
<td>30-100</td>
<td>Good humidity, comfortable, fairly accurate FiO2</td>
<td>Uncomfortable for some</td>
</tr>
<tr>
<td>T-piece</td>
<td>8-10</td>
<td>30-100</td>
<td>Same as tracheostomy collar</td>
<td>Heavy with tubing</td>
</tr>
<tr>
<td>Face Tent</td>
<td>8-10</td>
<td>30-100</td>
<td>Good humidity, fairly accurate FiO2</td>
<td>Bulky &amp; cumbersome</td>
</tr>
<tr>
<td><strong>O2 Conserving Devices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Dose (or demand)</td>
<td>10-40 mL/breath</td>
<td></td>
<td>Deliver O2 only on inspiration, conserve 50%-75% of O2 used</td>
<td>Must carefully evaluate function individually</td>
</tr>
</tbody>
</table>

- T-pieces & tracheostomy collars are used when weaning patients from mechanical ventilation.
- Demand Oxygen Delivery System (DODS) is a newer device that only provides additional O2 during inspiration. Studies are showing that DODS models conserve O2 and maintain O2 saturation better than continuous-flow O2 systems when respiratory rates increase.
- Hyperbaric O2 therapy is administration of O2 greater than 1 atm.
  - Used to treat:
    - Air embolism
    - Carbon monoxide poisoning
    - Gangrene
    - Tissue necrosis
    - Hemorrhage

- Hyperbaric O2 therapy is administration of O2 greater than 1 atm.
- Controversially used to treat
  - multiple sclerosis
  - diabetic foot ulcers
  - closed head trauma
  - acute myocardial infarction
  - unstable angina
  - slow-to heal bone fractures

- Side effects include
  - ear trauma
  - CNS disorders
  - O2 toxicity
  - claustrophobia
### Administering Oxygen By Cannula, Face Mask, or Face Tent

Before administering oxygen, check (a) the order for oxygen, including the administering device and the liter flow rate (L/min) or the percentage of oxygen; (b) the levels of oxygen (PaO2) and carbon dioxide (PaCO2) in the client's arterial blood (PaO2 is normally 80 to 100 mm Hg; PaCO2 is normally 35 to 45 mm Hg); and © whether the client has COPD. NOTE: If the client has not had arterial blood gases ordered, oxygen saturation should be checked using a noninvasive oximeter.

#### Purposes

**Cannula**
- To deliver a relatively low concentration of O2 when only minimal O2 support is required
- To allow uninterrupted delivery of O2 while the client ingests food or fluids

**Face Mask**
- To provide moderate O2 support and a higher concentration of O2 and/or humidity than is provided by cannula

**Face Tent**
- To provide high humidity
- To provide O2 when a mask is poorly tolerated
- To provide a high flow of O2 when attached to a Venturi system

#### Assessment

**Cannula**
- Skin & mucous membrane color: note whether cyanosis is present
- Breathing patterns: note depth of respirations & presence of tachypnea, bradypnea or orthopnea
- Identify COPD if applicable
- Chest movements: note whether there are any intercostal, substernal, suprasternal, supraclavicular or tracheal retractions during inspiration or expiration
- Chest wall configuration (e.g. kyphosis)
- Lung sounds audible by auscultating the chest & by ear
- Presence of clinical signs of hypoxemia
- Presence of clinical signs of hypercarbia
- Presence of clinical signs of oxygen toxicity [[substernal discomfort, paresthesias, dyspnea, restlessness, fatigue, malaise, progressive respiratory difficulty, refractory hypoxemia, alveolar atelectasis, and alveolar infiltrates evident on chest x-ray]]
- Vital signs
- Review results of diagnostic studies, tests, labs

**Face Mask**
- Presence of clinical signs of hypoxemia
- Presence of clinical signs of hypercarbia
- Presence of clinical signs of oxygen toxicity [[substernal discomfort, paresthesias, dyspnea, restlessness, fatigue, malaise, progressive respiratory difficulty, refractory hypoxemia, alveolar atelectasis, and alveolar infiltrates evident on chest x-ray]]
- Vital signs
- Review results of diagnostic studies, tests, labs

### Planning

Consult with a respiratory therapist as needed in the beginning and during ongoing care of clients receiving ordered oxygen therapy. In many agencies, the therapist establishes the initial equipment and client teaching.

### Equipment

<table>
<thead>
<tr>
<th>Cannula</th>
<th>Face Mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2 supply w/ flow meter &amp; adapter</td>
<td>O2 supply w/ flow meter &amp; adapter</td>
</tr>
<tr>
<td>Humidifier w/ distilled water or tap water according to agency protocol</td>
<td>Humidifier w/ distilled water or tap water according to agency protocol</td>
</tr>
<tr>
<td>Nasal cannula &amp; tubing</td>
<td></td>
</tr>
<tr>
<td>Tape</td>
<td>Tape</td>
</tr>
<tr>
<td>Padding for elastic band</td>
<td></td>
</tr>
</tbody>
</table>

### Delegation

Initiating the administration of oxygen is considered similar to administering a medication.
and is not delegated to unlicensed assistive personnel (UAP). However, reapplying the oxygen delivery device may be performed by the UAP, and many aspect of the client's response to O2 therapy are observed during usual care and may be recorded by persons other than the nurse. Abnormal findings must be validated and interpreted by the nurse. The nurse is also responsible for ensuring that the correct delivery method is being used.

| Face Tent | • O2 supply w/ flow meter & adapter  
• Humidifier w/ distilled water or tap water according to agency protocol  
• Face tent of the appropriate size |
|---|---|

**Implementation**

**Preparation**

1. Determine the need for O2 therapy & verify the order for the therapy  
   • Perform a respiratory assessment to develop baseline data if not already available or performed  
2. Prepare the client and support people  
   • Assist the client to a semi-fowler's position if possible, to permit easier chest expansion

**Performance**

1. Prior to performing the procedure, introduce self and verify the client's identity using agency protocol. Explain to the client what you are going to do, why it is necessary, and how he or she can cooperate. Discuss how the effects of the O2 therapy will be used in planning further care or treatments  
2. Perform hand hygiene and observe appropriate infection control procedures  
3. Provide for client privacy, if appropriate  
4. Set up the O2 equipment and the humidifier  
   • attach the flow meter to the wall outlet or tank. The flow meter should be in the off position.  
   • If needed, fill the humidifier. This can be done before coming to the bedside.  
   • Attach the humidifier to the base of the flow meter.  
   • Attach the prescribed oxygen tubing and delivery device to the humidifier  
5. Turn on the O2 at the prescribed rate and ensure proper functioning  
   • check that the O2 is flowing freely through the tubing. There should be no kinks in the tubing, and the connections should be airtight. There should be bubbles in the humidifier as the O2 flows through. You should feel O2 at the outlets of the cannula, mask or tent.  
   • Set the O2 at the flow rate ordered  
6. Apply the appropriate oxygen delivery service

**Cannula**

• Put the cannula over the client's face with the outlet prongs fitting into the nares and the elastic band around the head. Some models have a strap to adjust under the chin  
• If the cannula will not stay in place, tape it at the sides of the face  
• Pad the tubing and band over the years and cheekbones as needed

**Face**

• Guide the mask toward the client's face, and apply it from the nose downward.
| Mask      | • Fit the mask to the contours of the client's face  
|          | • Secure the elastic band around the client's head so that the mask is comfortable but snug  
|          | • Pad the band behind the ears and over bony prominences  
| Face Tent | • Place the tent over the client's face, and secure the ties around the head  

7. Assess the client regularly  
   ◦ Assess the client's vital signs, level of anxiety, color, and ease of respirations, and provide support while the client adjusts to the device.  
   ◦ Assess the client in 15 to 30 minutes, depending on the client's condition, then regularly after that.  
   ◦ Assess the client regularly for clinical signs of hypoxia, tachycardia, confusion, dyspnea, restlessness, & cyanosis. Review O2 saturation or arterial blood gas results if they are available.

| Nasal Cannula | • Assess the client's nares for encrustations and irritation. Apply a water soluble lubricant as required to soothe the mucous membranes.  
|              | • Assess the top of the client's ears for any signs of irritation from the cannula strap. If present, padding with a gauze pad may help relieve the discomfort  
| Face Mask or Tent | • Inspect the facial skin frequently for dampness or chaining, and dry and treat it as needed.  

8. Inspect the equipment on a regular basis.  
   ◦ Check the liter flow and the level of water in the humidifier in 30 minutes and whenever provider care to the client.  
   ◦ Be sure that water is not collecting in dependent loops of the tubing.  
   ◦ Make sure that the safety precautions are being followed

9. Document findings in the client record using forms or checklists supplemented by narrative notes when appropriate

**Evaluation**

- Perform follow-up based on findings that deviated from expected or normal for the client. Relate findings to previous data if available (e.g. check O2 saturation to evaluate adequate oxygenation)  
- Report significant deviations from normal to the primary care provider