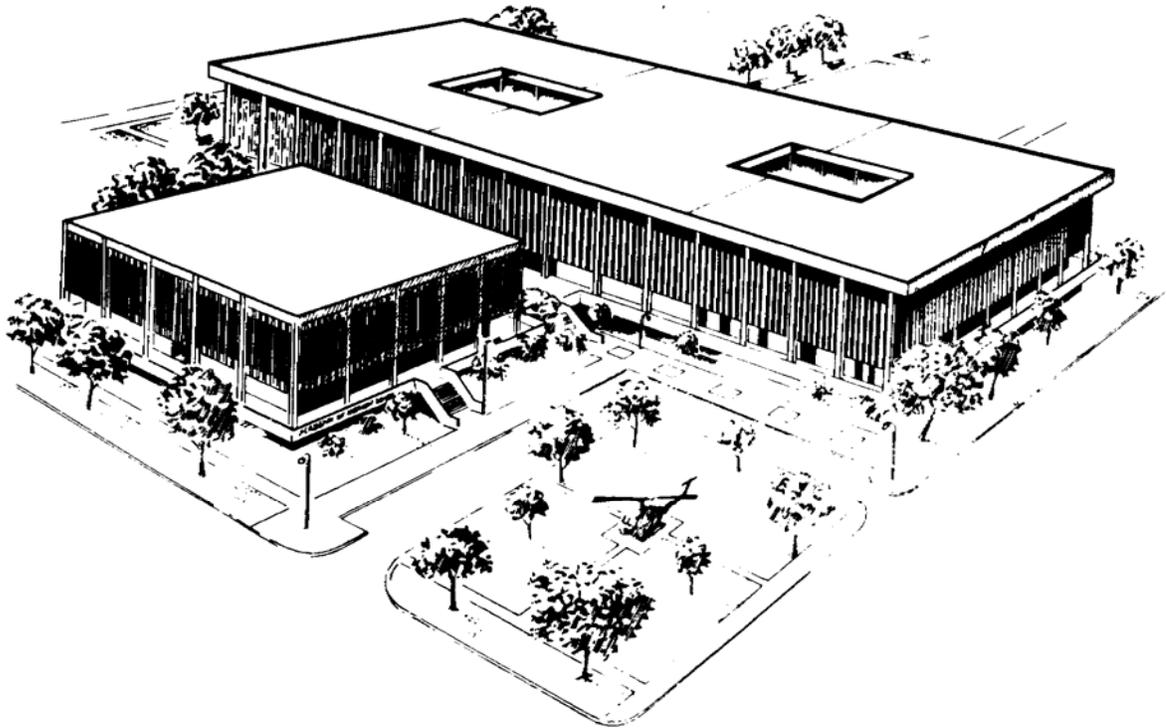


---

**U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL  
FORT SAM HOUSTON, TEXAS 78234-6100**

---



# **MANAGEMENT OF PATIENTS WITH RESPIRATORY DYSFUNCTIONS**

**SUBCOURSE MD0542    EDITION 200**

## **DEVELOPMENT**

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

## **ADMINISTRATION**

Students who desire credit hours for this correspondence subcourse must enroll in the subcourse. Application for enrollment should be made at the Internet website: <http://www.atrrs.army.mil>. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application; then follow the on-screen instructions.

For comments or questions regarding enrollment, student records, or examination shipments, contact the Nonresident Instruction Branch at DSN 471-5877, commercial (210) 221-5877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail [accp@amedd.army.mil](mailto:accp@amedd.army.mil), or write to:

NONRESIDENT INSTRUCTION BRANCH  
AMEDDC&S  
ATTN: MCCS-HSN  
2105 11TH STREET SUITE 4191  
FORT SAM HOUSTON TX 78234-5064

Be sure your social security number is on all correspondence sent to the Academy of Health Sciences.

## **CLARIFICATION OF TERMINOLOGY**

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

## **USE OF PROPRIETARY NAMES**

The initial letters of the names of some products may be capitalized in this subcourse. Such names are proprietary names, that is, brand names or trademarks. Proprietary names have been used in this subcourse only to make it a more effective learning aid. The use of any name, proprietary or otherwise, should not be interpreted as endorsement, deprecation, or criticism of a product; nor should such use be considered to interpret the validity of proprietary rights in a name, whether it is registered or not.

## TABLE OF CONTENTS

<u>Lesson</u>		<u>Paragraphs</u>
	INTRODUCTION	
1	THE RESPIRATORY SYSTEM.....	1-1--1-11
	Exercises	
2	DEVICES USED TO AID BREATHING.....	2-1--2-10
	Exercises	
3	ADMINISTERING OXYGEN .....	3-1--3-8
	Exercises	
4	ORAL, NASOPHARYNGEAL, AND NASOTRACHEAL SUCTIONING .....	4-1--4-4
	Exercises	

**CORRESPONDENCE COURSE OF  
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL**

**SUBCOURSE MD0542**

**MANAGEMENT OF PATIENTS WITH RESPIRATORY DYSFUNCTION**

**INTRODUCTION**

This subcourse presents a review of the respiratory system, devices such as the oropharyngeal airway and bag-valve-mask (BVM) systems which are used to assist a patient's breathing efforts, procedures for supplying the patient with additional oxygen through the use of the face mask and nasal prongs, and procedures for removing secretions interfering with breathing through the use of suction.

Successful completion of this subcourse does not mean that you are ready to begin managing patients with respiratory dysfunctions. You must still be trained under the supervision of a person who is qualified to instruct you in these processes, supervise your practice, and carefully evaluate your skills and abilities.

**Subcourse Components:**

The subcourse instructional material consists of four lessons as follows:

Lesson 1, The Respiratory System.

Lesson 2, Devices used to Aid Breathing.

Lesson 3, Administering Oxygen.

Lesson 4, Oral, Nasopharyngeal, and Nasotracheal Suctioning.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

**Credit Awarded:**

Upon successful completion of the examination for this subcourse, you will be awarded 6 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site <http://atrrs.army.mil> and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: <http://www.usapa.army.mil/pdffiles/p350-59.pdf>.

## **LESSON ASSIGNMENT**

### **SUBCOURSE 542**

The Respiratory System.

### **LESSON ASSIGNMENT**

Paragraphs 1-1 through 1-11.

### **LESSON OBJECTIVES**

After completing this lesson, you will be able to:

- 1-1. Describe the respiration processes.
- 1-2. Identify the components of the respiratory system and their functions.

### **SUGGESTIONS**

After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

## LESSON 1

### THE RESPIRATORY SYSTEM

#### 1-1. GENERAL

a. The cells of the body require a constant supply of oxygen to carry on the chemical processes necessary to life. As a result of these processes, carbon dioxide (a waste product) is formed and must be removed from the body so that the cells do not become poisoned by their own wastes. Oxygen and carbon dioxide are continuously being exchanged, both between the body and the atmosphere and within the body, by the physiological process known as respiration. The system that performs the exchange of gases between the body and the atmosphere is the respiratory system.

b. There are two types of respiration--external and internal. External respiration is the exchange of gases between the air in the lungs and blood. Internal respiration is the exchange of gases between the blood and the individual cells of the body.

c. Breathing is the mechanical process that moves air into and out of the lungs. There are two types of breathing in humans--costal (thoracic) and diaphragmatic (abdominal). In costal breathing, the major structure causing the movement of the air is the rib cage. In diaphragmatic breathing, the diaphragm causes the air to move into and out of the lungs.

#### 1-2. COMPONENTS AND SUBDIVISIONS OF THE RESPIRATORY SYSTEM

a. **Components.** The human respiratory system consists of air passageways and two lungs (figure 1-1). Air moves from the outside of the body through the air passages into tiny sacs in the lungs called alveoli.

b. **Main Subdivisions.** The main subdivisions of the respiratory system may be identified by their relationship to the voice box (larynx). Thus, the main subdivisions are as follows:

(1) Supralaryngeal (above the larynx) structures. These structures include the external nose, nasal chambers, and pharynx. These structures cleanse, warm, moisten, and test inflowing air.

(2) Larynx (voice box). This structure controls the volume of inflowing air and produces selected pitch (vibration frequency) in the moving column of air.

(3) Infralaryngeal (below the larynx) structures. These structures include the trachea, bronchi, alveoli, lungs, and pleural cavities. They distribute air to the alveoli of the lungs where the actual external respiration takes place.

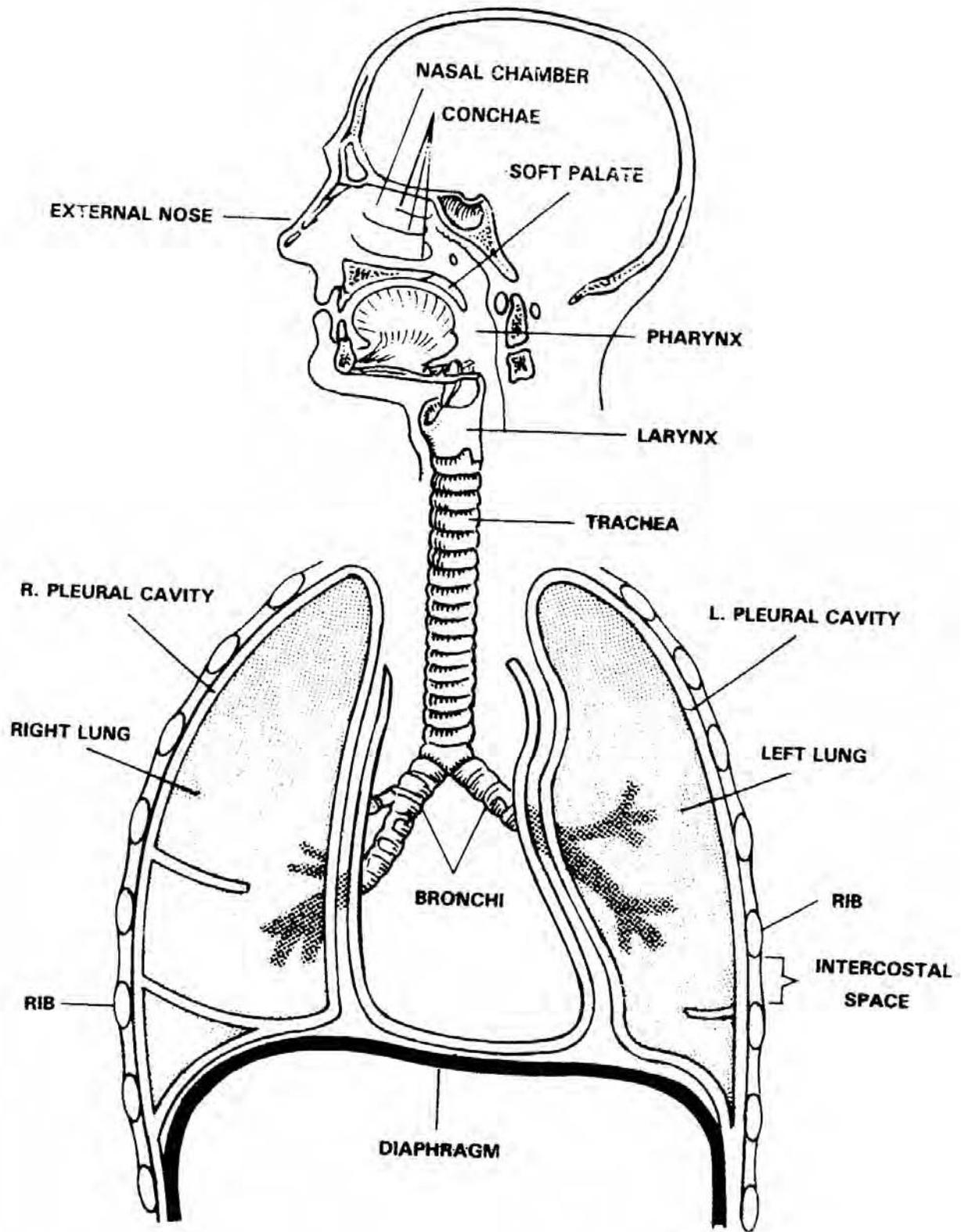


Figure 1-1. The human respiratory system.

### 1-3. SUPRALARYNGEAL STRUCTURES

Supralaryngeal structures are shown in figure 1-2.

a. **External Nose.** The external nose is the portion projecting from the face. It is supported primarily by cartilages. It has a midline divider, called the nasal septum, which extends from the internal nose. There are paired openings (nostrils) that lead to paired spaces (vestibules). Guard hairs in the nostrils filter inflowing air.

b. **Nasal Chambers (Internal Nose).** Behind each vestibule of the external nose is a nasal chamber. The two nasal chambers together form the internal nose. These chambers, too, are separated by the nasal septum.

(1) The walls of the nasal chambers are lined with a thick mucous-type membrane known as the mucoperiosteum. It has a ciliated (hair-like projection that move fluids to the rear) epithelial surface. It also has a rich blood supply that provides warmth and moisture. At times, the membrane may become quite swollen.

(2) The lateral wall of each chamber has three scroll-like extensions into the nasal chamber that help to increase the surface area exposed to the inflowing air. These scroll-like extensions are known as conchae.

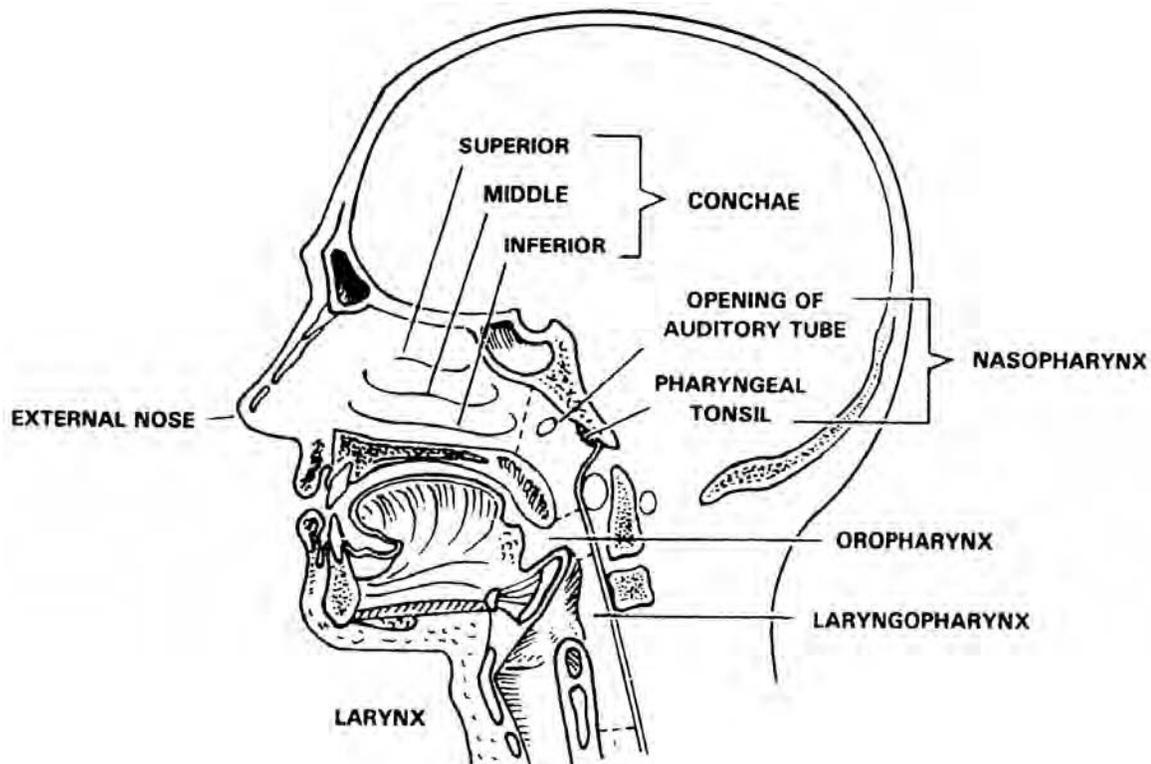


Figure 1-2. Supralaryngeal structures.

(3) The sense of smell is due to special nerve endings located in the upper areas of the nasal chambers. The epithelium containing the sensory ending is known as the olfactory epithelium.

(4) There are air "cells" or cavities in the skull called paranasal sinuses. The paranasal sinuses are connected with nasal chambers and are lined with the same ciliated mucoperiosteum. Thus, these sinuses are extensions of the nasal chambers into the skull bones. For this reason, they are known as paranasal sinuses.

c. **Pharynx.** The pharynx is the common posterior space for the respiratory and digestive systems.

(1) The portion of the pharynx specifically related to the respiratory system is the nasopharynx. It is the portion of the pharynx above the soft palate. The two posterior openings (nares) of the nasal chambers lead into the single space of the nasopharynx. The auditory (eustachian) tubes also open into the nasopharynx. The auditory tubes connect the nasopharynx with the middle ears. This allows the pressure between the outside and inside of the eardrum to be equalized. Lying in the upper posterior wall of the nasopharynx are the pharyngeal tonsils (adenoids). The soft palate floor of the nasopharynx is a trapdoor that closes off the upper respiratory passageways during swallowing.

(2) The portion of the pharynx closely related to the digestive system is the oropharynx. It is the portion of the pharynx below the soft palate and above the upper edge of the epiglottis. The epiglottis is the flap that prevents food from entering the larynx when a person swallows.

(3) The portion of the pharynx that is common to both the respiratory system and the digestive system is the laryngopharynx. It is the portion of the pharynx below the upper edge of the epiglottis. Thus, the digestive and respiratory systems lead into it from above and lead off from it below.

#### **1-4. LARYNX**

The larynx, also called the Adam's apple or voice box, connects the pharynx with the trachea. The larynx is located in the anterior neck region and has a box-like shape (figure 1-3). The larynx of the male becomes larger and heavier during puberty and causes the voice to deepen. The adult male's larynx tends to be located lower in the neck. In the female, the larynx remains higher and smaller.

a. The larynx has a vestibule ("entrance hallway") that can be covered over by the epiglottis. The glottis itself is the hole between the vocal cords. Through the glottis, air passes from the vestibule into the main chamber of the larynx (below the cords) and then into the trachea. The skeleton of the larynx is made up of a series of cartilages.

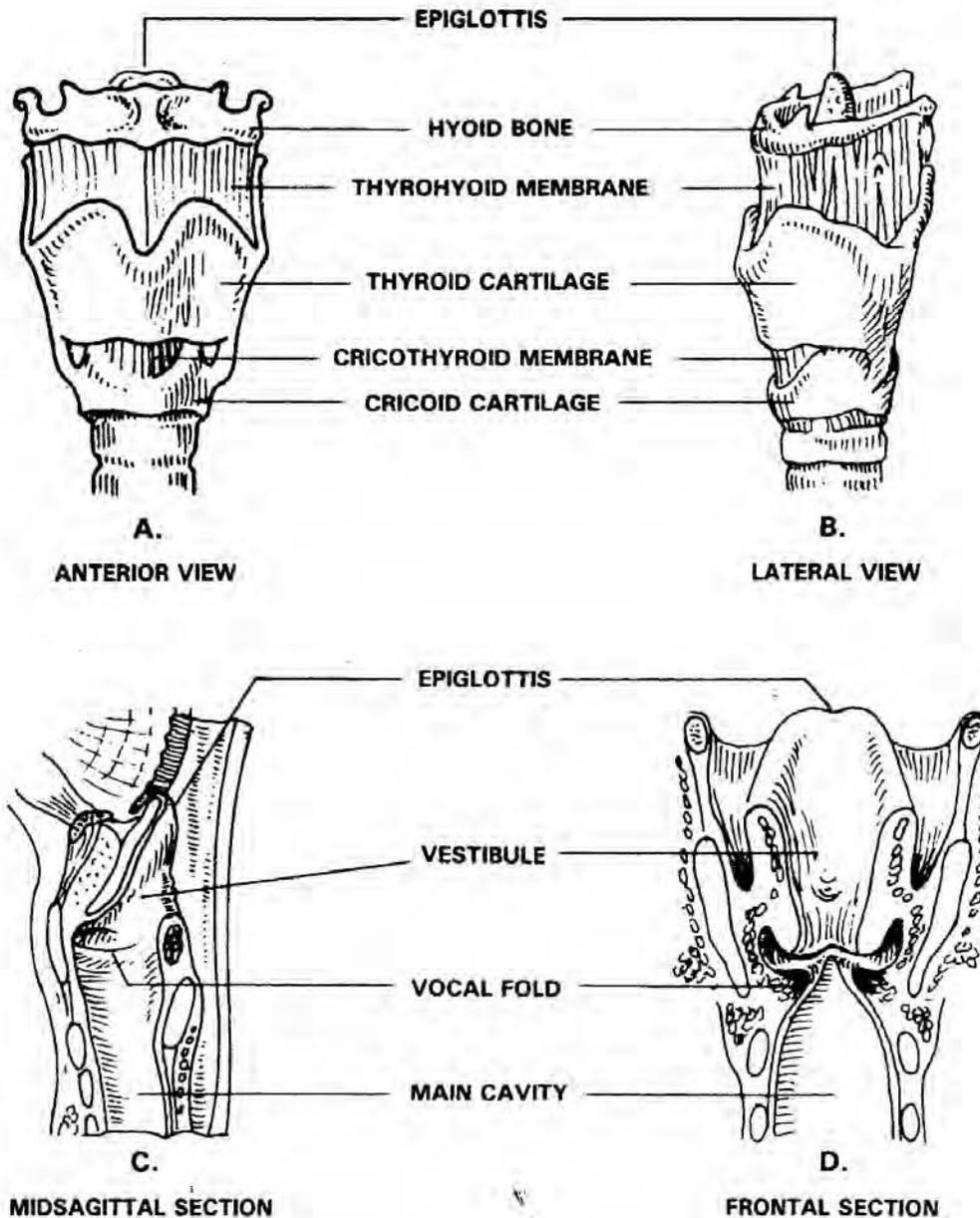


Figure 1-3. The larynx.

b. The larynx serves two functions and has two sets of muscles--one for each function.

(1) One set controls the size of the glottis. Thus, it regulates the volume of air passing through the trachea.

(2) The other set controls the tension of the vocal cords. Thus, it produces vibrations of selected frequencies (variations in pitch) of the moving air used in the process of speaking.

## 1-5. INFRALARYNGEAL STRUCTURES

Infralaryngeal structures are shown in figure 1-4.

a. **Trachea and Bronchi.** The respiratory tree is the set of tubular structures that carry the air from the larynx to the alveoli of the lungs. The respiratory tree is so named because it has the appearance of an inverted tree with its trunk and branches. These tubular parts are held open (made patent) by rings of cartilage. Their lining is ciliated to remove mucus and other materials that get into the passageway.

b. **Alveoli.** The alveoli are tiny spherical balloon-like sacs that are connected to the larger tubes of the lungs by alveolar ducts and bronchioles. The alveoli are so small that there are billions in the adult lungs. This very small size produces a maximum surface area through which external respiration takes place. External respiration is the actual exchange of gas between the air, the alveolar spaces, and the adjacent blood capillaries through their wall. (Note: Alveoli is the plural of alveolus.)

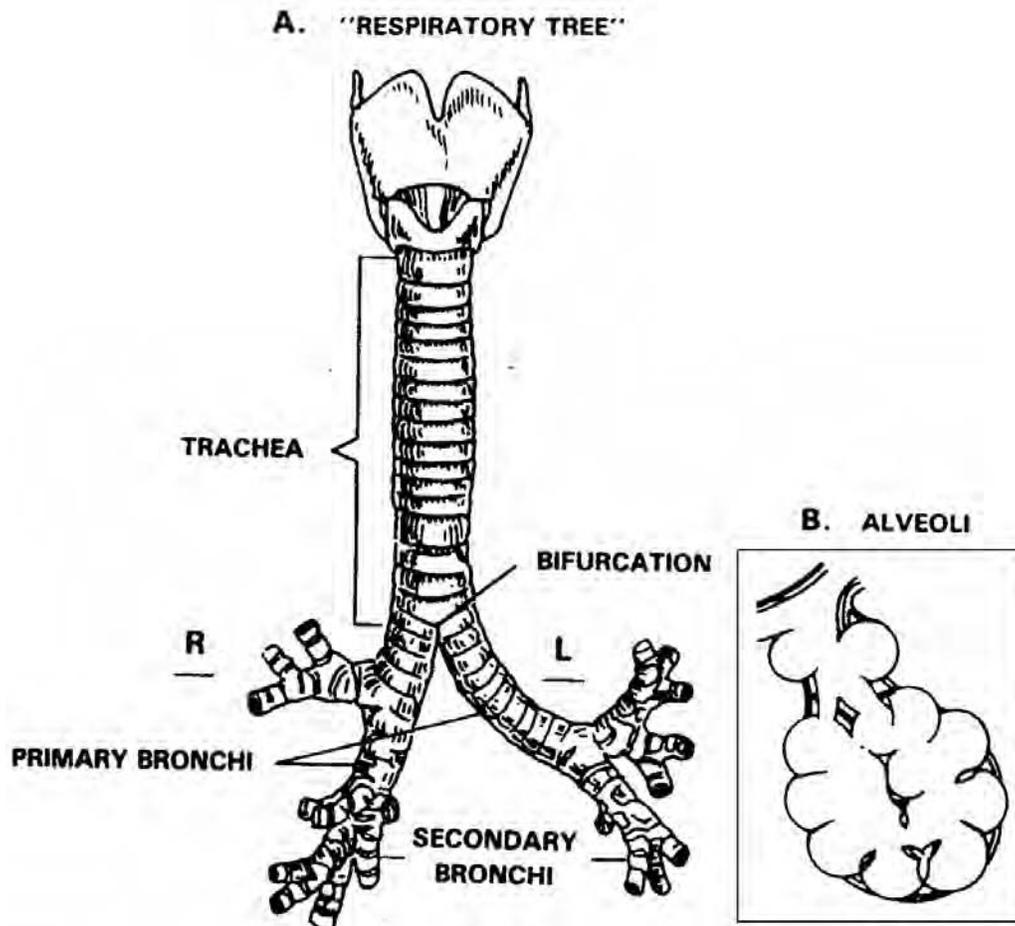


Figure 1-4. Infralaryngeal structures.

c. **Lungs.** A lung is an individual organ composed of tubular structures and alveoli, bound together by fibrous connective tissue. In the human, there are two lungs-right and left. Each lung is divided into lobes. A pulmonary lobe is a major subdivision of a lung marked by fissures (deep folds). Each lobe is further partitioned into bronchopulmonary segments.

(1) The right lung is larger in volume than the left lung since the left lung must leave room for the heart. The right lung is divided into three pulmonary lobes (upper, middle, and lower) and ten bronchopulmonary segments (2+3+5). The left lung is divided into two pulmonary lobes (upper and lower) and eight bronchopulmonary segments (4+4).

(2) Each lung is supplied by a primary or mainstream bronchus leading off the trachea. Each lobe is supplied by a secondary or lobar bronchus branching off of the primary bronchus. Each segment is supplied by a tertiary or segmented bronchus, a branch of the lobar bronchus.

d. **Pleural Cavities.** Each lung is encased in a serous cavity called the pleural cavity. Each serous cavity has inner and outer membranes. The serous membranes secrete fluid that act as a lubricant between the membranes, allowing freer motion for the organs. The pleural cavities allow the lungs to move freely with a minimum of friction during the expansion and contraction phases of breathing. Located in the middle of the thorax, between the two pleural cavities, is the mediastinum ("I stand between"). The mediastinum is a tissue and organ-filled space. Within it is the heart, which is located at the same level as the lungs.

## 1-6. BREATHING AND BREATHING MECHANISMS

a. Boyle's law (named after Robert Boyle, British physicist, 1627-1691) states that as the volume of a gas-filled container increases, the pressure inside decreases. Conversely, as the volume of a closed container decreases, the pressure inside increases. When two connected spaces of air have different pressures, the air moves from the space with greater pressure to the one with lesser pressure. In regard to breathing, we can consider the air pressure around the human body to be constant. The pressure inside the lungs may be greater or less than the pressure outside the body. Thus, a greater internal pressure causes air to flow out; a greater external pressure causes air to flow in.

b. The human trunk can be compared to a hollow cylinder. This cylinder is divided into upper and lower cavities by the diaphragm. The upper is the thoracic cavity and is essentially gas-filled. The lower is the abdominopelvic cavity and is essentially water-filled. By changing the size (volume) of the thoracic cavity, air can be forced into and out of the cavity. The size of the thoracic cavity is changed by movement of the rib cage (coastal or thoracic breathing) and by movement of the diaphragm (diaphragmatic or abdominal breathing).

## 1-7. COSTAL (THORACIC) BREATHING

Muscles attached to the thoracic cage (rib cage) cause the chest to expand during inhalation and return to normal during exhalation.

a. **Inhalation.** Muscles attached to the thoracic cage contract and raise the ribs. A typical rib might be compared to a bucket handle, attached at one end to the sternum (breastbone) and at the other end to the vertebral column (spine). The "bucket handle" is lifted by the overall upward and outward movement of the rib cage. These movements increase the thoracic diameters from right to left (transverse) and from front to back. Thus, the volume within the chest increases. Recalling Boyle's law, the increase in volume leads to a decrease in pressure. The higher air pressure outside the body then forces air into the lungs and inflates them.

b. **Exhalation.** The rib cage movements and pressure relationships are reversed for exhalation. The muscles relax, the ribs return to their normal position, and the size of the chest decreases. The pressure within the chest increases and forces air outside the body.

## 1-8. DIAPHRAGMATIC (ABDOMINAL) BREATHING

The diaphragm is a thin, but strong, dome-shaped muscular membrane that separates the abdominal and thoracic cavities. The abdominal wall is elastic in nature. The abdominal cavity is filled with soft, watery tissues.

a. **Inhalation.** As the diaphragm contracts, the dome flattens and the diaphragm descends. This increases the depth (vertical diameter) of the thoracic cavity and thus increases its volume. This decreases air pressure within the thoracic cavity. The greater air pressure outside the body then forces air into the lungs.

b. **Exhalation.** As the diaphragm relaxes, the elastic abdominal wall forces the diaphragm up again by pushing the watery tissues of the abdomen against the underside of the relaxed diaphragm. The dome moves upward, the volume of the thoracic cavity is decreased, and air is forced from the lungs and into the atmosphere.

## 1-9. NERVOUS CONTROL OF BREATHING

Breathing can be controlled voluntarily to some extent, such as holding your breath for a short period of time or breathing deeply during a medical examination. However, breathing is usually controlled by the nervous system without the need to consciously order the body to inhale or exhale. Respiratory reflexes are controlled by the respiratory center found in the medullar portion of the brainstem. The respiratory center coordinates the actions of costal breathing and diaphragmatic breathing to ensure that they work together (chest and abdominal muscles contract at the same time and relax at the same time). The amount of carbon dioxide (CO<sub>2</sub>) in the circulating blood is one of the major influences on the actions of the respiratory center.

## **1-10. MOVEMENT OF BLOOD**

a. The veins of the systemic blood circulatory system bring oxygen-poor blood from all parts of the body to the right atrium of the heart. From the right atrium, the blood flows into the right ventricle of the heart. Upon contraction of the right ventricle, blood is forced into the pulmonary arch. The pulmonary arch divides into the right and left pulmonary arteries that delivers the oxygen-poor blood to their respective lungs. Paralleling the branching of the respiratory tree, the arteries divide and subdivide within the lungs. These arteries lead to capillaries that surround the alveoli. The walls of these capillaries are thin enough to accommodate the passage of gases to and from the alveolus. The oxygen-poor blood gives up the carbon dioxide which it has been carrying and absorbs oxygen from the alveolus. Just as oxygen travels from the alveolus to the capillary, carbon dioxide travels from the capillary to the alveolus.

b. The blood, now saturated with oxygen, is collected by the pulmonary venous system. The blood flows through the pulmonary veins into the left atrium of the heart. From the left atrium, it flows into the left ventricle. When the left ventricle contracts, the oxygen-rich blood is forced into the aorta of the systemic blood circulatory system. Other arteries branch off of this large artery and carry the oxygen-rich blood to all living cells within the body. As the arteries continue to subdivide and get smaller, they eventually reach the capillary stage. At this stage, oxygen moves from the blood into the surrounding body cells and carbon dioxide, a waste material, travels from the body cells to the blood. The blood then flows from the capillaries into veins and eventually returns to the right atrium of the heart.

## **1-11. TRANSPORTATION OF GASES**

Oxygen and carbon dioxide are the primary gases involved in respiration. Under special circumstances, nitrogen may also be of concern. Some of the gases are dissolved directly in the plasma of the blood. Most of the gasses, however, are carried within the erythrocytes (red blood cells, commonly called RBCs). The RBCs, found in great numbers in the blood, are specially constructed for transporting the gases. Hemoglobin, a substance found within RBCs, has a great affinity for oxygen. Yet, the hemoglobin can readily give up the oxygen wherever it is needed.

**Continue with Exercises**

## EXERCISES, LESSON 1

**INSTRUCTIONS.** Answer the following items by completing the statement or by writing the answer in the space provided at the end of the item.

After you have completed all of these items, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. Name and define the two types of respiration.

a. \_\_\_\_\_

\_\_\_\_\_

b. \_\_\_\_\_

\_\_\_\_\_

2. What does the larynx control?

\_\_\_\_\_

3. What is found in the nose to filter inflowing air?

\_\_\_\_\_

4. The walls of the nasal chambers are lined with a thick mucous-type membrane called the \_\_\_\_\_.

5. The common posterior space for the respiratory and digestive systems is called the \_\_\_\_\_.

6. The part of the pharynx that is related to the respiratory system is the:

\_\_\_\_\_.

7. The tubes that are used to equalize the pressure between the outside and inside of the eardrum are called \_\_\_\_\_.

8. How is the upper respiratory passageway closed when the person swallows food?

---

---

9. Which flap prevents food from entering the larynx during swallowing?

---

10. The two common terms that refer to the larynx are \_\_\_\_\_ and \_\_\_\_\_.

11. Describe the alveoli.

---

---

12. Which lung is the smaller lung and why?

---

---

13. Where is the mediastinum located?

---

---

14. How is Boyle's law related to a person's breathing?

---

---

---

---

15. During inhalation, how is the rib cage lifted?

---

---

16. Describe the action of the diaphragm during inhalation.

---

---

---

---

17. Which part of the brain controls the respiratory reflexes?

---

---

18. The primary gases involved in respiration are \_\_\_\_\_ and

---

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 1

1. External respiration is the exchange of gases between the air in the lungs and blood.  
Internal respiration is the exchange of gases between the blood and the individual cells of the body. (para 1-1b)
2. The larynx controls the volume of inflowing air and produces selected pitch (vibration frequency) in the moving column of air. (para 1-2b(2))
3. Hairs in the nose filter inflowing air. (para 1-3a)
4. Mucoperiosteum. (para 1-3b(1))
5. Pharynx. (para 1-3c)
6. Nasopharynx. (para 1-3c(1))
7. Auditory (eustachian) tubes. (para 1-3c(1))
8. The soft palate floor of the nasopharynx is a trapdoor that closes off the upper respiratory passageways during swallowing. (para 1-3c(1))
9. The epiglottis. (para 1-3c(2))
10. Adam's apple and voice box. (para 1-4)
11. The alveoli are tiny spherical (balloon-like) sacs that are connected to the larger tubes of the lungs by alveolar ducts. (para 1-5b)
12. The left lung is smaller because it must leave room for the heart. (para 1-5c)
13. The mediastinum is found in the middle of the thorax, between the two pleural cavities. (para 1-5d)
14. When the volume of the chest cavity decreases, the air pressure inside the lungs increases and forces to flow out from the lungs. When the volume of the chest cavity increases, the air pressure inside the lungs decreases and causes air to flow in. (para 1-6a)
15. Muscles attached to the thoracic cage raise the rib cage during inhalation. (para 1-7a)

16. As the diaphragm contracts, the dome flattens and the diaphragm descends, thereby increasing the size of the thoracic cavity. This results in decreased air pressure within the thoracic cavity. The greater air pressure outside the body forces air into the lungs. (para 1-8a)
17. The respiratory center located in the brainstem. (para 1-9a)
18. Oxygen and carbon dioxide. (para 1-11)

**End of Lesson 1**

## LESSON ASSIGNMENT

### LESSON 2

Devices Used to Aid Breathing.

### LESSON ASSIGNMENT

Paragraphs 2-1 through 2-10.

### LESSON OBJECTIVES

After completing this lesson, you will be able to:

- 2-1. List/identify the steps used to insert a nasopharyngeal airway.
- 2-2. Identify when a nasopharyngeal airway should be used.
- 2-3. List/identify the steps used to insert an oropharyngeal airway.
- 2-4. Identify when an oropharyngeal airway should be used.
- 2-5. List/identify the steps used to insert a Combitube.
- 2-6. Identify when a Combitube should be used.
- 2-7. List/identify the steps used to perform a surgical cricothyrotomy.
- 2-8. Identify when a cricothyrotomy should be performed.
- 2-9. List/identify the steps used to ventilate a patient with a bag-valve-mask system.
- 2-10. Identify the procedures used to assist the patient's breathing.

### SUGGESTIONS

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

## LESSON 2

### DEVICES USED TO AID BREATHING

#### 2-1. NASOPHARYNGEAL AIRWAYS

a. Among the most critical skills the soldier medic must know are basic and advanced airway management. Without proper airway management techniques and oxygen administration, the patient may die needlessly. The soldier medic must be able to choose and effectively utilize the proper equipment for administering oxygen for both the medical and trauma casualty. The soldier medic must also keep in mind the principles of tactical casualty care and always do the appropriate intervention at the appropriate time.

b. There will be situations in the field where you will encounter a patient who not only needs his breathing restored, but must also have it maintained by mechanical means. In the field, rescue breathing is the preferred method of maintaining respiration. Before any airway adjuncts are utilized, it should be remembered that the airway can be improved in most cases by tilting the head back and performing the chin lift or jaw thrust. These maneuvers displace the tongue forward and away from the posterior pharyngeal wall. If the patient is capable of spontaneous breathing, this positioning may be all that is necessary. In some situations, however, a nasopharyngeal airway, oropharyngeal airway, or Combitube airway may be needed to maintain an open air passage.

c. The nasopharyngeal airway (figure 2-1) is a flexible tube inserted through the external nasal passage and into the nasopharynx and oropharynx to elevate the tongue off of the back of the throat to maintain a patent airway. The insertion of this device can be used with a conscious or unconscious patient; therefore it is the preferred airway during the tactical field care phase. It is also more effective than the oropharyngeal airway because it is less likely to be dislodged during movement of the patient during evacuation.

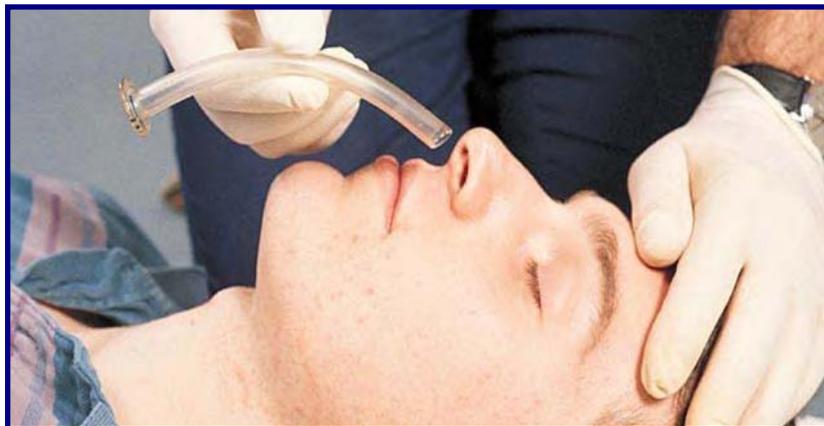


Figure 2-1. Nasopharyngeal airway.

## 2-2. PROCEDURE FOR INSERTING THE NASOPHARYNGEAL AIRWAY

a. **Determine the Need for the Nasopharyngeal Airway.** Before you insert the nasopharyngeal airway (NPA), you must assess the patient. This assessment should include checking for signs of facial trauma; this is a contraindication for the use of the nasopharyngeal airway. The assessment should also include determination of the casualty's mental status. Any casualty with an altered mental status should have their airway protected with a nasopharyngeal airway. Use the following indications and contraindications to help with determining the need for the nasopharyngeal airway.

(1) Indications.

- (a) Casualty is conscious, semi-conscious or has an active gag reflex.
- (b) Casualty has injuries to mouth (for example, broken teeth, massive oral tissue damage).
- (c) Seizure casualties who may have clenched teeth due to active seizing.
- (d) When vomiting is likely to occur.

(2) Contraindications.

- (a) Any evidence of a head injury or roof of mouth (cribriform) fracture; the airway may inadvertently enter the cranial vault with this type fracture.
- (b) Exposed brain matter.
- (c) Cerebrospinal fluid (CSF) draining from nose, mouth, or ears.

b. **Determine the Proper Size Nasopharyngeal Airway.**

- (1) Diameter: Select an airway with a diameter smaller than the casualty's nostril or one that is approximately the diameter of the casualty's little finger.
- (2) Length: Measure from the tip of the patient's nose to their ear lobe (figure 2-2).

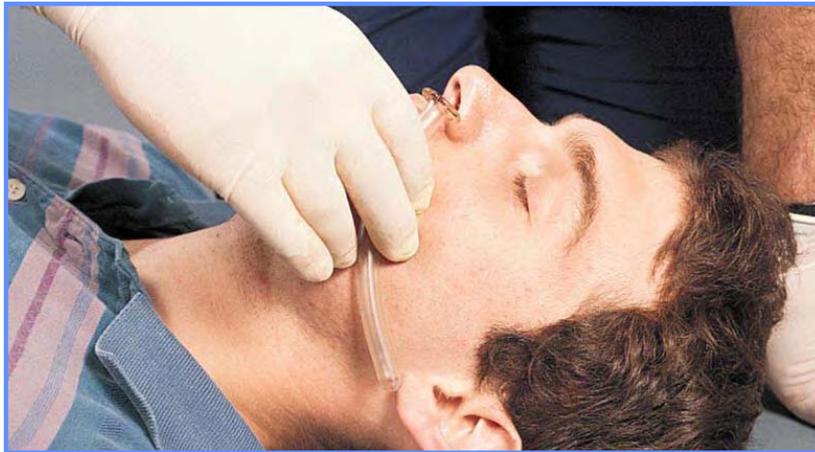


Figure 2-2. Measuring the nasopharyngeal airway.

**NOTE:** Most nasal pharyngeal airways are made to fit the right nostril. If you have to insert it into the left nostril, turn the airway upside down so that bevel remains toward the septum, then insert it straight back until you reach the posterior pharynx. Turn the airway 180 degrees until it lies behind the tongue.

### c. **Nasopharyngeal Insertion Procedures.**

- (1) Place the casualty on a firm surface in the supine position with the cervical spine stabilized.
- (2) Lubricate the NPA with a water-soluble lubricant (or tap water if lubricant is not available).
- (3) Push the tip of the patient's nose slightly upward to expose the opening in the nostril.
- (4) Keeping the head in a neutral position, insert the tip of the NPA through the nostril.
- (5) Slowly advance tube along floor of nasal cavity with bevel pointing toward septum until flange rest firmly against casualty's nostril (figure 2-3).
  - (a) If resistance is met during insertion, do not continue to insert.
  - (b) Stop, remove the adjunct, relubricate, and try the other nostril.
  - (c) If resistance is still met, check proper size or use alternate artificial airway method.

(6) Place the casualty in the recovery position if you cannot constantly monitor them.

(7) To remove the airway, pull out with a steady motion along the curvature of the nasal cavity.

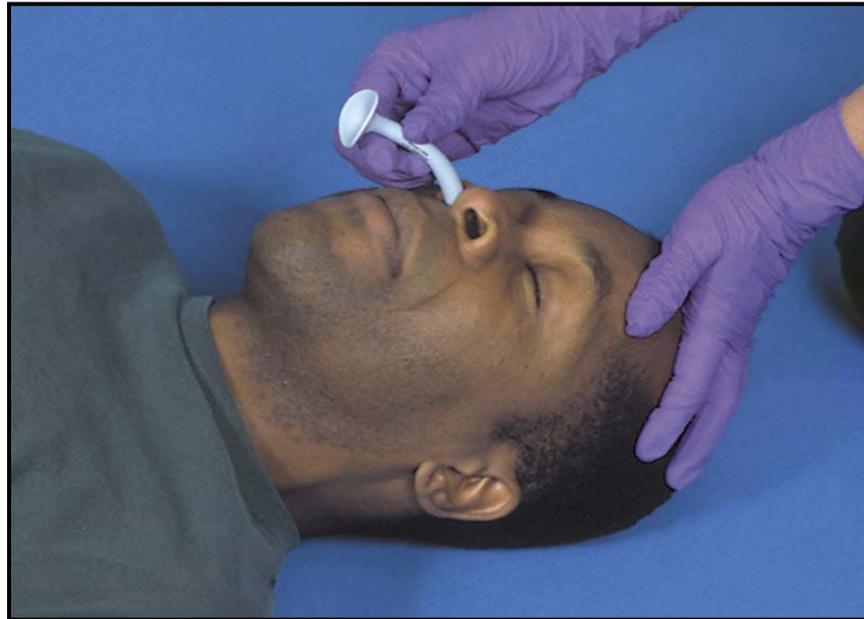


Figure 2-3. Inserting the nasopharyngeal airway.

**d. Complications.**

(1) The most common complication is minor tissue trauma such as epistaxis (nosebleed); this however, is not sufficient indication to remove the airway.

(2) The airway may trigger a gag reflex with some patients.

**2-3. OROPHARYNGEAL AIRWAYS (J-TUBES)**

a. The oropharyngeal airway is a semicircular apparatus of plastic, rubber, or metal. The apparatus is also called a J-tube because of its shape. It is curved to fit over the back of the tongue and is inserted into the lower posterior wall of the pharynx. In this location, the apparatus will hold the tongue away from the posterior wall of the pharynx and keep the patient's airway patent (open).

b. The insertion of this mechanical airway device is advised only when the patient is unconscious and does not have a gag reflex. Before inserting the airway, attempt normal resuscitation procedures manual airway procedures (the head-tilt chin-lift maneuver or jaw thrust maneuver).

## 2-4. PROCEDURE FOR INSERTING AN OROPHARYNGEAL AIRWAY

a. **Determine Need for Oropharyngeal Airway.** Before you insert an oropharyngeal airway (J-tube), you must survey the patient, open the airway, clear the upper airway of obstruction (if applicable), and perform rescue breathing. If the patient begins breathing on his own but does not regain consciousness and you are unable to stay with the patient to keep his airway open, a J-tube may be inserted in order to keep the patient's airway patent.

b. **Select the Proper Size Oropharyngeal Airway.** To select the correct size of airway, select one of the J-tubes (figure 2-1) and hold it alongside the patient's jaw (jaw in the normal position with the mouth closed). Then measure from the corner of the patient's mouth to the bottom tip of his ear. Use the J-tube that best matches this measurement.

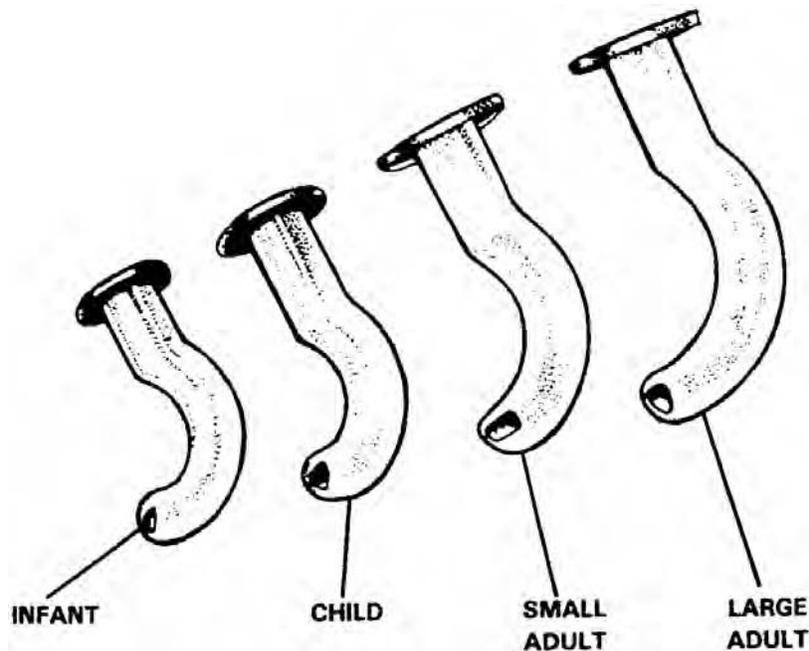


Figure 2-4. J-tubes.

c. **Open the Patient's Airway.** Open the patient's mouth using the crossed-finger method.

(1) Place your crossed thumb and index finger of one hand on the patient's upper and lower teeth at the corner of the mouth (figure 2-5).



Figure 2-5. Opening the patient's mouth.

(2) Use a scissor motion to pry the teeth apart and hold the mouth open. If the patient's teeth are clenched, use the modified jaw thrust method to open the mouth. In cases where neck or spinal injuries are present or suspected, use the jaw thrust method of opening the airway to prevent further injury.

d. **Insert the Oropharyngeal Airway.** Remember, the oropharyngeal airway is used for UNCONSCIOUS patients only. Do not try to insert the artificial airway in a conscious or semi-conscious patient due to the patient's gag reflex. The presence of an airway in such patients may induce vomiting and cause aspiration of the stomach contents into the lungs.

- (1) Place the tip of the airway into the patient's mouth (figure 2-6).
- (2) Point the tip of the airway toward the roof of the patient's mouth to prevent the tongue from being pushed into the back of the throat.
- (3) Slide the airway along the roof of the mouth, following the natural curvature of the tongue, past the soft palate.
- (4) Rotate the airway 180 degrees as the tip reaches the back of the tongue (figure 2-7).

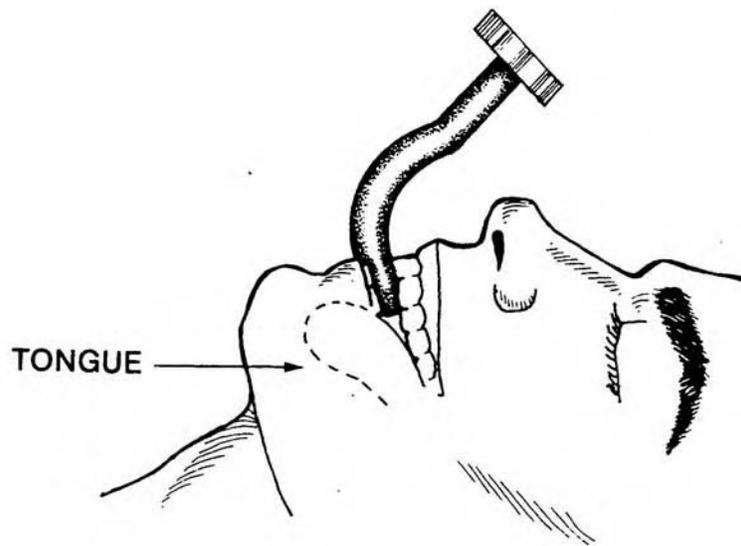


Figure 2-6. Tip of the oropharyngeal airway placed into the mouth.

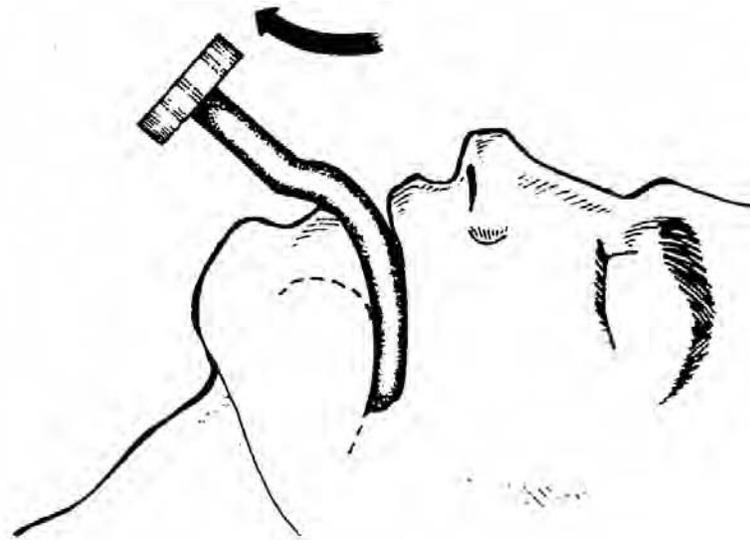


Figure 2-7. Tip of the J-tube at the back of the tongue.

(5) Gently advance the airway and adjust it so the flange rests on the patient's lips. If the flange of the airway does not seat properly or if the patient begins to gag or vomit, the airway may be the wrong size. The tip of the airway should rest just above the epiglottis (figure 2-8).

(6) If you have any difficulty inserting the airway, grasp the tongue with your index finger and thumb (using a gauze pad, if available) and pull the tongue forward or use a tongue blade to depress the tongue.

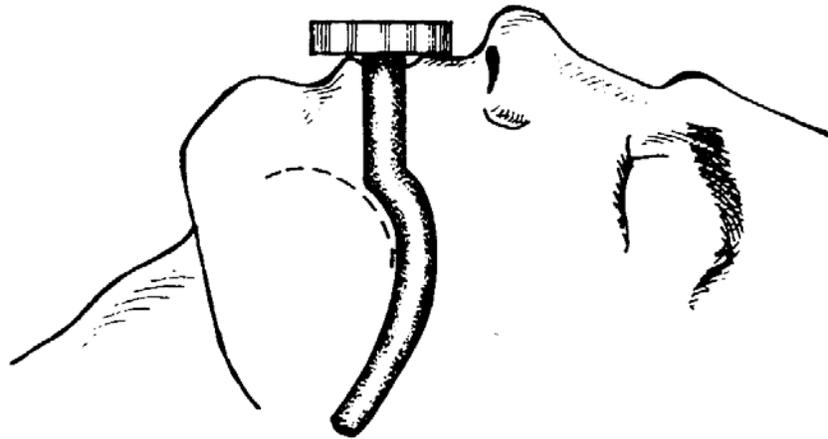


Figure 2-8. J-tube in place.

e. **Remove Oropharyngeal Airway, If Needed.** When the patient starts to regain consciousness or gags, remove the airway quickly to prevent regurgitation and possible aspiration of stomach contents.

f. **Record Treatment and Evacuate the Patient.**

(1) Complete a Field Medical Card and attach the card to the patient's clothing.

(2) Evacuate the patient for further evaluation and treatment by a physician. The patient must be watched constantly so that the airway can be removed in the event he becomes conscious. During evacuation, check the airway periodically to ensure that it is free from obstacles and is functioning properly. This is why the oropharyngeal airway is not recommended in MASCAL and tactical situations when constant airway monitoring is not possible.

## 2-5. COMBI-TUBE AIRWAYS

a. The Combitube (figure 2-9) is an esophageal-tracheal double lumen airway. It is considered to be an intermediate airway whose abilities lie between the airway adjuncts oropharyngeal airway (OPA), nasopharyngeal airway (NPA), and an endotracheal intubation tube (ETT).

b. The Combitube airway is designed to provide a patent airway for a respiratory/cardiac-arrested patient. The Combitube is a blind-insertion airway device (BIAD). It has been used successfully in patients with difficult airways secondary to severe facial burns, trauma, upper airway bleeding, and vomiting where there was an inability to directly visualize the vocal cords.



Figure 2-9 Combi-tube airway.

c. The Combitube can be used in patients whose cervical spine has been immobilized with a rigid cervical collar, though placement may be more difficult. Ventilation does not seem to be affected by the rigid cervical collar if the Combitube is emplaced.

d. The double lumen design allows for effective ventilations to be provided regardless of whether the tube is placed in the trachea or the esophagus.

e. The Combitube comes in two sizes: 37 French and 41 French.

## **2-6. PROCEDURES FOR INSERTING THE COMBI-TUBE AIRWAY**

### **a. Indications.**

- (1) Adult patients in respiratory arrest.
- (2) Adult patients in cardiac arrest.

**b. Contraindications.**

- (1) Intact gag reflex.
- (2) Patients less than 5 feet in height.
- (3) Known esophageal disease.
- (4) Caustic substance (acid or lye) ingestion.

**c. Side Effects and Complications.**

- (1) An increased incidence of sore throat, dysphagia, and upper airway hematoma as compared to ETT.
- (2) Esophageal rupture is a rare complication, but has been described.
- (3) Complications may be partially preventable by avoiding over-inflation of the distal and proximal cuffs.
- (4) Take appropriate BSI precautions, including facial protection, as vomiting can occur through the Number 2 tube if the initial placement is in the esophagus.

**d. Intubation Procedures.**

- (1) Inspect the upper airway for visible obstruction.
- (2) Hyperventilate (> 20/min) the patient for 30 seconds.
- (3) Position patient's head in a neutral position.
- (4) Test both cuffs (white and blue) for leaks by inflating with 15 ml (white) or 100 ml (blue) of air.
- (5) Insert the Combitube in the same direction as the natural curvature of the pharynx.
  - (a) Grasp the tongue and lower jaw between your thumb and index fingers and lift upward (jaw-lift maneuver).
  - (b) Insert the Combitube gently, but firmly, into the pharynx until the black rings on the tube are positioned between the patient's teeth.

(c) Do not use force - if the tube does not insert easily, withdraw it and retry; hyperventilate the patient between each attempt.

(d) Inflate the Number 1 (blue) pilot balloon with 100 ml of air using a 100 ml syringe. Inflate the Number 2 (white) pilot balloon with 15 ml of air using a 20 ml syringe.

(e) Ventilate through the primary Number 1 (blue) tube. If auscultation of breath sounds is positive and auscultation of gastric sounds is negative, continue to ventilate.

(f) If auscultation of breath sounds is negative and gastric insufflation is positive, immediately begin ventilations through the shorter (white) Number 2 connecting tube. Confirm tracheal ventilation of breath sounds and absence of gastric insufflation.

(g) If auscultation of breath sounds and auscultation of gastric insufflation is negative, the Combitube may have been advanced too far into the pharynx. Deflate the Number 1 balloon/cuff, and move the Combitube approximately 2 to 3 cm. out of the patient's mouth.

(h) Re-inflate the Number 1 balloon with 100 ml of air and ventilate through the longer Number 1 connecting tube. If auscultation of breath sounds is positive and auscultation of gastric insufflation is negative, continue to ventilate.

(i) If breath sounds are still absent, immediately deflate both cuffs and extubate the patient.

(j) Insert oropharyngeal or nasopharyngeal airway and hyperventilate the patient with a bag-valve-mask (BVM) device.

**e. Combitube Removal Procedure.**

(1) The Combitube should not be removed unless:

(a) Tube placement cannot be determined.

(b) The patient no longer tolerates the tube (begins to gag).

(c) The patient vomits past either the distal or pharyngeal tube.

(d) There is a palpable pulse and the patient starts breathing on his own.

(e) A physician or physician assistant (PA) is present to place an ETT.

- (2) Have suction equipment available and ready.
- (3) Logroll the patient to the side, unless a spinal injury exists.
- (4) Deflate the pharyngeal cuff using the Number 1 pilot balloon.
- (5) Deflate the distal cuff using the Number 2 pilot balloon.
- (6) Gently remove the Combitube while suctioning the airway.

## **2-7. SURGICAL AIRWAYS**

a. The establishment of an opening in the cricothyroid membrane is indicated for relief of life-threatening upper airway obstruction when:

- (1) Manual maneuvers (head-tilt-chin-lift, modified jaw-thrust) and attempts at ventilation have failed.
- (2) Endotracheal intubation is not feasible due to:
  - (a) Unable to remove an upper airway foreign body airway obstruction (FBAO).
  - (b) Laryngeal or glottic edema (anaphylaxis, burns, etc.).
  - (c) Maxillofacial trauma (distortion of landmarks).
  - (d) Severe oropharyngeal hemorrhage.

b. Although creating a surgical opening in the cricothyroid membrane is a very invasive procedure, its use may be necessary due to life threatening conditions. Inability to establish an airway due to obstruction or other complication creates a situation that requires quick thinking and rapid action. The surgical airway may be the only viable option in this critical time.

## **2-8. SURGICAL CRICOTHYROTOMY**

a. **Advantages.**

- (1) Rapid, relatively safe procedure.
- (2) Patient experiences noticeably less CO<sub>2</sub> retention because of better ventilation.

**b. Disadvantages.**

- (1) Requires some surgical skill and knowledge of anatomy.
- (2) Only good for a relatively short time (24 to 48 hours).

**c. Contraindications.** A surgical cricothyroidotomy should not be performed on children under 12 years of age. In cases where standard airway maneuvers are unsuccessful, a less invasive needle cricothyroidotomy is indicated.

**d. Complications of Cricothyroidotomy.**

- (1) Asphyxiation.
- (2) Aspiration of blood or stomach contents.
- (3) Cellulitis.
- (4) Esophageal perforation or laceration.
- (5) Incorrect placement (most commonly through the thyrohyoid membrane).
- (6) False passage.
- (7) Subcutaneous or mediastinal emphysema.

**e. Equipment Needed.**

- (1) Body substance isolation (BSI).
- (2) Antimicrobial solution.
- (3) Local anesthetic (lidocaine 1 percent with epinephrine).
- (4) Number 3 scalpel handle with a Number 10 blade (for skin) and a Number 11 blade (to incise the cricothyroid membrane).
- (5) Hemostat (curved mosquito or curved Kelly).
- (6) Oxygen source.

(7) Delivery device.

(a) Tracheostomy tube.

(b) Endotracheal tube. A modified ET tube (7.0 to 7.5 mm) will suffice. Simply remove the connector from the non-cuffed end and cut the tube just above where the inflation line enters the endotracheal tube and replace the connector. Do not cut the inflation line since this will prevent you from inflating the endotracheal cuff to help seal the airway.

f. **Procedure.**

(1) Place the patient in the supine position with the neck moderately hyperextended.

(2) Identify the landmarks. Palpate the "V" notch just above the thyroid cartilage (Adam's apple), which feels like a high, sharp bump. Stabilize the larynx between your thumb and middle fingers while you palpate the site with your index finger. Once you have located the "V" notch, slide your index finger down into the depression between the thyroid and cricoid cartilages; this is the cricothyroid membrane.

(3) Prepare the area with an antimicrobial solution and infiltrate the site with the anesthetic (if time will permit). Utilize a sterile field if available.

(4) Stabilize the larynx and thyroid cartilage with your non-dominant hand.

(5) Make a 2 to 3 cm longitudinal skin incision directly over the cricothyroid membrane (mid-sagittal), carefully incise through the membrane (see figure 2-10).

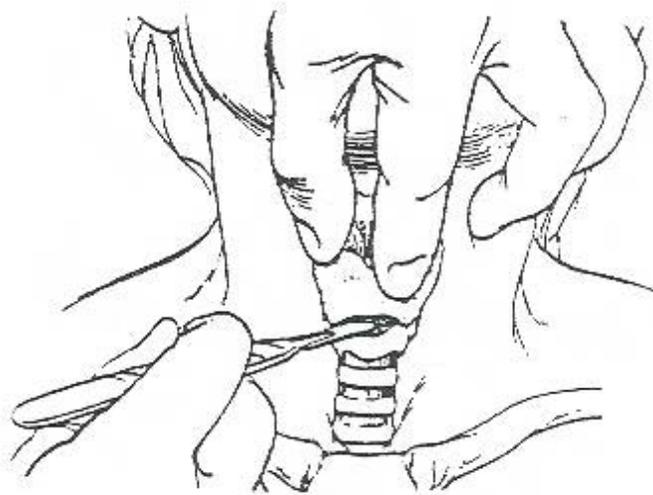


Figure 2-10. Cricothyroid membrane.

(6) Dilate the opening by inserting the blunt end of the scalpel handle into the incision and rotate it 90 degrees to open the airway. Alternately, a hemostat may be used in place of the scalpel handle. You can also use a manufactured or improvised hook device to hold the membrane open as you prepare for the next step in the process.

(7) Insert the cuffed endotracheal tube cut down to just above the pilot balloon into the cricothyroid membrane incision, directing the tube down the trachea approximately 4.5 mm in a caudal direction. Inflate the cuff with approximately 6 to 10 ml of air).

(8) Immediately ventilate the patient and auscultate all lung fields and over the epigastrium. Confirm (symmetrical) rise and fall of the chest. It should be noted that manually-triggered flow-restricted, oxygen-powered ventilation devices (FROPVD) should not be used in conjunction with any of these devices.

(9) Secure the tube with tracheal ties passed around the neck or with tape.

REMEMBER: ASSESS--TREAT--REASSESS

## **2-9. BAG-VALVE-MASK SYSTEMS**

a. The primary function of the bag-valve-mask (BVM) system is to deliver a high concentration of supplemental oxygen (above 55 percent) and simultaneously ventilate the patient. When using the BVM system with an unconscious patient, the use of an oropharyngeal airway is desirable in order to maintain the patient's airway.

b. The primary advantages of the BVM system over the mouth-to-mouth and mouth-to-nose methods are user convenience and the ability to deliver enriched oxygen mixtures. However, the mouth-to-mouth and mouth-to-nose methods can deliver a greater volume of air (up to four liters at a time) than the BVM system (usually one liter). The BVM system may also be used with or without supplemental oxygen to assist the efforts of a spontaneously breathing patient who is having difficult respirations.

c. There are many different BVM systems in use. Most of them use these following items:

(1) A self-inflating bag.

(2) A non-return valve to prevent rebreathing exhaled air.

(3) A face mask, usually made of clear plastic so that vomitus or secretions around the patient's mouth can be seen.

(4) An inlet for supplemental oxygen delivery.

d. Most systems have oxygen reservoir bags and adaptors for use with endotracheal and tracheostomy tubes. The type of supplemental oxygen delivery system used depends on the patient's ability to adequately inhale a sufficient volume of air. If he is unable to inhale efficiently, a BVM system is used to force a greater volume of air and oxygen into the lungs. If the patient requires an increase in oxygen content and is able to inhale adequately, a simple face mask or nasal prongs is preferred if available.

## 2-10. PROCEDURE FOR VENTILATING THE PATIENT USING A BAG-VALVE-MASK SYSTEM

a. **Survey the Patient.** Visually check the patient for obvious causes of breathing difficulty. If no difficulties are evident, check further to determine his ability to breathe on his own.

b. **Position Yourself and Patient.** Position yourself behind the patient's head. In a hospital situation, the headboard of the bed may have to be removed or the patient moved partially across the bed to bring his head closer to the edge of the bed.

c. **Insert Oropharyngeal Airway, if Appropriate.** If the patient is unconscious, insert an oropharyngeal airway (J-tube) in order to keep the airway open while you use the BVM. If the patient is conscious or semi-conscious, do not use the J-tube.

d. **Stretch Mask.** Check the mask and bag to ensure that they are in working order (no rips, and so forth). Then stretch the mask on both sides with your thumbs and fingers (figure 2-11) so that the mask will fit the patient.

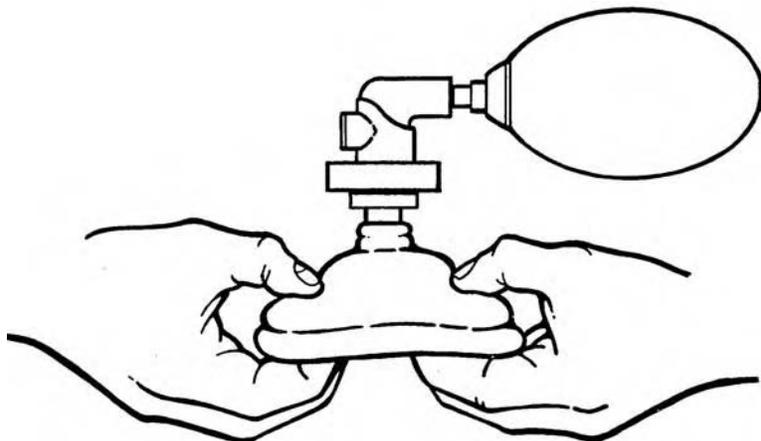


Figure 2-11. Stretching the mask.

**e. Seat Mask.**

(1) Place the mask over the patient's nose and mouth to so that it fits over the bridge of the nose, extends below the lower lips (figure 2-12), and forms a tight seal. As the stretched mask is positioned on the patient's face, it will return to its original shape and the patient's skin will be pulled slightly inward.



Figure 2-12. Positioning the mask.

(2) Place your thumb and index finger of one hand on the mask. Position the thumb above and the finger below the valve connection. Use the other fingers (on the same hand) to grip the lower jaw in order to maintain the tight seal of the mask (figure 2-13).

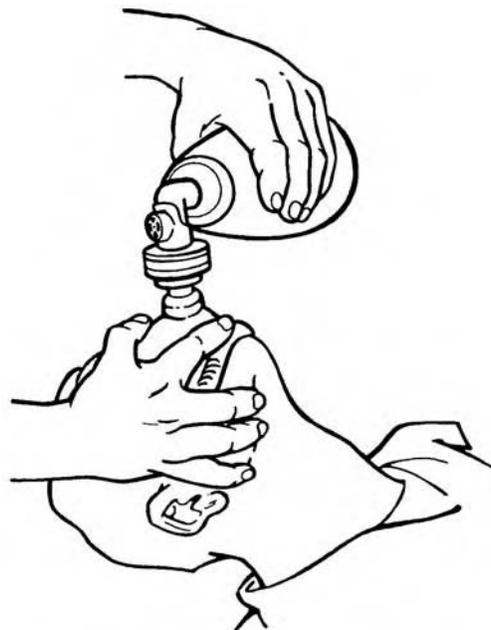


Figure 2-13. Giving ventilations using BVM.

f. **Begin Ventilations.** Perform ventilations by squeezing the bag with the hand that is not holding the mask in place (figure 2-13).

(1) Squeeze two breaths lasting about 1 second each into the bag.

(2) Thereafter, use your other hand to squeeze the bag in a rhythmical manner once every five seconds to give a rate of about twelve breaths per minute.

(3) An oxygen source may be attached to the mask if available and ordered by a physician.

(4) A reservoir bag should be used with the BVM to help obtain nearly 100% oxygen concentration.

**NOTE:** When the BVM system is used to assist the breathing of a spontaneously breathing patient, time the ventilations so they will coincide with the patient's inhalations by observing the rise and fall of his chest. Try to obtain a more normal rate and depth of respirations.

g. **Check for Effectiveness.** Observe the patient's chest to see if it rises and falls. If the chest does not rise and fall, reopen or clear the airway. If the rising and falling chest movement is observed, continue to ventilate the patient.

h. **Continue Ventilations.** Continue to ventilate the patient at a rate of one breath every five seconds until spontaneous breathing returns. When the patient begins to breathe on his own again, time your ventilations to correspond to the patient's inhalations. Continue until the patient's respirations attain a normal rate and depth or until you are ordered to stop by a physician.

i. **Evacuate, if Needed.** In a field situation, you may need to prepare a Field Medical Card and evacuate the patient for further evaluation and treatment by a physician. Maintain adequate ventilation en route, if necessary.

**Continue with Exercises**

## EXERCISES, LESSON 2

**INSTRUCTION.** The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. Why is the J-tube not used for conscious and semi-conscious patients?

---

---

2. When do you remove the airway?

---

---

3. List the steps to follow when inserting a J-tube after the patient's airway has been opened.

---

---

---

---

4. What do you do if you have difficulty keeping the tongue in the proper position while inserting the J-tube?

---

---

5. List the steps used when putting the mask of a BVM on a patient's face.

---

---

---

---

6. List the contraindications for the use of the nasalpharyngeal airway.

---

---

---

7. What are the advantages of the surgical cricothyrotomy?

---

---

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 2

1. Conscious and semi-conscious patients may still have a gag reflex and the presence of an airway may induce vomiting and cause aspiration of the stomach contents into the lungs. (para 2-4d)
2. When the patient starts to regain consciousness, or gags. (para 2-4e)
3. Place the tip of the airway into the patient's mouth.

Point the tip of the airway toward the roof of the patient's mouth to prevent the tongue from being pushed into the back of the throat.

Slide the airway along the roof of the mouth, following the natural curvature of the tongue, past the soft palate.

Rotate the airway 180 degrees as the tip reaches the back of the tongue.

Gently advance the airway and adjust it so the flange rests on the patient's lips. (para 2-4d(1) through (5))

4. Grasp the tongue with your index finger and thumb (using a gauze pad, if available) and pull the tongue forward or use a tongue blade to depress the tongue. (para 2-4d(6))
5. Check the mask and bag to ensure that they are in working order.

Stretch the mask on both sides with your thumbs and fingers.

Place the mask over the patient's nose and mouth so that it fits over the bridge of the nose and extends below the lower lips and forms a tight seal.

Place your thumb and index finger of one hand on the mask. Position the thumb above and the finger below the valve connection.

Grip the patient's lower jaw with the other fingers in order to maintain the tight seal of the mask (para 2-10d, e).

6. Any evidence of a head injury or roof of mouth (cribriform) fracture.  
Exposed brain matter.  
CSF draining from nose, mouth or ears (para 2-2(2), (a), (b), (c))
7. Rapid, relatively safe procedure.  
Patient experiences noticeably less CO<sub>2</sub> retention because of better ventilation. (para 2-8a(1), (2))

**End of Lesson 2**

## LESSON ASSIGNMENT

### LESSON 3

Administering Oxygen.

### LESSON ASSIGNMENT

Paragraphs 3-1 through 3-8.

### LESSON OBJECTIVES

After completing this lesson, you should be able to:

- 3-1. Identify the purpose of oxygen therapy.
- 3-2. Identify medical conditions that should be treated with oxygen therapy and those that should not be treated with oxygen therapy.
- 3-3. State the signs, symptoms, and treatment for hypoxemia and hyperventilation.
- 3-4. State/identify the procedures for setting up an oxygen tank.
- 3-5. State/identify the procedures for setting up a wall oxygen unit.
- 3-6. State/identify the procedures for administering oxygen therapy using nasal prongs.
- 3-7. State/identify the procedures for administering oxygen therapy using a face mask.
- 3-8. Calculate the duration of flow.
- 3-9. State/identify procedures for managing the patient on oxygen therapy.
- 3-10. State/identify safety procedures used with oxygen.

### SUGGESTIONS

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you achieve the lesson objectives.

## LESSON 3

### ADMINISTERING OXYGEN

#### 3-1. GENERAL

Oxygen is essential to life. It cannot be stored in the body. The supply of oxygen must be constant and in sufficient amounts to sustain the life of the body's cells. Body tissues die when they are deprived of oxygen. Brain cells can be damaged beyond recovery in three to seven minutes.

#### 3-2. HYPOXEMIA AND OXYGEN THERAPY

Normally, the 21 percent concentration of oxygen in inspired room air is adequate for the body. However, after any severe disturbance of the respiratory or circulatory system, hypoxemia (low level of oxygen in the blood) can occur. Hypoxemia can occur at varying levels. If it is severe, it may cause irreversible tissue damage in a short period of time. Oxygen therapy may be used for acute or chronic conditions that cause hypoxemia.

a. **Signs and Symptoms of Hypoxemia.** Signs and symptoms of hypoxemia include:

- (1) Increased heart rate (tachycardia).
- (2) Increased respiratory rate (tachypnea).
- (3) Difficult or labored breathing (dyspnea).
- (4) Shortness of breath.
- (5) Restlessness.
- (6) Mental confusion and weakness.
- (7) Cyanosis (bluish tint of skin--a late sign).

b. **Treatment of Hypoxemia.** Hypoxemia is treated by administering extra oxygen (oxygen therapy). Prolonged oxygen therapy and/or high doses may cause respiratory complications such as hyperventilation or atelectasis. This is not a major concern in the pre-hospital environment and oxygen should never be withheld from anyone, especially in times of respiratory distress. Oxygen is normally supplied from tanks (also called cylinders and bottles) or from wall outlets (piped-in oxygen).

### 3-3. IDENTIFYING NEED FOR OXYGEN THERAPY

Certain medical conditions require that the patient receive oxygen in greater amounts than is available in the atmosphere.

a. Cardiac conditions, such as heart attack and congestive heart failure, require oxygen therapy. Congestive heart failure (CHF) is a condition in which the heart fails to maintain an adequate output, resulting in a diminished blood flow to the tissues and congestion in the pulmonary and/or systemic circulation.

b. Pulmonary edema (an excessive collection of fluid in the pulmonary tissues and air spaces), shock, hemorrhage, or any airway obstruction requires the use of oxygen. An acute respiratory failure and/or pulmonary insufficiency (impaired gas exchange between the circulating blood and the surrounding air) also requires the administration of oxygen. All trauma patients should receive oxygen, if possible. In the combat environment, this may not be available until much later in the care of the patient than is commonly recommended.

### 3-4. DELIVERY DEVICES

The two major devices for oxygen delivery are the non-rebreathing face mask and the nasal prongs (cannula). The amount of oxygen delivered is dependent upon the flow rate (given in liters per minute) and the patient's respiration rate.

a. **Nasal Prongs.** The nasal prongs (nasal cannula) are most frequently used to administer a low concentration of oxygen. It is a short, disposable, plastic tube with two plastic prongs that fit into the patient's nostrils. It is held in place with an elastic headband (figure 3-1). The nasal cannula is relatively comfortable and enables the patient to eat, talk, and move without difficulty; however, the prongs can be easily dislodged by restless or disoriented patients. To be effective, the patient's nasal passages must be clear.

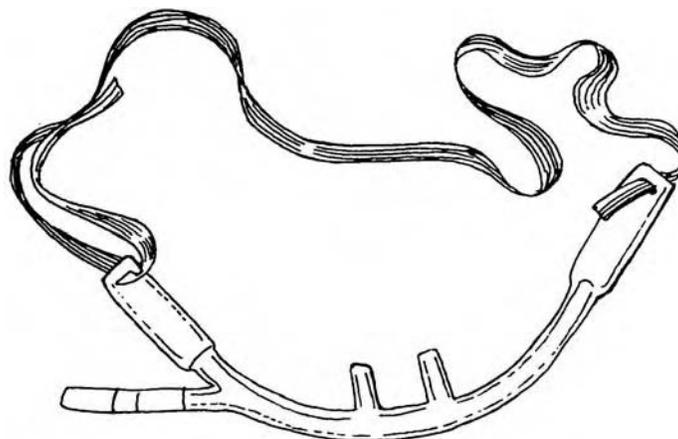


Figure 3-1. Nasal cannula.

b. **Non-Rebreathing Face Mask.** The most commonly used oronasal face mask is a disposable, clear plastic type that covers the nose and mouth and has a reservoir bag increase the inspired oxygen concentration to nearly 95 percent. Exhaled air passes through small holes in the sides of the mask. These holes also allow room air to be drawn in and mixed with the oxygen. This device must be used with caution with patients who may be unable to maintain a clear airway, including patients who may vomit easily and are unable to remove the mask to prevent aspiration of the stomach contents. The mask must be replaced with nasal prongs while the patient eats and put back in place after he has finished the meal. Use the face mask, not the prongs, if the patient is unconscious or has an artificial airway.

### 3-5. PROCEDURE FOR SETTING UP AN OXYGEN TANK

The nasal prongs and the face mask require an oxygen source, usually from an oxygen tank or from piped-in oxygen. Most fixed-facility hospitals have piped-in oxygen. However, older hospitals and non-fixed facilities rely on oxygen tanks (figure 3-2) to deliver oxygen. If an oxygen tank is to be used, it must be properly prepared.

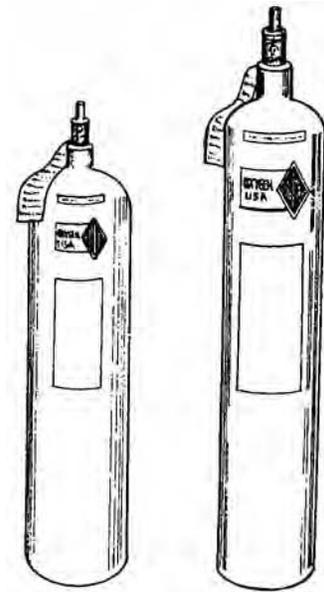


Figure 3-2. Oxygen (O<sub>2</sub>) cylinders.

a. **Determine Need to Set up an Oxygen Tank.** In a hospital, you will set up an oxygen tank when required to do so by orders from the physician or supervisor or when required to do so by the standing operating procedures (SOP). In a field situation, the medic must use his own judgment in determining the need for oxygen.

b. **Perform Handwash.** Follow procedures for performing a patient care handwash.

c. **Obtain Equipment.** Obtain the following equipment as needed.

(1) Full oxygen tank (cylinder). Oxygen tanks are usually kept in a central location designated by the hospital SOP.

(a) Oxygen tanks are color coded (painted) **green**; however, the international color code for oxygen is **white**.

(b) Tanks are available in various sizes, but the most commonly used tanks are D, E, and M cylinders. The "D" tank contains 356 liters of oxygen; the "E" contains 650 liters; and the "M" contains 3,000 liters. Each is filled to specified limits with a pressure of from 2,000 to 2,200 pounds per square inch (p.s.i.). As the oxygen is used, the pressure decreases. A tank is considered to be sufficiently pressurized for use as long as it maintains a pressure of 500 p.s.i. or greater.

(c) Check the tag on the oxygen cylinder. The oxygen cylinder tag is a three-part perforated design with the three sections labeled "Full," "In Use," and "Empty" (figure 3-3). The tag should have all three sections intact. When the cylinder is turned on for use by the patient, the "Full" segment is torn off. When the tank is empty, the "In Use" segment is removed, leaving the only the "Empty" portion of the tag. The tank is considered to be empty when the gauge reads 500 p.s.i. A residual pressure of 200 p.s.i. should be maintained on all tanks.

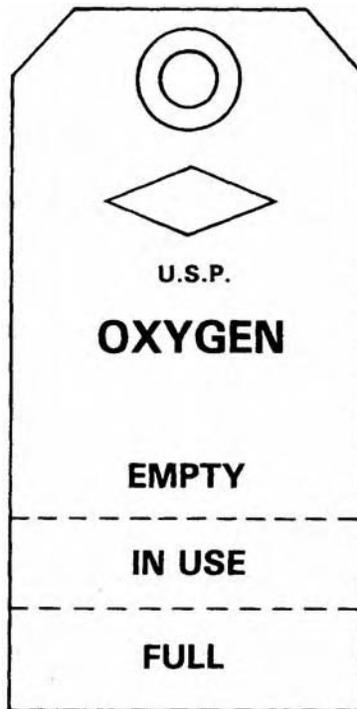


Figure 3-3. Cylinder tag.

(2) Oxygen cylinder truck, if applicable. A transport designed for gas cylinders must be used when moving a large ("M") oxygen cylinder.

(3) Cylinder regulator. The cylinder regulator (figure 3-4) is used to control the flow of oxygen from the cylinder. The oxygen in the cylinder is under great pressure. By controlling the rate at which oxygen leaves the cylinder, the oxygen pressure is lowered to a pressure that is safe for the patient. The regulator ensures a steady, even flow of oxygen and provides a means for adjusting the rate of flow. The cylinder regulator has two gauges.

(a) The cylinder contents gauge shows the amount of oxygen in the cylinder and is calibrated in pounds of pressure per square inch (p.s.i.). When the tank is almost depleted (a pressure of 500 p.s.i. is considered to be "on empty"), the needle points to a red warning that the tank needs to be replaced.

(b) The second gauge, called a flow meter (or flow indicator gauge) shows the amount of oxygen being delivered and is calibrated in liters per minute. There are two main types of flow meters. One is the Bourdon gauge (round type) shown in figure 3-4. The other is the pressure compensated flow meter that works on gravity and must be kept upright. A pressure compensated flow meter is shown in figure 3-10.

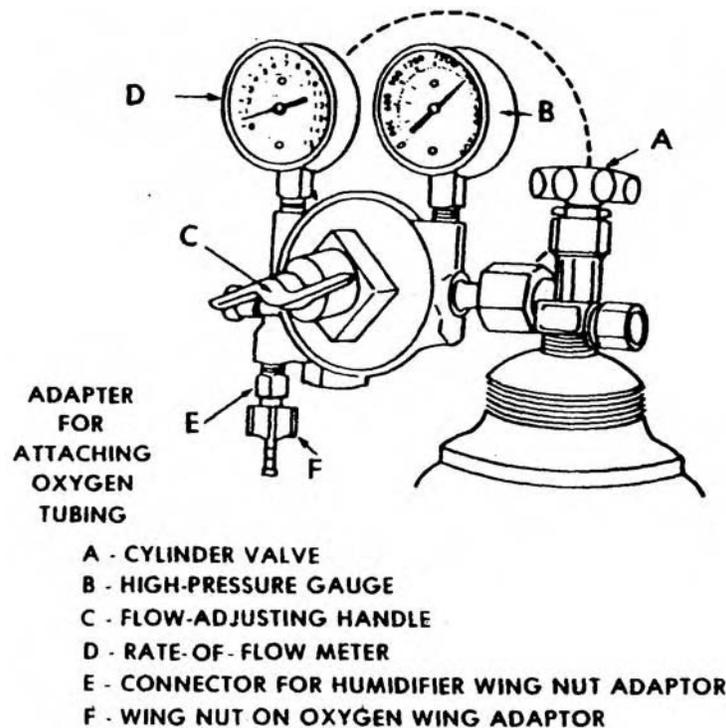


Figure 3-4. Cylinder regulator.

**CAUTION:** Because of the extreme pressure in these tanks, they should be handled with the utmost care and respect. If the tanks are violently banged together, dropped, or knocked over, the valve may be broken. A broken valve can cause the tank to become an uncontrolled torpedo-like object, destroying whatever is in its path.

(4) Humidifier. A humidifier (figure 3-5) is used to add moisture to the oxygen. This helps to prevent drying and irritation of the patient's mucous membranes during the administration of oxygen.



Figure 3-5. Humidifier.

(5) Distilled water. One liter of distilled water is needed to fill and replenish the humidifier.

(6) Non-sparking cylinder wrench. Non-sparking wrenches (figure 3-6) are used to reduce the chance of a spark occurring in case the wrench hits against the metal cylinder. Non-sparking wrenches are usually made of brass. A non-sparking wrench is normally attached to the cylinder stand or carrier.

(7) Oxygen delivery system. An oxygen delivery device (nasal prongs or non-rebreathing mask) and tubing to connect the delivery device to the oxygen supply is needed.

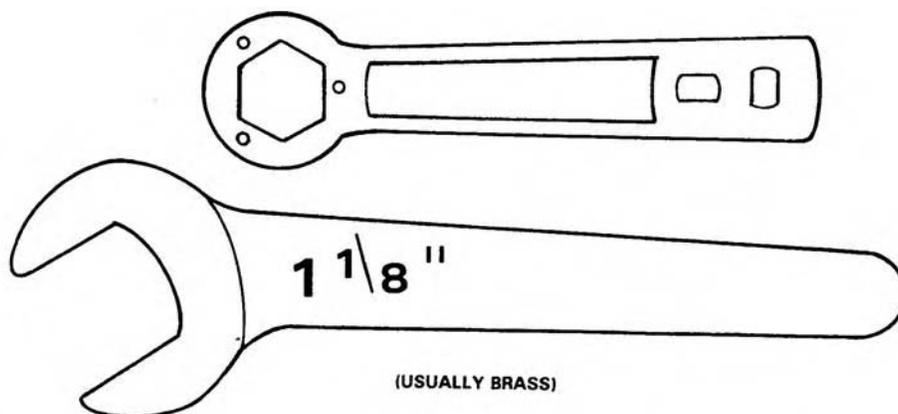


Figure 3-6. Nonsparking cylinder wrenches.

d. **Remove Cylinder Valve Cap.** All oxygen cylinders have a steel cap that is screwed onto the top of the cylinder to protect the valve from damage while the cylinder is not in use. The cap may be difficult to remove or noisy during removal. Do not oil the threads of the cylinder cap. Even though oxygen itself does not burn or explode, it does support combustion. In an oxygen-enriched atmosphere, a small spark can cause flammable objects (bed linen, and so forth) or flammable liquids (oil, etc.) to burst into flames. Remove the cylinder valve cap by turning it counterclockwise with your hand.

e. **"Crack" the Cylinder.** "Crack" the cylinder by fitting a handwheel over the cylinder stem, quickly turning the cylinder handwheel counterclockwise to open the valve slightly, and immediately turning it back clockwise to close the valve (figure 3-7). The "cracking" procedure produces a loud hissing noise that can be frightening if not expected; therefore, it should be accomplished prior to moving the cylinder into the patient's room. "Cracking" the cylinder removes any dust particles that may have accumulated on the outlet.

(1) If the cylinder valve does not have a handwheel, fit a non-sparking cylinder wrench over the stem, turn counterclockwise, and immediately turn back clockwise to close the valve. "M" cylinders usually have handwheels; the smaller cylinders usually do not.

(2) If the cracking procedure does not result in a noisy rush of air through the valve, report the problem to your supervisor and obtain another cylinder.

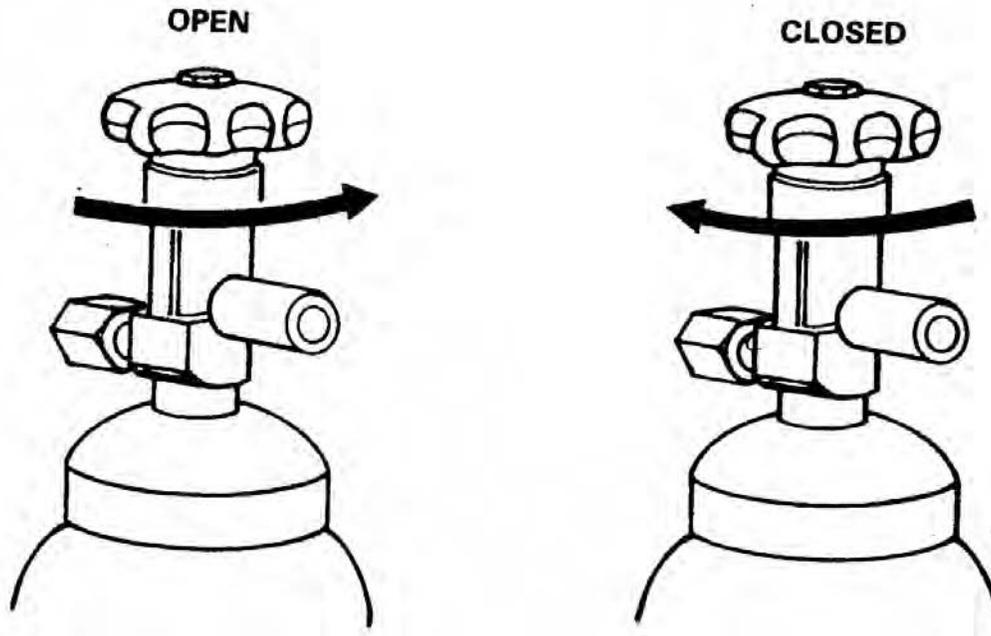


Figure 3-7. "Cracking" the cylinder.

f. **Move the Cylinder.** Move the cylinder into the patient's room at this time if so desired. However, you may wish to attach other devices before moving the cylinder. When the cylinder is taken to the patient area, put the cylinder beside the head of the bed away from doors, doorways, heaters, and areas that have heavy traffic.

g. **Attach the Cylinder Regulator.**

(1) "M" cylinder. To attach the cylinder regulator to the oxygen cylinder, hold the gauges in the upright position. Then insert the male portion of the cylinder regulator inlet into the threaded outlet on the oxygen cylinder (figure 3-8). Use your hand to tighten the inlet nut located on the cylinder regulator. Complete the tightening of the nut with a non-sparking wrench.

(2) "D and "E" cylinders. Attach the yoke regulator to the cylinder using the following procedures.

(a) Locate the three holes on the cylinder stem as shown in figure 3-9.

(b) Examine the yoke attachment and locate the three pegs that correspond to the holes on the cylinder stem (figure 3-9).

(c) Make sure that the "O" ring is present on the main peg of the attachment. If the ring is not present, an oxygen leak could develop.

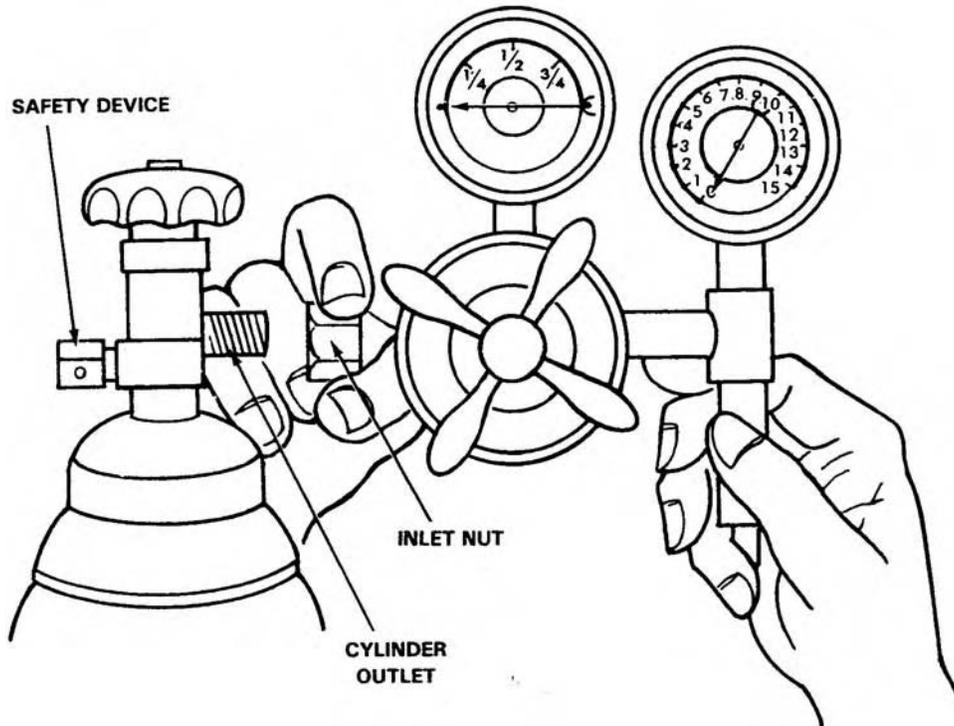


Figure 3-8. Attaching a cylinder regulator.

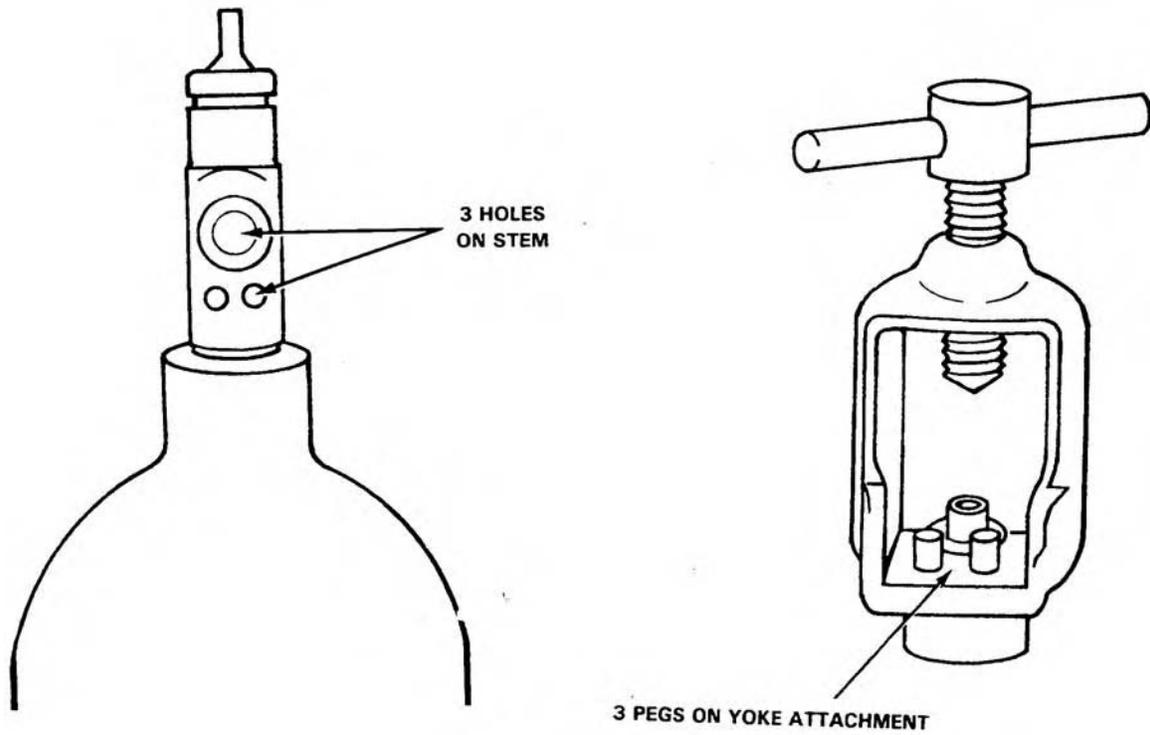


Figure 3-9. Cylinder stem and yoke attachment.

(d) Holding the yoke attachment firmly in both hands, slide it over the cylinder stem, making sure the pegs are correctly seated in the proper holes. The main peg connects with the oxygen valve. The two lower pegs must fit into the two smaller holes below the valve. The two lower holes are a safety precaution. Each type of gas container (oxygen, nitrous oxide, etc.) has the lower holes located in different positions. The different hole locations prevent an oxygen delivery system from being connected to a non-oxygen cylinder.

(e) Turn the viselike screw on the slide of the yoke attachment to secure it.

h. **Fill the Humidifier.** Fill the humidifier bottle with distilled water so that the water level is between the marked minimum and maximum levels (approximately 2/3 full). Refill as necessary to maintain water level above the minimum mark.

(1) Because oxygen is very drying to the mucous membranes, it is bubbled through water to add humidity that makes it less irritating to tissues. Oxygen may be administered without humidification for short periods such as in emergency situations or during transportation.

(2) Bacterial growth on oxygen humidifiers may occur. Therefore, humidifiers and tubing should be changed at least every 24 hours or in accordance with local SOP.

i. **Attach the Humidifier to the Flow Meter.** Remove the oxygen tube connector from the flow meter by turning the wing nut. Attach the wing nut on the humidifier to the flow meter and secure by tightening the wing nut (figure 3-10).

j. **Attach the Administering Device.** Open the package containing the device to be used in administering the oxygen (nasal prongs or face mask) only far enough to expose the end of the connecting tube. Attach the end of the connecting tube to the oxygen outlet on the humidifier. The rest of the device should remain in the wrapper until ready for use to protect it from dust and contamination.

k. **Secure the Oxygen Cylinder.** Secure the cylinder in accordance with the local policy. Some facilities have special devices used to secure oxygen cylinders. Other facilities use straps to secure the cylinder to stable areas such as the bed or the wall.

l. **Report the Setup Procedure.** Report the completion of the setup procedure to the supervisor.

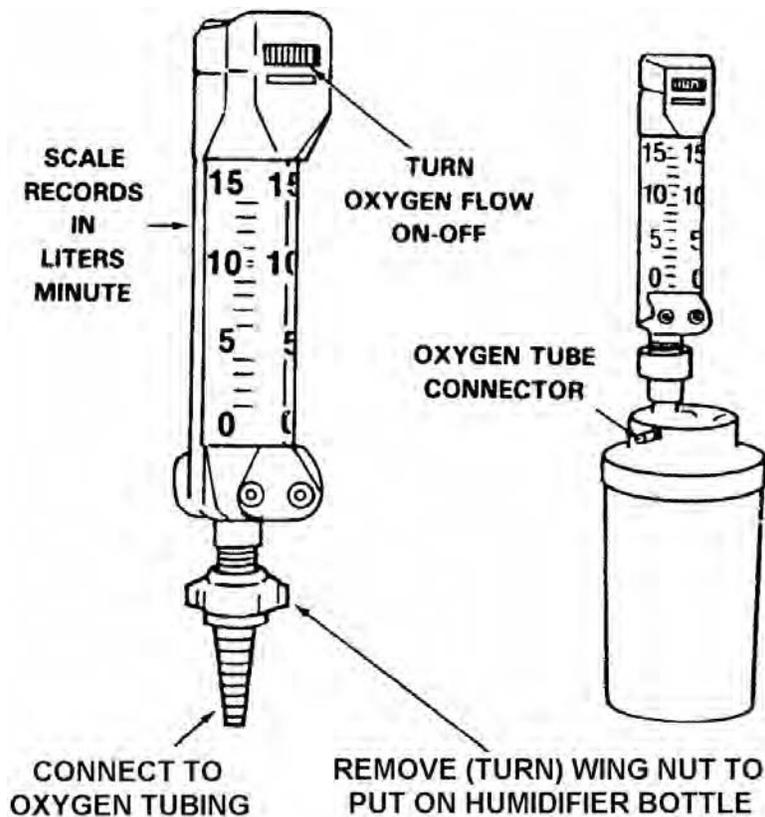


Figure 3-10. Attaching humidifier to flow meter.

### 3-6. PROCEDURE FOR SETTING UP A WALL OXYGEN UNIT

When oxygen is to be obtained from a piped-in supply, a station valve is located on the wall. Two general types of station outlet valves are currently in use. One is a manually operated valve with which the oxygen is turned on and off with a knob (figure 3-11). The other type is the "quick connect" coupler to which a flow meter can be connected simply by plugging it into the valve (figure 3-12). Other piping outlets, such as vacuum, may be located in the same area with the "quick connect" oxygen outlet. The wall outlet is keyed so that only oxygen equipment can be plugged into an oxygen valve and only vacuum equipment can be plugged into a vacuum valve. Oxygen outlets are color-coded **green** and vacuum outlets are color-coded **yellow**.

a. **Determine Requirement To Set Up Wall Oxygen Unit.** The requirement for the wall oxygen unit to be set up will normally be obtained from the physician's order or from your supervisor.

b. **Perform Handwash.** Follow the procedures for performing a patient care handwash.

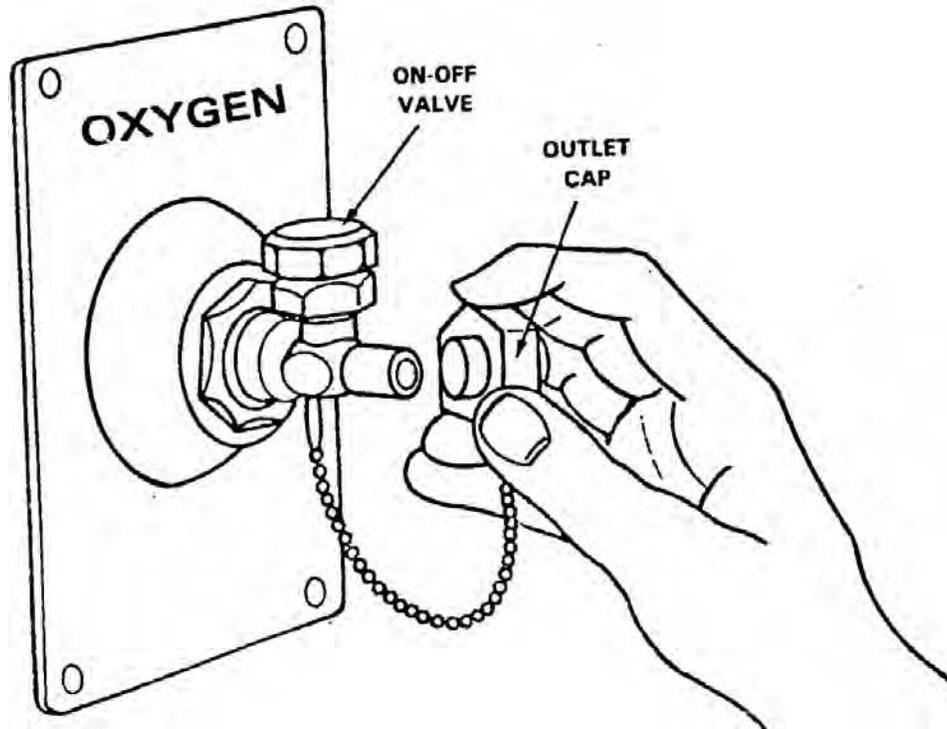


Figure 3-11. Manually operated valve.

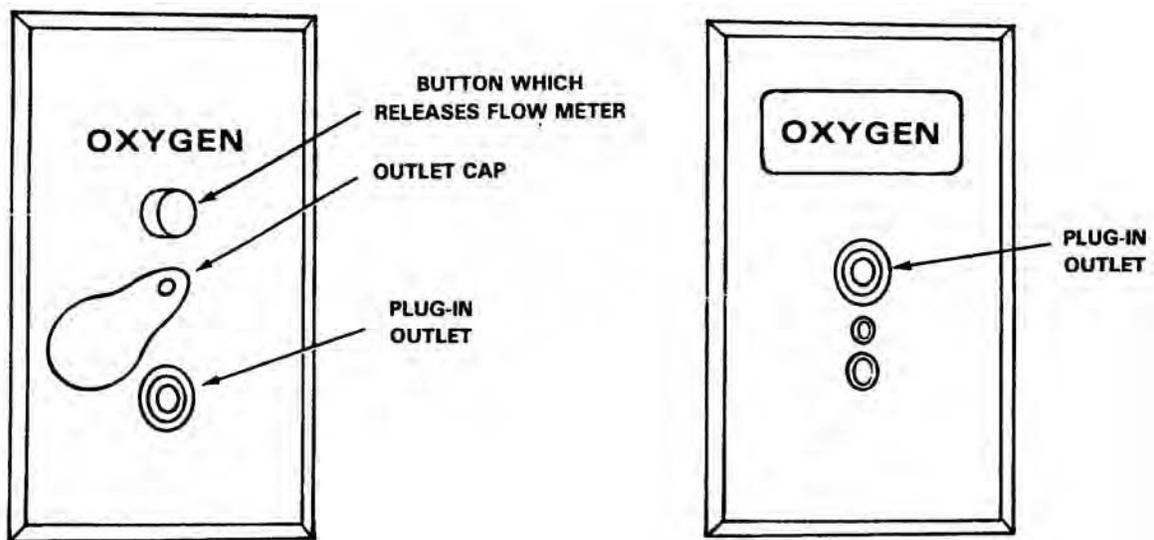


Figure 3-12. "Quick connect" couplers.

c. **Obtain Equipment.**

(1) Flow meter. Oxygen flows through the pipeline at a low pressure, usually 50-60 pounds per square inch. A flow meter (figure 3-13) must be attached to the wall outlet to control the flow of oxygen to the patient.

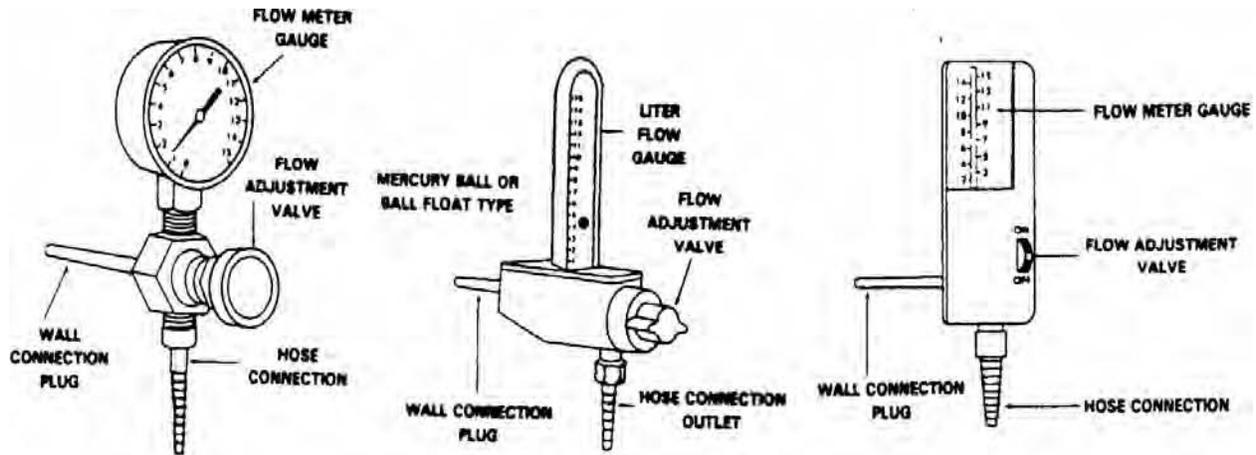


Figure 3-13. Flow meters for wall oxygen setups.

(2) Humidifier. The humidifier prevents drying and irritation of the patient's mucous membranes by adding moisture to the oxygen being inhaled.

(3) Distilled water. One liter of distilled water will be needed for the humidifier.

(4) Delivery device. Obtain the packaged nasal prongs or face mask as per physician's order or supervisor's directive.

d. **Fill Humidifier Bottle.** Fill the humidifier bottle to the level indicated (about 2/3 full) with distilled water. Refill as necessary to maintain the water level above the minimal level.

e. **Attach Humidifier to Flow Meter.** Remove the oxygen tube connector from the flow meter by turning the wing nut. Attach the wing nut on the humidifier to the flow meter outlet; then secure the wing nut to the flow meter.

f. **Attach Flow Meter to Wall Unit.** Close or turn the flow-adjusting valve of the flow meter to the "off" position. (Closing or turning the flow adjusting valve/dial to the "off" position will prevent damage to the gauge caused by a sudden influx of oxygen under pressure.) Insert the flow meter adapter into the opening of the oxygen outlet (figure 3-14) and press until a firm connection is made. You will hear a small "hiss" when the connection has been made.

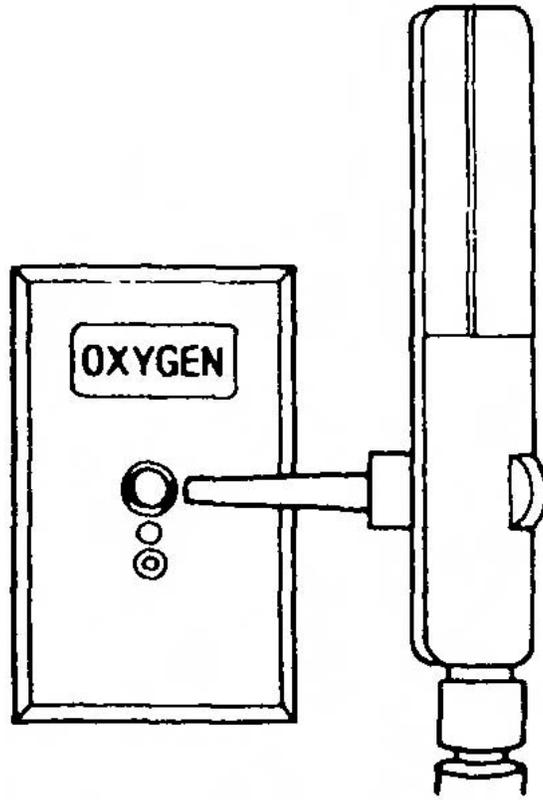


Figure 3-14. Attaching flow meter to "quick connect" coupler.

g. **Attach Delivery Device.** Open the package of the device (nasal prongs or face mask) only far enough to expose the end of the connecting tube. Attach the end of the connecting tube to the oxygen outlet on the humidifier. After the connecting tube is attached to the humidifier outlet, leave the rest of the device in the wrapper until it is ready to be used. This will protect it from dust and contamination.

h. **Report to Supervisor.** Report the accomplishment of the procedure to the supervisor.

### 3-7. PROCEDURE FOR ADMINISTERING OXYGEN USING NASAL PRONGS OR NON-REBREATHING FACE MASK

a. **Identify the Patient.** Determine the patient's name by asking his name and by checking his identification bracelet and bed card.

b. **Explain the Procedure to the Patient.** Show the nasal cannula or face mask to the patient and explain what is going to happen during the administration of oxygen.

c. **Prepare the Equipment for Administering Oxygen.** Ensure that the humidifier is filled to the proper level. (If the humidifier is too full, the bubbling water will overflow into the gauges.) Attach the humidifier to the flow meter and attach the connecting tube from the nasal cannula or face mask to the humidifier (paragraphs 3-5 and 3-6). Set the flow rate at two liters per minute. Feel to determine if the oxygen is flowing through the nasal tips of the cannula.

d. **Calculate the Duration of Flow.** The duration of flow is the estimated amount of time that a given cylinder of oxygen will supply oxygen at a given rate. A safety factor (the safe residual) is built into the formula.

(1) Determine the pressure of the oxygen in the cylinder from the pressure gauge on the cylinder.

(2) Determine the safe residual level. The safe residual established by the American Academy of Orthopedic Surgeons is 200 p.s.i. Your SOP, however, may establish a different safe residual.

(3) Determine the available cylinder pressure by subtracting the safe residual from the cylinder pressure. For example, a cylinder with a pressure of 2000 p.s.i. has an available pressure of 1800 p.s.i. if the safe residual level is 200 p.s.i. (2000 - 200 = 1800 p.s.i. available pressure.)

(4) Determine the conversion factor. Each type of oxygen cylinder employs a conversion factor based upon its size. For example, the "D" cylinder authorized for use in battalion aid stations has a conversion factor of 0.16. The conversion factors are:

(a) "D" = 0.16

(b) "E" = 0.28

(c) "G" = 2.41

(d) "H" & "K" = 3.14

(e) "M" = 1.56

(5) Determine the available liters by multiplying the available pressure by the conversion factor. For example, a "D" oxygen cylinder with an available cylinder pressure of 1800 p.s.i. has 288 liters of available oxygen (1800 x 0.16 = 288). Remember that the available liters do not include the oxygen that is still left in the cylinder when the safe residual level is reached.

(6) Determine the flow rate. The flow rate is prescribed by the physician and expressed as liters per minute (lpm or l/m).

(7) Determine the duration of flow by dividing the available liters by the flow rate. For example, a cylinder with 288 available liters of oxygen that is to be administered at a rate of 10 lpm will reach the safety level and need to be replaced by a new cylinder after 29 minutes ( $288 / 10 = 28.8$ ; fractions of a minutes are rounded up or down, as appropriate).

**e. Apply the Nasal Prongs or Non-Rebreathing Face Mask.**

(1) Nasal prongs.

(a) Place the tips of the prongs in the patient's nose.

(b) Position the prongs so that the tips do not extend more than one inch (2.5 cm) into the nose.

(c) Adjust the flow rate to the prescribed rate. A flow rate of one to six liters per minute should provide an inspired oxygen concentration of 22 to 44 percent, depending on the patient's breathing pattern.

(d) Secure the headband or retaining strap so that it is comfortable for the patient and is sufficient to hold the apparatus in place.

(e) Fasten the tubing to the pillow and bed clothing. Ensure that the tubing is secure and is not kinked or crimped.

(2) Non-rebreathing face mask. The patient who requires low, constant concentrations of oxygen and whose breathing pattern varies greatly may need to use the Venturi mask, especially if the patient is prone to retain carbon dioxide.

(a) Obtain the proper size mask.

(b) Before applying, hold the mask near the patient's face to show him how it and the retaining strap are to be placed.

(c) Start the oxygen at the prescribed rate. This is done prior to the placement of the mask since the patient may be less apprehensive if he hears the oxygen coming through the mask.

(d) Place the mask on the patient's face. Tell the patient to breathe naturally while you are adjusting the mask over his mouth and nose.

(e) Adjust the headband or retaining strap so that it is comfortable for the patient and holds the mask securely in place.

f. **Position Patient.** Place the patient in the semi-Fowler's position for ease of breathing.

g. **Record the Procedure on the Nursing Notes.** Record the time the treatment was initiated, the method used, the rate of flow, and the patient's response to treatment given.

**h. Manage the Patient and Equipment at Regular Intervals.**

(1) Observe the patient for mental confusion, for disturbed unconsciousness, and for abnormal color. Check for any change in the patient's blood pressure and for increasing heart and respiratory rates.

(2) Check the equipment. Make sure that the tubing connections are intact, the flow meter registers at the prescribed rate, and the nasal prongs or face mask is positioned properly. Check the water level in the humidifier and refill as needed. Change the cannula, humidifiers, tubing, and other equipment exposed to moisture on a daily basis. The equipment is changed daily because moisture can promote bacterial growth, thus rendering the equipment contaminated and creating conditions which can cause infections.

### **3-8. SAFETY PRECAUTIONS ASSOCIATED WITH OXYGEN THERAPY**

a. Post "Oxygen" and "No Smoking" signs. These signs should be posted on the cylinder in use, in oxygen storage areas, and at entrances to a ward or room where oxygen is in use. The chief danger in using oxygen is fire. The pressure of oxygen in increased concentrations makes all materials more combustible. Things that burn slowly in ordinary air will burn violently and even explosively in the presence of increased oxygen.

b. Inform the patient and visitors of the requirement for no smoking and no open flames in the room. None of these should be a problem in the modern hospital since smoking is not allowed in any Army hospital or other federal buildings; however, in third world countries, this may not be the case.

c. Ensure that oil or grease is not used around the oxygen fittings. (Petroleum-based products will burn.)

d. If an oxygen tank is used, secure it away from the door and high traffic areas to reduce potential unauthorized tampering of cylinder gauges and to reduce the possibility of the cylinder being knocked over and the valve being damaged or broken.

e. Use only nonsparking wrenches on tanks.

f. Ensure that all electrical equipment is properly grounded. If necessary, have medical maintenance personnel check electrical plugs and outlets.

g. Avoid static-generating materials. Avoid nylon or other static-generating materials in uniforms, nightgowns, and pajamas. Do not use wool blankets on the bed since they also produce static.

h. When transporting a large oxygen cylinder, strap it to the carrier. If the oxygen cylinder is not secured, it may drop or fall. Upon falling, the weight of the cylinder may injure personnel or patients and damage equipment, walls, and flooring. The valve could possibly break off from the cylinder creating a high velocity missile (the cylinder) because of the suddenly released high pressure. A full oxygen cylinder has enough force to penetrate concrete walls.

**Continue with Exercises**

### EXERCISES, LESSON 3

**INSTRUCTIONS.** Answer the following items by completing the statement or by writing the answer in the space provided at the end of the item.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. What is hypoxemia?

---

2. How is hypoxemia treated?

---

3. Name two ways in which oxygen is normally supplied.

---

---

4. What is the US color code for oxygen tanks? The international color code?

---

5. How could the oxygen tank become an uncontrolled torpedo-like object?

---

6. Why is a cylinder regulator used when administering oxygen?

---

---

---

7. A flow meter (or flow indicator gauge) is calibrated in \_\_\_\_\_.

8. Why is the humidifier used when administering oxygen?

---

---

9. How do you "crack" the cylinder?

---

---

10. Humidifiers and tubing should be changed at least every 24 hours or in accordance with the local SOP because:

---

---

11. Vacuum outlets may be located in the same area with the oxygen outlet. Oxygen outlets are color coded \_\_\_\_\_ and vacuum outlets are color coded \_\_\_\_\_.

12. When you are attaching the flow meter to the wall unit (piped-in oxygen), why do you close or turn the flow adjusting valve of the flow meter to the OFF position?

---

---

13. Why must the face mask be used with caution?

---

---

14. What are four of the signs and symptoms of hyperventilation?

---

---

---

---

15. How would you treat a person who is hyperventilating?

---

---

---

---

16. When do you replace the oxygen cylinder with one that is full?

---

---

17. The conversion factor for the "D" type cylinder is \_\_\_\_\_.

18. A "M" cylinder is at 2100 p.s.i. The safe residual level is 200 p.s.i. the rate of flow is 9 l/m. What is the duration of flow?

---

19. Position the nasal prongs in the patient's nose so that the tips do not extend more than \_\_\_\_\_ into the nose.
20. You are checking on a patient who is being administered oxygen. What are four of the danger signs that indicate a problem?
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
21. Use only \_\_\_\_\_ wrenches on oxygen tanks.
22. Inform the patient and visitors of the requirement for \_\_\_\_\_ and \_\_\_\_\_ in the room while oxygen is being administered.
23. During oxygen therapy, do not use \_\_\_\_\_ blankets on the patient's bed.

**Check Your Answers on Next Page**

## **SOLUTIONS TO EXERCISES, LESSON 3**

1. A low level of oxygen in the blood. (para 3-2)
2. By administering extra oxygen. (para 3-2b)
3. Oxygen tank (cylinder).  
Wall outlets (piped-in oxygen). (para 3-2b(1))
4. United States color code is green; the international color is white. (para 3-5c(1)(a))
5. If the valve is broken. (para 3-5c(1) Caution)
6. Used to reduce the high pressure in the cylinder to a low pressure that is safe for the casualty. (para 3-5c(3))
7. Liters per minute. (para 3-5c(3)(b))
8. It is used to add moisture to the oxygen to prevent drying and irritation of the patient's mucous membranes. (para 3-5c(4))
9. By quickly turning the cylinder handwheel (or wrench if a handwheel is not available) counterclockwise to open it slightly, listening for a loud hiss of escaping oxygen, and immediately turning it back clockwise to close it. (para 3-5e)
10. bacterial growth may occur. (para 3-7h(2))
11. oxygen: green; vacuum: yellow. (para 3-6)
12. To prevent damage to the gauge caused by a sudden influx of oxygen under pressure. (para 3-6f)
13. Patient may vomit and be unable to remove the mask to prevent aspiration of the stomach contents. (para 3-4b)
14. Any four of the following  
Rapid and unusually deep breathing.  
Extreme anxiety and apprehension.  
Dizziness.  
Numbness of hands, fingers, toes, lips, and tongue.  
Healthy pink color to the skin.  
Stabbing chest pain.  
Flexed position of the hands with thumb curved toward the palms.  
Trembling and muscle cramping of the extremities. (para 3-3b(1)(a))

15. Reassure the casualty and encourage him to slow his breathing rate. Place a paper bag or other suitable item over his nose and mouth. Have him breathe into the bag and rebreathe the exhaled air, which has a high concentration of carbon dioxide. (para 3-3c(1)(b))
16. When the pressure gauge registers 200 p.s.i. (or the local SOP safe residual guideline). (paras 3-5c(1)(c), 3-7d(2))
17. 0.16. (para 3-7d(4)(a))
18. 
$$\frac{(\text{Cylinder pressure} - \text{safe residual}) \times \text{conversion factor}}{\text{flow rate}} =$$

$$\frac{(2100-200)(1.56)}{9} = \frac{1900 \times 1.56}{9} = \frac{2964}{9} = 329.3 \text{ minutes or 5 hours 29 minutes}$$

(para 3-7d)
19. 1 inch (2.5cm). (para 3-7e(1)(b))
20. Any four of the following
  - Mental confusion.
  - Disturbed unconsciousness.
  - Abnormal color.
  - Change in blood pressure.
  - Increasing heart rate.
  - Increased respiratory rate. (para 3-7h(1))
21. Nonsparking (para 3-8e)
22. No smoking, no open flames. (para 3-8b)
23. Wool (or static-generating). para 3-8g)

**End of Lesson 3**

## **LESSON ASSIGNMENT**

### **LESSON 4**

Oral, Nasopharyngeal, and Nasotracheal Suctioning.

### **LESSON ASSIGNMENT**

Paragraphs 4-1 through 4-4.

### **LESSON OBJECTIVES**

After completing this lesson, you will be able to:

- 4-1. State/identify the steps in the performance of oral suctioning.
- 4-2. State/identify the steps in the performance of nasopharyngeal suctioning.
- 4-3. State/identify the steps in the performance of nasotracheal suctioning.
- 4-4. State/identify possible complications which can result from suctioning.
- 4-5. Identify when suctioning should be performed.

### **SUGGESTIONS**

After completing the lesson assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

## LESSON 4

### ORAL, NASOPHARYNGEAL, AND NASOTRACHEAL SUCTIONING

#### 4-1. SUCTIONING

a. Suctioning is a common nursing activity performed for the purpose of removing accumulated secretions from the patient's nose, mouth, and/or tracheobronchial tree in order to maintain a patent (open) airway as well as to remove lung secretions that block gaseous exchange. Removal of these secretions can be carried out through the oropharyngeal (mouth and pharynx), nasopharyngeal (nose and pharynx), or nasotracheal (nose, pharynx, and trachea) routes. Artificial airways, such as an endotracheal tube (a tube inserted into the trachea through the nose or mouth) or a tracheostomy tube (a tube inserted through a surgical incision into the trachea), can also be used as routes for suctioning.

b. Suctioning is performed on patients who have lost control of their ability to swallow and to cough up secretions due to a stroke, unconsciousness, or disease process. The procedure should be performed ONLY when needed. Frequent suctioning causes trauma to the mucous linings of the respiratory tract and can result in hemorrhage and edema. Nasotracheal suctioning can also cause hypoxemia, infections in the lungs (pneumonia), atelectasis (collapsed lung), and cardiac arrest.

c. It is desirable to have the patient manage his own secretions. Postoperative patients must be turned and encouraged to cough and deep breathe frequently (usually every two hours) following surgery. This practice will be helpful in preventing postoperative complications such as pneumonia and reducing the need for suctioning.

d. When more than one route is used, either route may be performed first. Whenever the route is changed, however, the used catheter and gloves are discarded and a new catheter and new gloves are used for the new route. Sterile technique must be used for all nasotracheal suctioning to prevent the introduction of "foreign" organisms (including numerous organisms normally found in the nose and pharynx) into the lungs.

#### 4-2. PROCEDURES PERFORMED PRIOR TO SUCTIONING

a. **Verify Need for Suctioning.** The need for suctioning can be determined from the following sources.

- (1) Physician's orders.
- (2) Nursing Care Plan.
- (3) The supervisor's directive.

(4) Local SOP.

(5) Personal observations. One or more of the following observations in a patient indicate a need for suctioning:

(a) Increased respirations accompanied by labored or difficult breathing.

(b) Moist, noisy, rattling, or gurgling sounds while breathing.

(c) Secretions drooling from the mouth and/or nose.

**NOTE:** The physician's orders, nursing care plan, or the supervisor's directive will dictate the frequency of suctioning, usually p.r.n. (as needed).

b. **Perform a Patient Care Handwash.** When suctioning, every effort must be made to prevent the introduction of pathogens into the lower airways. Clean technique and thorough handwashing are essential for suctioning of the oral and nasal cavities. Sterile technique is mandatory for deep suctioning in the tracheobronchial tree and suctioning through the endotracheal and tracheostomy tubes. Follow aseptic techniques for all suctioning of the airway in order to minimize the spread of microorganisms that are not normally found in the air passages.

c. **Obtain the Necessary Equipment.** Obtain the following equipment.

(1) Disposable suction equipment set. If such a set is not available, assemble the following:

(a) Sterile, disposable suction catheters. (Catheters are sized using the French scale: the smaller the number, the smaller the catheter. For example, 12 is smaller than 14 by this scale. These two catheter sizes are the most commonly used for suctioning the adult patient.)

(b) Liter flask of sterile saline or water.

(c) Sterile solution basin.

(d) Sterile gloves.

(2) Suction apparatus. Suctioning of the airway requires a source of vacuum. Most hospitals that have piped-in oxygen also have a piped-in vacuum source. When a piping system is not available, portable suction units must be used. Most portable suction used in hospitals units must be connected to an electrical source. Many portable units designed for field use, however, obtain their power from compressed gas (air, oxygen, or Freon) cylinders and do not need electrical power. Figure 4-1 shows two types of suction devices.

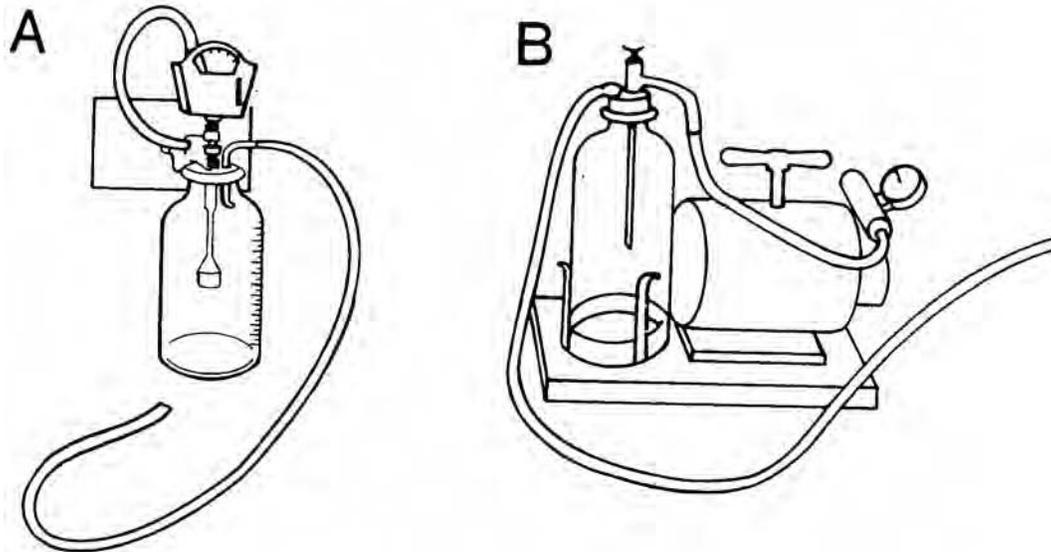


Figure 4-1. Suction apparatus. A Wall (fixed) unit. B Portable unit.

(3) "Y" connectors (if applicable). "Y" connectors/ adapters are needed if the suction catheters do not have suction ports.

d. **Identify the Patient.** When you have orders to suction a patient, verify the patient's identity to make sure that you perform the procedure on the correct patient.

(1) If the patient is conscious, ask him his name and check his bed card and hospital identification bracelet.

(2) If the patient is unconscious, check the name on the bed card and on the hospital identification bracelet. Make sure that the name is the same on the card and the band.

(3) In a field situation, check the patient's ID card or "dog tags."

e. **Explain the Procedure.** Explain the suctioning procedure to the patient to lessen his fears and gain his cooperation.

f. **Provide Privacy.** Place a screen or curtain around the patient's area or close the door if the patient is in a room.

g. **Position the Patient.** Place the patient in a semi-Fowler's position. This position is a semi-sitting position in which the patient manages secretions better and breathes easier. In some cases (such as spinal injuries), the patient will have to be suctioned without being moved.

#### h. Check the Pressure on Suction Apparatus.

- (1) Turn on the suction apparatus.
- (2) Place a thumb over the end of the suction tubing and observe the pressure gauge (figure 4-2).
  - (a) Suction pressure is usually expressed in inches (in) of mercury (Hg) on the portable unit and in millimeters (mm) of mercury (Hg) on the wall-mounted units. The recommended pressure settings for adult patients are 7 to 15 inches of Hg for the portable unit and 120 to 150 mm Hg for the wall-mounted unit.
  - (b) If the pressure is too low, the secretions cannot be removed. If the pressure is too high, the mucous lining may be forcibly torn away and pulled into the catheter openings.
- (3) If the pressure is not within the recommended limits, notify the supervisor before continuing.
- (4) Turn off the suction unit after the correct pressure has been verified.

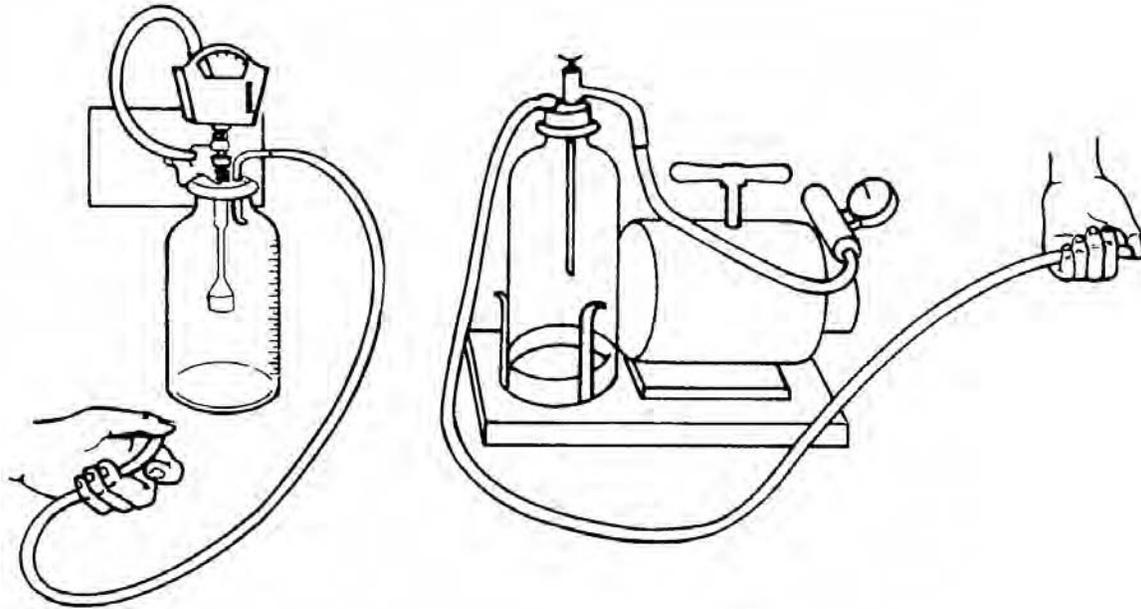


Figure 4-2. Checking pressure gauge of suctioning apparatus.

i. **Prepare Materials.** Open the disposable suction set (if used) or prepare materials for suctioning.

(1) Open the sterile solution basin on the bedside table.

(2) Pour the sterile solution into the solution basin without contaminating the solution, basin, or sterile field.

(3) Follow the package directions and open the suction catheter package to expose the suction part of the catheter.

(4) Open the sterile gloves package. In a disposable kit, the catheter and a sterile glove may be wrapped together. If the gloves are wrapped separately from the suction catheter, open the catheter package first.

j. **Oxygenate the Patient.** Provide additional oxygen for the patient prior to suctioning in order to prevent further hypoxemia (oxygen deficiency in the blood). Suctioning removes available air and oxygen as well as removing accumulated secretions.

(1) If the patient is on oxygen therapy, increase the percentage of oxygen to 100 percent for one minute.

NOTE: If the patient has a respiratory disease, check with the supervisor before increasing oxygen.)

(2) If the patient is not on oxygen, have him take a minimum of five deep breaths.

(3) If the patient is unable to breathe on his own, administer five breaths with a BVM system.

k. **Put on Sterile Glove(s).**

(1) Some suction kits provide only one sterile glove. If only one sterile glove is available, put it on your dominant hand. Use the gloved hand to handle sterile items. The gloved hand must remain sterile throughout the procedure.

(2) If two sterile gloves are available, put one glove on your nondominate hand. Then put the remaining glove on your dominate hand. Your gloved dominate hand will be used to handle sterile items and must remain sterile throughout the procedure. The glove on the other hand provides protection to you and is used to handle nonsterile items.

l. **Remove Catheter From Package.** Remove the sterile catheter from the package with the sterile (dominant) hand. Keep the catheter coiled to prevent contamination.

m. **Attach Catheter to Suction Tubing.** Attach the suction catheter to the tubing from the suction apparatus (figure 4-3). When performing this step, hold the suction catheter in the gloved dominate hand and hold the tubing from the suction apparatus in the nonsterile (ungloved) hand.

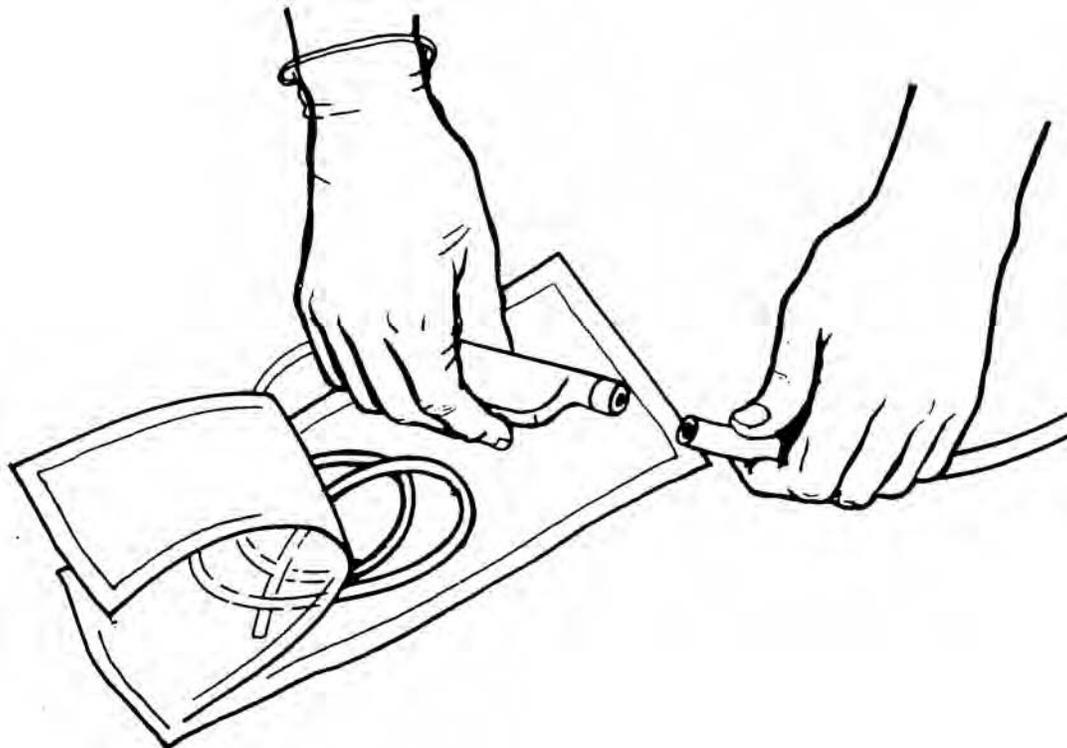


Figure 4-3. Connecting a catheter to suction apparatus.

n. **Test Patency of Catheter.**

- (1) Turn the suction apparatus on with the nonsterile hand.
- (2) Hold the catheter in the sterile hand and insert the tip in the basin of sterile solution.
- (3) Place the thumb of the nonsterile hand over the suction port and observe the fluid entering the drainage bottle. If no fluid enters the drainage bottle, the catheter is blocked. If this occurs, obtain another catheter and repeat the procedure.

**CAUTION:** Do not leave the catheter in the solution. Even antibacterial solutions can promote the growth of certain types of bacteria.)

#### 4-3. SUCTIONING THE PATIENT

Suctioning should not be continuous for more than 10 to 15 seconds. Suctioning removes oxygen as well as secretions; therefore, longer periods of continuous suctioning may result in an oxygen deprivation that is too severe for the patient.

**NOTE:** If you hold your breath during the suctioning period, you will be more aware of the oxygenation level of the patient. Procedures for suctioning are given in the following paragraphs.

a. **Oral Route.** The oral route is normally used with an alert, cooperative patient.

(1) Tell the patient to cough. Coughing will help to bring up secretions to the back of the throat so they can be easily removed.

(2) Insert the tip of the catheter into the patient's mouth without using suction.

(a) Be aware that advancing the catheter too far into the back of the patient's throat may stimulate his gag reflex. This could lead to vomiting and aspiration of the stomach contents.

(b) If an oropharyngeal airway is in place, insert the catheter alongside the airway, then back into the pharynx.

(3) Apply suction by placing the thumb of the nonsterile hand over the suction port. Aspirate secretions from the back of the throat, along the outer gums and cheeks, and around the base of the tongue. Do not apply continuous suctioning for more than 10 to 15 seconds.

(4) Withdraw the catheter using a rotating motion. This prevents sucking mucous membrane tissue into the catheter.

(5) Clear the catheter by inserting the tip in the sterile solution and suction the solution through the catheter.

(6) Repeat these procedures until all secretions have been aspirated.

**NOTE:** Allow the patient to rest between suctioning and re-oxygenate the patient before each suctioning.)

(7) Discontinue suctioning when the patient's breathing efforts become less labored and difficult; and when the noisy, rattling, or gurgling sounds are no longer heard. In some patients, the complete absence of gurgling or rattling sounds cannot be achieved. If the sounds are still present after aspirations, notify the supervisor.

**b. Nasopharyngeal Route.** If the patient is uncooperative (clenches his teeth, bites, or chews the catheter), nasopharynx suctioning may be required to remove secretions from the back of the throat. This procedure is also used to remove secretions from the nose.

(1) Estimate the maximum distance the catheter is to be inserted. Do this by measuring from the tip of the patient's ear to his nose.

(2) Insert the suction catheter into one of the patient's nostrils without using suction.

(a) Generally, it is easier to insert a catheter into the right nostril than into the left, due to a lower incidence of septal deviation (a deformity of the wall separating the two nasal cavities, causing a partial or complete blockage of the nostril).

(b) If an obstruction is met, remove the catheter and try the left nostril.

(c) If an obstruction is still met, remove the catheter and obtain assistance from your supervisor or other appropriate personnel.

(3) Advance the catheter quickly and gently about 3 to 5 inches (but no more than the estimated maximum distance) into the nostril without using suction.

(4) Apply suction by placing the thumb of the non-sterile hand over the suction port. Suction for no more than 15 seconds

(5) Withdraw the catheter using a rotating motion. This prevents sucking mucous membrane tissue into the catheter.

(6) Clear the catheter by inserting the tip in the sterile solution and suction the solution through the catheter.

(7) Repeat these procedures until the secretions have been aspirated and a patent airway restored. Allow the patient to rest between suctioning and re-oxygenate the patient before each suctioning.

**c. Nasotracheal Route.** Nasotracheal suctioning is similar to nasopharyngeal suctioning with deeper (trachea) suctioning being accomplished.

(1) Estimate the distance the catheter is to be inserted. Do this by measuring from the patient's nose to the tip of his ear, then to his larynx.

(2) Lubricate the tip of the catheter by dipping it into the basin of sterile solution.

(3) Instruct the alert, cooperative patient to flex his head and stick out the tongue. This helps to keep the patient from swallowing and makes the catheter insertion easier.

(4) Gently insert the suction catheter into the nasopharynx without suctioning. (Remember, it is usually easier to insert the catheter into the right nostril.) If the catheter cannot be inserted into the nasopharynx through either nostril, remove the catheter and obtain assistance from your supervisor or other appropriate personnel.

(5) Quickly and gently advance the catheter into the trachea (figure 4-4). The insertion process may cause the patient to cough. Mild coughing is usually not a problem and may actually help in the insertion process.

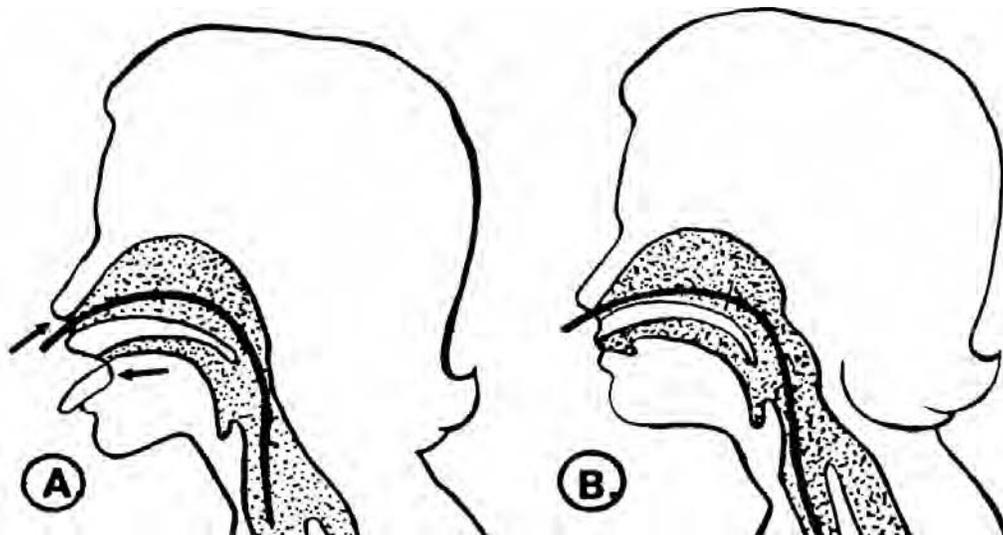


Figure 4-4. Inserting catheter using nasotracheal route.  
A Patient sticking out tongue. B Insertion completed.

(6) Suction secretions by placing the thumb over the suction port. Suction the patient for approximately 15 seconds.

(7) Observe the patient throughout the procedure for color change or increased pulse rate. Pulse rate increases with hypoxemia. Listen for changing breath sounds. As secretions are removed, breathing should become quiet again. Discontinue suctioning if severe changes in color or pulse occurs.

(8) After suctioning, remove your thumb from the suction port and withdraw the catheter using a slow, rotating motion.

(9) Clear the catheter as required between suctioning. This is accomplished by inserting the tip of the catheter in the sterile solution, applying suction, and allowing the solution to run through the catheter until the catheter is clear of secretions.

(10) Repeat suctioning until all secretions have been aspirated. Allow the patient to rest between suctioning and re-oxygenate the patient before each suctioning.

#### **4-4. PROCEDURES PERFORMED AFTER SUCTIONING**

a. **Remove Catheter and Glove.** After the suctioning is complete and the catheter has been removed, turn off the suction apparatus and disconnect the catheter from the suction tubing. Discard the catheter into the contaminated trash receptacle. Remove your glove(s) and discard into the contaminated trash receptacle also.

b. **Make the Patient Comfortable.** Provide for the patient's comfort by straightening and tightening bed linens, placing the patient in the semi-Fowler's position, raising the bedside rails (if indicated), and placing the call bell/light within easy reach of the patient.

c. **Dispose of Used Items.** Discard other disposable items into the trash receptacle. Clean and store non-disposable items in accordance with the local SOP and replenish supplies as needed.

d. **Wash Hands.** Perform a patient care hand wash.

e. **Record Procedure in the Nursing Notes.** Record the time, patient's respiration rate, description of respirations (labored, noisy, etc.), procedure used (oral, nasopharynx, or nasotracheal), and the type and amount of secretions obtained. If you cleared the catheter between suctioning, remember to subtract the amount of saline solution used from the total amount of fluid in the drainage bottle in order to arrive at the amount of secretions actually obtained.

**Continue with Exercises**

## EXERCISES, LESSON 4

**INSTRUCTION.** The following exercises are to be answered by completing the incomplete statement or by writing the answer in the space provided at the end of the question.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. A common nursing activity performed to removing accumulated secretions from the patient's nose, mouth, and/or tracheo-bronchial tree is known as

\_\_\_\_\_.

2. Name five complications which can be caused from nasotracheal suctioning:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. What two sizes of catheters are most commonly used for suctioning adult patients?

\_\_\_\_\_

4. Why is it important to explain the procedure to the patient?

\_\_\_\_\_  
\_\_\_\_\_

5. The position in which the patient manages secretions better and breathes easier is known as the \_\_\_\_\_ position.

6. How can you check the pressure of the suctioning apparatus?

---

7. What is the recommended suction pressure setting for adult patients?

a. On the portable unit, it is \_\_\_\_\_.

b. On the wall-mounted unit, it is \_\_\_\_\_.

8. If the pressure is not within the established limits, you should

---

9. List the steps necessary to test the patency of the catheter.

---

---

---

10. You are to perform an oral suctioning on a patient. The patient is uncooperative and clenches his teeth. What should you do?

---

---

---

11. The patient on whom you are performing oral suctioning is alert and cooperative. What can he do to help?

---

---

12. How do you clear the catheter?

---

---

13. For nasotracheal suctioning, how do you measure the maximum distance the catheter is to be inserted?

---

---

14. Which nostril usually allows easier entry of the catheter?

---

15. Observe the patient throughout the nasotracheal suctioning procedure for

---

\_\_\_\_\_ or

---

16. You have two sizes of catheters available for nasotracheal suctioning--size 12 and size 14. You are told to use the larger of the two catheters. You should choose the:

- a. Size 12 catheter.
- b. Size 14 catheter.

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 4

1. Suctioning. (para 4-1a)
2. Hemorrhage and edema.  
Hypoxemia.  
Infections in the lungs.  
Collapsed lung.  
Cardiac arrest. (para 4-2b)
3. Sizes 12 and 14 catheters. (para 4-2c(1)(a))
4. To lessen his fears and gain his cooperation. (para 4-2e)
5. Semi-Fowler's. (para 4-2g)
6. Place your thumb over the end of the suction tube and observe the pressure gauge. (para 4-2h(2))
7. a On the portable unit, it is 7 to 15 inches of Hg.  
b On the wall-mounted unit, it is 120 to 150 mm Hg. (para 4-2h(2)(a))
8. Notify the supervisor before continuing. (para 4-6h(3))
9. Turn on the suction apparatus with the ungloved hand. Hold the catheter in the gloved hand and insert the tip in a basin of sterile water. Place the thumb over the suction port and observe the saline entering the drainage bottle. (para 4-2n)
10. Insert the catheter into the patient's nose, without suction, 3 to 5 inches. Apply suction (no more than 15 seconds). Withdraw the catheter using a rotating motion. (para 4-3b)
11. Have him to cough and bring up secretions to the back of the throat so they can be easily removed. (para 4-3a(1))
12. Insert the tip in the sterile solution and suction the solution through the catheter. (para 4-3a(5))
13. Measure from the patient's nose to the tip of his ear, then to the larynx. (para 4-3c(1))
14. The patient's right nostril. (para 4-3c(3))
15. Color change or increased pulse rate. (para 4-3c(7))
16. b. (para 4-2c(1)(a))

**End of Lesson 4**