CE
2.5 ANCC/AACN CONTACT HOURS

Clearing away pulmonary secretions

Excess or retained pulmonary secretions impair ventilation, invite infection, and may threaten survival. Find out who's at greatest risk and how to keep airways clear.

BY BILL PRUITT, RRT, AE-C, CPFT, MBA, AND MICHAEL JACOBS, RN, CCRN, CEN, MSN

EXCESS OR RETAINED pulmonary secretions cause a host of problems for the patient by increasing the work of breathing and setting the stage for infection. Frequent coughing as he tries to clear secretions drains his oxygen and energy reserves and makes muscles sore; coughing may also spread infection, cause vomiting, or trigger an asthma attack. Allowed to accumulate, excess pulmonary secretions impair gas exchange, which can lead to hypoxemia, pneumonia, respiratory failure, and death.

Keeping your patient hydrated is a basic step to keeping airway secretions fluid and easier to clear. If he's on mechanical ventilation, he may need humidity added to the ventilator circuit to prevent the airway from drying out. If he's receiving supplemental oxygen and thick secretions are a problem, adding humidity (if the device allows) may be appropriate.

Some patients are at greater risk for problems with pulmonary secretions than others. In this article, we'll describe who they are, how to spot problems early, and what to do to prevent complications. For details on the lungs' normal lines of defense, see *A nose (and more) for trouble*.

Who needs help?

Anticipate problems if your patient has a disease that increases airway secretions. One or more of these mechanisms is at work.

- Increased mucus production by the goblet cells in the tracheobronchial tree inundates small airways with excess mucus.
- The mucociliary transport system, which works like an escalator to move airway secretions up the tracheobronchial tree where they can be expectorated, may be damaged or impaired.
- Airway inflammation and constriction can slow or prevent the upward movement of airway secretions, leaving excessive amounts below the level of airway inflammation or constriction.

Let's take a closer look at how these mechanisms come into play with diseases likely to cause problems.

Asthma is a chronic inflammatory disorder of the airways with intermittent acute exacerbations. It's characterized by the release of inflammatory mediators causing reversible spasms of the bronchial tubes, excessive mucus secretion,

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failure of the mucociliary transport system, and airway inflammation and constriction. During an acute exacerbation, the patient complains of chest tightness and shortness of breath. Your assessment may reveal wheezing, tachypnea, tachycardia, and use of accessory muscles of respiration. As the asthma attack resolves and the airways open, the patient may develop a productive cough triggered by secretions that were retained during airway bronchospasm.

Note that arterial blood gas (ABG) results may reflect respiratory alkalosis early in an asthma attack, proceed to a normal pH, then move into respiratory acidosis late in the attack because of elevated $PaCO_2$ levels. This transition occurs if airway bronchoconstriction is severe and unrelieved. Patients who have this progression into acidosis are at high risk for acute respiratory failure and death.

Chronic bronchitis, a form of chronic obstructive pulmonary disease (COPD), is characterized by an increased number of goblet cells secreting excessive amounts of mucus. The airway walls become chronically inflamed, reducing airway diameters. These conditions raise the risk of mucus plugging. Your assessment may reveal crackles, wheezes, and gurgles on chest auscultation.

Chronic bronchitis is diagnosed when the patient has a productive cough for at least 3 months in 2 consecutive years that can't be attributed to other causes. As the disease progresses, ABG analysis will reveal hypoxemia and respiratory acidosis with decreased PaO_2 and increased $PaCO_2$.

Bronchiectasis is a respiratory disorder characterized by chronic bronchial dilation and inflammation. The mucociliary transport system is impaired, and mucus production increases. As excessive airway secretions pool, the epithelial layer lining the airways erodes, predisposing the patient to bacterial pulmonary infections. Muscular and elastic components supporting the airways also are destroyed, rendering the dilation and inflammation permanent.

Possible causes of this disorder include foreign body aspiration, benign airway tumors, cystic fibrosis (CF), ciliary malfunction, or allergic bronchopulmonary aspergillosis.

Your assessment may reveal inspiratory and expiratory crackles that clear with a cough. Results of ABG analysis are similar to those for chronic bronchitis.

Cystic fibrosis is a genetic disorder characterized by overproduction of thick mucus affecting the respiratory, digestive, and reproductive systems. Excessive pulmonary mucus causes a lifetime of pulmonary inflammation, impaired breathing, and lung infections. To maintain lung function and avoid potentially fatal infections, patients must undergo a rigorous daily regimen to remove pulmonary secretions.

In the past, few patients with CF lived beyond the teenage years. But treatment advances have extended the median survival age to 32 (as of 2000). Some patients even live into their 50s or 60s, so CF is no longer just a pediatric disorder.

When you assess a patient with an advanced case of CF, or one who's having problems with secretions, you may find progressive dyspnea and crackles. Results of an ABG analysis will reveal hypoxemia and respiratory acidosis with decreased PaO_2 and increased $PaCO_2$. The patient may become increasingly fatigued and may have decreased activity tolerance.

Pneumonia results in pooling of secretions and debris in the alveoli and lower airways, leading to hypoxemia and atelectasis. Bacterial or viral pneumonia develops when someone breathes in a pathogen or aspirates foreign matter (such as gastric contents) that breeds infection. The body responds by initiating the inflammatory process. Exudate and normal airway secretions begin to pool. As these pulmonary fluids collect they become viscous, depressing the mucociliary transport system.

Typical respiratory signs and symptoms of pneumonia include cough (with or without mucus), chest pain, rapid breathing, crackles, wheezing, and shortness of breath. Nonrespiratory signs and symptoms include fever, sweating, headache, and weakness. Patients at particular risk for developing pneumonia include those with chronic illnesses such as diabetes; those with artificial airways; older adults; chronically ill, immunosuppressed, or immobile patients; and those who abuse alcohol.

Neuromuscular diseases such as myasthenia gravis and Guillain-Barré syndrome cause respiratory muscle weakness, paralysis, or nerve conduction problems that can reduce cough effectiveness and lead to retained secretions. Trauma to the central nervous system can also disrupt the ability to cough or impair the cough reflex.

Other contributing factors linked to retained or excessive secretions include *smoking*, which greatly increases production of airway secretions and damages the mucociliary transport system; *air pollution or occupational exposure to irritants,* which cause the same problems as tobacco smoke; and *analgesia and sedation*, which depress the cough reflex.

Assessing your patient

A thorough nursing assessment is the key to identifying subtle changes in your patient's status, including increased airway secretions that obstruct airflow. Follow trends in the patient's SpO_2 and

ABG values that could indicate impending respiratory difficulties. Follow these pointers for physical assessment:

• **Inspection.** Look for signs of increased work of breathing (because of resistance to airflow), increased respiratory rate, intercostal retractions, and increased use of accessory muscles to breathe.

• **Palpation.** Decreased fremitus (palpable vibrations transmitted through the bronchopulmonary tree to the chest wall when the patient speaks) indicate mucus plugging of a bronchus. Test for fremitus by using the ball or ulnar surface of your hand to palpate the chest while the patient repeatedly says "99." When he breathes deeply, you may also feel chest vibrations related to retained secretions; usually this is accompanied by audible rattling.

• **Percussion.** This technique is of limited use in trying to detect retained secretions because percussion penetrates only 2 to 3 inches (5 to 7.5 cm) in the chest. Still, a mucus plug that causes an atelectatic lung may produce a dull percussion note over the airless area.

• **Auscultation.** Adventitious (added) breath sounds are a hallmark of retained secretions, but you may need the patient's cooperation to properly assess breath sounds. A shallow- to medium-sized breath may not produce adventitious breath sounds, so ask him to breathe deeply through an open mouth. Retained secretions often cause crackles and wheezes that are more common on exhalation, but may also be present on inspiration.

Clearing the pipes

The first method you should try to clear secretions is also the simplest: Ask the patient to *cough*. If he's just had abdominal or thoracic surgery, make sure he has adequate analgesia first and show him how to use a

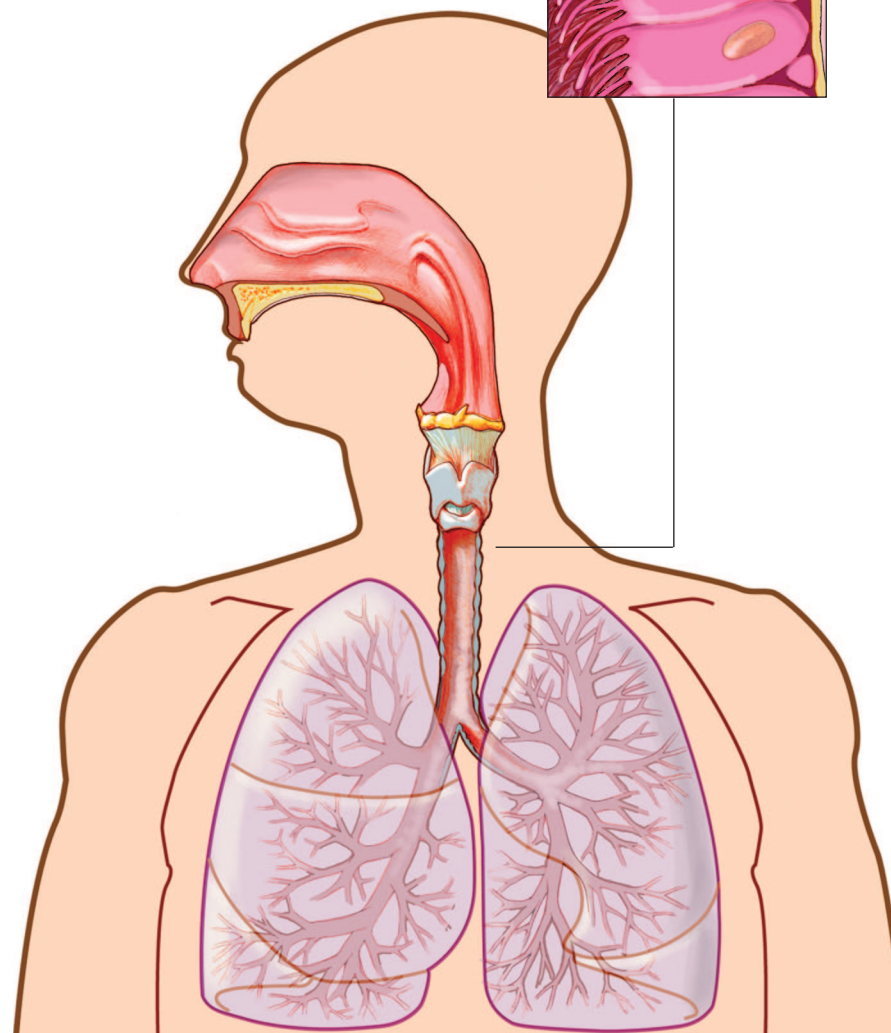
A nose (and more) for trouble

The same airways that bring oxygen into the lungs also bring in dust, microbes, toxic particles, and smoke that can wreak havoc with normal lung function and the patient's health. Fortunately, the pulmonary system has several ways to keep itself clean.

• **Filtering.** Nasal hairs stop large particles as air moves into the nares. The mucus layer of the nasal epithelium traps more, smaller particles. Progressively smaller particles usually filter out in the lower airways and alveoli.

• **Mucus.** The nose, trachea, and much of the lower airway is lined with mucus-producing *goblet cells* and *ciliated columnar epithelial cells* whose cilia act like microscopic brooms. The cilia actually move the mucus blanket (with the trapped particles) toward the pharynx, a mechanism known as the mucociliary escalator. Goblet and ciliated cells gradually disappear as the airways get smaller and aren't present in the alveoli. The airways also are surrounded by smooth muscle that constricts to keep harmful particles from getting deep into the lungs.

• **Coughing.** The cough reflex helps remove secretions and particles that have landed in the lung. Rapid expiratory flows and positive pressure actually shear the mucus free from the airway walls and carry it out. The larynx, trachea, and mainstem bronchi have receptors that react to irritants and trigger the cough reflex.



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pillow to splint his incision. Have tissues available to remove any secretions that he coughs up.

Have him sit in high Fowler's position (or stand, if he can); an upright position lets him take in a deeper breath and generate a more forceful, effective cough. Tell him to wrap his arms around the pillow in a hugging motion, take a deep breath, hold it for a few seconds while squeezing the pillow tight against his body, then give two controlled coughs.

Patients with COPD may have problems with premature airway closure when attempting a forceful cough. Teach these patients to use a "huff" cough, which starts from a middle to low inspiration (not a full inspiration), and to make two or three expiratory efforts with an open glottis.

Assisted cough is indicated for a patient with a weak or paralyzed diaphragm. Place your hands on the patient's abdomen, then have him inhale deeply and cough. As he coughs, perform an abdominal thrust in the same way you would to clear an obstructed airway. (Remember your basic life support training.) For a patient who can't inhale, have a colleague give him a deep breath using a resuscitator bag connected to a mask (for a spontaneously breathing patient) or the artificial airway (for a mechanically ventilated patient).

Incentive spirometry can help prevent atelectasis by filling the underventilated areas of the lung, reopening alveoli. Incentive spirometry and deep breathing and coughing improve ventilation and improve exercise tolerance in respiratory muscles. As a result, the patient may be able to generate a more forceful cough, helping to move secretions.

Mucoactive agents to clear secretions include acetylcysteine, used to treat patients with chronic bronchitis, and dornase alfa, used to treat patients with CF. Another option is guaifenesin, which thins secretions and is a common ingredient in over-the-counter cold medications.

Suctioning can help clear secretions, especially in patients with artificial airways. For patients who aren't intubated, use the nasotracheal route for suctioning the lower airways. If a patient has a reflex cough that clears secretions from the lower airway but can't remove secretions from his mouth, use a tonsil suction device such as a Yankauer suction device.

Clearing retained secretions from the mouth helps reduce aspiration and infection risks. Careful attention to mouth care reduces microbial growth in the mouth and lowers the potential for hospital-acquired pneumonia. (For information on closed suctioning, see "Clear the Air with Closed Suctioning" on page 44.)

To perform deep suction, use a sterile catheter to reach the lower airway (below the glottis). This stimulates a strong cough in many patients, which also helps clear secretions. Even if the patient has no cough reflex, though, deep suction will often clear secretions.

Chest physiotherapy uses a combination of patient positioning (postural drainage) and chest percussion or vibration to dislodge and move secretions from smaller to larger airways. Patients with a lot of secretions (more than 25 ml/day of sputum), such as those with CF or bronchiectasis, are most likely to need chest physiotherapy.

Once the patient is positioned appropriately, use your hands or a mechanical device to percuss or vibrate a specific area of the lung. Chest physiotherapy is usually performed two to four times a day; each procedure may last 10 to 30 minutes, depending on how many positions are being used for postural drainage.

Positive expiratory pressure (PEP) consists of taking in a deep breath and exhaling through a device that resists airflow, creating positive pressure in the lung. This therapy helps refill underventilated areas of the lung, prevents premature airway closure, and prolongs expiration, making more air available to help dislodge and move secretions during coughing.

Recently, PEP therapy has been combined with *high-frequency compression/oscillation* to mechanically move secretions in patients who aren't intubated. This combination therapy, given three to four times a day for 10 to 20 minutes each treatment, makes secretions less viscous and easier to move. The patient uses a portable, single-patient-use device such as the Flutter valve or the Acapella. As he blows through the pipelike device, the expiratory flow causes a steel ball (or flipper and magnet) to move rapidly, generating 10 to 25 cm H_2O of PEP and high-frequency oscillation. This dislodges secretions and lets them move into the larger airways. The Flutter device must be used when the patient is upright. The Acapella isn't gravity dependent, and aerosol treatments can be administered through it simultaneously with PEP treatment.

High-frequency chest wall oscillation relies on a device to exert external forces on the chest to reduce mucus viscosity and mobilize secretions. This therapy also may enhance the activity and effectiveness of the cilia, which increases secretion mobility. The patient wears an inflated, nonstretchable vest attached to an air pulse delivery system that delivers oscillating pressures. (For more details, see "Close to the Vest: A Novel Way to Keep Airways Clear" in the December issue of *Nursing2003*.) He can take his aerosol treatments concurrently with this oscillation

therapy. Therapy typically includes two treatments a day, each lasting 20 minutes.

Intrapulmonary percussive ventilation (IPV) is another high-frequency device used to move secretions, but this one creates pressure in the airways rather than through the chest wall. Delivered through a mask, this therapy is indicated for patients breathing spontaneously.

During spontaneous breathing, the IPV device delivers positive airway pressure along with high-frequency microbursts of air. These microbursts are delivered on inspiration only or during the full inspiratory-expiratory cycle and create an oscillating effect in the airways. The device also delivers either a medication or 0.9% sodium chloride solution by aerosol. Treatments typically are given three to four times a day for 15 to 20 minutes each.

Continuous lateral rotation therapy can help prevent pooled secretions in critically ill patients. The patient is placed in a specialized bed that rotates from side to side, moving up to about 45 degrees in lateral rotation. Gravity helps move secretions more centrally, making them easier for the patient to cough up (or for you to remove by suctioning).

To perform *bronchoscopy,* a physician uses a flexible fiber-optic endoscope to view the airways; at the same time, he can use the device to remove secretions that can't be removed any other way. He may perform lavage with a sterile 0.9% sodium chloride solution to help clear secretions, or he may instill a mucolytic to break them down. The patient is sedated and given analgesia so he's comfortable during the procedure. Because it's invasive and stressful to the patient, as well as labor-intensive and costly, bronchoscopy is performed only as needed to manage secretions, with a day or more between treatments.

Free and clear

By knowing who's at risk for retained or excess pulmonary secretions and how to manage them, you can help your patient get the correct treatment and keep his airways open. ‹›

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SELECTED WEB SITE

RT: The Journal for Respiratory Care Practitioners: Secretion Removal in the ICU
http://www.rtmagazine.com/Articles.ASP?articleid=R0502F03

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Clearing away pulmonary secretions

GENERAL PURPOSE To provide nurses with information to accurately assess and safely care for patients with excessive pulmonary secretions. **LEARNING OBJECTIVES** After reading the preceding article and taking this test, you should be able to: **1.** Identify patients at risk for excess or retained pulmonary secretions. **2.** Describe assessment findings related to excess or retained pulmonary secretions. **3.** Describe nursing interventions to help keep airways clear.

1. To help maintain a clear airway, you should
a. encourage prolonged coughing.
b. keep the patient hydrated.
c. limit environmental humidity.
d. administer oxygen at a high flow rate.

2. Which condition results in excessive pulmonary secretions and airway constriction?
a. bronchiectasis
b. Guillain-Barré syndrome
c. CF
d. asthma

3. Which early assessment findings are most likely in a patient who has an acute exacerbation of asthma?
a. fever and nasal congestion
b. wheezing and bradypnea
c. shortness of breath and tachycardia
d. sneezing and hemoptysis

4. Which change in ABGs is found *early* in an asthma attack?
a. increased pH level
b. increased Pao_2 level
c. decreased bicarbonate level
d. increased $Paco_2$ level

5. Which respiratory disorder is characterized by chronic bronchial dilation and inflammation?
a. bronchiectasis
b. asthma
c. chronic bronchitis
d. viral pneumonia

6. Chronic bronchitis is characterized by
a. reversible spasms of the bronchial tubes.
b. an increased number of goblet cells secreting excessive mucus.
c. pooling of debris and secretions in the alveoli.
d. nerve conduction problems.

7. ABG analysis in a patient with advanced CF commonly reveals
a. metabolic acidosis.
b. respiratory alkalosis.
c. metabolic alkalosis.
d. respiratory acidosis.

8. Which neuromuscular disease can cause respiratory muscle weakness and decreased cough effectiveness?
a. CF
b. bronchiectasis
c. myasthenia gravis
d. bacterial pneumonia

9. Which assessment finding *best* suggests increased work of breathing?
a. frequent coughing
b. purulent nasal discharge
c. deep inspirations
d. intercostal retractions

10. To assess a patient for fremitus
a. inspect for diaphragmatic movement.
b. palpate the chest wall while the patient repeatedly says "99."
c. percuss the chest wall lightly.
d. auscultate all lung lobes.

11. When assessing for adventitious breath sounds, ask the patient to
a. exhale completely and stop breathing in expiration.
b. breathe in and out through the nose.
c. breathe deeply through an open mouth.
d. take quick, shallow breaths.

12. Teach patients with COPD who have problems with premature airway closure to use which type of cough?
a. assisted
b. huff
c. closed glottis
d. pursed lip

13. Performing an abdominal thrust as your patient inhales deeply and coughs is the best technique for a patient with
a. chronic bronchitis.
b. asthma.
c. bronchiectasis.
d. diaphragmatic paralysis.

14. Incentive spirometry can help reopen alveoli and prevent
a. bronchospasm.
b. atelectasis.
c. asthma.
d. bronchiectasis.

15. Which mucoactive agent is indicated to improve pulmonary function in patients with CF?
a. acetylcysteine
b. codeine
c. dornase alfa
d. guaifenesin

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