Understanding Asthma Patients in the Dental Office

Barbara Fried, RDH, MBA
Continuing Education Units: 1 hour


Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

This continuing education course provides information to assist clinicians in understanding the patient with asthma and the implications for the care of asthmatics in the dental office. This course includes an overview of the respiratory system, the manifestations and epidemiology of asthma, measures for ongoing assessment and control, and implications for the dental practice.

Conflict of Interest Disclosure Statement
• Ms. Fried has done consulting work for P&G.

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Respiratory Overview

The Respiratory System

The term “respiration” includes the processes of oxygen uptake in the lungs and transfer to the bloodstream, oxygen uptake by cells all over the body, carbon dioxide removal from the cells and expiration from the lungs. The average adult breathes approximately 25,000 times per day.\(^1\)

The upper respiratory tract’s main function is the movement of air between the outside and the lower respiratory tract. Additional functions include filtering, warming, humidifying air and protecting the airways from unintended aspiration. The components of the upper respiratory tract include the nasal cavity, mouth, pharynx, epiglottis and larynx. The pharynx or throat, which conducts air and swallowed food and liquids, connects the nasal cavity and mouth to the larynx. The epiglottis is a flap formed primarily of cartilage that closes during swallowing to protect the lower respiratory tract and to direct food to the digestive tract. The larynx is a small, triangular structure
that leads into the lower respiratory system. It is muscular and contains the vocal chords as well.

An inverted tree is often used to represent the structures of the lower respiratory tract. The major components include the trachea and lungs. The right lung has three lobes and the left lung has two lobes. The lungs contain circulatory blood flow and airways for gas exchange. The branching airways within the lungs include the primary bronchi, secondary bronchi, and tertiary bronchi. Each succeeding branch is less rigid, narrower, shorter, more numerous and has greater surface area. The branching bronchi conduct air deep into the bronchioles of the lungs. The respiratory bronchioles continue to branch into terminal bronchioles, which lead into approximately 14 million alveolar ducts, lined with alveoli. There are more than 300 million alveoli, where oxygen and carbon dioxide exchange with the blood gases in a pulmonary capillary.

Regulation/Control of Respiration
Respiration is regulated via chemical and nervous system interactions. Both the central nervous system (CNS) and the peripheral nervous system (PNS) regulate and control respiration. The peripheral nervous system consists of nerves outside of the brain and spinal cord. It has two distinct parts; the autonomic nervous system (ANS) and the somatic nervous system. The somatic nervous system regulates skeletal muscle. The autonomic nervous system controls heart and lung functions, and the two divisions often have opposite effects. Within the lungs the sympathetic nervous system can act to relax smooth bronchial muscles (bronchodilation) while the parasympathetic nervous system can act to contract smooth bronchial muscles (bronchoconstriction).

The sympathetic nervous system regulates involuntary functions, including heart rate, blood pressure, digestion and respiration in response to emotional stress and/or physical exertion. Norepinephrine, a chemical mediator released by sympathetic cells, binds to Beta, adrenergic receptors and acts to increase bronchodilation which improves lung function. Medications used to control asthma, such as SABAs (short-acting beta2-agonists), which act like norepinephrine likewise improve airflow but do not affect the underlying cause of bronchoconstriction and other asthma changes.

The respiratory control center in the brain stem regulates breathing in response to the stimuli of various receptors. There are four types of receptors. First the peripheral chemoreceptors respond to changes in the concentration of carbon dioxide and oxygen in the blood. Receptors in the cerebrospinal fluid respond to pH changes. Stretch receptors within the airways detect mechanical changes in the lungs and prevent hyperinflation. Irritation receptors initiate a cough reflex when stimulated.

The autonomic nervous system can also act locally to control mucus secretion. Afferent sensory nerves transmit signals to the brain and spinal cord, while the efferent nerves may bring messages from the brain to the respiratory organs. Neuropeptides are chemicals, which are released from efferent nerve endings and then bind to receptors on bronchial smooth muscles. Agonists and antagonists are types of neurotransmitters. Agonists bind to receptors to stimulate a specific response, while antagonists bind to receptors to block a specific response.

Cellular Structure of the Lower Respiratory Tract
Respiration is accomplished via the function of a multitude of molecules, cells, glands, and muscles. The epithelial lining in the respiratory tract provides protection by secreting mucus, removing irritants, and activating the immune system. Air is approximately 79% nitrogen and 21% oxygen. Air is conducted through the respiratory system into the structures involved in gas exchange, which occurs primarily in the bronchioles, alveolar ducts, alveolar sacs, and the alveoli. Three layers make up the walls of the trachea and bronchi: respiratory mucosa, basement membrane and submucosa. The inner surface of the respiratory mucosa is lined with ciliated columnar epithelial cells containing goblet cells, which produce mucus. The basement membrane provides support for the mucosa. The submucosa contains cells that include muscle, mucous and serous glands, mast cells, lymphocytes, fibroblasts and blood vessels. Normally the muscle fibers are relaxed, but bronchoconstriction may occur as a protection mechanism or as part of an overreaction in hypersensitive airways. For example, cold air may
produce bronchoconstriction for some people. Epithelial cells line the airways but can become inflamed and hyper-reactive. Goblet cells produce mucus, but excess mucus can narrow the airway and cause asthma symptoms. Mast cells may mediate inflammation, but may also increase swelling in asthma. Muscle tissue normally regulates the open lumen, but may contract and limit airflow.

The exchange of oxygen into the bloodstream and carbon dioxide out of the bloodstream occurs via diffusion, which is simply the movement of gases from an area of high concentration to an area of low concentration. Specifically, there is a high concentration of oxygen in the alveoli, so oxygen moves from the alveoli into the blood, which has a lower concentration of oxygen. The opposite is true for carbon dioxide, which moves out of the blood and into the alveoli.

**Asthma Disease State**

**Incidence and Impact**

Asthma is a chronic inflammatory disorder of the airways, which has implications for the diagnosis, management, and potential prevention of the disease. Airway inflammation contributes to airway hyper-responsiveness, airflow limitation, respiratory symptoms, and disease chronicity. Persistent changes in airway structures may occur, including sub-basement fibrosis, mucus hyper-secretion, injury to epithelial cells, smooth muscle hypertrophy, and angiogenesis.

As of 2010, more than 25 million people in the United States have asthma. Seven million of these asthma patients are children. Most individuals with asthma will have at least one asthma attack per year. Overall asthma accounts for more than 10 million missed work days and almost 13 million missed school days each year. Additionally, there are ethnic and racial disparities in asthma morbidity and mortality, including the disproportionate burden of asthma on lower-income, inner-city residents.

The current evidence-based clinical practice guidelines for asthma have provided increased benefits. Yet, many clinicians have not fully implemented the guidelines-based care for their patients with asthma. Likewise patients have not always complied with recommended treatment plans. As a result, optimum asthma care remains a goal to be achieved.

The National Asthma Control Initiative (NACI) is an initiative of the National Asthma Education and Prevention Program (NAEPP), coordinated by the National Heart, Lung, and Blood Institute (NHLBI). The NACI aims to use the recommendations of the NAEPP's Expert Panel Report 3 (EPR-3) Guidelines for the Diagnosis and Management of Asthma and its companion Guidelines Implementation Panel (GIP) Report to educate and motivate meaningful change in asthma clinical care practices and quality of life for people who have asthma.

**Asthma Manifestations and Physical Changes**

The most frequent symptoms of asthma, wheezing, coughing, chest tightness, and breathlessness occur differently among patients and are common symptoms for other diseases, such as rhinitis, sinusitis, obstructive airway diseases, gastroesophageal reflux (GERD) or drug-related cough. Asthma often has some distinguishing features that assist in diagnosis, such as recurrence, reversibility, daily variation and response to triggers.

Asthma is considered persistent when symptoms occur more than two days per week or more than two nights per month. It is considered intermittent when symptoms occur less often. Asthma symptoms may be mild, moderate or severe and the symptoms may vary over time.

When asthma is diagnosed in children, approximately 70-90% of patients have coexisting allergies. The remaining 10-30% of pediatric patients have non-allergic asthma. Pediatric asthma frequently occurs by five years of age.

When asthma is diagnosed in adults, it can be due to allergic and/or non-allergic factors and frequently complicated by other existing diseases and treatments.

Physical changes result when allergic triggers initiate an inflammatory response that may cause asthma symptoms such as coughing, wheezing, chest tightness and shortness of breath. Inflammation affects respiratory hyper-responsiveness and airflow reduction.
Inflammation may continue through several phases, including an acute phase, a late phase and a chronic phase. Inflammatory cells are recruited to the respiratory tract in the acute phase. During the late phase, the inflammatory cells and locally occurring cells are activated. During the chronic phase, which can last for days and weeks, persistent cell damage and repair continue to occur. Lung function can fluctuate and slowly deteriorate.

Once sensitization to an allergen occurs, the inflammatory process may be initiated on subsequent exposures. During the acute phase, mast cells are activated and produce inflammatory mediators. These mediators include histamine and leukotrienes. The resulting inflammation process causes mucus production and tissue swelling. During the late phase, eosinophils and T cells cause increased inflammation, airway epithelium destruction, loss of cell protection, airway swelling and increased thick mucus production. Along with these changes the asthmatic airways experience muscle tightening, increased wall thickening, airway narrowing and abnormal mucus overproduction. Some changes lead to irreversible airway remodeling, including mucus plugs, wall thickening and lumen narrowing.

**Diagnosis and Classification**

The diagnosis of asthma involves identifying recurrent symptoms and at least partially reversible airflow obstruction while ruling out alternatives. Methodology includes a medical history, physical exam, spirometry and other studies. The exam may show signs of asthma, including difficulty breathing, wheezing, coughing, increased mucus, swelling, and possibly signs of eczema. Spirometry measures the patient’s forcibly exhaled breath to determine pulmonary function. The forced vital capacity (FVC) is a measure of forcibly exhaled air following a maximal inhalation. The forced expiratory volume in 1 second (FEV1) is a measure of the volume of air exhaled in the first second of the FVC. The presence of reversibility is determined by comparing the first spirometry with a second one following inhalation of a short-acting bronchodilator. Reversibility is defined as an improvement in the second FEV1 by 12% or more (approximately 200 ml) as compared to the unmedicated first test. Additional tests could involve the home use of peak flow meters that measure peak expiratory flow (PEF), to determine lung function trends.

The National Institutes of Health (NIH) guidelines details four asthma levels of severity determined by day and nighttime symptoms, use of SABAs (short-acting beta2-agonists) for symptom control, interference in daily activities, lung function measured as percent of predicted value of FEV1, or PEF, PEF variability, exacerbations and other features. Diagnosis depends upon the results of medical histories and tests.

For example, using the chart on Figure 1, a patient with a history of daily symptoms, nighttime awakenings often twice a week, daily use of SABAs as needed for these symptoms and some limitation of normal activity may be classified as having moderate persistent asthma. Step 3 or 4 management may be appropriate for this patient. Whereas a patient with symptoms throughout the day, nighttime awakenings every week or two, daily use of SABAs and some limitation of normal activity may be classified as having severe persistent asthma, because asthma is assigned to the most severe category of any one finding. For this patient step 5 or step 6 treatment may be required to maintain control. The clinical relevance of this information is to guide the clinician in patient questioning during the review of health history.

For example, the following stepwise approach for managing asthma in youths ≥ 12 years of age and older, and in adults, provides a framework of treatment alternatives. The preferred treatment for intermittent asthma is SABA as needed. The preferred treatment choices in the previous examples can be initiated as follows:

1. The patient with moderate persistent asthma may be treated per Step 3 with either the combination of low-dose ICS (inhaled corticosteroids) and LABAs (long-acting beta2-agonists), or medium-dose ICS. The preferred Step 4 alternative is the combination of medium-dose ICS and LABA.

2. The patient with severe persistent asthma may be treated per Step 5 with either the combination of high-dose ICS (inhaled corticosteroids) and LABAs (long-acting beta2-agonists), or per Step 6 with added oral corticosteroid.
Frequent reevaluations are critical and medication levels can be stepped up when more control is needed, and stepped down when possible and when asthma is well controlled for at least three months.

Other factors considered include level of control achieved, patient education, patient compliance, environmental factors and comorbidities. Asthma specialists should be consulted for patients with moderate or severe persistent asthma.21

Figure 3 provides an algorithm for continued assessments of asthma and appropriately adjusting therapy. Patients who are well controlled may continue current therapy with regular follow-ups. Step down in therapy can be considered following at least three months of well-controlled asthma. Patients who are not well controlled may need an increase in step therapy, frequent reevaluation, and a consideration of alternative treatments. Patients who are
Figure 2. Stepwise Approach for Managing Asthma in Youths ≥ 12 Years of Age and Adults.

very poorly controlled may need oral systemic corticosteroids, more frequent reevaluations, and alternative treatments. Consideration is given to both the risk of disease progression and the risk of treatment-related adverse effects.\textsuperscript{22}

**Risk Factors and Triggers**

Generally there are three risk factors which increase the chances an individual will develop asthma. The first is atopy, a genetic tendency to develop allergic responses to various triggers. Atopy is the most common risk factor and it is associated with allergic asthma, atopic dermatitis, allergic rhinitis, etc. Gender is a factor in that females are more likely to experience asthma after puberty, while males are more likely to experience asthma before puberty. Additionally environmental factors, including air pollution and smoke exposure can contribute to the problem.

Following the onset of asthma, various triggers can stimulate exacerbations. These include...
occupational triggers (such as chemicals, dusts and particulates, vapors, gases, and aerosols), respiratory infections, gastroesophageal reflux disease (GERD), seasonal allergens, cold air, pollutants, hormonal changes, exercise, aspirin and NSAIDs. Asthma patients have various degrees of sensitivity and reactivity to triggers. Many triggers assault the respiratory mucosa directly, inducing asthma symptoms in response. Others, such as aspirin-induced asthma increase inflammatory mediators.

Asthma Management and Treatment Options

Guidelines
The National Heart, Lung, and Blood Institute's National Asthma Education and Prevention Program (NAEPP) developed updated guidelines in 2007. Its Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma, resulted from a relatively transparent, evidence-based review of the literature. The relevant evidence was ranked as follows:

- Evidence Category A: Randomized controlled trials with a rich body of data,
- Evidence Category B: Randomized controlled trials with a limited body of data,
- Evidence Category C: Nonrandomized trials and observational studies,
- Evidence Category D: Panel consensus judgment.

The goal is to update recommendations for managing asthma long term and for managing exacerbations by focusing on four essential components of asthma care: assessment and monitoring, patient education, control of factors contributing to asthma severity, and pharmacologic treatments.

The goals of asthma therapy include reducing impairment and reducing risk.

Reducing impairment includes:
- Prevent symptoms
- Infrequent use of inhaled SABA for quick symptom relief
- Maintain optimal pulmonary function
- Maintain normal activity levels
- Meet patient and family expectations

Reduce risk:
- Prevent recurrent exacerbations of asthma and minimize the need for hospital visits
- Prevent progressive loss of lung function
- Provide optimal pharmacotherapy

Figure 1 provides a framework for classifying patients and initiating treatment as appropriate. There are four levels of asthma severity: intermittent, mild persistent, moderate persistent, and severe persistent. The levels of asthma severity are based on the following components:
- Symptoms
- Nighttime awakenings
- SABA use for symptom control
- Interference with normal activity
- Lung function as expressed by peak expiratory flow (PEF), forced expiratory volume in 1 second (FEV₁), and PEF variability (a measure that compares the PEF obtained in the morning with the PEF obtained later in the day).

History of Asthma Guidelines
The NAEPP’s Guidelines for the Diagnosis and Management of Asthma were first published in 1991 in a landmark report that redefined the commonly held views about asthma. The following lists the updates to the original report:

1989 – NHLBI establishes the NAEPP and convenes first expert panel.


Regulation and Control
Asthma management, as outlined by NIH can best be achieved through a combination of
regular assessment and monitoring, trigger control, pharmacotherapy and patient education. Spirometry is primarily used to evaluate lung function for asthma diagnosis, whereas peak flow meters are often used to monitor lung function at home and at many outpatient appointments. Patients can determine their personal optimum peak expiratory flow (PEF) by identifying their best score during several weeks when the disease is under best control. Eighty percent or better than the patient’s personal best PEF score is considered to be good control. Sixty to seventy-nine percent of the patient’s personal best PEF score is considered to indicate caution. Less than 60% of personal best score indicates a medical alert.

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Pharmacology
Pharmacology defines the interactions between the drug and the patient's body. Pharmacodynamics is the study of how drugs affect the body, while pharmacokinetics is the study of how the body absorbs, distributes, metabolizes and excretes drugs. Pharmacodynamics includes an attempt to understand the drug's mechanism of action, clinical effects and adverse effects. Pharmacokinetics studies systemic bioavailability, the portion of the drug dose that reaches the bloodstream. Increased systemic bioavailability may be undesirable with asthma drugs intended to work in the airways, due to increased unintended drug exposure to other body systems and an increased risk of adverse effects.

Asthma medications may fall into two categories: relievers and controllers. Relievers, such as short-acting beta$_2$-agonists, anticholinergics and systemic corticosteroids (via injection or oral) can help with acute symptoms. The short-acting beta$_2$-agonists are preferred. There are five types of controllers, which are taken daily over the long-term to achieve and maintain control when indicated. Controllers include long-acting beta$_2$-agonists, corticosteroids (usually inhaled) and anticholinergics.

Long-acting beta$_2$-agonists (LABAs) such as formoterol and salmeterol are indicated for the long-term prevention and reduction of asthma symptoms when added to an inhaled corticosteroid. Side effects include tachycardia. LABAs are not anti-inflammatory agents, nor are they indicated as monotherapy nor for treatment of acute asthma symptoms or exacerbations.

There are three types of inhalation devices usually used for the control and treatment of asthma, the pressurized metered-dose inhaler (pMDI), the dry powder inhaler (DPI) and the nebulizer. pMDIs are the most popular, being small and portable, but can be challenging to coordinate. Spacers can be used as extensions to pMDIs to allow for delayed inhalation. DPIs require less coordination, but require effective ability to inhale. Nebulizers can be used by any age patient but are time consuming and may have varying output.

Asthma Implications for Dentistry

Asthma Recognition and Understanding
Understanding asthma is essential in the dental office. A patient with asthma symptoms may present with a need for emergency treatment. Additionally patients may need to use rescue medication during treatment in the office. It is important to determine in advance that the rescue inhaler should always be present and easily available to the patient. Of course asthma symptoms and treatment side effects need to be recognized and managed appropriately. For example, side effects of asthma controller medications include throat irritation and oral fungal overgrowth. Patients may be advised to rinse with water after each inhalation to minimize this side effect.

Additionally, a history of asthma is reported commonly by adult dental patients and may be
more prevalent in children. An acute episode of asthma in the dental office may be precipitated by extrinsic factors such as inhaled allergens, as well as intrinsic factors such as fear or anxiety. An asthma episode should be considered a medical emergency and must be treated promptly by inhalation of a bronchodilating agent. A history of asthma in the dental patient should alert the dentist to implement strategies that may prevent an acute attack and to be prepared to manage this potentially life-threatening medical emergency appropriately. The chronic use of bronchodilating inhalers and/or glucocorticoids for the management of asthma can increase the likelihood of oral candidiasis, particularly in patients who have additional risk factors such as smoking, denture use, or the use of xerostomic medications.

Pharmacology Considerations
As discussed, SABAs provide short term symptom relief, while LABAs provide long term prevention when added to ICS therapy. It is essential to recognize that the potential side effects of LABAs and SABAs include tachycardia.

Conclusion
In conclusion, this course increases understanding of asthma patients in the dental office. The National Institutes of Health National Asthma Education Program Expert Panel III defines their goal as, “improving asthma care and the quality of life for every asthma patient...” It is important for dental professionals to understand the manifestations of asthma, its treatments and its measures of control.
Course Test Preview
To receive Continuing Education credit for this course, you must complete the online test. Please go to:

1. The average adult breathes approximately ________ times per day.
   a. 5,000
   b. 25,000
   c. 125,000

2. The larynx is a ____________.
   a. small, square structure that leads into the lower respiratory system
   b. large, round structure that leads into the lower respiratory system
   c. small, triangular structure that leads into the lower respiratory system

3. The sympathetic nervous system regulates involuntary functions, including heart rate, blood
   pressure, digestion and respiration in response to emotional stress and/or physical exertion.
   a. True
   b. False

4. Agonists bind to receptors to stimulate a specific response, while antagonists bind to receptors to
   block a specific response.
   a. True
   b. False

5. Antagonists bind to receptors to stimulate a specific response, while agonists bind to receptors to
   block a specific response.
   a. True
   b. False

6. Three layers make up the walls of the trachea and bronchi:
   a. Respiratory mucosa, sub membrane and mucosa
   b. Respiratory mucosa, basement membrane and submucosa
   c. Mucosa and submucosa

7. More than __________ people in the United States have asthma.
   a. 25 million
   b. 100 million
   c. 144 million
   d. 222 million

8. Asthma is considered persistent when symptoms occur more than ____________.
   a. two days per week or more than two nights per month
   b. four days per week or more than two nights per month
   c. two days per week or more than eight nights per month

9. Whereas a patient with symptoms throughout the day, nighttime awakenings every week or two, daily
   use of SABAs and some limitation of normal activity may be classified as having ____________.
   a. intermittent asthma
   b. severe persistent asthma
   c. mild persistent asthma
10. **Asthma is assigned to the most severe category of any one finding.**
   a. True
   b. False

11. **Step down in therapy can be considered following at least __________.**
   a. three days of well-controlled asthma
   b. three weeks of well-controlled asthma
   c. two months of well-controlled asthma
   d. three months of well-controlled asthma

12. **The goals of asthma therapy include __________.**
    a. identify symptoms
    b. infrequent use of inhaled SABA for quick symptom relief
    c. reduce pulmonary function

13. **The Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma (EPR-3) was released in ________.**
    a. 2007
    b. 2009
    c. 2012

14. **Asthma medications may fall into two categories:**
    a. Preventers and Controllers
    b. Relievers and Rescuers
    c. Relievers and Controllers

15. **There are three types of inhalation devices usually used for the control and treatment of asthma, the pressurized metered-dose inhaler (pMDI), the dry powder inhaler (DPI) and the nebulizer.**
    a. True
    b. False
References


About the Author

Barbara Fried, RDH, MBA

Ms. Fried has been a professional relations manager, oral care, for Procter & Gamble and for AstraZeneca.

Email: friedbarbara@yahoo.com