Asthma is one of the most prevalent chronic respiratory diseases worldwide (Miller, 2016). Despite advances in health care and medication management, asthma continues to be a serious global health issue for people of all ages. An estimated 300 million people globally are affected with asthma (Global Initiative for Asthma [GINA], 2018). Results of the National Health Interview Survey indicated approximately 24.6 million people in the United States have asthma, and more than 11.5 million people with asthma report having had disease exacerbations (U.S. Environmental Protection Agency [EPA], 2018). During 2014-2016, 10 states reported having greater than 10% of adults ages 18-64 with current asthma, and 8% of U.S. adults reported current asthma (Centers for Disease Control and Prevention, 2018). The economic burden of asthma is over $56 billion in medical costs as well as lost work and school days (EPA, 2018).

Although it is a chronic illness, asthma can be managed and controlled with proper strategies. According to the most recent recommendations by the National Heart, Lung, and Blood Institute (NHLBI, 2007), asthma management is based on four essential components. These include measures of assessment and monitoring, education for a partnership in asthma care, control of environmental factors and comorbid conditions that affect asthma, and pharmacologic therapy. Education and alterations to asthma therapy could have a significant impact on a person’s ability to be active and attain control (Miller, 2016).

People with asthma may not exhibit symptoms consistently. Assessing severity and control at every encounter is essential. The physical examination in a person with asthma is often normal (Tietze, 2017). The ultimate goal of asthma treatment is to enable people with asthma to live active, healthy lives with minimal limitations and exacerbations. After the initial diagnosis is made, treatment should be initiated based on severity and adjusted in a stepwise approach based on responsiveness and level of control. Asthma severity is classified as intermittent, mild persistent, moderate persistent, and severe persistent. Asthma control is classified as well controlled, not well controlled, and very poorly controlled (Miller, 2016; NHLBI, 2007; Tietze, 2017).

Asthma Treatment

Anyone diagnosed with asthma should have a short-acting beta₂-adrenergic agonist (SABA) bronchodilator for the treatment of acute symptoms (Miller, 2016; Tietze, 2017). Mild, moderate, or severe, persistent asthma requires a long-term controller medication daily. Primarily this is an inhaled corticosteroid (ICS) medication and the dose is based on the level of control (Miller, 2016; NHLBI, 2007; Tietze, 2017). The goal is to use the lowest dose possible to maintain control and minimize risk. Reassessment is recommended 1-3 months after initiating ICS medication; routine visits should be scheduled once control is attained (GINA, 2018; NHLBI, 2007).

Any decision to decrease or increase asthma therapy should be evaluated at every visit with the...
healthcare provider. The decision to decrease therapy should be based on the patient maintaining control for at least 3 months (Tietze, 2017). Further reductions in dose can be made when a person has been symptom-free with no risk factors for exacerbations for 6-12 months (GINA, 2018). However, most people with persistent asthma will require treatment with daily medication to suppress airway inflammation and will often relapse if ICS is stopped completely (Miller, 2016).

Routine asthma visits will allow healthcare providers to assess response to the current regimen and determine if treatment needs to be increased. If at any time the disease is less well controlled, the provider will need to use the stepwise approach to adjust treatment. It is also essential to evaluate inhalation technique, adherence, co-morbid conditions, and environmental triggers (Miller, 2016; Tietze, 2017).

Treatment decisions should be made with a shared decision-making process. Preferred treatment, type of asthma, patient preferences, inhaler technique, adherence, and costs should be evaluated when a treatment plan is initiated (GINA, 2018). Treatment recommendations for patients with persistent asthma include long-term controller medications (GINA, 2018; Miller, 2016; NHLBI, 2007; Tietze, 2017; Woo, 2016). These are primarily in the form of an ICS generally initiated at a low dose.

Inhaled Corticosteroids

ICS medication is considered the gold standard for treatment of persistent asthma. These medications are very effective, potent anti-inflammatory agents (NHLBI, 2007; Zimmermann, 2018). Regular use of ICS medicines can lead to successful reduction of asthma symptoms, as well as decreased risk for exacerbations, hospitalizations, or death (GINA, 2018). ICS medications may be used concurrently as necessary with bronchodilators and other anti-inflammatory agents, such as mast cell stabilizers or leukotriene modifiers (Zimmermann, 2018). ICS are anti-inflammatory agents that reduce asthma severity, decrease asthma symptoms, increase pulmonary function, and decrease airway hyperresponsiveness. Inhaled steroids may be used by children and adults, generally are tolerated very well, and have been found to be safe (Miller, 2016).

Commonly prescribed ICSs for asthma are beclometasone dipropionate (QVAR®), triamcinolone acetonide (Azmacort®), budesonide (Pulmicort®), flunisolide (AeroBid®), mometasone furoate (Asmanex Twisthaler®), fluticasone (Flivent®), and ciclesonide (Alvesco®). Because each has a unique formulation, substantial differences are possible in the delivered amount of steroid in each inhalation. ICSs should not be used interchangeably without proper adjustment in dosing (Miller, 2016).

Mechanism of Action

Corticosteroids work to reduce airway inflammation by inhibiting production of end-effector proteins. Altering this production leads to numerous effects, including alteration of vascular tone, vascular permeability, and body water distribution; stimulation of lipolysis, glucose, glycogen storage, and increased responsiveness of beta-adrenergic receptors; mobilization of amino acids from muscles; impairment of leukocyte migration; prevention of nuclear factor-kappa, which regulates production of pro-inflammatory proteins (e.g., cytokines, interleukins, interferons, chemokines) (Tietze, 2017). ICS inhibits the migrations of inflammatory cells, immunoglobulin E, and mast cells into the bronchial tissue (Tietze, 2017; Woo, 2016). However, the exact mechanism of bronchoconstriction and smooth muscle relaxation is unknown (Woo, 2016). Beneficial effects of the suppression of airway inflammation include decreased mucus secretion, decreased edema of airway mucosa, and repair of damaged epithelium, with subsequent reduction of airway reactivity (Zimmermann, 2018).

Absorption and Distribution

The onset of action of ICS is delayed due to the time it takes for the drug to influence protein expression. ICS response typically begins during the first week and continues to increase for weeks to months with continued use (Tietze, 2017). Therapeutic effects generally occur at about 4 weeks (Zimmermann, 2018).

Absorption of ICSs occurs in the lungs, liver, and gastrointestinal (GI) tract, while drugs are excreted in feces and urine (Woo, 2016; Zimmermann, 2018). The amount delivered to the lungs is absorbed almost completely (NHLBI, 2007). Some portion of the ICS inevitably will be swallowed (Woo, 2016). The use of a spacer will decrease the amount that is swallowed. After GI absorption, all ICS medications undergo high first-pass liver metabolism (NHLBI, 2007; Woo, 2016). A small portion is absorbed into systemic circulation (Woo, 2016).

Dosage Ranges

Dosage of ICS depends on asthma severity. Treatment of mild persistent asthma starts with a low-dose ICS; medium-dose ICS is indicated for moderate persistent asthma, and high-dose ICS is indicated in severe persistent asthma (Tietze, 2017). Dosages for ICS vary with each specific product and the delivery method (Woo, 2016). People with asthma may need to adjust to a higher dose during acute exacerbations or with changes in the season. NHLBI (2007) recommended use of a stepwise approach to maintain asthma control. It may be necessary to increase therapy if the disease is not well controlled. Deciding which dosage of ICS is appropriate also is based on if the person has ever taken an ICS medication. The lowest possible dose should be used to achieve the desired effect. Table 1 provides a comparison of daily ICS dosage for adults.
Contraindications

ICS medications are contraindicated in anyone with a history of hypersensitivity to any component of corticosteroids (Tietze, 2017; Zimmermann, 2018). They are not meant for treatment of acute bronchospasms or status asthmaticus. ICS medications should be avoided in people with Cushing's syndrome (Woo, 2016). Caution should be exercised when using with people with ocular herpes simplex, tuberculosis, oral surgery, or untreated respiratory infections (Woo, 2016; Zimmermann, 2018). Although a significant change in serum glucose has not been shown, caution also should be used in persons with diabetes (NHLBI, 2007).

Although low, the risk for hypothalamic-pituitary-adrenal suppression may increase if ICS medication is used with oral steroids (Woo, 2016). Corticosteroids are metabolized by the hepatic cytochrome P-450 isoenzyme CYP3A4 and induce CYP2C19 and CYP3A4 (Tietze, 2017; Woo, 2016). Caution should be taken when using ICS with all nonprescription, prescription, and complementary medications (Tietze, 2017). Concurrent use with medications that are strong inhibitors of CYP3A4 (e.g., clarithromycin, ketoconazole, fluconazole, nelfinavir, zileuton) may increase plasma concentrations and the risk of adverse effects (Tietze, 2017; Woo, 2016).

Adverse Effects

Because ICS medications do not have the same bioavailability as oral systemic corticosteroids, the risk of potential side effects is reduced substantially (NHLBI, 2007). Common adverse effects include oral candidiasis, headache, pharyngitis, dysphonia, cough, dry mouth, hoarseness, and nausea (Miller, 2017; NHLBI, 2007; Tietze, 2017; Woo, 2016; Zimmermann, 2018). Rinsing the mouth and spitting after use, using a spacer or valved holding chamber, and decreasing the dose may reduce local adverse effects of inhaled corticosteroids (Miller, 2017; NHLBI, 2007; Tietze, 2017; Zimmermann, 2018). Urticaria or other rashes also have been noted (Woo, 2016).

People taking long-term, high-dose ICS may be at increased risk for adverse effects, including increased blood pressure, hyperglycemia, increased appetite, weight gain, or edema (Tietze, 2017). Additional potential severe adverse reactions include decreased bone mineral density, cataracts, dental thinning, ecchymosis, or adrenal suppression (Tietze, 2017; Woo, 2016). Linear growth alteration is an important consideration with the use of ICS. Systemic adverse effects causing reduced growth in height may occur as a result of long-term use of ICS by children or adolescents. However, research has shown the potential of decreasing growth in height is small, non-progressive, and could be reversible when using low- or medium-dose ICS (NHLBI, 2007). The NHLBI suggested the significant improvement of asthma with the use ICS medication outweighs the small reduction in growth in height. Authors of the guidelines further noted if high doses of ICS are needed to achieve asthma control, use of adjunctive long-term control therapy to reduce the dose of ICS may minimize possible dose-related long-term effects.

### TABLE 1.
Estimated Comparative Daily Dosages for ICS for Adults

<table>
<thead>
<tr>
<th>Drug</th>
<th>Low Daily Dose</th>
<th>Medium Daily Dose</th>
<th>High Daily Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beclomethasone HFA 40 or 80 mcg/puff</td>
<td>100-200 mcg</td>
<td>&gt;200-400 mcg</td>
<td>&gt;400 mcg</td>
</tr>
<tr>
<td>Budesonide DPI 90 or 180, mcg/inhalation</td>
<td>200-400 mcg</td>
<td>&gt;400-800 mcg</td>
<td>&gt;800 mcg</td>
</tr>
<tr>
<td>Ciclesonide HFA 80 or 160 mcg/puff</td>
<td>80-160 mcg</td>
<td>&gt;160-320 mcg</td>
<td>&gt;320 mcg</td>
</tr>
<tr>
<td>Fluticasone HFA/MDI: 44, 110, or 220 mcg/puff</td>
<td>100-250 mcg</td>
<td>&gt;250-500 mcg</td>
<td>&gt;500 mcg</td>
</tr>
<tr>
<td>DPI: 50, 100, or 250 mcg/inhalation</td>
<td>100-250 mcg</td>
<td>&gt;250-500 mcg</td>
<td>&gt;500 mcg</td>
</tr>
<tr>
<td>Mometasone DPI 100 or 200 mcg/inhalation</td>
<td>110-220 mcg</td>
<td>&gt;220-440 mcg</td>
<td>&gt;440 mcg</td>
</tr>
<tr>
<td>Triamcinolone acetonide 75 mcg/puff</td>
<td>400-1,000 mcg</td>
<td>&gt;1,000-2,000 mcg</td>
<td>&gt;2,000 mcg</td>
</tr>
</tbody>
</table>

Source: Adapted from GINA, 2018; Woo, 2016

DPI = dry powder inhaler, HFA = hydrofluoroalkane, MDI = metered-dose inhaler
on growth. Further recommendations include weighing the benefits and risks of ICS use and close monitoring of growth of children and adolescents. Growth also may be inhibited by poorly controlled asthma (Woo, 2016).

An important consideration in adult patients, especially perimenopausal women, is the use of a calcium supplement (1,000-1,500 mg per day) and vitamin D (400-800 units a day). For people taking medium or high-dose of ICS, bone-sparing therapy (e.g., bisphosphonate) should be considered, particularly for those who are at risk of osteoporosis or who have low bone mineral density scores (Robinson & Shaw, 2016).

**Special Considerations**

**Important Considerations with Delivery of ICS**

Use of a spacer device with ICS is essential to assure proper delivery of medication. Approximately 80% of the dose from a metered-dose inhaler (MDI) is swallowed if a spacer is not used, altering the oral bioavailability (Woo, 2016). Triamcinolone MDI has a built-in spacer to improve medication delivery to the lungs.

**ICS Use in Children**

Safety and effectiveness of ICS medicines have been proven in all ages. However, it is important to consider the patient’s age when choosing treatment, as well as doses of ICS. Long-term use in children may cause decreased adrenal function, bone mass, and linear growth. ICS dose, type of inhaler device, and individual characteristics influence the extent and severity of systemic effects. Although considered the most effective anti-inflammatory agent, high-dose ICS use should remain a concern in children. Adrenal insufficiency is most likely to occur with high-dose ICS use in children. To reduce the risk, the lowest possible dose should be used to achieve effect, inhalation technique enhanced to reduce swallowing the medication, and treatment combined with other anti-asthmatic drugs to reduce corticosteroid dose (Zimmermann, 2018). These include cromolyn, nedocromil, leukotriene modifiers, and antihistamines (Woo, 2016).

**Pregnancy**

ICS medications are the long-term control treatment of choice, with budesonide having the most data available in pregnant women (NHLBI, 2007). All ICS medications are Pregnancy Category C. Currently, no well-controlled studies have examined the effects of ICS during pregnancy (Woo, 2016).

**Nursing Implications**

**Patient Education**

Nurses play an integral role in managing asthma and assisting patients to understand the use of ICS medications and potential adverse effects. People with asthma should be included in management plans. A partnership of the patient and family with the healthcare team is essential (Miller, 2016; NHLBI, 2007). Asthma education has been found to reduce asthma morbidity and be very cost effective (Miller, 2016).

Education should include asthma characteristics, overall treatment plan, a written asthma action plan, goals for self-management, inhalation technique, self-assessment of symptoms, and asthma triggers to avoid (Miller, 2016; Tietze, 2017). People taking ICS medicines should be helped to understand these are not fast-acting rescue medications used to resolve an asthma exacerbation (Zimmermann, 2018). ICS medications should be continued even when the person is not having asthma symptoms. Patients taking ICS need to be aware several months could be needed to achieve benefit of the medication and they should have a short-acting beta$_3$ agonist (SABA) available at all times.

Education for administration of ICS medication should include inhalation technique, rinsing of the mouth and throat, and regular use to maintain control (Woo, 2016; Zimmermann, 2018). If the patient is using inhaled bronchodilators concurrently, education should be given regarding administering the bronchodilator first and then waiting several minutes before using the ICS (Woo, 2016). This will enhance the absorption of the steroid. Patients also need to understand there are various forms of ICS delivery, each with a unique administration technique. Respiratory drug delivery systems include MDIs, spacer or valved holding chambers, dry powder inhalers (DPIs), soft mist inhalers, and nebulizers (Tietze, 2017).

MDIs do not require as much forceful inhalation as DPIs to deliver the medications to the lungs. Learning to inhale ICS properly can be challenging for most adults. The patient’s technique should be observed to determine if the medication is being used correctly. Careful attention needs to be given to assist adults to learn how to coordinate the release of the medication from the inhaler with a deep breath. Nurses should augment written and pictorial instructions with verbal and hands-on demonstrations with placebo inhalers to reinforce the education (Woo, 2016). These instructions and demonstrations should be reiterated at all follow-up appointments.

People with asthma also should have education about needed lifestyle changes. Lifestyle management includes self-monitoring, smoking cessation and avoidance, and avoidance of any triggers at home or work (Woo, 2016). Good nutrition and physical activity are also important factors in lifestyle management that should be encouraged for people with asthma (Tietze, 2017).

**Monitoring**

Persons using ICS should be monitored continually for any adverse medication effects, medication effectiveness, and the asthma disease process (Woo, 2016; Zimmermann, 2018). Further monitoring should include blood glucose, potassium, and growth, if
Inhaled Corticosteroids for Asthma Management

high-dose ICSs are used for a long time (Woo, 2016). Ongoing monitoring of signs and symptoms, pulmonary function, quality of life and functional status, history of asthma exacerbations, and pharmacotherapy is recommended (Miller, 2016; NHLBI, 2007).

Recognizing and monitoring asthma symptoms are essential components of self-management. All patients should be taught age-appropriate techniques to keep records of symptoms. Examples include a self-assessment diary that includes recordings of symptoms, peak expiratory flow (PEF), and any triggers (Miller, 2016). Clinical assessments with appropriate screening questions and physical examination should be done at each healthcare visit (Miller, 2016; NHLBI, 2007). When assessing symptoms, the provider must differentiate among daytime symptoms, nighttime symptoms, and symptoms that occur in the early morning or persist after inhaling a SABA (Miller, 2016).

Objective measures of lung function are essential in the diagnosis and management of asthma (Miller, 2016). Pulmonary function testing includes spirometry and PEF. Spirometry is recommended at initial assessment, after treatment has been initiated, and then every 1 to 2 years routinely (Miller, 2016; NHLBI, 2007). Monitoring functional status and quality of life is important to aid in determining if goals of asthma treatment are being met (Miller, 2016). Any missed work, reduction in usual activities, and sleep disturbances should be evaluated (Miller, 2016; NHLBI, 2007).

Any asthma exacerbations should be monitored at every healthcare visit. Providers should evaluate self-monitoring records, emergency room visits, and hospitalizations to determine if the patient has had any asthma exacerbations (Miller, 2016). Any changes in medication treatment should be based on the history of exacerbations and level of control (Miller, 2016; NHLBI, 2007).

Successful asthma treatment is based on the effectiveness of pharmacological therapy. The patient’s adherence, inhaler technique, use of SABA, frequency of oral steroid use, and changes needed in dose of ICS are important to consider (Miller, 2016). The healthcare provider also must determine if the patient is at the appropriate level of step therapy and if any changes need to be made (Miller, 2016; NHLBI, 2007).

Conclusion

Pharmacologic therapy is used to prevent and control asthma symptoms, improve quality of life, reduce the frequency and severity of asthma exacerbations, and reverse airflow obstruction. Evaluating the effectiveness of asthma therapy, including ICS, should be an ongoing process. People with asthma should be able to maintain active, healthy lives with minimal symptoms or restrictions. ICS medications have been proven safe and very effective in managing persistent asthma. Care should be focused to use the least dose to achieve the most effective outcomes. Referral to an asthma specialist should be considered if the person is not able to achieve or maintain control. Open communication with the entire healthcare team will lead to improved patient outcomes as well as a reduction in healthcare costs and asthma mortality (GINA, 2018; NHLBI, 2007).

REFERENCES


