

**FEDERAL BUREAU OF PRISONS
CLINICAL PRACTICE GUIDELINES
MANAGEMENT OF ASTHMA
NOVEMBER, 2000**

PURPOSE

The BOP Clinical Practice Guidelines for the Management of Asthma provide guidelines for the evaluation and treatment of federal inmates with asthma.

REFERENCES

National Asthma Education Program. Expert Panel Report II: Guidelines for the diagnosis and management of asthma. U.S. Department of Health and Human Services, National Heart, Lung, and Blood Institute; NIH Publications No. 97-4051, July 1997.

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DEFINITIONS

Asthma is a chronic inflammatory disorder of the airways, associated with increased airway responsiveness, and usually widespread but variable airway obstruction that is often reversible, either spontaneously or with treatment.

Clinician is a physician or mid-level provider.

FVC is Forced Vital Capacity, the maximal volume of air forcibly exhaled from the point of maximal inhalation by a patient during spirometry.

FEV₁ is Forced Expiratory Volume in 1 second, the volume of air exhaled during the first second of the FVC.

MDI is Metered Dose Inhaler, a device designed to deliver an exact dose of an inhaled medication with each activation of the device. Most inhaled asthma medications are delivered via metered dose inhalers.

PEF is Peak Expiratory Flow, a test which measures the peak expiratory flow rate (PEFR).

PEFR is Peak Expiratory Flow Rate, the maximum rate of exhalation during testing using a peak flow meter or spirometer.

PFM is Peak Flow Meter, a simple device intended for home or clinic use, which allows a patient with asthma to measure his or her peak expiratory flow rates, and compare them to expected ranges.

Pulsus paradoxus is an inspiratory diminution in arterial pressure that exceeds 10 mm Hg during a normal cardiac rhythm with a respiration of normal rhythm and depth. The degree of pulsus paradoxus correlates with the reduction in the FEV₁ in patients with acute airway obstruction such as occurs with a severe asthma exacerbation. Other clinical conditions associated with pulsus paradoxus include chronic obstructive pulmonary disease and cardiac tamponade.

Spirometry is a clinic or hospital-based test which measures FEV₁ and FVC.

PROCEDURES

1. DIAGNOSIS

The diagnosis of asthma requires clinical judgment since signs and symptoms may vary widely from inmate to inmate as well as within each inmate over time. Due to the highly variable nature of asthma as well as the heterogeneous aspects of affected patients, set diagnostic criteria are not defined by the National Institutes of Health Expert Panel on Asthma. Clinicians should use the following guidelines to establish the diagnosis of asthma:

- Episodic symptoms of airflow obstruction are always present
- Airflow obstruction is at least partially reversible
- Alternative diagnoses have been excluded

The differential diagnoses for asthma include the following:

- Chronic obstructive pulmonary disease (chronic bronchitis or emphysema)
- Congestive heart failure
- Pulmonary embolism
- Laryngeal dysfunction
- Mechanical obstruction of the airways (benign and malignant)
- Pulmonary infiltration with eosinophilia (Churg-Strauss syndrome)
- Cough secondary to drugs (e.g. angiotensin converting enzyme inhibitors)
- Vocal cord dysfunction

The medical history in persons with asthma reveals multiple of the following key historical factors:

- Wheezing: high pitched whistling sounds when exhaling (lack of wheezing by inmate history does not exclude asthma)
- Cough, worse particularly at night
- Recurrent difficulty in breathing
- Recurrent chest tightness
- Reversible airflow limitation and diurnal variation as measured by using a peak flow meter
- Symptoms occur or may worsen in the presence of the following precipitants:
 - Exercise

- Viral infection
- Animals with fur or feathers
- House dust mites
- Mold
- Smoke
- Pollen
- Changes in weather
- Strong emotional expression (laughing or crying)
- Airborne chemicals or dust
- Menses
- Ingestion of aspirin or non-steroidal anti-inflammatory agents
- Non-selective beta-blocker therapy

The physical examination of the upper respiratory tract, chest and skin may indicate the following findings:

- Hyperexpansion of the thorax
- Sounds of wheezing during normal breathing or a prolonged phase of forced exhalation
- Increased nasal secretions, mucosal swelling, and nasal polyps
- Atopic dermatitis/eczema or any other manifestation of an allergic skin condition

A diagnosis of asthma, suggested by the medical history and physical examination, should be supported by findings from the peak flow assessment or pulmonary function testing (spirometry). Depending upon the availability of spirometry, the assessment of peak expiratory flow rates may be more efficient and cost-effective as the first objective measurement for diagnosing asthma.

Peak Expiratory Flow (PEF) measurements should be made using the following guidelines:

Assessment of diurnal variation in peak expiratory flow over 1 to 2 weeks is recommended for inmates with asthma symptoms. PEF is generally lowest on first awakening and highest several hours before the midpoint of the waking day. Measuring PEF on waking and in the evening may be more practical, but values will tend to underestimate the actual diurnal variation. Reversible and variable airflow limitation, as measured by using a peak flow meter, may be ascertained in any of the following ways:

- PEF should be optimally measured upon arising, before taking an inhaled short-acting beta₂-agonist, and after 1:00 P.M. A 20% difference between morning and afternoon measurements in an inmate using a bronchodilator suggests asthma. (If the inmate is not using a bronchodilator during the day, a difference of more than 10% between morning and 1:00 P.M. suggests the diagnosis of asthma)
- PEF increases more than 15%, 15 to 20 minutes after inhalation of a short-acting beta-2 agonist
- PEF decreases more than 15% after 6 minutes of running or exercise

Spirometry measurements (FEV₁, FVC, FEV₁/FVC) before and after the inmate inhales a short acting bronchodilator should be undertaken for inmates in whom the diagnosis of asthma is suspected. Spirometry helps determine whether there is air flow obstruction and whether it is reversible over the short term.

Spirometry measurements are interpreted in accordance with the following parameters:

- FVC (forced vital capacity) is the maximal volume of air forcibly exhaled from the point of maximal inhalation.
- FEV₁ (forced expiratory volume in 1 second) is the volume of air exhaled during the first second of the FVC).
- Airflow obstruction is indicated by reduced FEV₁, and FEV₁/FVC values relative to reference or predicted values.
- Abnormalities of lung function are categorized as obstructive or restrictive defects. A reduced ratio of FEV₁/FVC (<65%) indicates obstruction to the flow of air from the lungs. A reduced FVC with a normal FEV₁/FVC ratio suggests a restrictive pattern.
- FEV₁ and FVC are measured before and after the patient inhales a short acting bronchodilator. Significant reversibility is indicated by an increase of $\geq 12\%$ and 200 ml in FEV₁, after inhaling a short-acting bronchodilator. A 2-3 week trial of an oral corticosteroid may be required to demonstrate reversibility. The spirometry measurements that establish reversibility may not indicate the inmate's best lung function.
- The severity of the abnormal spirometric measurements is

evaluated by comparison of the inmate's results with reference values based on age, height, sex, and race. Knutson standards are the most commonly used. Most spirometers will print out the test results, the predicted value for each parameter, and the "percent of predicted" value, i.e. the test result divided by the predicted value.

- Although asthma is typically associated with an obstructive impairment that is reversible, neither this nor any other single test or measurement is adequate to diagnose asthma. Many diseases are associated with this pattern of abnormality. The inmate's pattern of symptoms, medical history and exclusion of other possible diagnoses are also needed to establish a diagnosis of asthma.

Additional diagnostic studies should be considered for inmates diagnosed with asthma when clinically indicated:

-**A baseline chest x-ray** should be performed for inmates with a history of asthma, or at the time that a new diagnosis of asthma is being considered. Chest x-rays are normal in persons with uncomplicated asthma, but are indicated to exclude other diagnoses.

-**A diffusing capacity test** is helpful in differentiating between asthma and emphysema for inmates at risk for both illnesses. Impaired diffusing capacity may suggest alveolocapillary bed loss which is mostly seen in emphysema.

-**Bronchoprovocation** with methacholine, histamine or exercise challenge may be useful when asthma is strongly suspected and spirometry is normal or near normal. However, bronchoprovocation should not be viewed as a routine test.

-**Lung volumes, inspiratory and expiratory flow volume loops** may be indicated if there are questions about coexisting chronic obstructive pulmonary disease, a restrictive defect or possible central airway obstruction.

-**Evaluation of the nose** for nasal polyps should be performed for inmates with concurrent aspirin or nonsteroidal anti-inflammatory drug (NSAID) allergies.

-**Sinus x-rays** should be considered on a case-by-case basis since a significant number of persons with asthma have chronic sinus disease or have an acute exacerbation of sinusitis. Antibiotic treatment of concurrent bacterial sinusitis is effective in reducing asthma severity.

-Evaluation for gastroesophageal reflux disease (GERD)

should be pursued if suggested by history or examination. Acid reflux is an underestimated and underdiagnosed trigger for asthma. GERD should be considered if the inmate's symptoms suggest dyspepsia, or if nocturnal awakening with asthma attacks is a consistent pattern. An empirical trial of a nightly antacid or H-2 blocker is recommended if GERD is suspected.

-Allergy testing is generally not indicated, but should be considered for inmates with persistent, moderate to severe asthma which is not responding adequately to standard treatment. As a diagnostic test, it may occasionally prove useful in determining specific allergens which should be avoided by the patient. Immunotherapy based upon allergy testing must be justified as medically necessary and approved on a case-by-case basis.

2. CLASSIFICATION OF ASTHMA SEVERITY

All inmates diagnosed with asthma should be classified in accordance with NIH criteria, as delineated in Appendix 1, Classification of Asthma Severity. Inmates should be subsequently reclassified when clinically indicated.

3. TREATMENT OF ASTHMA

All inmates with asthma should be offered **influenza vaccination annually and a pneumococcal vaccination** in accordance with current Centers for Disease Control and Prevention guidelines.

Medications for the treatment of asthma include quick-relief and long-term-control medications. Specific medications prescribed for treating asthma, along with recommended dosages, are outlined in Appendix 2, Asthma Medication Dosage Guidelines.

QUICK-RELIEF MEDICATIONS

Short-acting beta-agonists such as albuterol, bitolterol, pirbuterol and terbutaline are the therapy of choice for the relief of acute bronchospasm and for the prevention of exercise-induced bronchospasm (EIB). Nonselective agents such as epinephrine and metaproterenol are not recommended due to the potential for excessive cardiac stimulation.

Anticholinergic agents such as ipratropium may provide some added benefit to inhaled beta₂-agonists in treating acute bronchospasm

and may serve as an alternative bronchodilator for inmates who do not tolerate inhaled beta₂-agonists. These agents are not effective in treating EIB. They are the agents of choice for treating bronchospasm secondary to beta-blockers.

Systemic Corticosteroids are indicated for moderate-to-severe exacerbations to speed recovery and prevent recurrence of exacerbations. Intramuscular or intravenous Solu-Cortef or dexamethasone are the most rapid-acting agents, yet their onset of action is still **several hours delayed from the time of administration**. Short-term therapy should continue until the inmate achieves 80% of his/her personal best, usually 3 to 10 days. Tapering systemic steroids following clinical improvement after a short treatment course does not prevent relapse and is not recommended.

LONG-TERM CONTROL MEDICATIONS

Corticosteroids are the most potent and effective anti-inflammatory medications available for the treatment of asthma. **The regular use of inhaled corticosteroids, when medically indicated for asthma, is associated with a decreased risk of death.** Inhaled formulations such as beclomethasone, budesonide, flunisolide, fluticasone, and triamcinolone are used for long-term control of asthma. Inhaled preparations are **not** interchangeable on a mcg or per puff basis (See Appendix 3, Guidelines for Inhaled Anti-Inflammatory Agents). Systemic corticosteroids such as methylprednisolone, prednisolone, and prednisone are used for long-term prevention of symptoms for severe persistent asthma.

Mast cell stabilizers such as cromolyn or nedocromil are mild to moderate potency anti-inflammatory medications. The therapeutic efficacy of these agents may not be apparent for 4 to 6 weeks after the initiation of treatment. These agents are not routinely used for the treatment of asthma, but should be prescribed selectively, and prophylactically to prevent asthma specifically related to exercise or unavoidable exposures to known allergens.

Long-acting beta₂-agonists such as salmeterol are used concomitantly with anti-inflammatory medications or short-acting beta adrenergic agonists, for long-term control of symptoms, especially nocturnal symptoms and for preventing exercise-induced bronchospasm. Inhaled beta₂-agonists are preferred over oral agents, since they are longer acting and have fewer side effects. **Salmeterol should never be used to treat acute symptoms or exacerbations of asthma. Acute asthmatic episodes should be**

treated with short-acting beta₂-agonists. Salmeterol administration frequency should not be increased. All beta agonists may cause CNS excitement, elevation of blood pressure and heart rate.

Methylxanthines such as sustained-release theophylline are mild to moderate potency bronchodilators used principally as an adjunct to inhaled corticosteroids for prevention of nocturnal asthma symptoms. These agents may also have a mild anti-inflammatory effect. Routine serum monitoring is essential since theophylline has a narrow therapeutic range of 5 to 15 mcg/ml with potentially serious toxicities, drug interactions, and significant person-to-person variability in dosage requirements. Theophylline is not recommended to treat exacerbations of asthma.

Leukotriene modifiers, such as leukotriene receptor antagonists, zafirlukast and montelukast, or the 5-lipoxygenase inhibitor, zileuton are adjunctive anti-inflammatory agents used for the treatment of asthma. Leukotriene receptor antagonists block smooth-muscle constriction, eosinophil migration, and airway edema. Inhibition of 5-lipoxygenase decreases chemotaxis. **Leukotriene modifiers are the agents of choice for treating persons with the triad of asthma, nasal polyps, and aspirin sensitivity; and are also specifically effective in treating exercise-induced asthma.** Leukotriene modifiers are also indicated for persons with mild persistent asthma when steroids are relatively contraindicated (e.g. brittle diabetes, HIV infection, complications from prolonged steroid use) or when adherence to inhaled medications is poor; and for the long-term control of persistent and symptomatic allergen-induced asthma when poorly controlled with standard asthma treatment regimens. Leukotriene modifiers may show different pharmacological profiles and daily dosage variation. Zileuton is rarely used due to multiple pharmacological interactions and the requirements for drug administration four times daily. Zafirlukast has fewer medication interactions than zileuton and is administered twice daily. Montelukast has fewer interactions than zileuton and is administered once daily. All of these agents must be administered a least 1 hour before or 2 hours after meals. Leukotriene modifiers have the potential for significant adverse effects as referenced in Appendix 2.

4. STEP THERAPY FOR ASTHMA (See Appendix 1, Classification of Asthma Severity, for Step Criteria)

The stepwise approach to managing inmates with asthma is based on the NIH Guidelines for the Diagnosis and Management of Asthma, April, 1997. Since asthma is a highly variable chronic illness,

these steps represent general guidelines, not specific prescriptions. Clinicians should individualize treatment plans for every inmate with asthma. The general goal of step therapy is to gain control as quickly as possible and then reduce treatment to maintain control with the least medication possible. A rescue course of systemic corticosteroids may be necessary at any time, at any step.

STEP 1: Mild Intermittent Asthma

Long-Term Control

No daily medication is needed.

Quick Relief

Use short-acting bronchodilators, inhaled beta₂-agonists, as needed for symptoms; e.g. 2 puffs of albuterol with one minute between puffs, **(The use of short-acting inhaled beta₂-agonists more than 2 times a week may indicate the need for long-term-control therapy or seasonal treatment)**. For certain persons with intermittent asthma, severe life-threatening exacerbations may occur separated by lengthy periods of normal pulmonary function without symptoms. Exacerbations are frequently precipitated by respiratory infections. A short course of systemic steroids along with treatment of the infection is recommended.

Assess compliance with treatment plan by discussion with inmate and by consulting pharmacy staff about adherence to medication treatment and refill history. Inmate education is paramount. Accordingly, institute the following:

- Teach basic facts about asthma **prevention and control**
- Ask inmate to demonstrate inhaler/spacer technique, **(Treatment failure or an apparent change in the level of severity is most often due to poor technique in the self-administration of inhaled medications.** Placebo inhalers are available for demonstration purposes and their use is strongly recommended)
- Discuss roles of medications
- Develop self-management plans
- Develop action plan for when and how to take rescue actions, especially for inmates with histories of severe exacerbations

- Discuss feasible, practical, environmental control measures to avoid exposure to known allergens and irritants

STEP 2: Mild Persistent Asthma

Long-Term Control

Inhaled corticosteroids (low dose) are the mainstay of therapy. Leukotriene modifiers should be considered for inmates with poor adherence to inhaled corticosteroids. Sustained-release theophylline to a serum concentration of 5-15 mcg/dl is an alternative, but is usually not the preferred therapy. Theophylline is best reserved to prevent nocturnal asthma, or as an adjunctive treatment for inmates with inadequate control on inhaled corticosteroids alone.

Quick Relief

Use short-acting bronchodilators, inhaled beta₂-agonists, as needed for symptom control, **(The use of short-acting inhaled beta₂-agonists on a daily basis, or increasing use, indicates the need for additional agents for long-term control).**

Assess compliance with treatment plan by discussion with inmate and by consulting pharmacy staff about the inmate's adherence to medication treatment and refill history. Inmate education is paramount. Accordingly institute the following:

Implement Step 1 action plans plus:

- Teach self-monitoring, (A peak flow meter is **recommended** for self-monitoring)
- Review and update self-management plan

STEP 3: Moderate Persistent Asthma

Long-Term Control

Inhaled corticosteroids (medium dose) are the mainstay of therapy. An alternative option is inhaled corticosteroid (low-medium dose) **plus** a long-acting inhaled beta₂-agonist, or sustained release theophylline, or long-acting beta₂-agonist tablets, or leukotriene modifier. Refer inmate to an asthma specialist if control of symptoms cannot be achieved.

Quick Relief

Use short-acting bronchodilators, inhaled beta₂-agonists, as needed for symptom control. The intensity of treatment will depend on the severity of the exacerbation (See Appendix 4, Classifying the Severity of Asthma Exacerbations). **The use of short-acting inhaled beta₂-agonists on a daily basis, or increasing use, indicates the need for additional long-term-control therapy.**

Assess compliance with treatment plan by discussion with inmate and by consulting with pharmacy staff about adherence to medication treatment and refill history. Inmate education is paramount. Accordingly institute the following:

Step 1 action plans plus:

- Teach self-monitoring. A peak flow meter is **essential** at this step for adequate self-monitoring
- Consider group education if feasible
- Review and update self-management plans

STEP 4: Severe Persistent Asthma

Long-Term Control

Inhaled corticosteroids (high dose) are the mainstay of therapy **plus:**

- a long-acting inhaled beta₂-agonist, or sustained release theophylline, or long acting beta₂-agonist tablets, or leukotriene modifier; **plus:**
- Systemic corticosteroid therapy with tablets or syrup (2 mg/kg/day, not to exceed 60 mg per day) should be used as necessary to stabilize symptoms. Long term systemic therapy should be minimized whenever possible to reduce the incidence of steroid complications. Repeated attempts should be made to reduce systemic steroid usage and maintain control with high dose inhaled steroids. Inmates receiving long term systemic corticosteroids must be tapered off their medications since adrenal axis suppression is likely. **The potent inhaled corticosteroid preparations available (e.g. fluticasone, beclomethasone), may provide a topical anti-inflammatory benefit to the lungs with decreased systemic**

adverse effects

Consultation with an asthma specialist is recommended for inmates with severe persistent asthma.

Quick Relief

Use short-acting bronchodilators, inhaled beta₂-agonists, as needed for symptom control. The intensity of treatment will depend on the severity of the exacerbation (See Appendix 4). Inmates with severe asthma are at highest risk for acute decompensation, which requires hospitalization and possible intubation. The use of short-acting inhaled beta₂-agonists on a daily basis, or increasing use, indicates the need for additional long-term-control therapy and further consultation with a physician with expertise in treating asthma.

Assess compliance with treatment plan by discussion with inmate and by consulting pharmacy staff about adherence to medication treatment and refill history. Inmate education is paramount. Accordingly, institute the following:

Step 3 actions **plus**:

Refer inmate for intensive education and counseling as necessary, including group education if feasible.

5. MANAGEMENT OF ASTHMA EXACERBATIONS

(See Appendix 4, Classifying the Severity of Asthma Exacerbations).

Assess Severity of Exacerbation

- Measure PEF: A value < 50% of personal best or predicted suggests a severe exacerbation
 - The degree of cough, breathlessness, wheeze, and chest tightness do not correlate well with the severity of exacerbation
 - Accessory muscle use and suprasternal retractions suggest a severe exacerbation
 - Inmates with a previous history of hospitalizations or intubations for asthma are at increased risk for future acute decompensation and life-threatening complications.
- All health care providers should recognize these at-risk**

inmates and use a low threshold for referral for emergency hospitalization when acute exacerbations develop

Initial Treatment of Asthma Exacerbation

Treat with inhaled short-acting beta₂-agonists, up to three treatments of 2-4 puffs by MDI at 20 minute intervals, or single nebulizer treatments.

Good Response: (Findings = Mild Exacerbation)

-PEFR > 80% predicted or personal best with no wheezing or shortness of breath, and the response to beta₂-agonist is sustained for 4 hours

Action: May continue beta₂-agonist every 3-4 hours for 24-48 hours, and for inmates on inhaled corticosteroid, double dose for 7-10 days

Incomplete Response: (Findings = Moderate Exacerbation)

-PEFR 50-80% predicted or personal best with persistent wheezing and shortness of breath

Action: Add oral corticosteroid and continue beta₂-agonist

Poor Response: (Findings = Severe Exacerbation)

-PEFR is <50% predicted or personal best with marked wheezing and shortness of breath

Action: Give systemic corticosteroid, such as IV Solu-Cortef. Repeat beta₂-agonists immediately. If distress is severe and/or inmate remains unresponsive to treatment, refer to local emergency department.

Key Treatment Principles for Asthma Exacerbations include the following:

- Oxygen is recommended for most persons to maintain an SaO₂ > 90% (>95 % in pregnant women and in persons with coexistent heart disease)
- Inhaled short-acting beta₂-agonists are recommended for all inmates unless medically contraindicated
- Anticholinergics should selectively be considered. Adding high doses of ipratropium (0.5 mg) to an aerosolized solution of a selective beta₂-agonist has been shown to

cause additional bronchodilation, particularly in those with severe airflow obstruction. Anticholinergic drugs are the agents of choice for acute exacerbations secondary to beta-blockers

- Systemic corticosteroids are recommended for most persons

- Methylxanthines are generally **not** recommended

- Antibiotics are not recommended for the treatment of asthma exacerbations, but may be necessary when associated with significant bronchopulmonary infections

- Review compliance with medication plan on inmate profile in pharmacy. Treatment failure is often due to compliance issues such as failure to use medications correctly or frequently enough to prevent exacerbations

- Aggressive hydration is not recommended

- Chest physical therapy is not generally recommended

- Mucolytics are not recommended

- Sedation is not recommended

The decision to hospitalize an inmate should be based on the inmate's history and severity of prior exacerbations, the severity of present signs and symptoms, the degree to which the inmate has already been receiving optimal long term therapy, the response to emergency treatment, and the duration of unresolved symptoms. Severe airflow obstruction, demonstrated by signs of impending respiratory failure such as declining mental clarity, worsening fatigue and a PCO₂ of >42 mm Hg requires immediate referral to a local emergency department regardless of other associated factors.

6. CHRONIC CARE MANAGEMENT OF ASTHMATIC INMATES

The Peak Expiratory Flow (PEF) should be measured before or during each clinic visit, with a post-bronchodilator PEF if helpful in determining the stage of asthma. Results should be recorded for each clinic visit.

Mild Intermittent Asthma: Inmates with mild intermittent asthma require infrequent short-acting bronchodilators or short courses of systemic corticosteroids. Many of these inmates may go many months to years without requiring treatment. Inmates with mild

intermittent asthma are not considered chronically ill and may be monitored periodically as clinically necessary, usually less than required by quarterly chronic care clinic evaluations.

Inmates with mild intermittent asthma who require no medications for greater than one year and have no sick call visits for asthma-related symptoms should be considered for removal from the chronic care clinic at the discretion of the supervising physician.

Mild Persistent Asthma: Inmates with mild persistent asthma should be seen at least quarterly in chronic care clinic and more frequently at the discretion of the treating clinician and supervising physician during periods of exacerbations (e.g. allergy season).

Moderate Asthma: Inmates with moderate asthma should be seen at least quarterly in chronic care clinic and more frequently at the discretion of the treating clinician during periods of exacerbations (e.g. allergy season). Physicians should be closely involved in the management of inmates with moderate asthma and should evaluate these inmates and review their treatment plans at least semi-annually. Inmates with poorly controlled asthma should be referred to an asthma specialist for evaluation.

Severe Asthma: Inmates with severe asthma should be monitored by a physician and evaluated in chronic care clinic at least quarterly and more frequently as clinically indicated. Monthly clinician visits are usually required. Referral to an asthma specialist for evaluation and follow-up care as clinically indicated is recommended. Severe asthmatics often require repeated education about their condition and treatment regimen, in order to prevent unnecessary hospitalizations.

Pharmacists are responsible for all inmates with asthma referred by an institution physician. Pharmacists should provide inmates information on proper inhaler usage and monitor inmate adherence to recommended treatments and adverse drug reactions. Pharmacists can assess peak flows, and write treatment recommendations for the management of asthma when privileged by the Clinical Director.

Documentation: All clinician evaluations and treatments for inmates with asthma should be documented in the inmate's medical record, including asthma classification. For sentenced inmates with mild persistent, moderate, or severe asthma, who will be monitored for over 1 year within the BOP, the use of an Asthma Flow Sheet (BP-S668.060) is strongly recommended. This flow

sheet is designed to quickly determine the level of severity ("step") of asthma at each visit, and lead the provider to logical therapeutic and educational interventions. Where appropriate, the provider documenting an inmate encounter on the progress note may note: "see flow sheet," minimizing duplication in the medical record.

Inmate education: All inmates diagnosed with asthma should receive education from a health care provider on the management and treatment of asthma at the time of diagnosis and periodically during clinician evaluations and during treatments administered by nursing and pharmacy staff. When feasible group educational efforts should be considered, particularly for inmates with moderate and severe asthma. The use of BOP educational materials on asthma and an inmate self-test are recommended for education and counseling of inmates with asthma (Appendices 5-7).

ATTACHMENTS

- Appendix 1: Classification of Asthma Severity
- Appendix 2: Asthma Medication Dosage Guidelines
- Appendix 3: Dosage Guidelines for Inhaled Anti-Inflammatory Agents
- Appendix 4: Classifying the Severity of Asthma Exacerbations
- Appendix 5: Asthma Patient Education Program
- Appendix 6: Asthma Fact Sheet for Inmates
- Appendix 7: Questions and Answers on Asthma for Inmates
- Appendix 8: Resources on Asthma
- Appendix 9: Provider Self Assessment: Management of Asthma

Classification of Asthma Severity

Step	Symptoms	Nighttime Symptoms	Pulmonary Function
Step # 1 Mild Intermittent	*Symptoms < 2 times a week *Asymptomatic & normal PEF between exacerbations *Exacerbations brief (from a few hours to a few days); intensity may vary	< 2 times a month	*FEV1 or PEF > 80% of predicted *PEF variability < 20 %
Step # 2 Mild Persistent	*Symptoms > 2 times a week but < 1 time a day *Exacerbations may affect activity	> 2 times a month	*FEV1 or PEF > 80% of predicted *PEF variability <20%
Step # 3 Moderate Persistent	*Daily symptoms *Daily use of inhaled short-acting beta ₂ -agonist *Exacerbations affect activity *Exacerbations > 2 times a week; may last days	> 1 time a week	*FEV1 or PEF >50% and <80% predicted *PEF variability > 30%
Step # 4 Severe Persistent	*Continual symptoms *Limited physical activity *Frequent exacerbations	Frequent	*FEV1 or PEF <50% of predicted *PEF variability > 30 %

PEF variability = $\frac{\text{Morning peak flow}}{\text{Afternoon peak flow}} \times 100$ or $\frac{\text{Pre-bronchodilator PEF}}{\text{Post-bronchodilator PEF}} \times 100$

Asthma Medication Dosage Guidelines

Quick-Relief Medications

1. Short-acting inhaled beta₂-agonists

Albuterol MDI, 90 mcg/puff, 200 puffs per canister
2 puffs 5 minutes prior to exercise
2 puffs t.i.d.-q.i.d. PRN
-May double dose for mild exacerbations

Albuterol Nebulizer 5 mg/ml (0.5%)
1.25-5 mg (0.25-1 cc) in 3 cc of saline every 4 to 8 hours
-May double dose for mild exacerbations
-May mix with cromolyn or ipratropium nebulizer solutions.

Caution: In the presence of hyperthyroidism, diabetes, cardiovascular disorders, and hypertension, beta₂-agonists may decrease serum K⁺ level. Decreased effect by concomitant use of beta blocker medications. Increased effect and duration with concomitant use of ipratropium.

2. Anticholinergic Agents

Ipratropium MDI, 18 mcg/puff, 200 puffs per canister
2-3 puffs every 6 hours

Ipratropium Nebulizer 0.25 mg/ml (0.025%)
0.25-0.5 mg every six hours

3. Systemic Corticosteroids

Prednisone, 1, 2.5, 5, 10, 20, and 25 mg tabs
-Short course "burst" 40 -60 mg/day in single or divided doses for 3 -10 days. A burst should be continued until the inmate achieves 80% of personal best PEF, or until symptoms resolve. Tapering of dose following improvement will not prevent relapse, so the drug may simply be discontinued to minimize the total number of days of exogenous steroid.

Asthma Medication Dosage Guidelines

Long-Term Control Medications

1. Systemic Corticosteroids

Prednisone, 1, 2.5, 5, 10, 20, and 25 mg tablets or 5 mg/cc solution.

7.5 - 60 mg daily in single or divided doses as needed for control.

-For long-term treatment of severe persistent asthma, administer single dose in A.M. either daily or on alternate days (alternate day therapy may produce less adrenal suppression). Short courses or "bursts" may be indicated if condition deteriorates off steroids, or for establishing control when initiating therapy.

2. Mast Cell Stabilizers

Cromolyn MDI, 1 mg/puff
2-4 puffs tid-qid

Nedocromil MDI, 1.75 mg/puff
2-4 puffs bid-qid

3. Long-Acting Beta₂-Agonists

Salmeterol MDI, 21 mcg/puff
2 puffs q 12 hours

4. Methylxanthines

Theophylline sustained release tabs

200-300 mg bid-tid

-Titrate to serum level between 5-15 mcg/dL. Levels above 15 mcg/dL rarely result in clinical improvement, but do increase risk of toxicity.

5. Leukotriene modifiers

-Should not be used for the treatment of acute asthma. These medications need to be taken daily, even during periods of worsening asthma.

Zafirlukast 20 mg tablets

1 tablet BID, one hour before or two hours after meals.

-Use with extreme caution if alcoholic liver cirrhosis is present. Caution with concomitant use of erythromycin, theophylline. Increases effects of aspirin and warfarin.

Zileuton 300 and 600 mg tablets

600mg QID, with or without food

-Use with extreme caution in the presence of liver disease and never initiate therapy if liver transaminases are greater than three time normal; monitor liver transaminases at baseline before initiating treatment and periodically thereafter.

Montelukast 10 mg tablets

10 mg/day

-Rarely may present a clinical picture of systemic eosinophilia and possibly vasculitis similar to Churg-Strauss syndrome.

Dosage Guidelines for Inhaled Anti-Inflammatory Agents

Agent	Low dose	Medium dose	High dose
Corticosteroids Beclomethasone (Beclovent, 42 and 84 mcg per puff; Vanceril, 84 mcg per puff)	2 puffs BID to 3 puffs QID at 42 mcg per puff; 1 puff BID to 2 puffs TID at 84 mcg per puff	3 to 5 puffs QID at 42 mcg per puff; 2 to 3 puffs TID at 84 mcg per puff	6 to 8 puffs QID at 42 mcg per puff; 3 puffs QID at 84 mcg per puff (exceeds PDR maximum recommended dosage of 840 mcg per day)
Triamcinolone acetonide (Azmacort): 100 mcg per puff	2 puffs BID to 3 puffs TID (Some patients may do well with BID dosing)	3 puffs TID to 4 puffs QID	5 or more puffs QID (exceeds PDR maximum recommended dosage of 1200 mcg per day)
Flunisolide (Aerobid): 250 mcg per puff	1 to 2 puffs BID	2 to 4 puffs BID	5 puffs BID (exceeds PDR recommended dosage of 2 mg per day)
Fluticasone (Flovent): 44 mcg, 110 mcg and 220 mcg per puff	2 to 6 puffs BID at 44 mcg per puff; or 2 puffs BID at 110 mcg per puff	2 to 6 puffs BID at 110 mcg per puff	7 to 8 puffs BID at 110 mcg per puff; or 4 puffs BID at 220 mcg per puff
Budesonide (Pulmicort): 200 mcg per puff	1 or 2 puffs BID	2 or 3 puffs BID	4 puffs BID
<u>Mast Cell Stabilizers</u> Cromolyn sodium MDI (Intal): 800 mg per puff	2 puffs TID	3 to 4 puffs TID, or 3 puffs QID	4 puffs QID
Nedocromil (Tilade): 1.75 mg per puff	2 puffs BID to TID	3 to 4 puffs TID	4 puffs QID

Classifying the Severity of Asthma Exacerbations

SYMPTOMS	Mild	Moderate	Severe	Respiratory Arrest Imminent
Breathlessness	*While walking *Can lie down	*Walking *Prefers Sitting	*While at rest *Sits upright	
Talks in:	*Sentences	*Phrases	*Words	
Alertness	*May be agitated	*Usually agitated	*Usually Agitated	*Drowsy or confused
SIGNS	Mild	Moderate	Severe	Respiratory Arrest Imminent
Respiratory Rate	Increased	Increased	Often > 30 min	
Use of accessory muscles, suprasternal retraction	*Usually not	*Commonly	*Usually	*Paradoxical thoraco-abdominal movement
Wheeze	*Moderate, often only end expiratory	*Loud throughout exhalation	*Usually loud; throughout inhalation and exhalation	*Absence of wheeze
Pulse/minute	* < 100	* 100-120	* > 120	Bradycardia
Pulsus Paradoxus	* Absent < 10 mmHg	* May be present 10-25 mmHg	* Often present > 25 mmHg	Absence suggest respiratory muscle fatigue
FUNCTIONAL ASSESSMENT	Mild	Moderate	Severe	Respiratory Arrest Imminent
PEF predicted or % of personal best	* > 80%	* Approx. 50-80 %, or response lasts < 2 hours	* < 50 % predicted or personal best	*Note: performing peak flow during severe attacks may provoke laryngospasm
PaO ₂ (on air) and/or PCO ₂	*Normal * < 42 mmHg	* > 60 mmHg * < 42 mmHg	* < 60 mmHg *possible cyanosis * > 42 mmHg *possible respiratory failure	
SaO ₂ (on air) at sea level	* > 95%	* 91-95%	* < 91%	

Asthma Patient Education Program

Objectives

1. Define asthma
2. List 5 potential "triggers" for an asthma attack
3. Describe the goals of therapy for asthma

Disease Description and Clinical Relevance

1. What is asthma? Asthma is a chronic disease of the lungs which is caused by inflammation or swelling of the airways. It is characterized by periodic attacks of wheezing alternating with periods of relatively normal breathing.

2. How frequently does asthma occur? Asthma affects 1 in 20 persons, but the incidence is 1 in 10 in children. Asthma can develop at any age, but some children seem to outgrow the illness. Cases of asthma have increased by approximately 25% in the last 10 years. Deaths attributed directly to asthma have increased by approximately 20% in the last 10 years.

3. What is the cause of asthma? Usually no one cause can be demonstrated for asthma, but asthma is sometimes caused by a specific allergy or **trigger**.

Common asthma triggers include:

- >allergies to mold, animal fur, or dust
- >respiratory infections
- >exercise
- >cold air
- >tobacco smoke or other pollutants
- >stress or anxiety
- >food allergies or drug allergies

4. What are the signs and symptoms of asthma? Symptoms of a "mild" attack of asthma may be breathlessness when walking, rapid breathing, and moderate wheezing. Symptoms of a "severe" attack include breathlessness when resting, needing to hunch forward to breathe, able to speak words but not talk in sentences, breathing more than 30 times per minute, needing to use the stomach muscles to breathe, pronounced wheezing, and a heart rate of more than 120 beats per minute. Emergency symptoms may include extreme difficulty breathing, bluish color to the lips and face, severe anxiety, rapid pulse, and sweating.

5. How is asthma diagnosed? Listening to the chest usually reveals wheezing during an asthma attack. However, lung sounds are usually normal between episodes. Other clues to asthma may include:

- cough, especially worse at night
- repeated episodes of difficulty breathing
- repeated episodes of chest tightness

Treatment

_____Goals of therapy are to reduce symptoms, particularly nighttime symptoms, have a minimal number of attacks, no emergency visits, no limitations on exercise, decrease the need for quick-relief inhalers, and avoid drug side effects.

Treatment is aimed at avoiding known allergens and controlling symptoms through medications. A variety of medications for treatment of asthma are available and include *controllers* and *relievers*. Controllers are used to try to control asthma so that the number or severity of attacks are minimized. Relievers are used to quickly relieve or avoid the symptoms of an attack.

Controllers include medications such as:

- Inhaled steroids (beclomethasone, triamcinolone)
- Theophylline
- Mast cell stabilizers (cromolyn, nedocromil)
- Leukotriene modifiers

Relievers include medications such as:

- Bronchodilators (albuterol, ipratropium)
- Injectable steroids in moderate to severe attack (hydrocortisone, dexamethasone)

People with mild asthma may use inhalers on an as-needed basis. Persons with significant asthma (symptoms at least every week) should be treated with anti-inflammatory medications and bronchodilators. Acute severe asthma may require hospitalization, oxygen, and intravenous medications.

A peak flow meter, a simple device to measure lung volume, can be used by patients to check on lung functions on a daily basis. This often helps determine when medication is needed.

Summary

Asthma is a disease that has no cure. With proper self management and medical treatment, most people with asthma can lead normal lives and not require hospitalization.

Asthma Fact Sheet For Inmates

What Is Asthma	Chronic or lifelong disease of the lungs which is caused by inflammation or swelling of the airways. Episodes of asthma, known as attacks, occur when the airways narrow, making it difficult to breathe.
Clinical Features	<p>Mild Attack:</p> <ul style="list-style-type: none"> *Breathlessness when walking *Rate of breathing increases *Wheezing *Heart rate is less than 100 beats/minute <p>Severe Attack:</p> <ul style="list-style-type: none"> *Breathlessness when resting *Need to hunch forward to breathe *Able to speak words but not sentences *Breathing more than 30 times/minute *Using stomach muscles to breathe *Pronounced wheezing *Heart rate of more than 120 beats/minute <p>Emergency:</p> <ul style="list-style-type: none"> *Extreme difficulty breathing *Bluish color to lips and face *Severe anxiety *Rapid pulse and sweating
Cause	Usually no cause identified however occasionally caused by allergy.
Treatment	<p>Self management and medical treatment</p> <p>Avoiding known allergens</p> <p>Medications</p> <ul style="list-style-type: none"> *Controllers (long term treatment) *Relievers (short term treatment) <p>No known cure, but taking treatments as prescribed greatly reduces the need for hospitalization and the risk of harmful attacks</p>

Questions and Answers on Asthma for Inmates

- | | | |
|---|---|---|
| 1. Asthma is characterized by periodic attacks of wheezing alternating with periods of relatively normal breathing. | T | F |
| <hr/> | | |
| 2. Asthma develops only in children. | T | F |
| <hr/> | | |
| 3. Cases of asthma have decreased in the last 10 years. | T | F |
| <hr/> | | |
| 4. Usually no cause can be demonstrated for asthma. | T | F |
| <hr/> | | |
| 5. When experiencing a "mild" attack of asthma, your heart rate is generally less than 100 beats per minute. | T | F |
| <hr/> | | |
| 6. Listening to the chest usually reveals wheezing during an asthma attack. | T | F |
| <hr/> | | |
| 7. One goal for therapy for asthma is to require emergency medical treatment on a frequent basis. | T | F |
| <hr/> | | |
| 8. People with mild asthma may use inhalers on an as-needed basis. | T | F |
| <hr/> | | |
| 9. A peak flow meter often helps determine when medication is needed. | T | F |
| <hr/> | | |
| 10. Asthma can be cured. | T | F |

-
1. **True.** Asthma is a chronic or lifelong disease of the lungs which is caused by inflammation or swelling of the airways. It is characterized by periodic attacks of wheezing alternating with periods of relatively normal breathing.
 2. **False.** Asthma can develop at any age. Some children with asthma outgrow the illness.
 3. **False.** Cases of asthma have increased by approximately 25% in the last 10 years. Deaths attributed directly to asthma have increased by approximately 20% in the last 10 years.
 4. **True.** Usually no single cause can be demonstrated for asthma, but asthma may be precipitated by a specific allergy (such as allergy to mold, animal fur, dust) or exercise.
 5. **True.** Symptoms of a "mild" attack include breathlessness when walking, rate of breathing increases, moderate wheezing, and a heart rate of less than 100 beats per minute.
 6. **True.** Listening to the chest usually reveals wheezing during an episode, whereas lung sounds are usually normal between episodes. In a severe asthma attack airflow obstruction can be so limited that wheezing is absent, however other sign and symptoms of a severe asthma attack are present.
 7. **False.** Goals of therapy are to reduce symptoms, particularly nighttime symptoms, have a minimal number of attacks, no emergency visits, no limitations on exercise, decrease the need for quick-relief inhalers, and avoid side effects from medications.
 8. **True.** Mild or infrequent asthma may respond well to reliever-type medications, without the need for controller medications.
 9. **True.** A peak flow meter, a device to measure lung volume, can be used by the patient to check on lung functions on a daily basis. This often helps determine when medication is needed.
 10. **False.** Asthma is a disease that has no cure. With proper self management and medical treatment, however, most people with asthma can lead normal lives and not require hospitalization or experience serious attacks.

Resources on Asthma

National Asthma Education and Prevention Program

National Heart, Lung, and Blood Institute Information Center
P.O. Box 30105
Bethesda, MD 20824
www.nhlbi.nih.gov

U.S. National Library of Medicine

National Institute of Health
8600 Rockville Pike
Bethesda, Maryland 20894
www.nlm.nih.gov
www.nlm.nih.gov/medlineplus/healthtopics_a.html

American Academy of Allergy, Asthma and Immunology

1-800-822-2762
www.aaaai.org

American Lung Association

1740 Broadway
New York, New York 10019
800-586-4872
www.lungusa.org

Asthma and Allergy Foundation of America

1125 15th Street NW, Suite 502
Washington, D.C. 20005
202-466-7643
www.aafa.org

Provider Self-Assessment: Management of Asthma

1. Which of the following is itself diagnostic of asthma?
 - A. Wheezing on lung auscultation
 - B. A FEV₁/FVC ratio < 65%
 - C. A FEV₁ that improves by 20% after bronchodilator treatment
 - D. Positive methacholine bronchoprovocation
 - E. None of the above

2. Which of the following is not used to determine a patient's asthma classification?
 - A. PEF variability
 - B. Chest x-ray
 - C. Frequency of symptoms
 - D. PEF or FEV₁
 - E. Nighttime symptoms

3. The most important class of medications for long-term management of step 2 and step 3 asthma is:
 - A. Mast cell stabilizers
 - B. Long-acting beta₂-agonists
 - C. Leukotriene modifiers
 - D. Oral bronchodilators (e.g. Proventil tablets)
 - E. Inhaled steroids

4. The most common reason for poor long-term asthma control in inmates is:
 - A. Abuse of short-acting inhaled bronchodilators
 - B. Not prescribing theophylline
 - C. Poor inhaler technique
 - D. Poor air quality and air circulation in the housing units

5. Match the asthma treatment with its specific indication?
 - A. Bronchospasm secondary to beta-blockers
 - B. Asthma associated with nasal polyps/aspirin sensitivity
 - C. Nocturnal symptoms/narrow therapeutic - toxicity window
 - D. Acute asthmatic episode

Choose from: theophylline, leukotriene modifier, short-acting beta₂-agonist, ipratropium.

6. Which of the following is false regarding the use of medications for the treatment of asthma?
- A. Zileuton is contraindicated for an inmate with hepatitis C and an ALT three times normal.
 - B. Adding zafirlukast may cause a nosebleed for an inmate on coumadin
 - C. IV theophylline is indicated for a severe asthma exacerbation.
 - D. Pulse doses of oral corticosteroids are intermittently beneficial for patients with severe asthma.
7. Which combination of assessments are the most useful in a prison setting for the management of an acute asthma attack in the urgent care room?
- A. Vital signs, spirometry, pulse oximetry
 - B. Chest auscultation, PEF measurement, capillary refill testing
 - C. Chest x-ray, PEF measurement, arterial blood gases
 - D. PEF measurement, pulse oximetry, vital signs
8. A 30 year old asthmatic inmate is using the following medications: Albuterol inhaler, 2 puffs PRN; Salmeterol, 2 puffs BID; Beclomethasone, 84mcg per puff, 2 puffs TID. He is having increasing frequency of acute episodes, usually mid-day. He has a history of seasonal allergy triggers, and was recently assigned to mowing lawns. Which of the following is not appropriate?
- A. Improve afternoon coverage/increase salmeterol to 2 puffs TID.
 - B. Consider removing the inmate from the landscape detail.
 - C. Have inmate demonstrate his inhaler technique to you.
 - D. Increase the Beclomethasone to 3 puffs TID.
9. A 25 year old inmate presents to the urgent care room with acute asthma. Baseline peak flow was 450, today it is 300. Pulse oximetry is 96% on room air. BP=150/90, P=110, R=28, T=99. All of the following are appropriate except:
- A. Administer albuterol inhaler 2 puffs via spacer every 5-10 minutes with assessment of response between treatment.
 - B. Oxygen by mask at 5-15 L/min in between inhaler treatments.
 - C. Solu-Cortef 100mg IV
 - D. If acute attack is aborted, continue albuterol 2 puffs q 4 hrs for 24-48 hrs, and double dose of inhaled steroid for 7-10 days.
10. All of the following are associated with a severe asthma attack progressing to imminent respiratory failure except?
- A. Increasing hyperventilation resulting in a $p\text{CO}_2 < 42$ mm Hg
 - B. Measurement of PEF is $< 50\%$ predicted and induces laryngospasm
 - C. Wheezing disappears
 - D. Pulsus paradoxus is $>$ than 25 mm Hg/then absent

Provider Self-Assessment Answers: Management of Asthma

Question 1: Answer is E.

Although asthma is associated with an obstructive impairment that is reversible with bronchodilator treatment, no single test, clinical sign, or symptom is itself diagnostic of asthma. Wheezing is caused by various etiologies and is not always evident in persons with asthma.

Question 2: Answer is B.

An assessment of symptoms and airway obstruction is used to determine a patient's asthma classification. A baseline chest x-ray is indicated to exclude other causes of airway obstruction, but is not used to classify asthma severity.

Question 3: Answer is E.

Inhaled steroids are the mainstay of treatment for long-term control of asthma. The other classes of medications may be useful for specific indications or where steroids are ineffective or contraindicated.

Question 4: Answer is C.

The most common reason for poor asthma control in any population is poor inhaler technique, which results in poor absorption of prescribed doses of medications. Although patients may abuse short-acting bronchodilators, the overuse of these inhalers is more commonly due to poor inhaler technique which results in the need to use three or four times the number of prescribed puffs in order to achieve sufficient absorption of drug to relieve symptoms. Inmates requesting premature refills of short-acting bronchodilators should be carefully assessed to ensure proper inhaler technique, and adequacy of the asthma treatment regimen. Noncompliance with long-term medications, such as inhaled steroids, is the second most common reason for poor asthma control. This is usually due to inadequate education of the inmate regarding the importance of using these medications on a regular basis, regardless of symptoms.

Question 5:

Answers are

- A. Ipratropium
- B. Leukotriene modifier
- C. Theophylline
- D. Short acting beta₂-agonist

Question 6: Answer is C.

Zileuton is contraindicated in persons with liver transaminases greater than three times normal due to the risk of drug-induced

hepatitis. Liver transaminases must be measured at baseline and during therapy with zileuton. Zafirlukast is metabolized by the liver and can increase the effects of coumadin. Although the chronic administration of systemic steroids should be avoided in persons with severe asthma due to side effects, the strategic use of short courses of systemic steroids as asthma control worsens can abort an attack and preclude the need for hospitalization. IV theophylline is not recommended for the treatment of an asthma exacerbation.

Question 7: Answer is D.

The management of acute asthma in an ambulatory care setting, such as the urgent care room of an FCI, is best accomplished using parameters which are readily obtained and reproduced in this setting. These parameters include monitoring of vital signs, peak flow, and pulse oximetry. Chest x-rays have no role in determining the severity of asthma nor the response to short-term treatment. Arterial blood gases are not readily available in FCI settings, nor do they contribute significantly to treatment decisions in the vast majority of asthmatics. If an inmate's condition is such that arterial blood gases are necessary to guide treatment, the inmate should be hospitalized immediately. Spirometry is not universally available in ambulatory care settings, and peak flow measurements are sufficient for management of acute attacks. Chest auscultation findings and capillary refill assessments are insensitive indicators of the severity of hypoxia and response to treatment.

Question 8: Answer is A.

Salmeterol should never be used to treat acute symptoms or exacerbations of asthma. Acute asthmatic episodes should be treated with short-acting beta₂-agonists. Salmeterol administration frequency should not be increased. In addition to assessing inhaler technique and considering increasing the dose of the inhaled steroid, removing the inmate from exposure to a known trigger would be appropriate.

Question 9: Answer is C.

This inmate is having a mild exacerbation. His pulse oximetry is greater than 95%, his pulse is less than 120, and his peak flow is greater than 50% of baseline. First line treatment includes albuterol by metered dose inhaler, with the additional advantage of a spacer, every five to ten minutes with continuous monitoring. Supplemental oxygen is also indicated. Assuming good response to these interventions, the inmate should be instructed to use his albuterol inhaler at 2 puffs every four hours for the next 24 to 48 hours, and to double the dose of his inhaled steroid for the next 7 to 10 days. IV steroids would not be indicated for a mild exacerbation. Inmates with severe exacerbations who are candidates for IV steroids should also be transported to the community hospital emergency department for continued monitoring, treatment, and possible admission.

Question 10: Answer is A

A severe asthma exacerbation is characterized by a pulsus paradoxus of > 25 mm Hg, that may disappear as respiratory failure becomes imminent. A markedly decreased PEF of $< 50\%$ predicted indicates a severe asthma attack. Note: If a severe asthma attack is clearly evident, the PEF should not be measured, since PEF testing may induce laryngospasm. The disappearance of wheezing in a patient with a severe asthma exacerbation is an ominous sign, suggestive of imminent respiratory arrest. During mild and moderate asthma exacerbations an increase respiratory rate results in a decrease in $p\text{CO}_2$. In a severe asthma exacerbation, respiratory weakening results in CO_2 retention (> 42 mm Hg) and heralds progression to respiratory arrest.