



Asthma management updates

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Abstract: This article discusses recent updates on the clinical management of asthma and outlines ways for nurses to engage patients in the management of their disease.

Keywords: airway disorder, asthma, short-acting beta₂-agonist, spirometry

Asthma is among the most common chronic diseases, affecting millions of Americans across all ages, genders, ethnicities, and socioeconomic strata.^{1,2} In 2020, the Global Initiative for Asthma (GINA) and an expert panel working group from the National Heart, Lung, and Blood

Institute (NHLBI) coordinated with the National Asthma Education and Prevention Program (NAEP) Committee to develop focused updates to the diagnosis and management of asthma.^{3,4} These changes were related to the use of inhaled corticosteroids, immunotherapy, indoor allergen mitigation, fractional exhaled nitric oxide (FeNo) testing, and bronchial thermoplasty. This article discusses recent updates on the clinical management of asthma and outlines ways for nurses to engage patients in the management of their disease.

Asthma is a chronic airway disorder characterized by a complex

cascade of pathophysiologic changes that result in airflow obstruction, bronchial hyperresponsiveness, and underlying inflammation.⁵ Approximately 25 million Americans, or 1 in 13, have asthma.^{6,7} In adults, it is more common in females (9.8%) than men (6.1%). However, in children, the occurrence is higher in boys (8.3%) than in girls (6.7%), with the highest incidence in teenagers.⁷⁻⁹ Due to the insidious and chronicity of symptoms, children and young adults continue to be underdiagnosed and undertreated, contributing to 9.8 million medical office visits and 1.6 million ED

evaluations.^{10,11} The updated guidelines recommend individualized asthma action plans to promote self-management and involvement of individuals living with asthma so they can actively participate in the management of their disease.^{3,4}

A case in point

DD is a 19-year-old male who presents to a health clinic because in the past 72 hours, he has experienced a nonproductive cough, chest tightness, and increased breathlessness that began shortly after the onset of a low-grade temperature (99.1° F) and rhinorrhea 5 days prior.

While his initial health history is being obtained in the exam room, he becomes agitated and starts coughing and speaking in short phrases. Physical assessment findings include tachypnea of 26/minute and peripheral capillary oxygen saturation via pulse oximetry (SpO₂) of 93% on room air. His breath sounds are

slightly diminished with expiratory wheezes throughout. The NP performs a COVID-19 rapid test followed by a peak expiratory flow (PEF) measurement. The COVID-19 test result was negative, and the PEF is 260 L/min (normal for DD based on age, height, and gender: 460 L/min). A chest X-ray and blood work are done in the clinic. (See *Case study: Initial test results*.)

DD's respiratory effort improves, and he appears more comfortable after an albuterol nebulizer is administered. Prior to leaving his appointment, the NP reviews with DD how to use a peak flow meter and an asthma action plan. (See *Visit 1 asthma action plan for DD*.) DD gives a return demonstration of the proper use of a metered-dose inhaler (MDI). He is encouraged to drink six to eight glasses of water per day to replace fluids lost because of low-grade fever and rapid breathing, and aid in reducing the viscosity of mucus.

He leaves the appointment with prescriptions for an intranasal H1-antihistamine twice daily for 5 days, albuterol MDI as needed for 5 days, a methylprednisolone dose pack, and azithromycin for 5 days, and instructions for a follow-up visit in 7 days.

Pathophysiology

The airway epithelium is continuously in contact with the environment, which exposes the lungs to irritants, sensitizers, and chemicals that lead to hypersensitivity of the airway if inhaled.¹² Awareness and avoidance of potential triggers are the bases for secondary prevention.^{3,13} The air, both outdoor and indoor, can contain environmental allergens (aeroallergens), potentially harmful chemical, physical, and biological agents. (See *Common sensitizers for asthma*.) Indoor irritants include dust mites, tobacco smoke, mold, pet dander, irritants (perfume, aerosolized household scents), and pollen. Nonallergenic triggers are also a major factor in asthma exacerbation. Infections, such as chronic sinusitis, localized upper respiratory tract infections, and viral respiratory infections (influenza, colds, respiratory syncytial virus) can all trigger an uncontrolled eosinophilic state triggering an asthma exacerbation.^{14,15} Other factors that interplay with asthma exacerbation include increased body mass index, gastroesophageal reflux disease (GERD), and cough induced by angiotensin-converting enzyme (ACE) inhibitors.¹⁵⁻¹⁷

Airway irritants can trigger an immune response that lead to airway edema, bronchoconstriction, and airway hyperresponsiveness.^{3,18} This proinflammatory state includes an interplay of many cells and inflammatory mediators, including mast cells, eosinophils, T-lymphocytes, macrophages, neutrophils, and epithelial cells, chemokines (chemoattractants of white blood cells), cytokines (chemicals that trigger an inflamma-

Case study: Initial test results

Test	Normal findings	DD's results
COVID-19 rapid test	Negative for IgM, IgG: no infection or detectable COVID-19 antibodies	Negative
PEF	Determined by age, gender, and height Personal best (PB) (average of three measurements) Male (65 inches in height) 460 L/min Stable (80% to 100% of PB and/or estimated normal value) Caution (50% to 80% of PB and/or estimated normal value) Emergency (Less than 50% of PB and/or estimated normal value)	250 L/min 260 L/min 270 L/min PB: 260 L/min
Complete blood count	White blood cell (WBC) count: 4,500-10,000/mm ³ Hemoglobin (HGB) [males] 13.5-17.5 g/dL Hematocrit (HCT) [males] 41-50 g/dL Platelets 150,000-400,000/mm ³ Eosinophils 0%-6%	WBC count 10.9/mm ³ HGB 13 g/dL HCT 45 g/dL Platelets 400,000/mm ³ Eosinophil 3%
Chest X-ray	No radiographic evidence of pneumonia, pneumothorax, trauma, or atelectasis	Normal

Visit 1 asthma action plan for DD

Asthma Action Plan
 Personal Best Peak Flow: 260L/min
 Category of Severity: Mild Intermittent

Green Zone: You are breathing your best	Yellow Zone: You are NOT breathing your best	Red Zone: Call your healthcare provider
Peak flow is greater than 220	Peak flow is between 140 And 220	Peak flow is less than 140
<p>You:</p> <ul style="list-style-type: none"> • Sleep through the night without coughing or wheezing • Have NO early warning signs of asthma flare • Can do your usual activities 	<p>You may:</p> <ul style="list-style-type: none"> • Cough or wheeze at night or during rest • Have early signs of a flare-up; chest tightness • Have trouble doing usual activities • Have early signs of a cold or allergies 	<p>You may:</p> <ul style="list-style-type: none"> • Have fast and hard breathing with cough and/or wheeze • Cough constantly • Have skin that is sucked in between ribs, above your breast bone, collarbone, or ribs when breathing • Have trouble walking or speaking 3 to 5 words • Have nostrils that are open wide • Have skin, mouth, or nail discoloration (blue, gray, white)
<p>Take Medications: Albuterol MDI 2 puffs 10-15 minutes before activity, repeat in 4 to 6 hours if needed for additional physical activity</p> <p>In addition, take the following medications as prescribed:</p> <ul style="list-style-type: none"> • Fluticasone propionate nasal spray • Azithromycin • Methylprednisolone dose pack <p>Call your primary care office within 24 hours if you get worse or if you have not improved after 2 days on medications.</p> <p>If you need your inhaler more than every 4 hours, you need to contact the primary care office now.</p>	<p>Take Quick Relief medication: Albuterol MDI 2 puffs every 15 minutes, total of two times</p> <p>If symptoms do not improve, then call your healthcare provider.</p> <p>Contact a healthcare provider:</p> <ul style="list-style-type: none"> • If you stay in yellow zone for more than 2 days • If symptoms do not improve or worsen, follow red zone instructions • If you use quick relief medication more than every 4 hours 	<p>Emergency Medical Plan Albuterol MDI 2 puffs</p> <p>Have someone drive you to the ED or CALL 911.</p> <p>Primary Care Provider: Dr/NP/PA _____ Office # _____</p>

tion cascade), cysteinyl leukotrienes (bronchoconstrictors), and nitric oxide (a vasodilator).^{18,19} In some individuals, genetics play a role in airway responsiveness that predisposes an individual to an imbalanced regulation of proinflammatory cytokines.^{17,20}

Airway flow adaptations

If the airway is conceptualized as a simple elastic cylinder tube, then the airway caliber will mechanically

stretch to accommodate the volume of air. The airway epithelium provides a mechanical barrier protecting the body from environmental elements. During inspiration, the epithelium can be exposed to allergens, toxins, pollutants, and temperature change, leading to acute structural and inflammatory changes in individuals with asthma. The epithelium and bronchial smooth muscles become thickened, leading to narrowing. This narrowing causes an

increased airway resistance leading to air trapping in the lower respiratory tract. Mechanically, the airway outside the smooth muscle wall becomes thickened resulting in a decreased elastic pull exerted by the thorax on the lungs and capacity to generate inspiratory and expiratory exchange. If reversibility of airflow is limited in those individuals with moderate to severe asthma, then persistent changes in the airway structure can occur. In moderate to severe

Common sensitizers for asthma

Agent	Examples
Physical	<ul style="list-style-type: none"> • Irritants: gas, fumes (gas, kerosene, and wood), vapors, aerosols, tobacco smoke (first and second hand) • Construction irritants: wood dust, flour, metals, persulfate
Molecular agents	<ul style="list-style-type: none"> • Common disinfectant and household sanitizer agents: bleach (sodium hypochlorite), ammonium (benzalkonium chloride), formaldehyde, and glutaraldehyde • Biocides and alcohol hand gel containing a quaternary ammonium bittering agent (denatonium) glutaraldehyde and chlorhexidine • Plant proteins (natural rubber) latex products • Beauty products: persulfate (hair dye) and henna
Environmental factors	<ul style="list-style-type: none"> • Cold air combined with exertion • Moving from cooler to warm air quickly • Exertion or physical activity • Droppings or body parts of cockroaches and other pests • Dust mites (mattress, upholstered furniture, bedcovers, stuffed toys, fabric covered items) • Pet skin flakes, urine, feces, saliva, and hair/fur • Strong emotions: crying, laughing hard, stress

Source: National Institute for Occupational Safety and Health (2017) and United States Environmental Protection Agency

Asthma management resources for healthcare workers

2020 Focused Updates to the Asthma Management Guidelines	www.nhlbi.nih.gov/sites/default/files/publications/AsthmaCliniciansGuideDesign-508.pdf
Global Initiative for Asthma	https://ginasthma.org
American Lung Association	www.lung.org/lung-health-diseases/lung-disease-lookup/asthma/diagnosing-treating-asthma/for-health-professionals
National Asthma Education and Prevention Program	www.nhlbi.nih.gov/science/national-asthma-education-and-prevention-program-naepp
Asthma and Allergy Foundation of America	www.aafa.org
National Asthma Education Certification Board	https://naecb.com
2021 GINA Report, Global Strategy for Asthma Management and Prevention	https://ginasthma.org/gina-reports

asthma, the airway wall is thickened, leading to sub-basement fibrosis, angiogenesis, and smooth muscle hypertrophy resulting in decreased airway diameter.^{17,18}

The activation of inflammatory cells, eosinophils, mast cells, lymphocytes, monocytes, and neutro-

phils releases chemical mediators leading to epithelial injury and airway edema. As the epithelial lining sheds, it will lose the physical protective barrier and cilia. Interleukin 4 (IL-4) and Interleukin 13 (IL-13) are major drivers of airway inflammation, triggering epithelium thickening

and goblet cell hyperplasia leading to hypersecretion and formation of inspissate mucus plugs, limiting airflow.^{21,22} These physiologic changes cause individuals to experience coughing, wheezing, chest tightness, shortness of breath, and decreased endurance with activities of daily living. Symptoms can last a few minutes to hours; in emergent cases, days. There is no cure for asthma. Although asthma is a chronic respiratory disease, it can be episodic where individuals can manage their disease and reduce the number of flareups with three key interventions: asthma trigger avoidance, medication adherence, and asthma flare treatment.^{4,16}

Diagnosis and monitoring

To diagnose asthma, healthcare providers need to integrate patient reports of symptoms, clinical findings on physical assessment, and clinical response to treatment.^{4,16} Spirometry is the single definitive test to diagnose asthma. The availability of spirometry testing in primary and family medical offices is dependent on access to good quality equipment and technical training of the clinical staff.²³⁻²⁵ In primary and family medical offices, peak flow meters are portable handheld cylindrical plastic devices with a mouthpiece that are used to measure PEF. Device prices, which range from \$10 to less than \$100, continue to decline; these are commonly available in medical supply companies, retail drug stores, or online merchants.

Peak flow meters can be used by an individual at home to indirectly determine if they have airflow limitation or if their asthma is worsening. National, regional, and advocacy groups have printed and internet-based patient education tools demonstrating proper technique and self-monitoring guidance (See *Asthma management resources for healthcare workers*.) To be an effective, reliable

tool, the individual must establish their personal best by using the peak flow meter twice a day for 2 consecutive weeks.^{16,26} Accurate assessment of asthma control can be difficult due to the pathophysiology complexity and limitation of traditional diagnostic testing. Individual self-assessment with questionnaires can shed light on asthma control, since individuals may underestimate or overestimate the level of their asthma control. (See *Asthma control assessment tools*.)

Spirometry is a routine test for pulmonary function that measures the volume and speed of air that an individual can inhale and exhale, predicting the lung size. When a healthcare provider suspects a restriction or obstruction in the airflow volume or airway caliber, a pre- and post-spirometry will be performed to determine the magnitude of smooth muscle relaxation and degree of responsiveness to a bronchodilator (for diagnosis and effectiveness of maintenance therapy).^{3,4} For this test, individuals will continue their inhaled corticosteroids and leukotriene modifiers but hold their bronchodilators to determine the degree of change in lung function.²⁷ The individual is asked to inhale fully then forcefully exhale and continue exhaling hard and fast until all the air is exhaled. During this maneuver, the volume of air exhaled in the first second (FEV₁), the total amount of air that has been forcefully exhaled (forced vital capacity or FVC), and the ratio of these two measurements (FEV₁/FVC) is determined. A post-spirometry measurement is obtained after the administration of an inhaled bronchodilator. The desired result is an increase in FEV₁ of greater than 12% and greater than 200 mL from baseline.^{3,4} The administration of albuterol or an equivalent short-acting beta₂ agonist by MDI with a spacer or chamber device in an individual with asthma will lead to quick and effective airway opening, in contrast to a lack of change in individuals

Asthma control assessment tools	
Tool	Summary
Asthma Control Questionnaire	<p>6 questions Answers: 7-point Likert scale Score 0 to 6: 6 = uncontrolled, 0 = complete control; >1 uncontrolled asthma Components: Asthma symptoms: nighttime awakening, symptoms with walking, activity limitations, shortness of breath, and wheezing; frequency of rescue medications</p>
Asthma Control Test (ACT)	<p>5 items Answers: 5-point Likert scale Score 0-25: scores range from 5 (poor control of asthma) to 25 (complete control of asthma), with higher scores reflecting greater asthma control. An ACT score >19 indicates well-controlled asthma. Components: Over past 4 weeks, asthma symptoms (daytime, nocturnal), use of rescue medications, effect of asthma on daily activities, and perception of asthma control</p>
Asthma Therapy Assessment Questionnaire	<p>4 items Answers: graded as having or not having control, item scored summed to provide total score Score: 0-4: 4 = asthma control problem, 0 = no asthma control problems, any score >1 indicates uncontrolled asthma Components: Over past 4 weeks, self-perception of asthma control, missed school, work, or normal activities due to asthma, nighttime awakening due to asthma symptoms, and use of rescue medication</p>

with chronic obstructive pulmonary disease (COPD). (See *Spirometry measurements and Contraindications to performing pulmonary function testing*.) When the pulmonary function test results are within normal limits and the healthcare provider suspects exercise-induced or allergen-induced asthma, a referral to a pulmonary or allergy specialist for bronchial provocation testing to assess airway hyperresponsiveness is appropriate. Challenging agents include inhaled methacholine and inhaled mannitol.

The fractional concentration of exhaled FeNO testing is recommended by GINA and NAEPP to confirm uncertain asthma based on history, physical exam, and inability to accurately complete spirometry (conditional recommendation, moderate certainty of evidence).^{3,4} FeNo testing is not supported as a tool for predicting exacer-

bations or primary assessment for asthma control (strong recommendation, low evidence). The individual is asked to breathe slowly and steadily into a mouthpiece as a machine measures the level of nitric oxide (NO) in their expired breath. FeNO is a biomarker used to determine if an individual's asthma is correlated with eosinophilic airway inflammation. In allergic asthma (eosinophilic asthma), the inflamed epithelial cells of the bronchial wall release higher-than-normal levels of NO. The findings of this test (conditional recommendations, low evidence) aid the practitioner to determine if the individual is adherent with their treatment regimen, and can be used to determine responsiveness to inhaled corticosteroids, or consideration before initiating biologic therapy.²⁸⁻³⁰ When used as a surveillance tool, a 20% decrease in FeNO value from the baseline

Spirometry measurements

Tidal volume (VT)	The volume of gas that is moved in and out of the lungs per breath. The normal VT is 6 to 8 mL/kg, regardless of age
Vital capacity (VC)	The maximum volume exhaled after maximum inspiration; can be measured during forced exhalation (FVC) or slow exhalation (SVC)
Forced expiratory volume in 1 second (FEV ₁)	The maximal volume of air exhaled in the first second of a forced exhalation that follows a full inspiration, expressed in liters. A healthy individual with no respiratory disease is expected to exhale 70% to 80% of their FVC.
FEV ₁ /FVC ratio	The fraction of the forced vital capacity that can be exhaled in the first second

supports a positive response to the anti-inflammatory therapy.³¹ The cost, maintenance, and healthcare worker training associated with the equipment might be cost-prohibitive for a primary care office or clinic. Referral to a pulmonary specialist may be warranted.³²

Past guidelines advised all individuals to improve their indoor air quality, allergy, and asthma control by limiting their indoor allergen sources, including wall-to-wall carpet, stuffed toys, soft furniture, mattress, pillows, and bedding. Careful inspection of the home-dwelling for mold sources was also recommended.³² However, the guidelines published by GINA

and NAEPP now advise this action only to individuals who have symptoms related to exposure to indoor or outdoor allergens to take steps to mitigate exposure (conditional recommendation, low evidence).^{3,4} Guidelines offer guidance on pest management strategies (mice, rat, or cockroaches), washable pillow and mattress covers, and use of high-efficiency particulate filters for vacuums. Changing clothing, taking a shower, using shampoo after working, or spending time outdoors can mitigate pollen triggers. Allergen testing may be warranted based on clinical presentation and history of exposure.^{3,4}

Management

The updated asthma guidelines published by GINA and NAEPP noted a conditional recommendation on shared decision-making between healthcare providers and individuals living with asthma.^{3,4} The updated guidelines moved from daily inhaled short-acting beta₂-agonist (SABA) to daily inhaled corticosteroids for acute asthma exacerbation and mild-persistent and mild-to-moderate persistent asthma (conditional recommendation, high, moderate level of evidence). Patients with any features of asthma should not be treated with a long-acting beta₂-agonist (LABA) or long-acting muscarinic antagonist (LAMA) alone, without an inhaled corticosteroid (ICS).³ (See *Asthma medications*.)

An ICS can reduce the inflammatory symptoms of asthma, decreasing airway edema and mucus. The new guidelines have changed the recommendation for the daily administration of inhaled long-term corticosteroids as first-line treatment, with research supporting these individuals had fewer incidences of hospitalizations, exacerbations, and death.³ The use of combination single maintenance and

Contraindications to performing pulmonary function testing

Contraindication	Rationale
Hemoptysis of unknown origin	The forced expiratory movement may aggravate underlying condition
Unstable cardiovascular condition	The forced expiratory maneuver can precipitate chest pain, angina, and negatively affect BP
Significant atrial/or ventricular dysrhythmias, symptomatic hypotension or hypertension, uncompensated heart failure	
Recent myocardial infarction (within 1 week), or pulmonary embolism	
Recent thoracic, abdominal, or aneurysm surgery (within 4 weeks)	Respiratory maneuvers can lead to fluctuation in thoracic and abdominal pressures
Gastric bypass surgery (within 4 weeks)	
Recent ophthalmic surgery (within 1 week), brain surgery (within 4 weeks), acute symptomatic concussion, sinus or middle ear surgery	Respiratory maneuvers may increase intracranial and intraocular pressures
Recent illness or symptoms such as nausea and vomiting	May interfere with test performance
COVID-19 infection	Can disseminate viral particles and expose patients and staff to risk of infection

Note: The data for contraindication for performing PFT is from Graham BL, Steenbruggen I, Miller MR, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. *Am J Respir Crit Care Med*. 2019;200(8):e70–e88. doi:10.1164/rccm.201908-1590ST.

reliever therapy (SMART), inhaler containing budesonide (ICS), and low-dose formoterol (a LABA) is preferred for both maintenance and quick relief in adolescent and adult patients with moderate-persistent asthma.^{3,4}

The SABA albuterol works in an acute situation by relaxing the muscle around the airways. In 2021, GINA guidelines no longer recommend SABAs such as albuterol as daily initial treatment of asthma in adolescents and adults. SABAs are still recommended for acute episodic, as needed, and short-term management of vigorous exercise-induced asthma or first signs of asthma symptoms. A LABA, when combined with an ICS, is recommended for those with uncontrolled persistent asthma.³

LAMAs, both short- and long-acting, are no longer recommended as an add-on therapy for uncontrolled persistent asthma (conditional recommendation, moderate evidence).^{3,4}

Leukotrienes, byproducts of arachidonic acid, are produced by a variety of tissues and cells in the body (mast cells, eosinophils, macrophages). When not blocked, they interact with specific airway receptors triggering inflammation. When stimulated, leukotriene causes airway smooth muscle contraction, increased production of mucus, chemotactic activity (attracting other inflammatory cells to the area), and airway edema. Antileukotriene agents (also known as leukotriene-modifying agents) are oral medications used for the treatment of allergic rhinitis, persistent asthma, and need to be taken at least 2 hours before activity as prophylaxis for exercise-induced bronchospasm.^{3,4,33}

For individuals living with mild-to-moderate persistent asthma and allergic asthma, biologic medications (subcutaneous, sublingual, or I.V. route) are recommended (conditional recommendation, moderate evidence). Biologic medication (immunosuppressive therapies) target spe-

Asthma medications

Medication Class	Generic Examples
Controller Medications	
Inhaled corticosteroids (ICS) (pMDI or DPIs)	Beclometasone, budesonide, ciclesonide fluticasone propionate, fluticasone furoate, mometasone, triamcinolone
ICS-LABA combinations (pMDI or DPIs)	Beclometasone-formoterol, budesonide-formoterol, fluticasone furoate-vilanterol, fluticasone propionate-salmeterol, mometasone-formoterol, fluticasone propionate-formoterol, and mometasone-indacaterol
Leukotriene modifiers (leukotriene receptor antagonists, LTRA) (tablets)	Montelukast, pranlukast, zafirlukast, zileuton
Biologics	
Anti-IgE	Omalizumab
Anti-IL-5 and Anti-IL 5R	Mepolizumab, reslizumab, benralizumab
Anti-IL 4R	Dupilumab
Systemic Corticosteroids	
Tablets, suspension, I.M. or I.V.	Prednisone, prednisolone
I.M. or I.V.	Methylprednisolone, hydrocortisone
Reliever Medications	
SABA (DPI)	Salbutamol (albuterol), terbutaline
Low-dose ICS-formoterol	Beclometasone dipropionate and formoterol, budesonide-formoterol
Short-acting anticholinergics	Ipratropium bromide, oxitropium bromide

cific T-helper cells (Th2 lymphocytes) that produce IL-4, IL-5, and IL-13 cytokines that drive B cells to secrete immunoglobulin E (IgE). Mast cells bound to IgE cause degranulation and the release of chemical mediators that cause bronchoconstriction and airway edema.³⁴⁻³⁶ The most common adverse reactions to these medications include myalgia, arthralgia, headache, fatigue, localized erythema at the injection site, pharyngitis, and a rare risk for anaphylaxis.^{35,36} Administration of I.V. biologics can lead to additional adverse reactions including injection-site reactions, anaphylaxis, pulmonary edema, cytopenia, infections (fungal or lethal tuberculosis),

drug-induced systemic lupus erythematosus, and even death. These medical emergencies may require immediate administration of epinephrine with or without glucocorticoids. For this reason, the administration should be done in a healthcare setting with onsite supervision of an advanced clinical practitioner with appropriate training in biologics.^{37,38}

With the inhibition of IL-4 and IL-13, studies suggest that the T-cell response to live vaccines may be inhibited. Prior to administering the first dose of biologic medication, healthcare practitioners should perform a Mantoux-tuberculin skin test and review individual vaccine health records for

Visit 2 pulmonary function test results

Parameter	Units	Pre-bronchodilator				Post-bronchodilator		
		Actual	Predicted	% Predicted	Confidence interval (CI)	Actual	% Predicted	% Change
FVC	L	3.46	4.74	73	3.62-5.86	3.88	82	12
FEV1	L	2.00	3.99	50	3.15-4.86	2.54	64	27
FEV1/FVC	%	58	84	69	76	65	77	12
Forced mid-expiratory flow (FEF25-75%)	L/s	2.69	8.05	33	4.79-12.57	6.48	75	20

Visit 2 asthma action plan for DD

Asthma Action Plan
 Personal Best Peak Flow: 300 L/min
 Category of Severity: Mild Intermittent

Green Zone:

You are breathing your best

Peak flow is greater than 240

You:

- Sleep through the night without coughing or wheezing
- Have NO early warning signs of asthma flare
- Can do your usual activities

Take long-term control medications as prescribed:

fluticasone propionate
 1 puff twice daily (12 hours apart)

Take quick relief medication as prescribed before exercise:

Albuterol MDI 2 puffs 10-15 minutes before activity, repeat in 4 hours if needed for additional physical activity

Yellow Zone:

You are NOT breathing your best

Peak flow is between 150 and 240

You may:

- Cough or wheeze at night or during rest
- Have early signs of a flare-up; chest tightness
- Have trouble doing usual activities
- Have early signs of a cold or allergies

Take quick relief medications as prescribed:

Albuterol MDI 2 puffs every 15 minutes, total of two times. If symptoms do not improve, call your healthcare provider.

Adjust long-term control medication as prescribed until back in Green zone:
 fluticasone propionate 2 puffs twice daily (12 hours apart)

Contact your healthcare provider if:

- you stay in the yellow zone for more than 2 days
- symptoms do not improve or worsen. Follow red zone instructions.
- you use quick relief medication more than every 4 hours

Red Zone:

Call your healthcare provider

Peak flow is less than 150

You may:

- Have fast and hard breathing with cough and/or wheeze
- Cough constantly
- Have skin sucked in between ribs, above your breast bone, or collar bone when breathing
- Have trouble walking or talking 3 to 5 words
- Have nostrils that are open wide
- Have skin, mouth, or nail discoloration (blue, gray, white)

Emergency medical plan
 Albuterol MDI 2 puffs

Have someone drive you to the ED or CALL 911.

Primary Care Provider:

Dr./NP/PA _____

Office # _____

the last dose and titer for measles, mumps, rubella, varicella-zoster, rotavirus, and intranasal influenza.^{34,39,40} With the recent COVID-19 pandemic, attention has been drawn to the safety and administration of the COVID-19 vaccines. The COVID-19 vaccine by Pfizer/BioNTech and Moderna are messenger RNA vaccines made from a synthetic material that signal the body to produce antibodies, while the Johnson & Johnson (Jansen) vaccine is a vector vaccine.^{41,42} A vector vaccine works by introducing the body to a weakened (recombinant) human adenovirus containing spike protein (antigenic determinant) of COVID-19 virus, triggering our immune system to muster B and T cells.⁴²⁻⁴⁴ The CDC and the US FDA have stated that the COVID-19 vaccines are not live vaccines; therefore, it is safe to administer to individuals 2 weeks prior to giving them prescribed biological (immunosuppressive) medication.^{38,43,45}

Bronchial thermoplasty is a newer invasive procedure reserved for uncontrolled moderate-to-severe asthma in adults 18 years of age or older who have failed conventional asthma therapy (conditional recommendation, low evidence).^{3,4} Performed under moderate sedation/analgesia, bronchial thermoplasty involves applying heat via a device that delivers localized controlled radiofrequency waves to the airways during bronchoscopy, which reduces the increased mass of airway smooth muscle associated with asthma.^{46,47} The procedure has a small benefit-to-risk ratio with uncertain long-term outcomes.^{3,4,32}

Continuation of case study

DD returns in 7 days to see the NP. He reports that he continues to have episodes of coughing 5 out of 7 evenings per week. He reports using his MDI as prescribed, and shares his peak flow log that shows he has been averaging 80% of his personal best. He denies experiencing heartburn (pyrosis), chest pain, or recur-

rent upper respiratory complaints. DD shares that he is a nonsmoker, lives alone, and works outdoors, and he has noticed that his breathing is harder during the cold winter months and on dry hot days. His lungs are clear bilaterally and the rest of the physical exam is unremarkable. A pre- and post-spirometry demonstrate good reversibility: pre-bronchodilator FEV₁/FVC 0.74; post-bronchodilator FEV₁/FVC 0.82. (See *Visit 2 pulmonary function test results*.) The NP has DD return demonstrate the use of an MDI. A new asthma action plan is made. (See *Visit 2 asthma action plan for DD*.) He is advised to continue his peak flow meter measurements and is prescribed a new corticosteroid inhaler, fluticasone propionate inhalation powder. He is referred to an immunology/allergy specialist for allergen testing. DD is scheduled to see the NP in 7 to 10 days for follow-up. ■

REFERENCES

1. Asthma and Allergy Foundation of America. Asthma disparities in America: a roadmap to reducing burden on racial and ethnic minorities. 2020. www.aafa.org/media/2743/asthma-disparities-in-america-burden-on-racial-ethnic-minorities.pdf.
2. Sullivan K, Thakur N. Structural and social determinants of health in asthma in developed economies: a scoping review of literature published between 2014 and 2019. *Curr Allergy Asthma Rep*. 2020;20(2):5. doi:10.1007/s11882-020-0899-6.
3. Global Initiative for Asthma. 2021 GINA Main Report. Global strategy for asthma management and prevention. 2021. <https://ginasthma.org/gina-reports/>.
4. Expert Panel Working Group of the National Heart, Lung, and Blood Institute (NHLBI) administered and coordinated National Asthma Education and Prevention Program Coordinating Committee (NAEPPCC), Cloutier MM, Baptist AP, Blake KV, et al. 2020 Focused updates to the asthma management guidelines: a report from the National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group. *J Allergy Clin Immunol*. 2020;146(6):1217-1270. doi:10.1016/j.jaci.2020.10.003.
5. National Asthma Education and Prevention Program, Third Expert Panel on the Diagnosis and Management of Asthma. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Section 2, Definition, Pathophysiology and Pathogenesis of Asthma, and Natural History of Asthma*. Bethesda, MD: National Heart, Lung, and Blood Institute; 2007. www.ncbi.nlm.nih.gov/books/NBK7223/.
6. Centers for Disease Control and Prevention. National current asthma prevalence. 2018. www.cdc.gov/asthma/most_recent_national_asthma_data.htm.

7. Centers for Disease Control and Prevention. COVID-NET preliminary data May 30, 2020. 2020. https://gis.cdc.gov/grasp/COVIDNet/COVID19_5.html.
8. Centers for Disease Control and Prevention. National health interview survey. 2018. www.cdc.gov/asthma/nhis/2018/table2-1.htm.
9. American Lung Association. Current asthma demographics. 2021. www.lung.org/research/trends-in-lung-disease/asthma-trends-brief/current-demographics.
10. Centers for Disease Control and Prevention. National ambulatory medical care survey: 2016 national summary tables. 2016. www.cdc.gov/nchs/data/ahcd/namcs_summary/2016_namcs_web_tables.pdf.
11. Centers for Disease Control and Prevention. National hospital ambulatory medical care survey: 2017 emergency department summary table. 2017. www.cdc.gov/nchs/data/nhamcs/web_tables/2017_ed_web_tables-508.pdf.
12. Tarlo SM, Lemiere C. Occupational asthma. *N Engl J Med*. 2014;370(7):640-649. doi:10.1056/NEJMra1301758.
13. Gautier C, Charpin D. Environmental triggers and avoidance in the management of asthma. *J Asthma Allergy*. 2017;10:47-56. doi:10.2147/JAA.S121276.
14. Adeli M, El-Shareif T, Hendaus MA. Asthma exacerbation related to viral infections: an up to date summary. *J Fam Med Prim Care*. 2019;8(9):2753-2759. doi:10.4103/jfmpc.jfmpc_86_19.
15. American Lung Association. Asthma risk factors. 2020. www.lung.org/lung-health-diseases/lung-disease-lookup/asthma/asthma-symptoms-causes-risk-factors/asthma-risk-factors.
16. Global Initiative for Asthma. Global strategy for asthma management and prevention. 2019. <https://ginasthma.org/wp-content/uploads/2019/06/GINA-2019-main-report-June-2019-wms.pdf>.
17. Mims JW. Asthma: definitions and pathophysiology. *Int Forum Allergy Rhinol*. 2015;5(suppl 1):S2-S6. doi:10.1002/alar.21609.
18. Fehrenbach H, Wagner C, Wegmann M. Airway remodeling in asthma: what really matters. *Cell Tissue Res*. 2017;367(3):551-569. doi:10.1007/s00441-016-2566-8.
19. Bhat JA, Dar NJ, Bhat WW. Asthma: pathophysiology, current status, and therapeutics. In: Rayees S, Din I, Singh G, Malik F, eds. *Chronic Lung Diseases*. Singapore: Springer; 2020. doi:10.1007/978-981-15-3734-9_2.
20. Fuhlbrigge AL, Castro M. Precision medicine in asthma—using phenotypes to understand endotypes that lead us to new therapeutic options. *J Allergy Clin Immunol Pract*. 2020;8(2):496-497. doi:10.1016/j.jaip.2019.12.001.
21. Murdoch JR, Lloyd CM. Chronic inflammation and asthma. *Mutat Res*. 2010;690(1-2):24-39. doi:10.1016/j.mrfmmm.2009.09.005.
22. Yaghi A, Dolovich MB. Airway epithelial cell cilia and obstructive lung disease. *Cells*. 2016;5(4):40. doi:10.3390/cells5040040.
23. Akinbami LJ, Salo PM, Cloutier MM, et al. Primary care clinician adherence with asthma guidelines: the National Asthma Survey of Physicians. *J Asthma*. 2020;57(5):543-555. doi:10.1080/02770903.2019.1579831.
24. Coates AL, Tamari IE, Graham BL. Role of spirometry in primary care. *Can Fam Physician*. 2014;60(12):1069-1077.

25. Cloutier MM, Salo PM, Akinbami LJ, et al. Clinician agreement, self-efficacy, and adherence with the guidelines for the diagnosis and management of asthma. *J Allergy Clin Immunol Pract*. 2018;6(3):886-894.e4. doi:10.1016/j.jaip.2018.01.018.
26. American Lung Association. Measuring your peak flow rate. 2020. www.lung.org/lung-health-diseases/lung-disease-lookup/asthma/living-with-asthma/managing-asthma/measuring-your-peak-flow-rate.
27. Graham BL, Steenbruggen I, Miller MR, et al. Standardization of spirometry 2019 update. An Official American Thoracic Society and European Respiratory Society Technical Statement. *Am J Respir Crit Care Med*. 2019;200(8):e70-e88. doi:10.1164/rccm.201908-1590ST.
28. Alahmadi F, Peel A, Keevil B, Niven R, Fowler SJ. Assessment of adherence to corticosteroids in asthma by drug monitoring or fractional exhaled nitric oxide: a literature review. *Clin Exp Allergy*. 2021;51(1):49-62. doi:10.1111/cea.13787.
29. Essat M, Harnan S, Gomersall T, et al. Fractional exhaled nitric oxide for the management of asthma in adults: a systematic review. *Eur Respir J*. 2016;47(3):751-768. doi:10.1183/13993003.01882-2015.
30. Lipworth B, Kuo CR, Chan R. 2020 Updated Asthma Guidelines: clinical utility of fractional exhaled nitric oxide (FeNO) in asthma management. *J Allergy Clin Immunol*. 2020;146(6):1281-1282. doi:10.1016/j.jaci.2020.03.006.
31. Bhattacharyya D, Garg Y. Fractional exhaled nitric oxide (FeNO) as monitoring tool for bronchial asthma: an Indian study. In: *A32. Asthma and Allergy Clinical Studies*. American Thoracic Society; 2017:A1311-A1311.
32. Cloutier MM, Dixon AE, Krishnan JA, Lemanske RF Jr, Pace W, Schatz M. Managing asthma in adolescents and adults: 2020 Asthma Guideline Update from the National Asthma Education and Prevention Program. *JAMA*. 2020;324(22):2301-2317. doi:10.1001/jama.2020.21974.
33. Godson C. Balancing the effect of leukotrienes in asthma. *N Engl J Med*. 2020;382(15):1472-1475. doi:10.1056/NEJMcibr2000118.
34. Damask C, Franzese C. Mechanisms and practical use of biologic therapies for allergy and asthma indications. *Otolaryngol Clin North Am*. 2021;54(4):717-728. doi:10.1016/j.otc.2021.04.003.
35. McCracken JL, Tripple JW, Calhoun WJ. Biologic therapy in the management of asthma. *Curr Opin Allergy Clin Immunol*. 2016;16(4):375-382. doi:10.1097/ACI.0000000000000284.
36. McGregor MC, Krings JG, Nair P, Castro M. Role of biologics in asthma. *Am J Respir Crit Care Med*. 2019;199(4):433-445. doi:10.1164/rccm.201810-1944CI.
37. American College of Rheumatology. Position Statement: Patient safety and site of service for biologics. 2021. www.rheumatology.org/Portals/0/Files/Biologics-Patient-Safety-and-site-of-Service.pdf.
38. United States Food and Drug Administration. Vaccines and related biological products advisory committee meeting. FDA Briefing Document: Janssen Ad26.COVID-19. 2021. www.fda.gov/media/146217/download.
39. Centers for Disease Control and Prevention. Tuberculin skin testing. 2020. www.cdc.gov/tb/publications/factsheets/testing/skintesting.htm.
40. Papp KA, Haraoui B, Kumar D, et al. Vaccination guidelines for patients with immunemediated disorders on immunosuppressive therapies. *J Cutan Med Surg*. 2019;23(1):50-74. doi:10.1177/1203475418811335.
41. Centers for Disease Control and Prevention. Asthma [online]. 2020. www.cdc.gov/asthma/default.htm.
42. Centers for Disease Control and Prevention. Interim clinical considerations for use of COVID-19 vaccines currently authorized in the United States. 2021. www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html.
43. Centers for Disease Control and Prevention. Understanding viral vector COVID-19 vaccines. 2021. www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/viralvector.html.
44. Nascimento IP, Leite LC. Recombinant vaccines and the development of new vaccine strategies. *Braz J Med Biol Res*. 2012;45(12):1102-1111. doi:10.1590/s0100-879x2012007500142.
45. United States Food and Drug Administration. Advisory committee meeting: vaccines and related biological products advisory committee: June 10, 2021 Meeting. 2021. www.fda.gov/advisory-committees/advisory-committee-calendar/vaccines-and-related-biological-products-advisory-committee-june-10-2021-meeting-announcement.
46. Nasim F, Iyer VN. Bronchial thermoplasty-an update. *Ann Thorac Med*. 2018;13(4):205-211. doi:10.4103/atm.ATM_365_17.
47. Krimsky W, Sobieszczyk MJ, Sarkar S. Thermal ablation for asthma: current status and technique. *J Thorac Dis*. 2017;9(suppl 2):S104-S109. doi:10.21037/jtd.2016.11.113.


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