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Medical Management of Hospitalized Patients with Asthma or Chronic Obstructive Pulmonary Disease

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KEYWORDS

• Asthma • COPD • Acute exacerbation • ACOS • Hospital medicine
• Hospitalized patients

BRIEF PATHOPHYSIOLOGY OF ASTHMA AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE

- Both asthma and chronic obstructive pulmonary disease (COPD) are treatable chronic inflammatory diseases of the lungs. Asthma is a common respiratory condition with reversible airflow obstruction, whereas COPD typically manifests as irreversible or partially reversible airflow obstruction.
- Pathologically, asthma and COPD are forms of chronic bronchiolitis with abnormal airway hyperreactivity, varying degrees of smooth muscle involvement, mucus production, and chronic bronchoconstriction. COPD is further distinguished by alveolar destruction leading to emphysema (which worsens air-trapping brought on by bronchoconstriction).
- In asthma, the outpatient therapeutic and management goals are to reduce impairment caused by breathlessness, to reduce risks such as respiratory failure, and to maintain drug therapy. Treatment is directed at reducing airway inflammation and reducing bronchospasm. The most common triggers are environmental allergens, air pollution, and viral infections.
- In COPD, the outpatient therapeutic and management goals are to reduce symptoms and risks from exacerbations, and to maintain drug therapy. In contrast with asthma, COPD is a disease caused by chronic and often daily exposure to

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noxious particles or gases. The small airways in COPD are gradually destroyed leading to chronic bronchitis and emphysema.[1]
- COPD is typically preventable with removing exposure to the noxious substance. Emphysema is not present in asthma but is a key pathologic feature of COPD.
- At present, there is no cure for either of these conditions.
- The goals during hospitalization for asthma and COPD are similar: to prevent acute respiratory failure and complications from hospital management.

HOSPITALIZATION OF ASTHMA AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE EXACERBATIONS

Overview

- The imminent danger during acute exacerbation of asthma or COPD is unrecognized and sustained cerebral hypoxia from acute respiratory failure, primarily from ventilation-perfusion mismatching and hypoventilation. Profound respiratory fatigue and exhaustion from increased work of breathing for days before admission contribute to the acute danger of an exacerbation.
- In asthma and COPD, the immediate goal is to guard against hypoxia with supplemental oxygen and to relieve dyspnea with short-acting beta-agonist bronchodilators with or without ipratropium bromide. The main goal is to avoid further respiratory compromise and failure.
- The 30-day mortality from acute COPD exacerbation is between 11% and 26% (more fatal than acute myocardial infarction), and approximately 340 patients with COPD and 10 asthmatics die each day in the United States.[2–4]
- The management of both diseases is similar. The fundamental difference from the home setting is close respiratory monitoring by registered nurses and respiratory therapists. In addition, noninvasive ventilation (NIV), particularly for patients with COPD, is available, and prevents the need for invasive mechanical ventilation, and associated risk of pneumonia. In severe stage 4 COPD, direct admission for hospice can be considered.
- Patients with asthma and COPD are hospitalized when they cannot manage at home, often indicated by the failure to improve with frequent albuterol use over a 2- or 3-day period. In both diseases, antibiotics and intravenous corticosteroids may shorten duration of symptoms and length of hospital stay, and prevent respiratory failure.
- On hospital discharge, patient with asthma or COPD benefit from outpatient transitional care services and instructions for follow-up care to ensure patient safety and prevent hospital readmission.

Identification of patients with undiagnosed asthma or COPD

Differentiating asthma from COPD in an undiagnosed hospital patient can be difficult. This problem has led to the recognition of asthma–COPD overlap syndrome (ACOS) (discussed later). The diagnosis of asthma or COPD is based primarily on clinical features of each individual case.

A focused and detailed clinical history along with inpatient spirometry near the end of the patient's hospital may assist with the diagnosis of asthma or COPD (**Table 1**). However, severe asthma may be indistinguishable from moderate and severe COPD on spirometry alone. The finding of a low carbon monoxide diffusing capacity suggests pulmonary emphysema and COPD, but these data are often not available. Emphysema on thoracic imaging can assist with the diagnosis of COPD. A low carbon monoxide

diffusing capacity in asthmatics should raise suspicion for another diagnosis (eg, asthmatic granulomatosis, bronchiolitis obliterans, and pulmonary arterial hypertension).

Asthma is often diagnosed when forced expiratory volume in 1 second (FEV_1) improves after bronchodilator treatment; however, nearly two-thirds of patients with COPD can show the same response.[5] Use of bronchodilator responsiveness is of little clinical value in distinguishing asthma from COPD. Some asthmatics do not show responsiveness until they have had 2 to 3 weeks of corticosteroid treatment.[4] Although smoking is a risk factor for emphysema and COPD, only 20% of chronic smokers develop COPD.[6]

The following questions can help differentiate between asthma and COPD, but this needs to be put into the context of the clinician's suspicion, experience, and patient response to treatments.[4,7] Of note, patients with ACOS may have all the symptoms mentioned here; therefore, consider consulting a pulmonologist.

1. Development of disease and age of onset
   - When did respiratory symptoms begin and what was the initial diagnosis?
   - What activities could you do a few years ago that you cannot do now because of breathing problems?
2. Symptom variability of airflow limitation
   - Are respiratory symptoms episodic/seasonal/diurnal and related to triggers?
3. History of atopy
   - Do you or your family members have a history of atopy or allergies? (This is the strongest identifiable predisposing factor for developing asthma.[4])
4. Smoking history
   - Do you smoke? If yes, how much daily and for how long?
5. Symptoms
   - Do you have a chronic dry or wet cough, wheezing, or dyspnea, and at what time of day are these symptoms most prominent?

In summary, both patients with asthma and those with COPD respond very well to bronchodilators. Notably, adult asthmatics may never return to baseline if they have a history of a FEV_1 to forced vital capacity ratio (FEV_1 /FVC) that is less than predicted for their age.

Evaluation, management, and postdischarge plan for acute asthma exacerbation

Immediate assessment and intervention is the best strategy when evaluating acute asthma exacerbations because they can become life threatening as the patient moves from the emergency department to the hospital ward. **Fig. 1** presents the recommended algorithm by the National Asthma Education and Prevention Program - Expert Panel Report (2007).

Expect patients with uncomplicated asthma to require 4 to 6 days in the hospital. A decrease in need for rescue albuterol use, walking without dyspnea on exertion, and the ability to sleep all night are all signs the patient may be safely discharged.

On discharge, to prevent relapse and rehospitalization, the following steps are recommended:

1. If the patient is not already using an inhaled corticosteroid (ICS), start treatment.
2. One day before discharge, change to the patient's outpatient regimen. Early initiation of home regimen helps with education, ensures adequate medication technique, and initiates therapy to overlap with systemic corticosteroids.
3. Discharge with a short-acting beta-agonist (SABA), flow chamber device, and oral corticosteroid for a course of 5 to 10 days pending clinical assessment. The authors recommend a 12-day taper as follows: prednisone 40 mg PO × 3 days, 30 mg PO × 3 days, 20 mg × 3 days, 10 mg PO × 3 days, then stop. We do not

Table 1
Clinical characteristics of COPD and asthma

	Features of Clinical History	Age of Onset	Significant Physical Examination Findings	Diagnostic Testing	Spirometry		
					Severity	FEV_1 (% Predicted)	FEV_1/FVC (After Bronchodilators)[c]
COPD	Dyspnea that is persistent and progressive over time Worse with exercise Chronic and intermittent productive sputum Symptoms occur or worsen at night vs morning History of exposure to noxious stimuli	>65 y, if not younger >10 pack y	Physical examination is rarely diagnostic in COPD because physical signs are not present until significant lung impairment Partial bronchodilator reversibility	CXR to exclude other diagnoses Spirometry with albuterol Consider diagnostic work–up for other differential diagnosis	Mild COPD Moderate COPD Severe COPD Very Severe COPD	≥80% 50%-79% 30%–49% <30% or <50% predicted plus chronic respiratory failure	<70% <70% <70% <70%

Asthma Normal FEV_1 FVC[4] 85% (8–19 y old) 80% (20–39 y old) 75% (40–59 y old) 70% (60–80 y old)	Personal/family history of atopic dermatitis, eczema or allergic skin condition[a] Symptoms occur or worsen at night History of wheezing (lack of wheezing does not exclude asthma) Symptoms worsen in presence of exercise, animals, airborne irritants, mold, viral infections, and/or dust Smoking begins in childhood	Usually childhood onset but can present as an adult A history of severe asthma in childhood portends severe adult asthma	Upper respiratory tract can show increased nasal secretions, nasal mucosal swelling, and/or nasal polyps Chest examination may show wheezing, prolonged expiratory phase, hyperexpansion of thorax, and accessory muscle use Skin examination may show atopic dermatitis or eczema	Increased IgE ImmunoCAP[b] CBC with eosinophilia Spirometry shows obstruction and reversibility (FEV_1 improves >10% of predicted FEV_1 or $FEV_1 \geq 12\%$ albuterol)[2] CXR Spirometry with albuterol Consider diagnostic work-up for other differential diagnosis	Intermittent Mild persistent Moderate persistent Severe persistent	>80% >80% Normal FEV_1 between exacerbations 60%–80% <60%	Normal for age Normal for age Reduced by 5% Replace by 5%

Abbreviations: CBC, complete blood count; CXR, chest radiograph; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity; IgE, immunoglobulin E.

[a] This is the strongest identifiable predisposing factor for developing asthma.[7]

[b] ImmunoCAP detects specific IgE antibodies in the blood to rule in or rule out atopy in patents with allergy-like symptoms.

[c] For work-up of COPD, age may play a factor in interpretation of FEV_1/FVC. An FEV_1/FVC less than 0.70 may be normal in an older individual (ie, >65 years old).

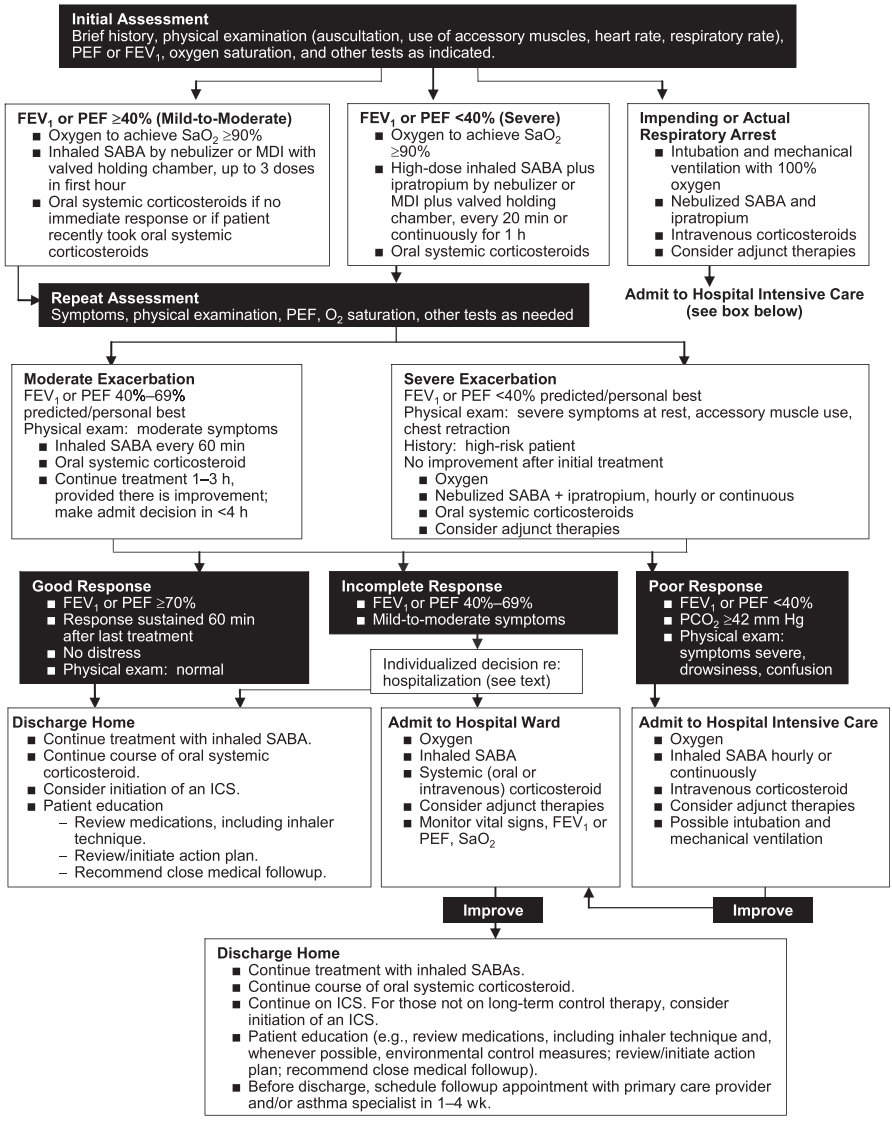

Fig. 1. Guidelines for inpatient diagnosis and management asthma exacerbation. FEV_1, forced expiratory volume in 1 second; ICS, inhaled corticosteroid; MDI, metered dose inhaler; PCO_2, partial pressure of carbon dioxide; PEF, peak expiratory flow; SABA, short-acting $beta_2$-agonist; SaO_2, oxygen saturation.

recommend treatment for more than 2 weeks because adrenal insufficiency can occur.

4. Education on asthma prevention (avoiding triggers, smoking cessation, peak flow meter use) and outpatient follow-up within 2 weeks.
5. For patients with severe asthma, consider adding a long-acting muscarinic antagonist (LAMA) to combination therapy with a long-acting beta agonist (LABA)+ICS,[8] to improve asthma symptom control and lung function. ICS + LABA + LAMA is

considered 'triple therapy', which may offer better symptom control compared with dual ICS + LABA therapy.

6. Pulmonary clinic referral is indicated for recurrent asthma exacerbations, hospitalizations, or life-threatening exacerbation. Also, refer for evaluation of further medical optimization or bronchial thermoplasty.

Evaluation, management, and postdischarge plan of acute COPD exacerbations

A COPD exacerbation is an acute sustained worsening from baseline functional status, with common symptoms of worsening cough, breathlessness, change in sputum color, and increased sputum production.

A COPD exacerbation accelerates natural disease progression by contributing to the permanent loss of lung function. If recovery of an exacerbation is slow then patients are more likely to have disease progression and are at an increased risk of additional COPD exacerbations in the future. Thus, it is imperative for physicians to understand the common causes of exacerbations, and the need for quick assessment of severity and facile medical management of exacerbations before progression respiratory failure.

The most common cause of exacerbations is infectious, primarily viruses and bacteria (**Box 1**).[9,10] However, noninfectious triggers and other comorbid conditions must be considered.

More than 80% of exacerbations can be managed on an outpatient basis.[1] Health-care providers benefit from being familiar with the classifications of COPD exacerbations:

- Mild (treatment with short-acting bronchodilators)
- Moderate (treatment with SABAs, antibiotics, and/or oral corticosteroids)
- Severe (requires hospitalization or emergency room visit for acute respiratory failure)

For hospitalized patients, classification of exacerbation severity can help triage the patient to the appropriate level of care (**Table 2**)[1,11,12] and then consider using the algorithm shown in **Fig. 2** to guide decision making.

The overall goal for treatment of a COPD exacerbation focuses on minimizing the negative impact of the current exacerbation and preventing the likelihood of future exacerbations (**Table 3**).

Interdisciplinary inpatient management at UC Davis Medical Center in Sacramento, California, involves the pulmonary and hospitalist divisions. Trained respiratory therapists act as COPD case managers. COPD case managers coordinate care, including medication reconciliation and COPD education; work with discharge planning, social

Box 1
Causes of acute exacerbation of chronic obstructive pulmonary disease

- Infection (most common)
- Viruses (rhinovirus, influenza, parainfluenza, adenovirus, respiratory syncytial virus, coronavirus, human metapneumovirus)
- Bacteria (*Haemophilus influenzae*, *Streptococcus pneumoniae*, pertussis, *Pseudomonas aeruginosa*, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*)
- Noninfectious causes
- Acute pulmonary embolism (PE)
- Environmental pollution

Table 2
Classification of acute exacerbation of COPD severity

	Acuity Level
No respiratory failure • RR: 20–30 bpm • No accessory respiratory muscle use • No change in baseline mental status • Hypoxemia improved with supplemental oxygen via Venturi mask 35%–40% FiO_2 or use of NC • No increase in $PaCO_2$	Evaluate for home therapy that includes severity of dyspnea and functional disability, clinical stability, living alone, home support, mental status, comorbidities, changes on CXR, and rate of onset Consider patient's preferences for treatment at home or in hospital
Non–life-threatening respiratory failure • RR: >30 bpm • Accessory muscle use • No change in mental status • Hypoxemia improved with supplemental oxygen via Venturi mask 35%–40% FiO_2 or use of NC • Hypercarbia ($PaCO_2$ increased compared with baseline or increased 50–60 mm Hg)	Management emergency department or hospital admission to ward unit
Life-threatening respiratory failure • RR: >30 bpm • Accessory respiratory muscle use • Altered mental status • Hypoxemia not improved with supplemental oxygen via Venturi mask 35%–40% FiO_2 or use of NC • Hypercarbia ($PaCO_2$ increased compared with baseline or increased >60 mm Hg or the presence of acidosis [pH $\leq$ 7.25])	Management in emergency department and, if does not respond to initial therapy with improvement to non–life-threatening respiratory failure, then consider medical intensive care unit admission or invasive mechanical ventilation as needed

Abbreviations: bpm, breaths per minute; FiO_2, fraction of inspired oxygen; NC, nasal cannula; $PaCO_2$, partial pressure of carbon dioxide; RR, respiration rate.

work, and transitional care pharmacy; and assist with primary care physician follow-up, ideally in 2 weeks.

This interdisciplinary program has reduced unplanned 30-day hospital readmissions for all causes to 6.6% from a historical 16% at UC Davis Medical Center.[13] Therefore, patients with COPD can better manage their disease and improve primary prevention and disease outcomes postdischarge.

The postdischarge checklist for COPD exacerbations and the clinical reasoning behind each intervention can be seen in **Table 4**.

ASTHMA-CHRONIC OBSTRUCTIVE PULMONARY DISEASE OVERLAP SYNDROME (ACOS)

Overview

- Patients with ACOS have persistent airflow limitation with overlapping features of asthma and COPD.[14]
- ACOS accounts for approximately 15% to 55% of patients with chronic airflow limitation.[15]
- ACOS is associated with a higher risk for exacerbations, and increased frequency and severity of acute exacerbation compared with COPD or asthma alone.[16–19]
- ACOS is associated with higher health care use, more progressive lung disease, and lower health care–related quality of life compared with asthma or COPD alone.[16,18–20]

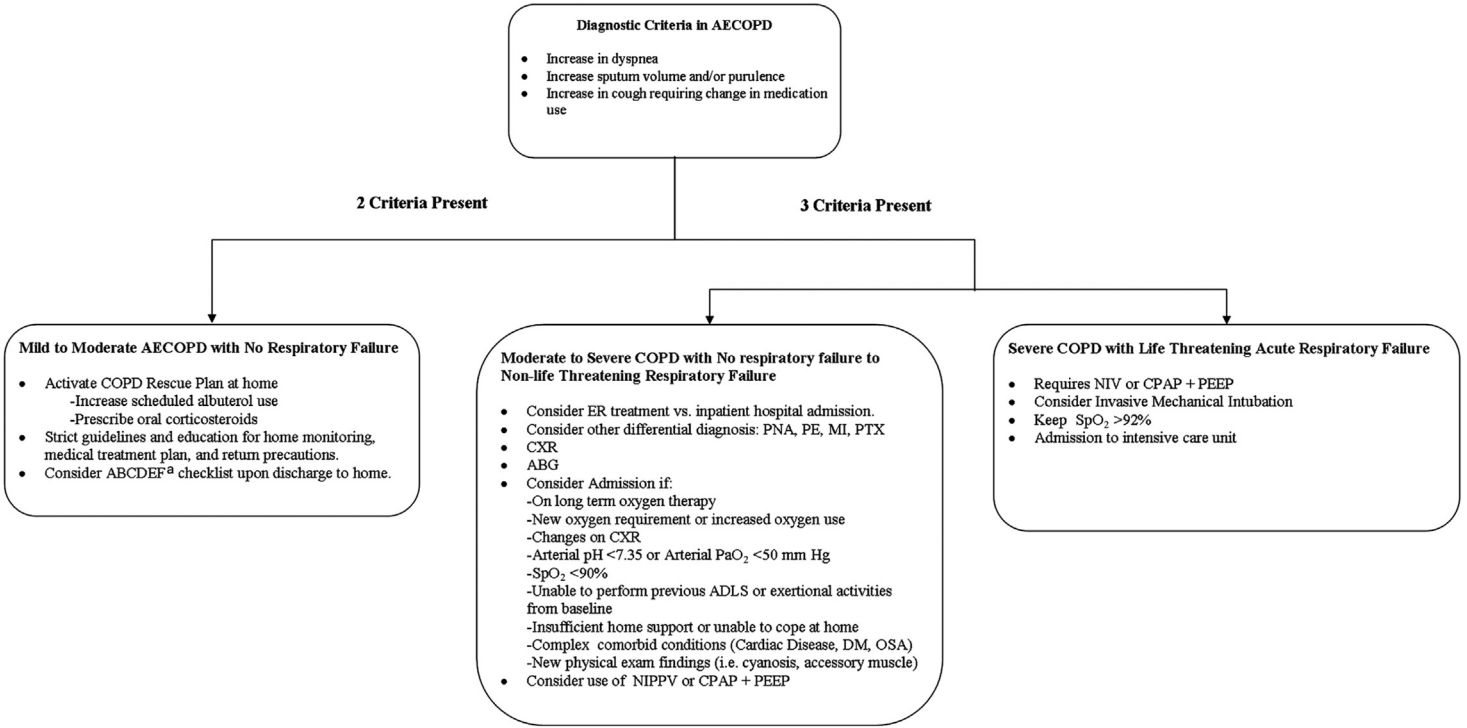

Fig. 2. Evaluation guide for hospital admission of Acute exacerbation of COPD (AECOPD). [a]ABCDEF checklist to reduce AECOPD (for patients with >2 AECOPD yearly or emphysema): A, anticholinergic bronchodilators, preferably LAMA; B, B-agonists (both long acting and short acting); C, inhaled corticosteroids; D, Daliresp (roflumilast); E, education, exercise, and empathy; F, friends and family for support, and Flu vaccine. ABG, arterial blood gases; CPAP, continuous positive airway pressure; CXR, chest radiograph; NIV, non-invasive ventilation; PEEP, positive end-expiratory pressure.

Table 3
Treatment of acute COPD exacerbation

Diagnostic Test/ Management Decision	Clinical Reasoning
Serial ABG/VBG	• ABG is for accurate oxygen saturation and CO_2 retention. • Serial VBGs are less invasive than ABGs and provide data for assessing the clinical course in conjunction with an ABG
ECG	• Exclude other comorbidities and differential diagnosis
Continuous pulse oximetry	• Continue until patient stabilizes
Sputum sample	• If purulent, send for culture to narrow antibiotic treatment
CXR	• Assess for pneumonia, emphysematous disease, rib fractures, and rule out pneumothorax • Chest pain should have a thorough work-up for a wide differential diagnosis in this population
Scheduled SABA and SAMA	• Cause bronchodilation of air passages • Both nebulizer and hand-held inhalers can be used • Patient should be changed to outpatient regimen as soon as possible. May permit earlier discharge from hospital, ensures appropriate technique, and maintains habitual use of inhaler therapy
Corticosteroids	• Oral corticosteroids recommended if gastrointestinal access and function are intact • Shorten recovery time, improves lung function (FEV_1) • Decrease risk of early relapse, treatment failure, and length of hospitalization • Prednisone 40 mg PO for 5 days is recommended by the authors
Antibiotics	• Consider antibiotics with the 3 cardinal symptoms: increase in dyspnea, sputum volume, and sputum purulence; or 2 of cardinal symptoms with increased sputum purulence or mechanical ventilation[1] • Antibiotic choice is based on local antibiotic resistance pattern with duration of treatment 5–7 days • Antibiotics can shorten recovery time, and reduce treatment failure, early relapse, and hospitalization duration[1] • If patients do not clinically improve consider treating for *Pseudomonas* species[11]
Anticoagulation	• In patients with COPD at risk for PEs, initiate thromboembolism prophylaxis
Acute or acute-on-chronic respiratory failure	• Use of NIV is recommended and early initiation decreases mortality and intubation rates[1]

Abbreviations: ABG, arterial blood gases; ECG, electrocardiogram; NIV, non-invasive ventilation; PE, pulmonary embolism; PO, by mouth; SAMA, short-acting muscarinic antagonist; VBG, venous blood gases.

- No evidence-based guidelines distinguishing asthma, COPD, and ACOS are available to date because patients with ACOS have historically been excluded from randomized clinical trials. Therefore, there are no evidence based guidelines that can guide therapy specifically for ACOS.
- For clinicians, the tool shown in **Fig. 3** is a syndromic approach proposed by a collaboration between the Global Initiative for Asthma (GINA) and Global Initiative for Chronic Obstructive Lung (GOLD) in 2015.

Table 4
Acute exacerbation of COPD postdischarge checklist

Plan	Clinical Reasoning
Create a simple self management plan that focuses on early recognition of symptoms of AECOPD	• Patient self-management plans are associated with improved health-related quality of life, improvement in dyspnea, reduction in respiratory-related and all-cause hospital admissions[10]
Assess need for home oxygen	• For patients with resting chronic hypoxemia, improves survival[1]
Reassess inhaler technique and education	• Up to 86% of patients misuse respiratory inhalers[10]
Medication management	• ICS + LABA, LAMA, and/or roflumilast; avoid ICS monotherapy • SABA as needed • Patients with emphysema or frequent exacerbation use ABCDEF mnemonic (see Fig. 2)
Assess and document whether patient's functional status is at baseline	• Ensures patient can safely return to home
Follow-up doctor appointment in 1 month	• Related to fewer AECOPD-related admissions. Those who do not have early follow-up have increased 90-day mortality[1]
Vaccinations	• Pneumococcal vaccination PPSV23 reduces incidence of community acquired pneumonia in patients with COPD patients <65 years with FEV_1 <40% predicted and those with comorbidities[1] • Influenza vaccination reduces serious illness and death in patients with COPD[1]
Smoking cessation resources	• Smoking cessations improves COPD prognosis by mitigating lung function decline and is the best prevention of lung cancer
Referral pulmonary rehabilitation	• Reduces readmission and mortality; recommend initiate within 3 wk of hospital discharge but not during initial hospitalization[1,13] • Rehabilitation can improve dyspnea, functional exercise capacity, health-related quality of life, especially in those with moderate to severe disease[1]

Treatment of Hospitalized Patient with ACOS

When ACOS is diagnosed in the outpatient setting, the recommendation is to treat for asthma first,[15] which means starting an ICS, which shows how important the control of inflammation is in this disease. However, during acute exacerbations requiring hospitalization, both disease components require treatment.

To date there are no evidence-based guidelines directing ACOS treatment. Therefore, treatment should be based on the available evidence in asthma and COPD, GINA and GOLD organization guidelines, the practitioner's clinical experience, and the patient's clinical response to treatment. A suggested guideline from the authors is given here:

- Consider inpatient pulmonary consultation given the greater disease severity and higher morbidity and mortality of patients with ACOS.

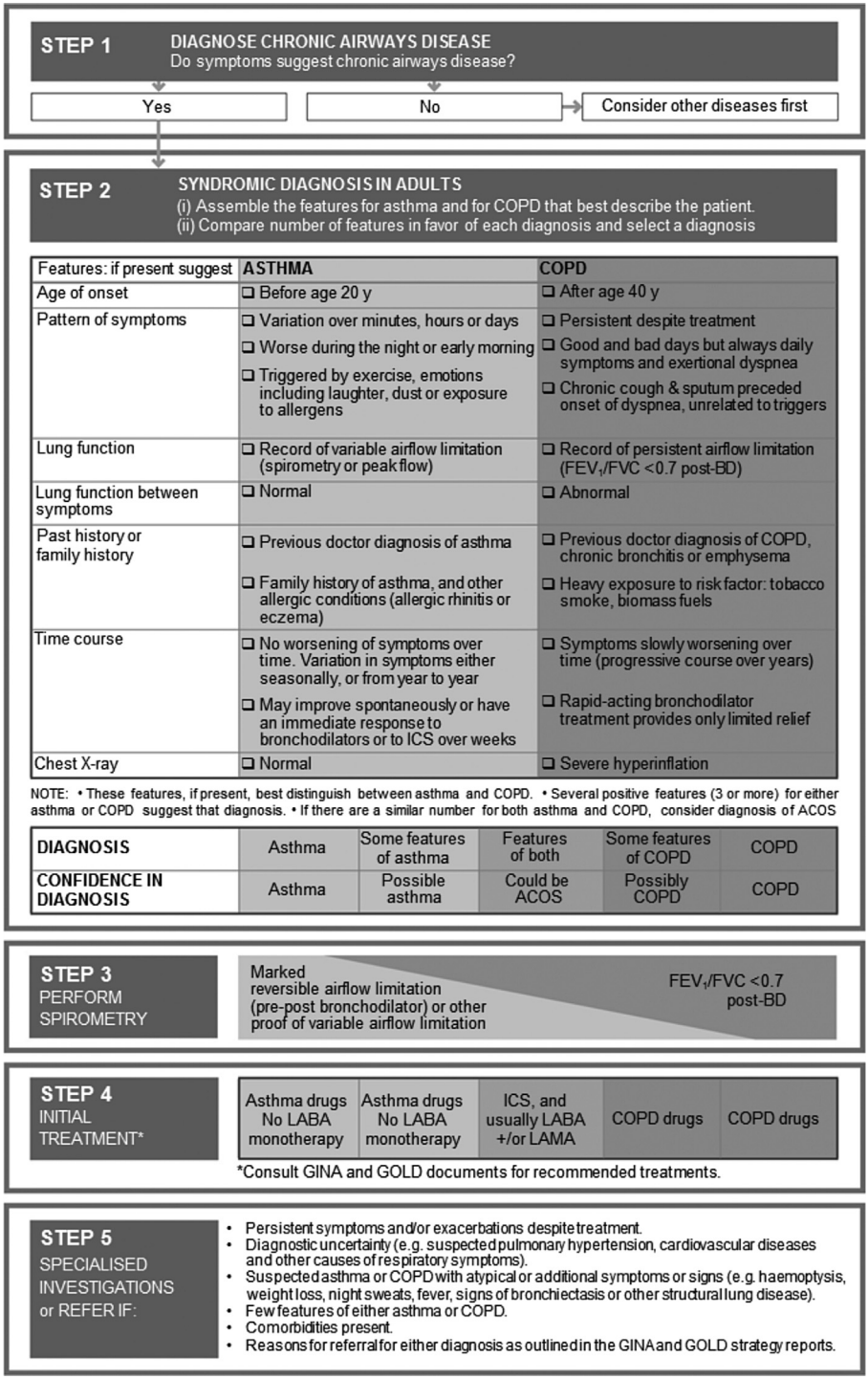

Fig. 3. ACOS: syndrome based assessment. (*From* GOLD: diagnosis of diseases of chronic airflow limitations: asthma, COPD, and asthma-COPD overlap syndrome 2015; with permission.)

- Consider a longer prednisone burst of 10 to 14 days, although there are no RCT data to support this.
- Use scheduled SABAs and SAMAs either via nebulizer or metered dose inhaler (MDI) with spacer.
- Consider antibiotic therapy based on clinical assessment of infection or infection risk.
- Continue ICS to ensure appropriate administration technique and maintain compliance as an outpatient.

A comprehensive discharge plan in a patient with suspected ACOS facilitates further outpatient work-up and prevents repeated readmissions:

- ICS (low or moderate dose) with LABA ± LAMA; avoid LABA monotherapy in ACOS because there is a FDA warning against LABA monotherapy in asthma
- Rescue SABA
- Referral to a pulmonary specialist for further diagnostic work-up and management
- Referral/resources for smoking cessation, counseling on physical activity, referral to pulmonary rehabilitation, and treatment of comorbid conditions

EVALUATION FOR ACUTE PULMONARY EMBOLISM

Patients with AECOPD are at increased risk of deep vein thrombosis (DVT) and pulmonary embolism (PE) and should receive thromboprophylaxis while hospitalized.[1] The prevalence of PE in unexplained AECOPD is estimated at 16%, and two-thirds of emboli are in the proximal pulmonary arteries, which is clinically significant and requires anticoagulation.[21] Evaluate for PE when there is no clear infectious origin, there is pleuritic chest pain, and signs of cardiac-associated disorder (syncope, acute heart failure).[21,22]

Asthmatics, especially severe asthmatics and those with frequent hospitalizations, have a significant risk for developing a PE and/or DVT.[23,24] At the time of this writing, there are no clear evidence-based or clinical guidelines on when to work up PE in the setting of asthma or AECOPD. The authors recommend using clinical suspicion and pretest probability to stratify patients with suspected PE. Consider using clinical decision tools (e.g., Wells score) before ordering tests to diagnosis PE in this population.

Because both COPD and asthma are risk factors for thromboembolic events, patients with ACOS have also been found to have increased risk of PE.[25] ACOS is an emerging disease entity and further clinical research must be done to further characterize its relationship to venous thromboembolic disease.

UTILIZATION OF INHALER AGENTS FOR ASTHMA AND COPD PATIENTS

COPD

- Bronchodilators are the first-line therapy and mainstay of treatment used to improve lung function; this is achieved by bronchial smooth muscle relaxation, decreased airway inflammation, reduced air-trapping, and reduced mucous plugging.
- For symptomatic patients on long-acting monotherapy with a LAMA or LABA, per the GOLD 2017 guidelines, it is recommended to start a combination LAMA + LABA because this improves lung function and patient outcomes more effectively.[1,26]

Asthma

- ICSs are the first-line therapy and the mainstay of treatment for long-term control of asthma because of their antiinflammatory actions.

- The US Food and Drug Administration issued a black-box warning for all LABAs because there is an increased risk of death. Nevertheless, LABA currently remains the preferred add-on bronchodilator for those on ICS.[4] Adding a LABA to ICS as combination therapy should be considered in patients 5 years of age or older who are not sufficiently controlled with ICS alone or who need increasing doses of ICSs.[4] LABA monotherapy in asthma is contraindicated.
- Alternatively, at UC Davis, a LAMA inhaler is added to ICS monotherapy or to ICS + LABA combination with similar results to the published literature.[27,28]

Novel Therapies for Chronic Obstructive Pulmonary Disease and Asthma

There are some novel therapies not yet included in the guidelines, because studies examining these agents are too small or are undergoing investigation (**Table 5**).[1,26,29–35]

- Newer agents are LABAs combined with LAMAs in a pressurized MDI, soft-mist inhaler, or dry-powder inhaler.
- For hospitalists, familiarity with these newer agents (see **Table 5**) helps optimize medical management on hospital discharge.

WHAT ARE THE PREOPERATIVE RECOMMENDATIONS FOR PATIENTS WITH ASTHMA OR COPD?

Asthma

Disease control in asthma is essential before any kind of surgery. Well-controlled asthma (per the Asthma Control Test [ACT] is a score of 20 or more) is obviously preferable to very poorly controlled asthma (ACT score $\leq$15). Asthmatics are at risk for several complications during and after surgery, including impaired cough, atelectasis, acute bronchoconstriction, mucous plugging, hypoxemia, hypercapnia, and respiratory infection. The likelihood of complications is related to the severity of the patient's asthma and degree of symptom control before, during, and immediately after surgery.[4]

The following are recommendations to help reduce the risk of complications during preoperative and postoperative elective nonemergent surgery.

- Evaluation before surgery focuses on clinical symptoms, review of systems, medication adherence, medication use (especially oral steroids for >2 weeks in the past 6 months), clinical history, and spirometry (**Box 2**).[36]
- If oral corticosteroids were used for greater than 2 weeks in last 6 months, then the patient should receive stress dose intravenous hydrocortisone 100 mg every 8 hours during the surgical period followed by a lower dose within 24 hours after surgery.
- For select patients with history of high-dose ICS therapy (high-dose ICS is 500–2000 μg/d), stress doses of corticosteroids may also be indicated; clinically relevant adrenal suppression has been reported.[4,37–39]
- If possible, an attempt to improve lung function preoperatively (FEV_1 or peak expiratory flow rate) to the patient's personal best or predicted values is recommended. A short course of oral corticosteroids can be considered in addition to daily controller drug therapy.
- Consider allergy or pulmonary consultation preoperatively if questions remain or the risk of pulmonary complications is considered very high.

Chronic Obstructive Pulmonary Disease

Patients with COPD undergoing surgery are at an increased risk of postoperative pulmonary complications. Impaired ability or effectiveness of cough and acute bronchoconstriction can reduce lung function and cause sequelae from acute bronchoconstriction. Other complications include reintubation, prolonged intubation

Table 5
Upcoming and newer drug treatments for asthma and COPD therapy

Drug Name	Pharmacologic Category	Dose Frequency	Population	Drug Characteristics
Fluticasone-furoate and vilanterol (Trade: Breo Ellipta)	ICS + LABA	Daily	Asthma	• Compared with older agents of ICS-LABA this combination is safe and as efficacious, once daily, and an easier to use device[29]
			COPD	• Some evidence showing associated with lower rates of exacerbations than twice-daily combination inhalers[30]
Umeclidinium and vilanterol (Anoro Ellipta)	LAMA + LABA	Daily	COPD	• Umeclidinium similar to tiotropium in mechanism of action • Can be considered as step-up therapy over tiotropium monotherapy in patients with moderate COPD who are on tiotropium alone[26]
Formoterol fumarate and mometasone furoate (Dulera)	LABA, ICS	BID	COPD	• Small retrospective study shows that change from fluticasone/salmeterol to mometasone/formoterol showed a decrease in exacerbations[31]
			Asthma	• Recommended for asthmatic patients who do not have adequate control with ICS alone. Good safety profile[32]
Glycopyrrolate and formoterol fumarate (Bevespi Aerosphere)	LAMA + LABA		COPD	• Consider use of LAMA + LABA rather than LABA + ICS if symptoms are not controlled on LAMA or LABA alone because decreases exacerbations[1,33] • Can be considered step-up therapy over tiotropium monotherapy in patients on tiotropium alone with moderate COPD
Tiotropium and olodaterol (Stiolto Respimat)	LAMA + LABA	Daily	COPD	• Comes as soft-mist inhaler, which is more user friendly • Can be considered step-up therapy over tiotropium monotherapy in patients on tiotropium alone with moderate COPD
Aclidinium (Tudorza Pressair)	LAMA (more long acting than ipratropium, but shorter acting than tiotropium)	BID	COPD	• Small study shows it may be better at controlling nighttime symptoms[34] • In moderate to severe stable COPD, improves quality of life and reduces hospitalizations; however, not enough data to compare efficacy with tiotropium or other LABAS or LAMAs[35]
Roflumilast (Daliresp)	Phosphodiesterase-4 enzyme inhibitor	Daily	COPD	• Reduces moderate to severe exacerbations treated with systemic corticosteroids with chronic bronchitis, severe COPD, and history of exacerbations[1] • Avoid in underweight individuals or depression history
Indacaterol (Aracapta)	LABA	Daily	COPD	• Improves breathlessness, health status, and exacerbation rate[1] • Adverse effects: cough following administration
Tiotropium	LAMA	Daily	COPD Asthma	• The only FDA-approved LAMA for COPD to reduce acute exacerbations and to treat asthma

Abbreviations: BID, twice a day; FDA, US Food and Drug Administration.
Data from Refs.[1,26,29–35]

Box 2
Preoperative checklist for asthmatic patients

- List asthma medications and dosages.
- Increase use of inhaled SABA.
- Recent asthma exacerbation.
- Recent emergency room visit or hospital visit in last 6 months for asthma.
- Recent use of oral systemic corticosteroids.
- Recent respiratory tract infection.
- History of preoperative bronchospasm during/after previous surgery.
- History of latex allergy.
- Presence of gastroesophageal reflux, which can trigger bronchospasm.
- Assess smoking status.

(>48 hours), aspiration pneumonia, and a prolonged intensive care unit (ICU) and hospital stay. The following recommendations apply to assessments before general surgery[12]:

- The decision to proceed with surgical intervention is made between the consultant surgeon and anesthesiologist based on the patient's comorbidities, functional status, and necessity for surgery.
- Composite assessment tools such as the American Society of Anesthesiologist Physical Status Classification System or American College of Surgeons National Surgical Quality Improve Program Surgical Risk Calculator should be used.
- If able, medical management should be optimized before surgery, including a course of pulmonary rehabilitation, if applicable.
- Consider pulmonary consultation preoperatively for pulmonary optimization and if there is heightened concern for pulmonary complications.

NON-INVASIVE VENTILATION IN COPD PATIENTS

Certain subpopulations of patients with COPD may benefit from NIV to assist spontaneous respirations. NIV provides a low-pressure ventilatory support system for patients who have an intact respiratory drive.

The first step is to assess the stability of the patient with COPD for NIV including comorbid conditions such as obstructive sleep apnea (OSA), in which formal sleep testing is considered. A trial of continuous positive airway pressure or bilevel positive airway pressure therapy can also be considered.

The following patient populations can benefit from nocturnal NIV[40]:

- Patients with daytime hypercapnia (arterial blood gases $PaCO_2$ >52 mm Hg).
- Oxygen desaturations during sleep (Spo_2<88% for $\geq$5 minutes of $\geq$2 hours of nocturnal sleep oximetry despite use of supplemental oxygen $\geq$2 L/min via nasal cannula).
- Patients who have needed continuous NIV for acute exacerbations in the past.

Per the National Institute for Health and Care Excellence (NICE 2010) guidelines,[12] patients who have chronic hypercapnic respiratory failure requiring invasive ventilation or NIV during an exacerbation, or patients who are hypercapnic or acidotic on long-term oxygen therapy, should be referred to a pulmonologist.

Absolute contraindications to NIV include uncooperative patients, respiratory arrest or unstable cardiopulmonary state, inability to protect the airway, and trauma or burns involving the face. Consider referral to a pulmonologist to discuss NIV, or whether an inpatient COPD team is available.

SUMMARY

Hospitalized patients with asthma or COPD benefit from an integrated team of hospitalists and specialty clinicians. Once recognized, a severe asthma attack and severe AECOPD are potentially life-threatening events and can quickly lead to acute respiratory failure and death. Early institution of bronchodilator therapy; oxygen supplementation; systemic corticosteroids; mucus clearance; and, if indicated, antibiotics can reduce the risk of progressive respiratory failure. Once acute respiratory failure occurs, hospitalists must coordinate a rapid and coordinated critical care team response with ICU monitoring, use of NIV, and invasive mechanical ventilation where indicated.

Patients with asthma and with COPD should be encouraged to complete a self-management plan on discharge to prevent recurrence and hospital readmission within 30 days. Education about the disease and implementing a written asthma action plan or COPD action plan should occur before discharge.

It is not necessary to achieve full resolution of asthma or COPD symptoms before discharge; however, it is critical that stability and safe functionality are established before discharge. With education and tailored evidence-based treatments coming from an experience interdisciplinary team led by hospitalists, patients are more likely to have shorter hospital lengths of stay, achieve regular outpatient follow-up, and ultimately reduce the rate of hospital readmission.

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