Overview of Asthma and Asthma Exacerbations

Asthma is a chronic inflammatory airway disease characterized by reversible airway obstruction, bronchial hyperresponsiveness, and recurrent episodes of wheezing, breathlessness, chest tightness, and coughing. Asthma exacerbations are acute or subacute worsening of symptoms requiring a change in treatment, often leading to hospitalization. Asthma affects ~8% of the U.S. population, with ~1.8 million emergency department visits and 189,000 hospitalizations annually (CDC, 2023). Exacerbations can range from mild to life-threatening, with a mortality rate of ~3,500 deaths per year in the U.S. Hospitalists play a critical role in managing acute exacerbations, preventing complications, and ensuring proper discharge planning. This guide provides a comprehensive overview of asthma and asthma exacerbations, including clinical presentation, pathophysiology, diagnostic studies, complications, causes, treatment strategies, hospitalist implications, and includes tables and clinical scenarios for practical application.

Pathophysiology

Asthma (Chronic):

- Mechanism:
  - Chronic airway inflammation driven by Th2-mediated immune response (e.g., IL-4, IL-5, IL-13), leading to eosinophilic infiltration, mast cell activation, and airway remodeling (smooth muscle hypertrophy, goblet cell hyperplasia).
- Response:
  - Bronchial hyperresponsiveness causes reversible airway obstruction, mucus plugging, and airflow limitation, resulting in wheezing and dyspnea.

Asthma Exacerbation (Acute):

- Mechanism:
  - Triggers (e.g., viral infections, allergens) exacerbate airway inflammation, leading to increased bronchoconstriction, edema, and mucus production.
- Response:
  - Acute airway obstruction causes hypoxia, hypercapnia, and respiratory distress; severe cases may lead to respiratory failure.

Causes and Triggers

Asthma Causes:

- Genetic:
  - Family history, atopy (e.g., eczema, allergic rhinitis).
- Environmental:
  - Allergens (pollen, dust mites), pollution, smoking.
- Occupational:
  - Chemical exposures (e.g., isocyanates).

Exacerbation Triggers:

- Infectious:
  - Viral infections (rhinovirus, RSV, 70% of exacerbations).
- Allergens:
  - Pollen, pet dander, mold.
- Environmental:
  - Cold air, air pollution, smoke.
- Medications:
  - Aspirin/NSAIDs (aspirin-exacerbated respiratory disease, AERD), beta-blockers.
- Other:
  - Exercise, stress, GERD, non-adherence to controller medications.

Clinical Presentation

Chronic Asthma:

- Symptoms:
  - Intermittent wheezing, shortness of breath, chest tightness, cough (worse at night/early morning).
- Physical Exam:
  - Wheezing on auscultation, prolonged expiration, normal between episodes.
- Severity:
  - Classified by GINA guidelines (e.g., intermittent, mild/moderate/severe persistent).

Asthma Exacerbation:

- Mild-Moderate:
  - Dyspnea with activity, wheezing, accessory muscle use, speaking in phrases.
  - RR 20-30/min, HR 100-120 bpm, SpO2 90-94% on room air, PEF 50-80% predicted.
- Severe:
  - Dyspnea at rest, unable to speak in full sentences, accessory muscle use, retractions.
  - RR >30/min, HR >120 bpm, SpO2 <90%, PEF <50% predicted.
  - Life-Threatening:
    - Silent chest (minimal air movement), cyanosis, altered mental status, paradoxical breathing.
    - RR <12 or >40/min, SpO2 <88%, PEF <33% predicted, PaCO2 >45 mmHg (respiratory failure).

Diagnostic Studies

Labs:

- Asthma (Chronic):
  - **CBC:** Eosinophilia (>500/µL, allergic asthma).
  - **IgE:** Elevated in atopic asthma.
  - **Allergy Testing:** Skin prick test for allergen identification.
- Asthma Exacerbation:
  - **ABG:** Hypoxemia (PaO2 <60 mmHg), hypercapnia (PaCO2 >45 mmHg, severe).
  - **CBC:** Leukocytosis (infection), eosinophilia (allergic trigger).
  - **BMP:** Monitor K+, glucose (steroid effects), lactate (if shock).
  - **Viral Testing:** Nasal swab for rhinovirus, influenza (common triggers).

Pulmonary Function Tests (PFTs):

- Chronic Asthma:
  - **Spirometry:** FEV1/FVC <0.7, FEV1 <80% predicted, >12% improvement post-bronchodilator.
  - **Peak Expiratory Flow (PEF):** Reduced, variability >20% (diurnal variation).
- Exacerbation:
  - **PEF:** <80% personal best (mild), <50% (severe), <33% (life-threatening).

Imaging:

- CXR:
  - Often normal, may show hyperinflation, atelectasis (mucus plugging), or exclude pneumonia.
- CT Chest:
  - Rarely needed, used for complications (e.g., pneumothorax, ABPA).

Other Tests:

- Pulse Oximetry:
  - SpO2 <94% (mild-moderate), <90% (severe).
- ECG:
  - Sinus tachycardia, right heart strain (severe exacerbation, cor pulmonale).
- Sputum Analysis:
  - Eosinophils (allergic asthma), neutrophils (infection).

Complications

Chronic Asthma:

- Airway Remodeling:
  - Chronic inflammation leads to irreversible obstruction, reduced FEV1.
- Allergic Bronchopulmonary Aspergillosis (ABPA):
  - 2-5% incidence, eosinophilia, fungal sensitization.
- Chronic Respiratory Failure:
  - 5-10% in severe asthma, chronic hypoxia (PaO2 <60 mmHg).

Asthma Exacerbation:

- Respiratory Failure:
  - 5-10% incidence in severe exacerbations, PaCO2 >45 mmHg, mortality 10-20%.
- Pneumothorax:
  - 1-2% incidence, barotrauma from high airway pressures.
- Arrhythmias:
  - 5-10% incidence, tachycardia, AF (hypoxia, beta-agonist overuse).
- Atelectasis:
  - Mucus plugging, 10-15% incidence, lobar collapse.

Treatment Strategies

Chronic Asthma:

- Controller Therapy:
  - **Inhaled Corticosteroids (ICS):** Budesonide 180-360 mcg BID (first-line).
  - **Long-Acting Beta-Agonists (LABA):** Add salmeterol 50 mcg BID (if uncontrolled on ICS).
  - **Leukotriene Modifiers:** Montelukast 10 mg PO daily (alternative or add-on).
  - **Biologics:** Omalizumab (anti-IgE, for allergic asthma), mepolizumab (anti-IL-5, for eosinophilic asthma).
- Reliever Therapy:
  - **Short-Acting Beta-Agonists (SABA):** Albuterol 90 mcg/puff, 2 puffs PRN q4-6h.
  - Duration:
    - Lifelong (step-up/step-down based on GINA control assessment).
- Supportive:
  - Allergen avoidance, smoking cessation, asthma action plan.

Asthma Exacerbation:

- Mild-Moderate:
  - **Bronchodilators:** Albuterol 2.5-5 mg nebulized q20min x 3 doses, then q1-4h.
  - **Corticosteroids:** Prednisone 40-60 mg PO daily x 5-7 days.
  - **Oxygen:** Titrate to SpO2 94-98% (avoid hyperoxia).
- Severe:
  - **Bronchodilators:** Albuterol 5 mg + ipratropium 0.5 mg nebulized q20min x 3, then q1-2h.
  - **Corticosteroids:** Methylprednisolone 60-125 mg IV q6h x 24-48h, then prednisone PO.
  - **Magnesium Sulfate:** 2 g IV over 20min (bronchodilation, if no response to initial therapy).
  - **Oxygen:** High-flow nasal cannula (HFNC) or non-invasive ventilation (NIV) if SpO2 <90%.
- Life-Threatening:
  - **Intubation:** If PaCO2 >45 mmHg, altered mental status, silent chest (settings: VT 6 mL/kg, RR 12-14/min, PEEP 5 cmH2O).
  - **Epinephrine:** 0.3-0.5 mg IM q20min (if impending arrest, bronchospasm).

        - **Antibiotics:** Only if bacterial trigger (e.g., azithromycin 500 mg IV daily x 3 days for pneumonia).
            - Duration: Bronchodilators until wheezing resolves, steroids 5-7 days (PO), 24-48h (IV).
    - Supportive: Fluids (NS 1 L bolus if dehydrated), monitor for beta-agonist toxicity (tachycardia, hypokalemia).

Hospital Medicine Implications

Early Recognition:

- Chronic asthma:
    - Wheezing, history of atopy, reversible obstruction on PFTs.
- Exacerbation:
    - Dyspnea, wheezing, accessory muscle use, PEF <80% predicted.

Consultations:

- Pulmonology:
    - For severe exacerbations, ABPA, or uncontrolled asthma.
- ID:
    - If bacterial infection suspected (e.g., pneumonia, sinusitis).
- Allergy/Immunology:
    - For biologics, allergen testing.

Monitoring:

- Vitals q1-2h (RR, HR, SpO2).
- PEF q2-4h (assess response to therapy).
- ABG q4-6h (if severe, PaCO2 >45 mmHg indicates failure).

Discharge Planning:

Medications: ICS/LABA (e.g., budesonide/formoterol), prednisone taper, albuterol PRN.

Follow-Up: Pulmonology, primary care within 1 week.

Education: Inhaler technique, asthma action plan, trigger avoidance.

Table: Asthma and Asthma Exacerbations - Key Features

Condition	Presentation	Pathophysiology	Labs/Tests	Complications	Treatment
Chronic Asthma	Wheezing, dyspnea, cough	Th2 inflammation, airway remodeling	Spirometry: FEV1/FVC <0.7, eosinophilia	Airway remodeling, ABPA	ICS (budesonide), LABA, albuterol PRN
Asthma Exacerbation (Mild-Moderate)	Dyspnea, wheezing, PEF 50-80%	Acute bronchoconstriction, edema	ABG: Hypoxemia, PEF <80%	Atelectasis, recurrence	Albuterol, prednisone PO
Asthma Exacerbation (Severe)	Dyspnea at rest, PEF <50%	Severe airway obstruction	ABG: Hypercapnia, SpO2 <90%	Respiratory failure, pneumothorax	Albuterol + ipratropium, methylprednisolone IV
Asthma Exacerbation (Life-Threatening)	Silent chest, cyanosis	Near-complete obstruction	PaCO2 >45 mmHg, PEF <33%	Respiratory arrest, arrhythmias	Intubation, epinephrine, HFNC/NIV

Table: Hospitalist Management Checklist for Asthma Exacerbations

Task	Mild-Moderate Exacerbation	Severe Exacerbation	Life-Threatening Exacerbation	Monitoring	Consults
Initial Stabilization	Albuterol, oxygen	Albuterol + ipratropium, steroids IV	Intubation, epinephrine, NIV	Vitals q1-2h, PEF q2-4h	Pulmonology, ICU
Treatment	Prednisone PO, bronchodilators	Methylprednisolone IV, magnesium	Mechanical ventilation, steroids	ABG q4-6h, SpO2 q1h	ID if infection
Supportive Care	Hydration, monitor symptoms	Telemetry, fluids	ICU, monitor for barotrauma	CXR q24h, K+ q6h	Allergy for biologics
Follow-Up	ICS/LABA, asthma action plan	Pulmonology follow-up	Long-term controller therapy	PFTs post-discharge	Primary care

Clinical Scenarios

Scenario 1: Young Female with Mild-Moderate Asthma Exacerbation

- Presentation: A 25-year-old female with asthma presents with 2 days of worsening dyspnea and wheezing after a viral URI. She reports chest tightness. Exam shows T 37.5°C, BP 120/80 mmHg, HR 100 bpm, RR 24/min, SpO2 92% on room air, wheezing, mild accessory muscle use, PEF 60% predicted.
- Diagnostic Workup: **ABG:** PaO2 70 mmHg, PaCO2 35 mmHg, labs: WBC 10,000/µL, eosinophilia 600/µL, CXR: Hyperinflation, no pneumonia, nasal swab: Rhinovirus.
- Diagnosis: Mild-moderate asthma exacerbation → Dyspnea, wheezing, PEF 60%, viral trigger.
- Management: Admit to medicine (exacerbation). Start albuterol 2.5 mg nebulized q20min x 3, then q2h. Prednisone 40 mg PO daily x 5 days. Oxygen 2 L/min (SpO2 96%). Monitor PEF q2h (improves to 80%), vitals q4h. Day 2: Symptoms resolved, discharged on budesonide/formoterol 160/4.5 mcg 2 puffs BID, albuterol PRN, with pulmonology follow-up.

Scenario 2: Middle-Aged Male with Severe Asthma Exacerbation

- Presentation: A 40-year-old male with asthma presents with 1 day of severe dyspnea, unable to speak in full sentences. Exam shows T 38°C, BP 130/80 mmHg, HR 120 bpm, RR 32/min, SpO2 88% on room air, diffuse wheezing, accessory muscle use, PEF 40% predicted.
- Diagnostic Workup: **ABG:** PaO2 55 mmHg, PaCO2 42 mmHg, labs: WBC 14,000/µL, eosinophilia 300/µL, CXR: No pneumonia, nasal swab: Negative.
- Diagnosis: Severe asthma exacerbation → Dyspnea at rest, PEF 40%, SpO2 <90%.
- Management: Admit to telemetry (severe exacerbation). Start albuterol 5 mg + ipratropium 0.5 mg nebulized q20min x 3, then q1h. Methylprednisolone 60 mg IV q6h x 24h, then prednisone 40 mg PO daily x 5 days. Magnesium sulfate 2 g IV over 20min. HFNC 40 L/min, FiO2 40% (SpO2 94%). Monitor PEF q2h (improves to 70%), ABG q4h. Day 3: RR 20/min, SpO2 96%, discharged on budesonide/formoterol, with pulmonology follow-up.

Scenario 3: Elderly Female with Life-Threatening Asthma Exacerbation

- Presentation: A 70-year-old female with asthma presents with 12h of severe dyspnea, now drowsy with minimal breath sounds. Exam shows T 37°C, BP 100/60 mmHg, HR 130 bpm, RR 10/min, SpO2 85% on room air, silent chest, cyanosis, GCS 12.
- Diagnostic Workup: **ABG:** PaO2 50 mmHg, PaCO2 60 mmHg, pH 7.2, labs: WBC 16,000/µL, Cr 1.5 mg/dL, lactate 3.0 mmol/L, CXR: Hyperinflation, no pneumothorax.
- Diagnosis: Life-threatening asthma exacerbation → Silent chest, hypercapnia, altered mental status.
- Management: Admit to ICU (respiratory failure). Intubate (VT 6 mL/kg, RR 12/min, PEEP 5 cmH2O). Start albuterol 5 mg + ipratropium 0.5 mg via ventilator q1h. Methylprednisolone 125 mg IV q6h x 48h. Epinephrine 0.3 mg IM given on arrival (bronchospasm). Consult pulmonology: Extubate day 3 (PaCO2 40 mmHg). Transition to prednisone 40 mg PO daily x 5 days. Day 5: SpO2 96%, discharged on budesonide/formoterol, with pulmonology follow-up.

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