Pulmonary

- CAP
- Asthma/COPD Flare
- Oxygen Therapy
- ARDS/Mechanical Ventilation
- Stepwise approach to managing Asthma

CAP

Common causes

Streptococcus pneumoniae (pneumococcus) and respiratory viruses are the most frequently detected pathogens in patients with CAP

Typical bacteria

- S. pneumoniae (most common bacterial cause)
- Haemophilus influenzae
- Moraxella catarrhalis
- Staphylococcus aureus
- Group A streptococci
- Aerobic gram-negative bacteria (eg, Enterobacteriaceae such as Klebsiella spp or Escherichia coli)
- Microaerophilic bacteria and anaerobes (associated with aspiration)

Atypical bacteria ("atypical" refers to the intrinsic resistance of these organisms to beta-lactams and their inability to be visualized on Gram stain or cultured using traditional techniques)

- Legionella spp
- Mycoplasma pneumoniae
- Chlamydia pneumoniae
- Chlamydia psittaci
- Coxiella burnetii
- Respiratory viruses
- Influenza A and B viruses
- Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
- Other coronaviruses (eg, Middle East respiratory syndrome CoV, severe acute respiratory syndrome CoV, CoV-229E, CoV-NL63, CoV-OC43, CoV-HKU1)
- Rhinoviruses
- Parainfluenza viruses
- Adenoviruses
- Respiratory syncytial virus
- Human metapneumovirus
- Human bocaviruses

Making the diagnosis

- The diagnosis of CAP generally requires the demonstration of an infiltrate on chest imaging in a patient with a clinically compatible syndrome (eg, fever, dyspnea, cough, and sputum production)
- For most patients with suspected CAP, obtain PA and lateral chest radiographs. Radiographic findings consistent with the diagnosis of CAP include lobar consolidations, interstitial infiltrates, and/or cavitations.
- For selected patients in whom CAP is suspected based on clinical features despite a negative chest radiograph, obtain chest CT.

For most patients with moderate CAP admitted to the general medical ward, obtain the following:

- Blood cultures
- Sputum Gram stain and culture
- Urinary antigen testing for S. pneumoniae
- Testing for Legionella spp (polymerase chain reaction [PCR] when available, urinary antigen test as an alternate)
- SARS-CoV-2 testing

DIFFERENTIAL DIAGNOSIS

Noninfectious illnesses that mimic CAP or co-occur with CAP and present with pulmonary infiltrate and cough include:

- Congestive heart failure with pulmonary edema
- Pulmonary embolism
- Pulmonary hemorrhage
- Atelectasis
- Aspiration or chemical pneumonitis
- Drug reactions
- Lung cancer
- Collagen vascular diseases
- Vasculitis
- Acute exacerbation of bronchiectasis
- Interstitial lung diseases (eg, sarcoidosis, asbestosis, hypersensitivity pneumonitis, cryptogenic organizing pneumonia)

Inpatient antibiotic therapy

Without suspicion for MRSA or Pseudomonas

●Combination therapy with ceftriaxone (1 to 2 g IV daily), cefotaxime (1 to 2 g IV every 8 hours), ceftaroline (600 mg IV every 12 hours), ertapenem (1 g IV daily), or ampicillin-sulbactam (3 g IV every 6 hours) plus a macrolide (azithromycin [500 mg IV or orally daily] or clarithromycin [500 mg twice daily] or clarithromycin XL [two 500 mg tablets once daily]). Doxycycline (100 mg orally or IV twice daily) may be used as an alternative to a macrolide.

●Monotherapy with a respiratory fluoroquinolone (levofloxacin [750 mg IV or orally daily] or moxifloxacin [400 mg IV or orally daily] or gemifloxacin [320 mg orally daily]) is an appropriate alternative for patients who cannot receive a beta-lactam plus a macrolide.

With suspicion for Pseudomonas

Acceptable regimens include combination therapy with an antipseudomonal/antipneumococcal beta-lactam antibiotic and an antipseudomonal fluoroquinolone, such as the following regimens:

●Piperacillin-tazobactam (4.5 g every 6 hours) or Imipenem (500 mg every 6 hours) or Meropenem (1 g every 8 hours) or Cefepime (2 g every 8 hours) or ●Ceftazidime (2 g every 8 hours; activity against pneumococcus more limited than agents listed above)

PLUS ●Ciprofloxacin (400 mg every 8 hours) or ●Levofloxacin (750 mg daily)

With suspicion for MRSA

- Empiric therapy for CA-MRSA: gram-positive cocci in clusters seen on sputum Gram stain, known colonization with MRSA, risk factors for colonization with MRSA (eg, end-stage kidney disease, contact sport participants, people who inject drugs, those living in crowded conditions, men who have sex with men, prisoners), recent influenza-like illness, antimicrobial therapy (particularly with a fluoroquinolone) in the prior three months, necrotizing or cavitary pneumonia, or presence of empyema.
- For treatment of MRSA, empiric regimens should include either vancomycin or linezolid (600 mg IV every 12 hours).
- In all patients treated empirically for MRSA, obtain a rapid nasal PCR for MRSA (when available) in addition to Gram stain and culture of sputum or other respiratory tract infection to help guide subsequent therapy.

Influenza therapy

- Antiviral treatment is recommended as soon as possible for all persons with suspected or confirmed influenza requiring hospitalization or who have progressive, severe, or complicated influenza infection, regardless of previous health or vaccination status

Antibiotic Therapy for Adults Hospitalized With Community-Acquired PneumoniaThe Clinical Utility of Methicillin-Resistant Staphylococcus aureus (MRSA) Nasal Screening to Rule Out MRSA Pneumonia

Treatment of CAP

Asthma/COPD Flare

Initial pharmacologic therapy

Beta adrenergic agonists

- Dose and administration – Albuterol 2.5 mg (diluted to a total of 3 mL with sterile normal saline) by nebulizer or one to two inhalations (most commonly two, occasionally four; 90 mcg per inhalation) by MDI with a spacer every one hour for two to three doses and then every two to four hours as needed, guided by the response to therapy. - Levalbuterol 1.25 mg (diluted to a total of 3 mL with sterile saline) by nebulizer at the same frequency as albuterol.
- Levalbuterol (45 mcg/actuation) by MDI is given one to two inhalations (most commonly two, occasionally four) every one hour for two to three doses, then every two to four hours as needed. When combined with ipratropium, albuterol 2.5 mg is mixed with ipratropium bromide 0.5 mg in 3 mL. Muscarinic antagonists — Suggest use of the combination of a SAMA (eg, ipratropium) and SABA for exacerbations.
- Dose and administration – When combined with albuterol for nebulization, ipratropium 0.5 mg (500 mcg) is mixed with albuterol 2.5 mg in 3 mL and given every hour for two or three doses and then every two to four hours as needed. - Combination ipratropium-albuterol soft mist inhaler (SMI) can be used, 1 inhalation, approximately every hour for two to three doses and then every two to four hours as needed, guided by the response to therapy.

Ipratropium

also available in an MDI that can be used with a spacer, 2 to 4 inhalations every hour for two to three doses, and then every two to four hours as needed.

Systemic glucocorticoids

- IV glucocorticoids administered to with a severe exacerbation, not responded to oral glucocorticoids at home, unable to take oral medication
- Dose prednisone 40 mg once daily for the majority of COPD exacerbations. Regimens range from prednisone 30 to 60 mg, once daily, to methylprednisolone 60 to 125 mg, two to four times daily.
- Duration – Range of 5 to 14 days

Antimicrobial therapy

Recommend antibiotics with at least two of these three symptoms – increased dyspnea, increased sputum volume, or increased sputum purulence.

Oxygen therapy

Supplemental oxygen be titrated to a target of 88 to 92 percent pulse oxygen saturation, rather than using high-flow, nontitrated oxygen

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Oxygen Therapy

●Venturi masks permit a precise upper limit for the FiO2, preferable for patients at risk of hypercapnia. Venturi masks can deliver an FiO2 of 24, 28, 31, 35, 40, or 60%.

●Nasal cannula can provide flow rates up to 6 L per minute with an associated FiO2 of approximately 40%

●When a higher FiO2 is needed, simple facemasks can provide an FiO2 up to 55% using flow rates of 6 to 10 L.

●Non-rebreathing masks with a reservoir, one-way valves, and a tight face seal can deliver an inspired oxygen concentration up to 90%

●High-flow nasal cannula (HFNC) provide supplemental oxygen (adjustable FiO2) at a high flow rate (up to 60 L/min that results in a low level of continuous positive airway pressure).

Oxygen Therapy

ARDS/Mechanical Ventilation

Pathophysiology:

Scattered, nonhomogeneous alveolar damage that leads to oxygenation (V/Q mismatch) problems

Diagnosis:

- Onset: within one week of a known clinical insult, or new or worsening respiratory symptoms
- Imaging: bilateral infiltrates on CXR not fully explained by effusions, nodules, or lung collapse
- Origin: respiratory failure not fully explained by cardiac failure or fluid overload. An objective assessment (eg ECHO) is required to exclude pulmonary edema if no ARDS risk factors are present
- Oxygenation: (on ventilator settings that include PEEP or CPAP >5cm H2O)
  - Mild ARDS: PaO2/FiO2 ratio 200-300 mmHg
  - Moderate ARDS: PaO2/FiO2 ratio 100-200 mmHg
  - Severe ARDS: PaO2/FiO2 ratio <100 mmHg

Etiology:

- Direct lung injury: Pneumonia, aspiration, pulmonary contusion, fat emboli, near-drowning, inhalational injury, post lung transplantation, or hematopoietic stem cell transplant
- Indirect lung injury: Sepsis, severe trauma, shock, drug overdose, DIC, pancreatitis, cardiopulmonary bypass, transfusion of blood products (TRALI)

Management:

- Mechanical ventilation:
  - Goal: Maintain adequate gas exchange until the inflammation and edema subside and minimize ventilator-induced lung injury
  - ARDSnet protocol (ARMA Trial): low tidal volume (4-6 ml/kg) and low airway pressure (Pplat <30 mmHg)
- Additional therapeutic considerations
  - "Conservative" fluid management: FACTT trial showed that it improves oxygenation and shortens the duration of mechanical ventilation and intensive care but does not

improve 60 day mortality. Goal CVP <4, PCWP <8. Excluded patients with hypotension, pressures, HD, oliguric renal failure.
    - Early neuromuscular blockade in severe ARDS: ACURASYS trial (single randomized trial) showed the use of cisatracurium in patients with severe ARDS resulted in a reduction in 90 day mortality and an increase in ventilator free days. ROSE trial did not reproduce this mortality benefit.
    - Prone positioning PROSEVA randomized trial showed a reduction in mortality in patients with severe ARDS; recommended for patients with P/F < 100, consider if P/F < 150
    - ECMO and high frequency oscillatory ventilation: further studies are required to evaluate high frequency oscillatory ventilation and extra-corporeal membrane oxygenation. There are no consensus guidelines but consider in P/F <80.
    - Steroids should NOT be initiated in late ARDS (14 days or longer). The impact of earlier steroid therapy on mortality is uncertain, as the DEXA-ARDS trial showed reduced mortality and improved liberation from the vent but previous studies were less clear.
    - Recombinant surfactant does not improve survival or ventilator free days
    - Low-dose nitric oxide temporarily improves oxygenation but not mortality
- Overall care
    - Identify and treat underlying causes
    - Ensure adequate nutrition (preferably enteral)
    - Provide GI and DVT prophylaxis
    - Prevent and treat nosocomial infections early

Indications for intubation

- Is there failure of airway maintenance or protection?
    - Upper airway obstruction, airway protection
- Is there a failure of oxygenation or ventilation?
    - Uncorrectable hypoxemia (pO2 <70 mmHg on 100% O2 NRB)
    - Hypercapnea (pCO2 >55 mmHg) with acidosis [clinical judgement for pCO2 in COPD]
    - Ineffective respiration (max inspiratory force <25 cm H2O)
- Does the anticipated clinical course require intubation?
    - Fatigue (RR>35 with increasing pCO2)

Initial ventilator settings

- ARDS
    - Initial TV 6ml/kg PBW (range 4-8 ml/kg)
    - Ventilator rate 14-22 breaths per minute
    - Initial PEEP of 5 cm H2O, up to 24 cm H2O
- Non-ARDS
    - Initial TV between 6-8 ml/kg PBW reasonable,
    - Ventilator rate 12-16 breaths per minute

- PEEP between 3-5 cm H2O

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Stepwise approach to managing Asthma

Intermittent (Step 1) —
Symptoms — <2 days a week, <2x nighttime awakenings/month, SABA use <2 days/week
Preferred: SABA prn

Mild persistent (Step 2) —
Symptoms — >2 days a week, 3-4x nighttime awakenings/month, SABA use >2 days/week
Preferred: Low dose ICS
Alternative: Cromolyn, LRTA, Nedocromil, Theophylline

Moderate persistent (Step 3) —
Symptoms — Daily, >1x nighttime awakenings/week, SABA use daily
Preferred: Low dose ICS + LABA OR Medium dose ICS
Alternative: Low-dose ICS + either LTRA, Theophylline, or Zileuton

Severe persistent (Step 4) —
Symptoms — Throughout the day, Often 7x nighttime awakenings/week, SABA use several times daily
Preferred: Medium dose ICS + LABA
Alternative: Medium dose ICS + either LTRA, Theophylline, or Zileuton

Severe Persistent (Step 5) —
Preferred: High-dose ICS + LABA AND Consider Omalizumab for patients who have allergies

Severe Persistent (Step 6) —
Preferred: High-dose ICS + LABA + oral corticosteroid AND Consider Omalizumab for patients who have allergies

https://getasthmahelp.org/documents/GIST-Stepwise-Approach.pdf