1.2 Lower Respiratory Tract Infections (LRTIs)

BRONCHIOLITIS/WHEEZY BRONCHITIS (EXPIRATORY WHEEZING)

- Respiratory syncitial virus (RSV) is the most important etiology; rapid diagnosis uses antigen detection methods.
- In adults, RSV accounts for 10.6% of hospitalizations for pneumonia, 11.4% for chronic obstructive pulmonary disease, 7.2% for asthma and 5.4% for congestive heart failure in patients >65 years of age. RSV caused 11% of clinically important respiratory illnesses in military recruits.
- There is a need for surveillance for etiologies of bronchiolitis and bronchitis.

Etiology	Preferred regimen	Comments
RSV in 50% Parainfluenza in 25% Human metapneumovirus	**P:** **Infants/ children ≤ 5 y:** **Ribavirin** for severe disease (i.e., requiring mechanical ventilation). Administer at a concentration of 20 mg/mL in sterile water by small particle aerosol generator (SPAG) 2 via continuous aerosol administration for over 18-20 hours daily for 3-5d. **A:** Antibiotics are not indicated.	Antibiotics not indicated in infants hospitalized with RSV bronchiolitis unless there is evidence of secondary bacterial infection. Mainstay of therapy is supportive care, which includes hydration, measurement of oxygen saturation and use of supplemental oxygen if needed. Ribavirin is not routinely recommended due to the high cost, toxicity, absence of controlled data. Aerosolized ribavirin should only be administered with SPAG 2.

BRONCHITIS

Acute bronchitis

- A throat swab polymerase chain reaction test may be done to diagnose *Mycoplasma* or *Chlamydophila* (formerly *Chlamydia*)

Etiology	Preferred regimen	Comments
Infants or children ≤ 2y Adenovirus (most common) **Children 2-5y** Respiratory syncytial virus Parainfluenza 3 virus Human metapneumovirus **Adolescent and adults** Usually viral *Mycoplasma pneumoniae* in 5% *Chlamydophyla pneumoniae* in 5%	**P: ≤ 5y** Antibiotics are indicated only with associated sinusitis or heavy growth on throat culture for *Streptococcus pneumoniae*, Group A Streptococci, *Haemophilus influenzae*; or there is no improvement in 1 week. Otherwise treatment is symptomatic. **A:** Antibiotics are usually not indicated. Antitussive +/- inhaled bronchodilators.	Purulent sputum alone not an indication for antibiotic therapy. Expect cough to last for 2 weeks. If there is fever or rigors, get a chest x-ray. If *Mycoplasma* is documented, prefer doxycycline over macrolides due to increasing macrolide resistance.

Persistent cough (>14 days), afebrile during community outbreak:
Pertussis (whooping cough)

- Presents as 3 stages: 1) catarrhal (1-2 weeks); 2) paroxysmal coughing (2-4 weeks); and 3) convalescence (1-2 weeks).
- Diagnosis is made through polymerase chain reaction on nasopharyngeal secretions or increased pertussis-toxin antibody titres.

Etiology	Preferred regimen	Comments

*Bordetella pertussi*s and occasionally, *B. parapertussis.* Differential diagnosis include the following: 1. Asthma 2. Gastroesophageal reflux 3. Post-nasal drip 4. *Mycoplasma* infection 5. *Chlamydophila* infection	**P:** **Neonates younger than 1 month:** **Azithromycin** 10 mg/kg/d for 5d OR **Erythromycin** 40 mg/kg/d in 4 div doses x 14d **>2 mos:** **Azithromycin** 10 mg/kg/d PO on day 1 then 5 mg/kg/d PO q24h x 4d OR **Clarithromycin** 7.5 mg/kg PO q12h x 7d (maximum of 1 g/d OR **Erythromycin estolate** 40 mg/kg/d in 4 divided doses OR **Erythromycin base** 40 mg/kg/d divided q6h x 7-14d, maximum of 1-2 g/d OR **Trimethoprim-sulfamethoxazole**, with trimethoprim 8 mg/kg/d and sulfamethoxazole 40 mg/kg/d in 2 divided doses/d **A:** **Azithromycin** 500 mg PO on day 1, 250 mg q24h on days 2-5 OR **Erythromycin estolate** 500 mg PO qid x 14d OR **Trimethoprim-sulfamethoxazole** 160/800 mg PO bid x 14d OR **Clarithromycin** 500 mg PO bid x 7d	Treatment may abort or eliminate pertussis in the catarrhal stage, but does not shorten the paroxysmal stage. Treatment is aimed at eradication of nasopharyngeal carriage. In the non-outbreak setting, the likelihood of pertussis increased if post-tussive emesis or inspiratory whoop is present. **Pertussis prophylaxis of household contacts (adults and children):** **Azithromycin** 500 mg PO single dose on day 1, then 250 mg q24h on days 2–5 OR **Erythromycin** 500 mg PO QID x 14d OR **Clarithromycin** 500 mg PO bid x 7d OR **Trimethoprim-sulfamethoxazole** 160/800 mg 1 tablet PO BID x 14d

Acute bacterial exacerbation of chronic bronchitis (ABECB), adults

- Almost always in smokers with chronic obstructive pulmonary disease. Tobacco use and air pollution contribute to ABECB.
- Severe ABECB is characterized by increased dyspnea, sputum viscosity/purulence and sputum volume.
- Management of severe ABECB includes: (1) consider a chest x-ray, especially if febrile and/or with low oxygen saturation; (2) inhaled anticholinergic bronchodilator; (3) oral corticosteroid; taper over 2 weeks; (4) tobacco cessation; and (5) non-invasive positive pressure ventilation.

Etiology	Preferred regimen	Comments
Viruses in 20%-50% *Chlamydophila pneumoniae* in 5% *Mycoplasma pneumoniae* in <1% The role of *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* is controversial.	**A:** <u>Mild-Moderate:</u> **Amoxicillin** 500 mg tid OR **Doxycycline** 100 mg PO bid OR **Trimethoprim-sulfamethoxazole** 160mg/800mg tablet PO bid OR **Cefuroxime** 500 mg PO BID <u>Severe:</u> Co-amoxiclav 875/125 mg bid OR **Azithromycin** 500 mg q24h x 3d OR **Clarithromycin** 500 mg PO bid OR **Levofloxacin** 500 mg PO q24h The recommended length of antibiotic therapy is usually 5-10d.	The role of antimicrobial therapy is debated even for severe diseases, but a recent study on over 80,000 patients show value of antimicrobial therapy in patients hospitalized with severe disease. The GOLD COPD 2015 Update states: Antibiotics should be given to patients with exacerbations of COPD who have: (1) three cardinal symptoms (increase in dyspnea, sputum volume, and sputum purulence; (2) have two of the cardinal symptoms, if increased sputum purulence is one of the two symptoms; or (3) require mechanical ventilation (invasive or non-invasive.

Influenza

- Fever, cough, myalgia during influenza season
- Complications include influenza pneumonia and secondary bacterial pneumonia due to community-acquired methicillin-resistant and susceptible *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Haemophilus influenzae*.
- Prevention includes annual vaccination.

Etiology	Preferred regimen	Comments
Influenza A and B	**Oseltamivir** **P:** Infant 2 weeks-11 months: 3 mg/kg bid x 5d ≤ 15 kg: 30 mg bid x 5d > 15 kg to 23 kg: 45 mg bid x 5d > 23 kg to 40 kg: 60 mg bid x 5d > 40 kg: 75 mg bid x 5d **Adult:** Oseltamivir 75 mg PO bid x 5d	Resistant to: Amantadine and rimantidine (100%)

Acute bacterial exacerbation (bronchiectasis)		
Etiology	**Preferred regimen**	**Comments**
Haemophilus influenzae *Pseudomonas aeruginosa* *Streptococcus pneumoniae* (rarely)	**A: Levofloxacin** 500 mg PO q24h x 7-10d Prevention of exacerbation: **Erythromycin** 500 mg PO bid OR **Azithromycin** 250 mg q24h x 8 weeks	May be caused by obstruction, decreased immunoglobulins, cystic fibrosis, dyskinetic cilia, tobacco, or prior severe or recurrent necrotizing bronchitis (e.g., pertussis). Higher rates of macrolide resistance in oropharyngeal flora may potentially increase the risk of cardiovascular deaths from macrolide-induced QTc prolongation, liver toxicity, or hearing loss (see JAMA 309:1295, 2013) Pre-treatment screening includes baseline liver function tests, electrocardiogram, hearing test, and sputum culture to exclude mycobacterial disease.
Aspergillosis *Aspergillus fumigatus* (most common) *A. flavus* and others Allergic bronchopulmonary aspergillosis (clinical manifestation: wheezing, pulmonary infiltrates, bronchiectasisa and fibrosis). Airway colonization is associated with increase blood eosinophils, increase lgE levels and isolation of *Aspergillus* spp. or other dematiaceous species (*Alternaria*, *Cladosporium*, etc)	**A:** Treatment of allergic bronchopulmonary aspergillosis: **Itraconazole** 200 mg PO bid x 16 weeks or longer.	Itraconazole decreases the number of exacerbations requiring corticosteroids with improved immunological markers improved lung function and exercise tolerance. Acute asthma attacks associated with allergic bronchopulmonary aspergillosis is treated with corticosteroids.

PNEUMONIAS AND INFECTIONS OF THE LUNG PARENCHYMA

Community-Acquired Pneumonia (CAP) in Neonates		
Etiology	**Preferred regimen**	**Comments**
Gram (-) bacilli Group B Streptococci	**Ampicillin** 100-200 mg/kg/d div q6 hrs IV (maximum: 12 g/d) OR **Penicillin G** 100,000-250,000 units/kg/d div q4-6 h IV infusion over 15-60 min For severe infections: 250,000-400,000 units/kg/d div q4-6 h IV infusion over 15-60 min (maximum: 24 million units/d IV) PLUS **Aminoglycoside:** **Amikacin** 15 mg/kg/d once day IV or **Gentamicin** 5 mg/kg/d once a day IV	Recommendation for immunization: • Pneumococcal Conjugate Vaccine given IM, given at 6 weeks of age. Primary vaccination includes 3 doses with an interval of 4 weeks in between doses, and a booster 6 months after the 3rd dose • Hib Conjungate Vaccine given IM, given at 6 weeks of age. Primary vaccination includes 3 doses with an interval of 4 weeks in between doses, and a booster at 12-15 months of age with an interval of 6 months after the 3rd dose

Community-Acquired Pneumonia (CAP) in Infants and Children up to 5 years
Pediatric CAP (PCAP) classification:

- PCAP A/B (non-severe): No or mild dehydration; no malnutrition; no pallor; awake; no signs of respiratory failure; respiratory rate of ≥50-≥60/min (3-12 mos.), ≥40-≤50/min (1-5y), ≥30-≤35/min (>5 years)
- PCAP C (severe): Moderate dehydration; moderate malnutrition; with pallor; irritable (+ intercostal/subcostal retractions, head bobbing, cyanosis); respiratory rate of >60-≤70/min (3-12 mos), >50/min (1-5 y), >35/min (>5y); NO grunting; NO apnea
- PCAP D (very severe): Severe dehydration; severe malnutrition; with pallor; lethargic/stuporous/in coma (+ supraclavicular/intercostal/subcostal retractions, head bobbing, cyanosis, grunting, apnea; respiratory rate >70/min (3-12 mos), >50/min (1-5 y), >35/min (>5 y)

Etiology	**Preferred regimen**	**Comments**
Streptococcus pneumoniae in 30%-50% *Haemophilus influenzae* type b in 10%-30%, *Staphylococcus aureus* *K. pneumoniae* Non-typeable *H. influenzae*	**PCAP A or B** If with complete Hib vaccination: **Amoxicillin** 80-90 mg/kg/d div q12h PO x 5d If with no Hib vaccination or incomplete or unknown vaccination history: **Co-amoxiclav** 80-90 mg (amoxicillin component)/kg/d ➢ div q8h PO **(for preparations with amoxicillin:clavulanic ratio of 4:1)** ➢ div q12h PO **(for preparations with amoxicillin:clavulanic ratio of 7:1)** For children >40 kg: 500 mg (amoxicillin)/125 mg (clavulanic acid) q8h PO (maximum of 2g amoxicillin/d) OR	Equal efficacy between oral amoxicillin and IV penicillin if feeding is tolerated.

	Cefuroxime 20-30 mg/kg/d div q 12 h PO <u>If allergic to amoxicillin, consider macrolide:</u> **Azithromycin** 10 mg/kg once a day PO x 3d or 10 mg/kg/d PO on day 1 then 5 mg/kg/d PO on days 2-5 OR **Clarithromycin** 15 mg/kg/d div q12h PO x 7d <u>If with non-response to initial treatment (48-72h), consider the following:</u> 1. If started on amoxicillin 80-90mg/kg/d, shift to co-amoxiclav 90 mg (amoxicillin)/kg/d div q12h PO. 2. If started on co-amoxiclav 80-90 mg/kg/d, admit for IV antibiotics. May also consider adding an oral macrolide. Consider other diagnosis. **<u>PCAP C:*</u>** <u>If with complete Hib vaccination:</u> **Penicillin G** 200,000 u/kg/d div q6 h IV (equal efficacy between oral amoxicillin and IV penicillin if feeding is tolerated) OR **Ampicillin** 200 mg/kg/d div q6h IV <u>If with no Hib vaccination or incomplete or unknown vaccination history:</u> **Ampicillin-Sulbactam** 100 mg/kg/d div q6h IV OR **Cefuroxime** 100 mg/kg/d div q8h IV OR **Ceftriaxone** 100 mg/kg/d div q12 h IV	Switch from IV to oral form 2-3 days after initiation of treatment in patients who are: 1. Responding to initial treatment 2. Able to feed, intact GI absorption 3. Free from pulmonary/extrapulmonary complications Although the total course of therapy is usually 7 to 10 days for uncomplicated pneumonia, longer courses of 2 to 3 weeks may be required for more severe disease (pleural empyema or pulmonary abscesses).

	PCAP D: Refer to Specialist Admit to critical care unit, refer to specialist for antibiotic guidance	
Children (>5 years) and adolescents *S. pneumoniae* *M. pneumoniae* *C. pneumoniae*	**Erythromycin** 50 mg/kg/d div q6-8h PO x10-14d OR **Clarithromycin** suspension 15 mg/kg/d div q12h x 10d OR **Azithromycin** 10 mg/kg once a day PO x 3d or 10 mg/kg/d PO on day 1 then 5mg/kg/d PO on days 2 to 5	Treatment choices are for when atypical pathogens are suspected. Clinical presentation may be indistinguishable from viral pneumonia. Complaints are related to slowly progressive systemic symptoms over 3 to 7 days, with malaise, pharyngitis, and headache, followed by cough that is irritative and nonproductive (lasting for 2-4 weeks). Physical examination may show rales, rhonchi, and wheezes in the context of a child who does not appear ill ("walking pneumonia").

Community-Acquired Pneumonia (CAP) in Adults		
Etiology	**Preferred regimen**	**Comments**
Low-risk CAP Stable Vital signs RR<30/minute PR<125/min SBP>90 mm Hg DBP>60 mm Hg Temp>36°C or <40°C No altered mental state of acute onset No suspected aspiration No or stable co-morbid conditions Chest X ray: localized infiltrates; no evidence of pleural effusion Potential pathogens *Streptococcus pneumoniae* *Haemophilus influenza* *Chlamydophila pneumoniae* *Moraxella catarrhalis* Enteric Gram (-) bacilli (among those	Without comorbid Illness **Amoxicillin** 1 g tid OR **Azithromycin** 500 mg od OR **Clarithromycin** 500 mg bid With stable comorbid illness: **Amoxicillin-clavulanic acid** 1 g bid OR **Cefuroxime axetil** 500 mg bid	If atypical pathogen is suspected, use extended spectrum macrolides such as azithromycin or clarithromycin. The recommendation to use amoxicillin as first-line drug for low-risk CAP in patients with no co-morbid illness is based on the 2014 ARSP data. Fluoroquinolones are not recommended as first line treatment option for low-risk CAP. It is recommended that they be reserved as potential second-line agents for the treatment of pulmonary tuberculosis, particularly for multi-drug resistant tuberculosis.

with co-morbid illness)	**+/-** **Azithromycin*** 500mg od OR **Clarithromycin** 500 mg bid **Duration of therapy:** If covering for *S. pneumoniae*, 5-7d 3-5d if azithromycin for *S. pneumoniae*) 10-14d for *Mycoplasma* and *Chlamydophila* 14-21d for *Legionella*; 10d if azithromycin is used *base, monohydrate or dihydrate	
Moderate-risk CAP Unstable Vital Signs: RR≥30/min PR ≥ 125/min Temp ≤ 36ºC or ≥ 40ºC Altered mental state of acute onset Suspected aspiration Unstable /Decompensated comorbid condition: uncontrolled diabetes mellitus, active malignancies, neurologic disease in evolution, congestive heart failure class II-IV, unstable coronary artery disease, renal failure on dialysis, uncompensated COPD, decompensated liver disease Potential Pathogens *S. pnumoniae* *H. influenza* *Chlamydophila pneumonia* *Mycoplasma pneumoniae* *M. catarrhalis* Enteric Gram (-)bacilli L*egionella pneumophila* Anaerobes (among those with risk of aspiration)	**Ampicillin sulbactam** IV 1.5 g q8h OR **Cefuroxime sodium** IV 1.5 g q8h OR **Ceftriaxone** IV 2 g q24h **PLUS** **Azithromycin** 500 mg PO od OR **Clarithromycin** 500 mg PO bid OR **Levofloxacin** 750 mg PO q24h **Duration of therapy:**[D1] 7-10d may be adequate. However, 14-21d may be needed for those with suspected or confirmed gram (-), *Staphylococcus aureus* or *Pseudomonas aeruginosa* infection.	For those at risk of aspiration, infections with anaerobes should be considered Because of increasing resistance of gram (-)bacilli to fluoroquinolones, monotherapy with fluoroquinolone is not recommended . Azithromycin and fluoroquinolones can cause prolongation of QT interval. Caution should be taken especially in elderly with cardiovascular diseases.
High-risk CAP Any of the clinical feature of Moderate risk CAP plus any of the following: severe sepsis and septic shock or need for mechanical ventilation	No risk for *P. aeruginosa* **Ceftriaxone** IV 2 g q24h OR **Ertapenem** IV 1g q24h	Reserve the use of carbapenems for risk of potential resistant strains such as extended-spectrum beta-lactamase-

Potential Pathogens *S. pnumoniae* *H. influenza* *Chlamydophila pneumonia* *Mycoplasma pneumoniae* *M. catarrhalis* Enteric Gram (-)bacilli L*egionella pneumophila* Anaerobes (among those with risk of aspiration) *S. aureus* *P. aeruginosa*	PLUS **Azithromycin** 500 mg IV q24h OR **Levofloxacin** 750 mg IV q24h With risk for *P. aeruginosa* **Piperacillin-tazobactam** 4.5 g IV q6h OR **Cefepime** 2 g IV q8h OR **Meropenem** 1g IV q8h PLUS **Azithromycin** 500 mg IV OD PLUS **Amikacin** 15 mg/kg q24h; **OR** **Piperacillin-tazobactam** 4.5 g IV q6h OR **Cefipime** 2 g IV q8h OR **Meropenem** 1g IV q8h PLUS **Ciprofloxacin** 400 mg IV q8-12h OR **Levofloxacin** 750 mg IV OD (high dose)	proucing strains (e.g., prior use of 3rd generation cephalosporins, fluoroquinolones) For hospitalized patients with severe community-acquired pneumonia defined by one of the following: 1) requirement for intensive care unit 2) necrotizing or cavitary infiltrates 3) empyema, empiric therapy for MRSA is recommended pending sputum and/or blood culture results. Treatment should be modified according to culture/sensitivity results once available. Aminoglycosides may cause nephrotoxicity.
Methicillin-resistant *S. aureus* (MRSA) pneumonia	**Vancomycin** 15 mg/kg q8-12h OR **Linezolid** 600 mg IV BID OR **Clindamycin** 600 mg IV q8h	Use of Linezolid or clindamycin monotherapy for MRSA bacteremia, even if associated with a pulmonary source, is not recommended.

	Duration of therapy: 7-10d may be adequate. However, 14-21d may be needed for those with suspected or confirmed gram (-), *S. aureus* or *P. aeruginosa* infection.	
Empyema		
Etiology	**Preferred regimen**	**Comments**
Acute Empyema *Staphylococcus aureus* *Streptococcus pneumoniae* *S. pyogenes*	**Pedia:** **FIRST LINE:** **Clindamycin** 25-40 mg/kg/d div q6-8h IV PLUS **Ceftriaxone** 50-100 mg/kg/dose q24h IV infusion over 10-30 min **SECOND LINE:** **Vancomycin** 40 mg/kg/d div q6h IV PLUS **Ampicillin-sulbactam** 100 mg/kg/d div q6h IV OR **Vancomycin** 40mg/kg/d div q6h IV PLUS **Ceftriaxone** 50-100mg/kg/dose q24h IV infusion over 10-30 min PLUS **Metronidazole** 30 mg/kg/d div q 6 h IV [JJ2] **Adult:** Treatment should depend on culture and sensitivity results.	Treatment includes systemic antibiotic and drainage. Treatment should be guided by culture results.
Chronic Empyema	No antibiotics are recommended. Refer to specialist.	Rule out the possibility of tuberculosis.

Lung abscess		
Etiology	**Preferred regimen**	**Comments**
Staphylococcus aureus *Streptococcus pneumoniae* Anaerobes of the upper respiratory tract	**Pedia:** **FIRST LINE:** **Clindamycin** 25-40 mg/kg/d div q6-8h IV PLUS	Treatment duration is for 4-6 weeks. Do surgical intervention if with failure to improve after 7d of appropriate antibiotics.

	Ceftriaxone 50-100 mg/kg/dose q24h IV infusion over 10-30 min **SECOND LINE:** **Vancomycin** 40mg/kg/d div q6h IV PLUS **Ceftriaxone** 50-100mg/kg/dose q24h IV infusion over 10-30 min PLUS **Metronidazole** 30 mg/kg/d div q 6 h IV **Adults:** **Clindamycin** 600mg IV q8h OR **Ampicillin-Sulbactam** 3 g IV q6h OR **Ceftriaxone** 2 g IV q24h plus **Metronidazole** 500 mg IV q6h or 1 g IV q12h OR **Piperacillin + tazobactam** 4.5 g IV q8h (for mixed infections with resistant Gram-negative aerobes)	

CAP with concomitant/post-influenza		
Etiology	**Preferred regimen**	**Comments**
Staphylococcus aureus *Streptococcus pneumoniae*	**Adults:** Refer to recommendations for CAP in adults and ADD: **Vancomycin** 15 mg/kg q8-12h OR **Linezolid** 600 mg IV bid	Use of linezolid monotherapy for methicillin-resistant *S. aureus* bacteremia, even if associated with a pulmonary source, is not recommended.

Healthcare-associated pneumonia (HCAP), Hospital-acquired pneumonia (HAP) and Ventilator-associated pneumonia (VAP) in Pediatrics		
Etiology	**Preferred regimen**	**Comments**

Pseudomonas aeruginosa *Acinetobacter baumanii* *Klebsiella pneumoniae* *Klebsiella spp.* *Escherichia coli* *Enterobacter spp.* *Proteus spp.* *Serratia marcescens* **Multi-drug resistant (MDR) pathogens:** *P. aeruginosa* *K. pneumonia* (extended spectrum beta-lactamase- and carbapanemase - producing *Klebsiella* strains) *Acinetobacter spp* *Stenotrophomonas maltophilia* *Burkholderiacepacia* Methicillin-resistant *S. aureus* Viral and fungal pathogens in immunocompromised hosts (patients on chronic immunosuppresants, solid organ and bone marrow transplant recipients)	**Ceftazidime** 100-150 mg/kg/d div q 8 h IV infusion over 15-30 minutes **PLUS** **Aminoglycoside** **Amikacin** 15 mg/kg/d once day IV OR **Gentamicin** 5 mg/kg/d once a day IV	Choice should be based on current antimicrobial susceptibility pattern in the institution. The recommendations for emperic therapy here are based on national resistance rates. If *S. aureus* is suspected, add vancomycin. For infections with MDR Gram (-) bacilli that are highly resistant to several classes of antimicrobial agents, referral to a specialist is warranted. **Risk factors for MDR pathogens:** • Prior antibiotic use within the preceding 90 days • High frequency of antibiotic resistance in the community or hospital • Presence of HAP risk factors • Duration of ICU stay • Mechanical ventilation • Immunocompromised state

Hospital-acquired pneumonia (HAP) in Adults		
Etiology	**Preferred regimen**	**Comments**
Early-onset: < 5 days in the hospital, no other risk factors for multidrug resistant (MDR) organisms Etiologies: *Streptococcus pneumoniae* *Staphylococcus aureus* *Haemophilus influenza* Enteric Gram (-) bacilli	**FIRST LINE:** **Ceftriaxone** 2 g IV q24h OR **Ampicillin-sulbactam** 3 g IV q6h **SECOND LINE:** **Ertapenem** 1 g IV q24h	Duration of therapy is not well defined.For relatively susceptible pathogens, treat for 8 days. For *S. aureus*, MRSA in particular, or more resistant organisms (e.g., *Pseudomonas, Acinetobacter*, *Stenotrophomonas*) treat for longer, e.g., 14 days.
Late onset: ≥ 5 days in the hospital, risk factors of MDR organisms present Etiologies: *S. aureus* (often methicillin-resistant [MRSA]) Gram (-) enteric pathogens (often MDR)	**FIRST LINE:** **Piperacillin–tazobactam** 4.5 g q6-8h OR **Cefepime** 2 g IV q12h	Risk factors for MDR: • Antibiotic therapy in preceding 90 days • Current hospitalization for 5 days or more • High frequency of antibiotic resistance in the community or in the specific hospital unit • Presence of risk factors for HCAP

Escherichia coli *Klebsiella spp.* *Enterobacter spp.* *Serratia marcescens* *Acinetobacter baumannii*	**SECOND LINE:** **Meropenem** 1 g IV q8h If MRSA is suspected, add **Vancomycin** 15-20 mg/kg q 8-12 h; If *Legionella* is suspected, add **Levofloxacin** or **Azithromycin** to a beta-lactam regimen	• Immunosuppressive disease and/or therapy The empiric regimen of choice may vary based on local prevalence and susceptibility of pathogens, known prior colonization with multidrug-resistant organisms, prior treatment history, severity of illness. The 2014 ARSP Report showed increasing resistance to carbapenem-resistant Enterobacteriaceae; hence, judicious use of carbapenems is encouraged to maintain its efficacy.

Ventilator-associated pneumonia (VAP) in Adults[D3]

Clinical Setting:

Onset of pneumonia ≥ 48 hours of mechanical ventilation.

Diagnostic criteria for VAP:

Clinical suspicion and presence of new or progressive pulmonary infiltrates on chest radiograph PLUS two of the following:

- Fever
- Peripheral leukocytosis
- Purulent tracheal secretions

	Preferred regimen	**Comments**
Mild to Moderate Illness < 5 days of hospitalization, low risk for infection with multidrug-resistant (MDR) organism	**FIRST LINE:** Ceftriaxone 2 g q24h OR Ampicillin-sulbactam 3 g IV q6h **SECOND LINE:** Ertapenem 1 gm IV q24h Add Vancomycin 15-20 mg/kg q 8-12 h if methicillin-resistant *Staphylococcus aureus* is suspected	Culture and gram strain of tracheal aspirate or lavage fluid should be performed in all cases of suspected VAP. De-escalate therapy to treat specific pathogen(s) based on results of culture and susceptibility tests. Discontinue MRSA coverage if no MRSA was isolated from respiratory cultures, if obtained, or if nasal swab or throat cultures show no growth of MRSA. Empiric regimen of choice may vary based on local prevalence and susceptibility of pathogens, known prior colonization with MDR organisms, prior treatment history, severity of illness.
More Severe Disease (i.e., sepsis, hypotension, rapid progression of infiltrates on chest radiograph or ≥ 5d of hospitalization or high risk of infection with MDR organisms)	**Piperacillin–tazobactam** 4.5 g q6-8h OR **Cefepime** 2 g IV q8-12h	Ventilator-associated pneumonia – Prevention: Keep head of bed elevated 30° or more. Remove Nasogastric, endotracheal tubes as soon as possible. If available, continuous subglottic suctioning. Chlorhexidine oral care.

	OR **Meropenem** 1 g IV every 8 hour If MRSA is suspected, add **Vancomycin** 15-20 mg/kg q 8-12 h; If *Legionella* is suspected, add **Levofloxacin** or **Azithromycin** to a beta-lactam regimen	Reserve the use of carbapenems for risk of potential resistant strains such as extended-spectrum beta-lactamase-proucing strains (e.g., prior use of 3rd generation cephalosporins, fluoroquinolones)

Healthcare-associated pneumonia (HCAP) in Adults		
Etiology	**Preferred regimen**	**Comments**
S. aureus (often methicillin-resistant [MRSA]) Gram (-) enteric pathogens (often MDR) *Escherichia coli* *Klebsiella spp.* *Enterobacter spp.* *Serratia marcescens* *Acinetobacter baumannii* *Pseudomonas aeruginosa*	**Cefepime** 2 g IV q12h OR **Piperacillin-Tazobactam** 4.5 g q6-8h OR **Meropenem** 1 g q8h If MRSA is suspected, add **Vancomycin** 15-20 mg/kg IV q8-12h	Risk factors for HCAP: • Hospitalized in an acute care hospital for > 48h within 90d of the diagnosis • Resided in a nursing home or long-term care facility • Home infusion therapy including antibiotics • Chronic hemodialysis clinic within 30 d • Home wound care • Family member with MDR pathogen