Trimethoprim-sulfamethoxazole also has good tissue penetration and is a viable treatment option. Treatment duration is typically 2 to 4 weeks (for further information, see MKSAP 19 General Internal Medicine 2). Hospitalized patients should initially receive a broad-spectrum parenteral antibiotic, such as an extended-spectrum penicillin or cephalosporin, with the possible addition of an aminoglycoside. Imaging studies are not recommended unless a prostatic abscess is suspected.

KEY POINTS

- Gram-negative uropathogens account for about 80% of acute prostatitis infections; in men 35 years or younger, sexually transmitted infections, including *Neisseria gonorrhoeae* and *Chlamydia trachomatis*, must be considered.
- Fluoroquinolone antibiotics for 2 to 4 weeks are the preferred oral agents for treating acute bacterial prostatitis but should not be used if recent genitourinary instrumentation was performed because most *E. coli* strains are resistant to fluoroquinolones.

Mycobacterium tuberculosis Infection

Epidemiology

Tuberculosis remains one of the most common causes of death from an infectious disease worldwide. Rates of *Mycobacterium tuberculosis* infection remain relatively low in North America. However, approximately one quarter of the world's population is infected with the bacteria. As of 2018, approximately 10 million new *M. tuberculosis* infections are reported each year throughout the world, and approximately 1.6 million deaths are documented each year. More than 5000 people per day die of tuberculosis throughout the world. More than 60% of infections are reported from Southeast Asia, India, China, Micronesia, Russia, and sub-Saharan Africa. Multidrug-resistant tuberculosis (MDR-TB) accounts for 4.6% of new infections and 20% of relapsed infections. Extensively drug-resistant tuberculosis (XDR-TB) accounts for approximately 10% of all MDR-TB infections worldwide. In 2018, 9025 tuberculosis infections were reported in the United States (2.8 per 100,000 persons). Infections in the United States occur 15 times more frequently in foreign-born persons than in U.S.-born persons; however, others at high risk include those with alcohol use disorder, urban poor, homeless persons, persons who inject drugs, prison inmates, persons living in shelters, persons with HIV, and older adults.

The burden of disease throughout the world and the rate of travel from country to country ensures a steady stream of active tuberculosis cases in the United States.

KEY POINTS

- Most *Mycobacterium tuberculosis* infections in the United States occur in foreign-born persons; however, others at high risk include those with alcohol use disorder, urban poor, homeless persons, persons who inject drugs, prison inmates, persons living in shelters, persons with HIV, and older adults.
- Multidrug-resistant tuberculosis (MDR-TB) accounts for 4.6% of new infections and 20% of relapsed infections; extensively drug-resistant tuberculosis accounts for approximately 10% of all MDR-TB infections worldwide.

Pathophysiology

Most persons who become infected with *M. tuberculosis* remain asymptomatic and develop latent tuberculosis. Specific risk factors for developing active tuberculosis among infected persons are shown in **Table 18**.

KEY POINTS

- Most persons who become infected with *Mycobacterium tuberculosis* remain asymptomatic and develop latent tuberculosis.
- Risk factors for developing active tuberculosis include recent infection, pulmonary fibrotic lesions, malnutrition, and comorbidities such as immunosuppression, tumor necrosis factor-α inhibitors, injection drug use, silicosis, chronic kidney disease, and diabetes mellitus.

Clinical Manifestations

Tuberculosis is classified as pulmonary, extrapulmonary, or both; the two main forms are primary and secondary tuberculosis. Primary tuberculosis occurs soon after the initial

TABLE 18. Risk Factors for Developing Active *Mycobacterium tuberculosis*

Recent infection (<1 year)
Pulmonary fibrotic lesions
Malnutrition
Comorbidities
HIV infection
Silicosis
Chronic kidney disease
Diabetes mellitus
Injection drug use
Immunosuppressive therapy
Jejunoileal bypass
Solid organ transplantation
Tumor necrosis factor-α inhibitors
Head and neck cancer

infection, most frequently in children and immunosuppressed persons. Often, the lesions heal spontaneously. Secondary or reactivation tuberculosis results from endogenous reactivation of a latent infection. Most cases of active tuberculosis are caused by reactivation of latent tuberculosis in the setting of immunosuppression. Seventy-five percent of secondary infections are pulmonary, except in those infected with HIV, in whom two thirds of patients have pulmonary and extrapulmonary infection.

Frequent manifestations of active infection include fever, night sweats, weight loss, productive cough (occasionally blood tinged), anorexia, malaise, and pleuritic chest pain. Hemoptysis occurs in 10% to 20% of patients with positive acid-fast bacilli (AFB) smear results. In immunosuppressed patients, the infection may also spread hematogenously, producing miliary (progressive, widely disseminated) tuberculosis, which can result in a systemic inflammatory response syndrome, septic shock, and ultimately death if not diagnosed and treated early. Additionally, patients with disseminated infection may present with atypical clinical manifestations and chest radiographs. Extrapulmonary disease may be the result of hematogenous dissemination and may be seen in up to 30% of patients with active tuberculosis. It may involve almost any organ system, including the pleura, lymph nodes, central nervous system, skeletal system, pericardium, larynx, peritoneum, and genitourinary system.

KEY POINTS

- Clinical manifestations of active tuberculosis include fever, night sweats, weight loss, productive cough (occasionally blood tinged), anorexia, malaise, and pleuritic chest pain.
- In immunosuppressed patients, tuberculosis infection may spread hematogenously, resulting in widely disseminated progressive tuberculosis, which can result in a systemic inflammatory response syndrome, septic shock, and ultimately death if not treated early.

Diagnosis

The key to the diagnosis of tuberculosis is a high index of suspicion in patients at high risk.

Diagnosis of Latent Tuberculosis Infection

The goal of diagnosing latent tuberculosis infection (LTBI) is to identify and treat persons at increased risk for reactivation tuberculosis. The lifetime risk of developing active infection in patients with LTBI is 5% to 10%, with half of active disease manifesting within 2 years of infection. The risk of developing active tuberculosis is considerably higher in patients who are immunocompromised. The estimated global frequency of LTBI is about 25%. Testing methods include interferon-γ release assay (IGRA) performed on a blood sample or tuberculin skin testing (TST). LTBI is diagnosed when an asymptomatic patient has a positive TST or IGRA result with no clinical or radiographic manifestations of active tuberculosis.

The CDC recommends performing an IGRA rather than a TST in persons 5 years or older who are likely to have *M. tuberculosis* infection, have a low or intermediate risk of disease progression, have a history of bacille Calmette-Guérin (BCG) vaccination, or are unlikely to return to have their TST result interpreted. IGRAs are in vitro assays that measure T-cell release of interferon-γ in response to stimulation with highly tuberculosis-specific antigens ESAT-6 and CFP-10 (QuantiFERON-TB Gold In-Tube and T-SPOT.TB test). IGRAs are more specific than TST because they have less cross-reactivity resulting from BCG vaccination and sensitization by nontuberculous mycobacteria. Although not used to diagnose active tuberculosis, IGRAs appear to be at least as sensitive as TST in patients with active tuberculosis.

TST has become the alternative diagnostic test if IGRA is not feasible or available. The purified protein derivative is injected intradermally and interpreted after 48 to 72 hours by measuring the transverse diameter of induration, not erythema. The criteria for a positive TST result are based on the patient's risk factors for tuberculosis (**Table 19**). A

TABLE 19. Interpretation of Tuberculin Skin Test Results

Criteria for Tuberculin Positivity by Risk Group		
≥5 mm Induration	**≥10 mm Induration**	**≥15 mm Induration**
HIV-positive persons	Recent (<5 years) arrivals from high-prevalence countries	All others with no risk factors for TB
Recent contacts of persons with active TB	Persons who inject drugs	
Persons with fibrotic changes on chest radiograph consistent with old TB	Residents or employees of high-risk congregate settings: prisons and jails, nursing homes and other long-term facilities for the elderly, hospitals and other health care facilities, residential facilities for patients with AIDS, homeless shelters	
Patients with organ transplants and other immunosuppressive conditions (receiving the equivalent of ≥15 mg/d of prednisone for >4 weeks)	Mycobacteriology laboratory personnel; persons with clinical conditions that put them at high risk for active disease (silicosis, diabetes mellitus, severe kidney disease, certain types of cancer, some intestinal conditions); children aged <4 years or exposed to adults in high-risk categories	

TB = tuberculosis infection.

false-negative TST result may occur in patients with recent tuberculosis infection, overwhelming active tuberculosis infection, recent viral infections, or severe immunocompromise (e.g., AIDS) and in those younger than 6 years. Patients with remote exposure to *M. tuberculosis* may initially have a negative TST result that can become positive several weeks later after a second TST, known as the "booster effect." The second test is recommended in health care workers 7 to 21 days after initial testing and should be performed on the opposite forearm; it is not required if IGRA is used. IGRAs are recommended in nearly all clinical settings in which TST is recommended; one exception is children younger than 5 years, for whom experts recommend both tests to increase specificity.

Recent guidelines by the CDC do not recommend annual tuberculosis testing for health care personnel unless a known exposure or ongoing transmission is identified in the facility.

KEY POINTS

HVC

- An interferon-γ release assay is preferred to tuberculin skin testing for *Mycobacterium tuberculosis* except for those younger than 5 years.
- Latent tuberculosis infection is diagnosed when an asymptomatic patient has a positive tuberculin skin test or interferon-γ release assay result with no clinical or radiographic manifestations of active tuberculosis.

Diagnosis of Active Tuberculosis Infection

The CDC recommends AFB smear microscopy in all patients suspected of having active pulmonary tuberculosis. In vitro fluorescence microscopy of sputum is the preferred methodology. Testing three specimens is highly recommended because false-negative results from a single specimen are not uncommon. However, false-positive results are also not uncommon, thus a positive smear result requires mycobacterial culture confirmation. At least 3 mL of sputum should be submitted, although 5 to 10 mL is preferred. Serial specimens must be obtained at least 8 hours apart, and one must be an early morning specimen. Sputum induction is preferable to bronchoscopy as the sample methodology because of its greater sensitivity in patients who are unable to expectorate sputum.

The gold standard for diagnosis of active infection remains the mycobacterial culture. Whether AFB staining results are positive or negative, liquid and solid cultures should be performed for every specimen obtained. Liquid culture allows for faster growth and more rapid identification of organisms (2-4 weeks).

When a sputum smear result is positive for AFB, nucleic acid amplification testing (NAAT) for *M. tuberculosis* is highly recommended to verify the organism. The positive predictive value of a NAAT on a smear-positive sputum sample is 95%. In patients with an intermediate to high level of suspicion for active disease who have a negative smear, the NAAT result will be positive in 65% of persons. If available, a NAAT assay that also detects rifampin resistance is recommended for timely identification. Although the NAAT assays are quick and sensitive, mycobacterial cultures are still recommended so that in vitro susceptibilities can be obtained. A negative NAAT result cannot be used to exclude pulmonary tuberculosis; however, NAAT can confirm the presence of *M. tuberculosis* in 50% to 80% of AFB smear-negative, culture-positive specimens. Moreover, NAAT can facilitate earlier decision making regarding whether to initiate tuberculosis therapy.

If signs of extrapulmonary infection are present, samples from those areas should be obtained and sent for AFB stain, mycobacterial culture, and histopathology. Histopathology may be beneficial by demonstrating caseating granulomas, which are suggestive for but not exclusive to or diagnostic of tuberculosis. In disseminated tuberculosis, blood cultures for mycobacteria using isolator methodology are helpful.

KEY POINTS

- The gold standard for the diagnosis of active *Mycobacterium tuberculosis* infection remains the mycobacterial culture; when a sputum smear result is positive for acid-fast bacilli, nucleic acid amplification testing is highly recommended to verify the presence of *M. tuberculosis*.
- If signs of extrapulmonary tuberculosis infection are present, samples from those areas should be obtained and sent for acid-fast bacilli staining, mycobacterial culture, and histopathology.

Radiographic Findings

The classic radiographic finding in pulmonary tuberculosis is that of upper lobe disease with air space disease and cavities (**Figure 17**). However, any radiographic pattern can be seen.

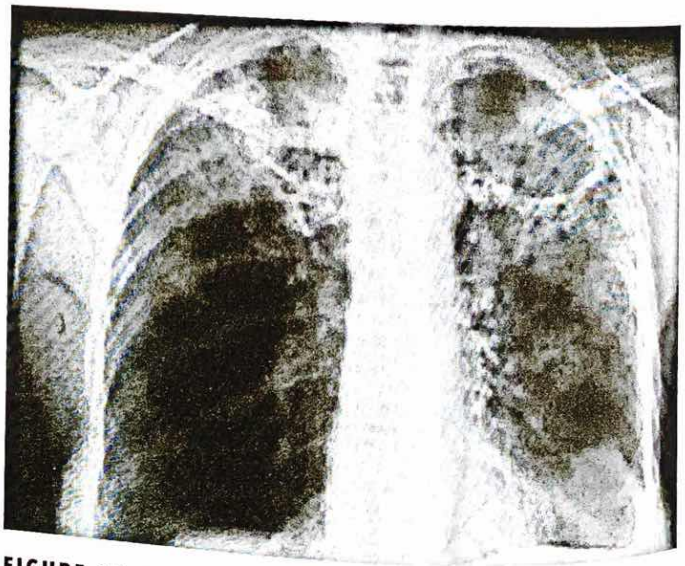

FIGURE 17. Posteroanterior (PA) chest radiograph of a patient with reactivation tuberculosis showing bilateral upper lobe cavitary infiltrates. A left pleural effusion is also present.

Management

When suitable antimicrobial therapy is administered and taken appropriately, clinical trials demonstrate clinical and microbiologic cure rates of approximately 95%. Therapy depends on several factors, including the classification of infection (latent versus active), pulmonary versus extrapulmonary infection, and patient adherence.

Treatment of Latent Tuberculosis

All patients who have a positive IGRA or a positive TST should be evaluated for active disease, with a full medical history, physical examination, and chest radiography, and be screened for HIV infection. If no sign of active infection is present, all patients should be offered treatment for LTBI. The 2020 CDC guidelines include five different treatment regimens (**Table 20**). Pyridoxine is recommended in patients who will receive isoniazid and are at risk for peripheral neuropathy (diabetes mellitus, chronic kidney disease, malnutrition, HIV infection, and alcoholism). Baseline and monthly monitoring of liver chemistry tests are not routinely required unless patients are at risk for hepatotoxicity (HIV, chronic hepatitis B or C infections, alcohol abuse, pregnancy, concurrent hepatotoxic drugs, or underlying liver disease).

In pregnant women with LTBI, a 6- to 9-month regimen of isoniazid plus pyridoxine may be offered; however, some experts prefer to defer therapy until after delivery, unless the patient is at high risk of developing active infection owing to immunocompromise, including HIV infection.

KEY POINTS

- All patients with latent tuberculosis should be screened for HIV infection.
- Recommended treatment regimens for latent tuberculosis infection include isoniazid plus rifapentine once weekly for 3 months, rifampin daily for 4 months, or isoniazid plus rifampin daily for 3 months.

Treatment of Active Tuberculosis

When active tuberculosis is verified, in vitro susceptibility testing of the initial isolate should be done for the first-line

TABLE 20. Treatment Regimens for Latent Tuberculosis Infection

Priority Rank[a]	Regimen	Frequency	Duration	Dose[b]	Total Doses
Preferred	Isoniazid plus rifapentine[c]	Once weekly, directly observed therapy	3 months	Isoniazid[d]: 15 mg/kg rounded up to the nearest 50 or 100 mg; 900 mg maximum Rifapentine[e]: 10.0-14.0 kg: 300 mg 14.1-25.0 kg: 450 mg 25.1-32.0 kg: 600 mg 32.1-49.9 kg: 750 mg ≥50.0 kg: 900 mg maximum	12
Preferred	Rifampin[f]	Daily	4 months	10 mg/kg Maximum dose: 600 mg	120
Preferred	Isoniazid plus rifampin[c]	Daily	3 months	Isoniazid[d]: 5 mg/kg; 300 mg maximum Rifampin: 10 mg/kg; 600 mg maximum	90
Alternative[g]	Isoniazid[c]	Daily	6 months	5 mg/kg[d] Maximum dose: 300 mg	180
Alternative	Isoniazid[c]	Daily	9 months	5 mg/kg[d] Maximum dose: 300 mg	270

[a]*Preferred*: excellent tolerability and efficacy; shorter treatment duration; higher completion rates than longer regimens, and therefore higher effectiveness. *Alternative*: excellent efficacy but concerns regarding longer treatment duration; lower completion rates, and therefore lower effectiveness.

[b]Doses listed are for adults.

[c]Including HIV-positive persons, as drug interactions allow.

[d]Isoniazid is formulated as 100-mg and 300-mg tablets.

[e]Rifapentine is formulated as 150-mg tablets in blister packs that should be kept sealed until use.

[f]No evidence reported in HIV-positive persons.

[g]Strong recommendation for those persons unable to take a preferred regimen (e.g., because of drug intolerability or drug-drug interactions).

Recommendations from Sterling TR, Njie G, Zenner D, et al. Guidelines for the treatment of latent tuberculosis infection: recommendations from the National Tuberculosis Controllers Association and CDC, 2020. MMWR Recomm Rep. 2020;69:1-11. [PMID: 32053584] doi:10.15585/mmwr.rr6901a1

TABLE 21. Antituberculous Drugs

Agent	Adverse Effects	Notes
First-Line Medications		
Isoniazid	Rash; liver enzyme elevation; hepatitis; peripheral neuropathy; lupus-like syndrome	Hepatitis risk increases with age and alcohol consumption. Pyridoxine may prevent peripheral neuropathy. Adjust for kidney injury.
Pyrazinamide	Hepatitis; rash; GI upset; hyperuricemia	May make glucose control more difficult in patients with diabetes. Adjust for kidney injury.
Rifampin	Hepatitis; rash; GI upset	Contraindicated or used with caution when administered with protease inhibitors and nonnucleoside reverse transcriptase inhibitors. Do not administer to patients also taking saquinavir/ritonavir. Colors body fluids orange.
Rifabutin	Rash; hepatitis; thrombocytopenia; severe arthralgia; uveitis; leukopenia	Dose adjustment required if taken with protease inhibitors or nonnucleoside reverse transcriptase inhibitors. Monitor for decreased antiretroviral activity and for rifabutin toxicity.
Rifapentine	Similar to rifampin	Contraindicated in patients who are HIV positive (unacceptable rate of failure/relapse).
Ethambutol	Optic neuritis; rash	Baseline and periodic tests of visual acuity and color vision. Patients are advised to call immediately if visual acuity or color vision changes. Adjust for kidney injury.
Second-Line Medications[a]		
Streptomycin	Auditory, vestibular, and kidney toxicity	Avoid or reduce dose in adults >59 years. Monitor hearing and kidney function. Adjust dose depending on kidney function.
Cycloserine	Psychosis; convulsions; depression; headaches; rash; drug interactions	Pyridoxine may decrease CNS adverse effects. Measure drug serum levels.
Capreomycin	Kidney, vestibular, and auditory toxicity	Monitor hearing and kidney function. Adjust dose depending on kidney function.
Ethionamide	GI upset; hepatotoxicity; hypersensitivity	May cause hypothyroidism.
Kanamycin and amikacin	Auditory, vestibular, and kidney toxicity	Not approved by the FDA for TB treatment. Monitor vestibular, hearing, and kidney function.
Levofloxacin, moxifloxacin	GI upset; dizziness; hypersensitivity; drug interactions	Not approved by the FDA for TB treatment. Should not be used in children.
Para-aminosalicylic acid	GI upset; hypersensitivity; hepatotoxicity	May cause hypothyroidism, especially if used with ethionamide. Measure liver enzyme levels.
Bedaquiline	Nausea; joint pain; headache; elevated aminotransferase levels; hemoptysis; prolonged QT interval	FDA-approved oral agent for MDR pulmonary TB treatment; indicated for combination therapy when other alternatives are not available. Novel mechanism of action inhibits mycobacterial adenosine triphosphate synthase. Should be given as directly observed therapy.
Pretomanid	Peripheral neuropathy; anemia; GI upset; elevated liver enzyme levels; headache; hypoglycemia; rash; hyperamylasemia; visual impairment; diarrhea	FDA-approved nitroimidazole, a novel oral agent, for XDR-TB or nonresponsive MDR-TB in combination with bedaquiline and linezolid.

CNS = central nervous system; GI = gastrointestinal; MDR = multidrug resistant; TB = tuberculosis; XDR = extensively drug resistant.

[a]Use these drugs in consultation with a clinician experienced in the management of drug-resistant TB.

agents (isoniazid, rifampin, pyrazinamide, and ethambutol). This becomes increasingly important because of the advent of MDR and XDR tuberculosis. If rifampin resistance has been detected during NAAT assessment, in vitro susceptibilities to first-line and second-line agents should be performed (**Table 21**).

The American Thoracic Society/CDC guidelines published in 2016 recommend 6 to 9 months of treatment in patients with drug-susceptible active tuberculosis. A four-drug regimen is given daily for 2 months, followed by a continuation phase of isoniazid plus rifampin daily, usually for 4 months (**Table 22**).

Directly observed therapy, generally through the local health department, must be used when treatment is administered less than 7 days per week. Sputum specimens should be evaluated at 1- and 2-month intervals to assess for efficacy. In addition, clinical assessment and laboratory testing (complete blood count, liver chemistry

TABLE 22. Preferred [illegible] Regimens for Active Tuberculosis

Treatment Phase	Regimen	Comments
Initial	Daily INH, RIF, PZA, and EMB[a] for 56 doses (8 wk) *or*	Alternative regimens available at https://www.cdc.gov/tb/topic/treatment/tbdisease.htm
	DOT 5 d/wk for 40 doses (8 wk)	DOT should be used when medications are administered less than 7 d/wk.
		Pyridoxine 25-50 mg/d is given to all patients at risk for neuropathy[b]; 100 mg/d for patients with peripheral neuropathy.
Continuation	INH and RIF 7 d/wk for 126 doses (18 wk) *or*	Based on expert opinion, patients with cavitation on the initial chest radiograph and positive cultures at completion of 2 months of therapy should receive a 7-month (31-wk) continuation phase.
	DOT 5 d/wk for 90 doses (18 wk)	

DOT = directly observed therapy; EMB = ethambutol; INH = isoniazid; PZA = pyrazinamide; RIF = rifampin.

[a]EMB can be discontinued if drug susceptibility studies demonstrate susceptibility to first-line drugs.

[b]Pregnant women; breastfeeding infants; persons with HIV; patients with diabetes, alcoholism, malnutrition, or chronic kidney disease; patients of advanced age.

Recommendations from the Centers for Disease Control and Prevention. Tuberculosis. Treatment for TB disease. TB Regimens for Drug-Susceptible TB. Available at www.cdc.gov/tb/topic/treatment/tbdisease.htm. Accessed January 26, 2021.

testing, hepatitis serology) should be performed before initiating therapy.

It is essential to advise the patient of the possible adverse effect profiles of the various medications (see Table 21). In several studies, approximately 15% to 25% of patients receiving the four-drug regimen experienced some type of adverse effect. Most adverse effects are mild, and therapy may be continued; up to 15% are severe enough that therapy must be discontinued temporarily. If a hypersensitivity reaction is observed, then all four drugs should be discontinued with sequential rechallenging to determine the cause.

KEY POINTS

- Directly observed therapy is recommended for active tuberculosis treatment regimens when medication is administered less than 7 days per week.
- American Thoracic Society/CDC guidelines recommend 6 to 9 months of treatment in patients with drug-susceptible active tuberculosis; a four-drug regimen is given daily for 2 months, followed by a continuation phase of isoniazid plus rifampin daily, usually for 4 months.

Drug-Resistant Tuberculosis

M. tuberculosis resistance to individual drugs arises by spontaneous point mutations. Depending on the resistance, the regimen must be altered. In isoniazid-resistant tuberculosis, the recommended regimen of rifampin, ethambutol, and pyrazinamide can be safely administered for 6 months, although adding a later generation fluoroquinolone to the regimen is recommended. In those with isoniazid- and rifampin-resistant tuberculosis (MDR-TB), experts agree that a five-drug regimen guided by susceptibility of the isolate should be provided for 5 to 7 months, followed by a four-drug regimen for a total treatment duration of 15 to 21 months after conversion (see Table 21).

KEY POINT

- In patients with multidrug-resistant tuberculosis (resistant to isoniazid and rifampin), experts agree that at least a five-drug regimen should be provided for 5 to 7 months after culture conversion (intensive-phase of treatment), followed by a four-drug regimen for a total treatment duration of 15 to 21 months (continuation phase).

Immune Reconstitution Inflammatory Syndrome in Tuberculosis and HIV

Tuberculosis in patients with HIV infection may be complicated by immune reconstitution inflammatory syndrome. Although the general recommendations for treatment are the same, antiretroviral therapy should be initiated within 2 weeks for patients with a CD4 cell count less than 50/μL and by 8 to 12 weeks for those with CD4 cell counts of 50/μL or more. An exception is HIV-positive patients with tuberculous meningitis, in whom antiretroviral therapy should not be initiated during the first 8 weeks of tuberculosis therapy regardless of the CD4 cell count to avoid increased morbidity because of immune reconstitution inflammatory syndrome.

KEY POINT

- Tuberculosis in patients with HIV infection may be complicated by immune reconstitution inflammatory syndrome, and antiretroviral therapy initiation should be delayed to prevent this occurrence.

Tumor Necrosis Factor Antagonist and Tuberculosis

Patients being treated with a tumor necrosis factor inhibitor (such as infliximab, etanercept, adalimumab, or certolizumab) have been reported to have an increased risk of reactivation tuberculosis and death from disseminated disease. It is recommended that these patients be evaluated for active or latent

tuberculosis by performing chest radiography and simultaneous TST or IGRA before beginning this therapy. All patients should receive treatment for tuberculosis (LTBI or active) if identified, although LTBI treatment does not eliminate risk for active mycobacterial infection in this population.

KEY POINT

- Before initiating treatment with tumor necrosis factor inhibitors, all patients should be screened for active or latent tuberculosis; those diagnosed should receive tuberculosis treatment to reduce the risk of reactivation and death from disseminated disease.

Prevention

From the public health perspective, the best way to prevent tuberculosis is to diagnose, isolate, and treat infection rapidly until patients are considered noncontagious and the disease is cured. In hospitalized patients with suspected or documented tuberculosis, airborne precautions should be implemented.

CDC guidelines recommend criteria to determine if a patient is no longer contagious and a possible public health threat. These include appropriate antimicrobial therapy for at least 2 weeks, clinical improvement of signs and symptoms, and three negative sputum smears collected at least 8 hours apart, with one being an early-morning specimen. Patients with negative smear results are less contagious, although they may still have tuberculosis.

KEY POINT

- Guidelines for determining a patient with tuberculosis is no longer contagious include appropriate antimicrobial therapy for at least 2 weeks, clinical improvement in signs and symptoms, and three negative sputum smears collected at least 8 hours apart.

Nontuberculous Mycobacterial Infections

Nontuberculous mycobacteria (NTM) comprise species other than *Mycobacterium tuberculosis* complex and *Mycobacterium leprae*. NTM are divided into slow and rapid growers (**Table 23**). These organisms are found in water, soil, domestic and wild animals, milk, and food products. They can be colonizers, particularly in the airways of persons with chronic lung disease, and cause a spectrum of infections (**Table 24**).

Risk factors for NTM infections include immunocompromise, chronic lung disease, and postoperative status.

NTM diagnosis is difficult because a positive culture result from a nonsterile site without evidence of disease may reflect colonization rather than infection. However, when recovered from a sterile site, active infection is likely. Because antibiotic susceptibility among species varies, it is important to identify

TABLE 23. Classification of Common Nontuberculous Mycobacteria

Slow-Growing Mycobacteria
M. kansasii
M. marinum
M. gordonae
M. scrofulaceum
M. avium complex (including *M. chimaera*)
M. ulcerans
M. xenopi
M. simiae
M. malmoense
M. szulgai
M. asiaticum
Rapidly Growing Mycobacteria
M. abscessus
M. chelonae
M. fortuitum

organisms to species level. American Thoracic Society (ATS) guidelines (updated in 2020) recommend fulfillment of clinical, radiologic, and microbiologic criteria to diagnose an NTM pulmonary infection. Treatment is recommended for patients meeting diagnostic criteria, especially if acid-fast sputum smears are positive and/or cavitary lung disease is present. Most NTM infections require prolonged treatment with multiple antimicrobials; susceptibilities and ATS guidelines should be used to guide therapy.

KEY POINTS

- Risk factors for nontuberculous mycobacteria infections include immunocompromise, chronic lung disease, and postoperative status; additionally, health care–associated *Mycobacterium chimaera* infections have been associated with heater-cooler units used during cardiac surgery.
- Antibiotic susceptibility varies among species, so identifying nontuberculous mycobacterial organisms to a species level is important.

Mycobacterium avium Complex Infection

Mycobacterium avium complex is a common cause of chronic lung infection worldwide. Cavitary lung disease is seen classically in White, middle-aged, or older adult men with underlying lung disease. Disseminated infection occurs predominantly in patients with HIV and CD4 cell counts less than 50/μL. The clinical presentation consists of fever, night sweats, weight loss, and gastrointestinal symptoms.