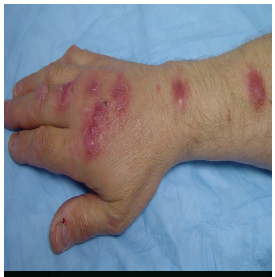
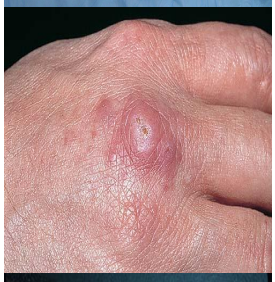
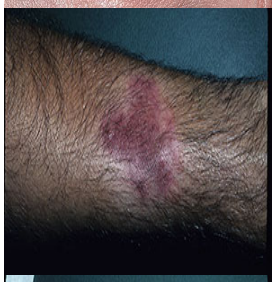
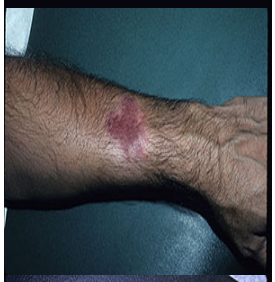
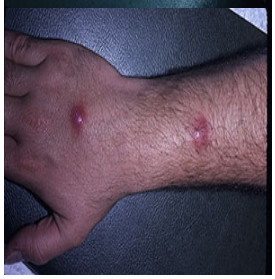
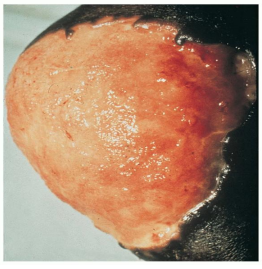
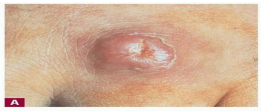
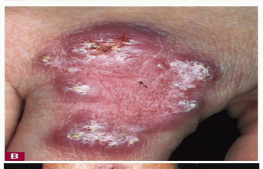
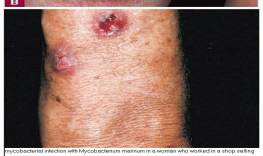
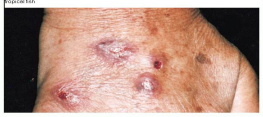







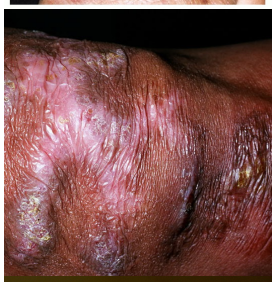


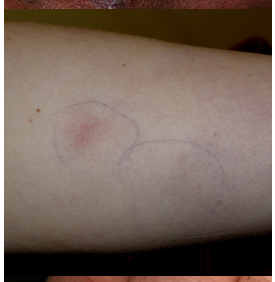


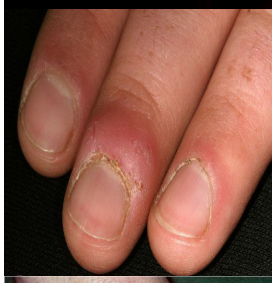


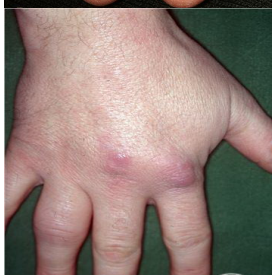
Mycobacterial infection with Mycobacterium marinum in a woman who worked in a shop selling tropical fish

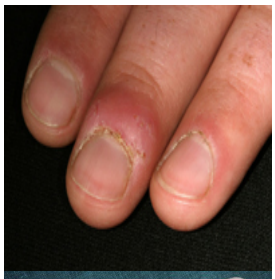
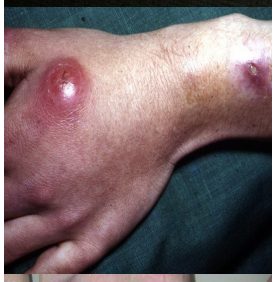
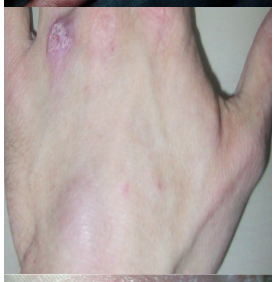
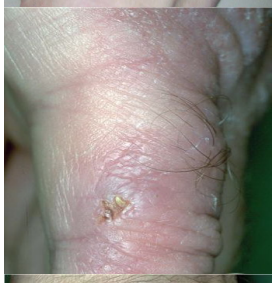
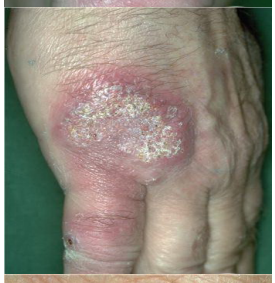
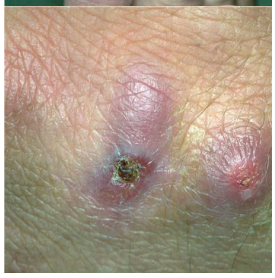


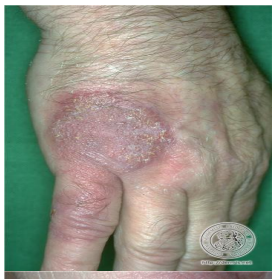
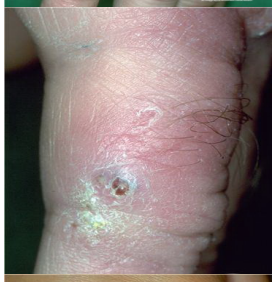
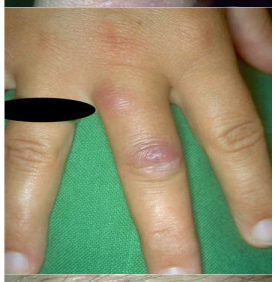
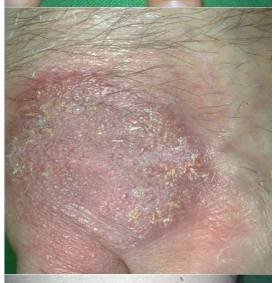
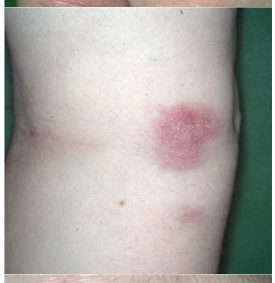
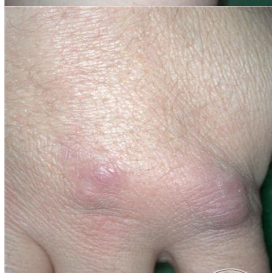


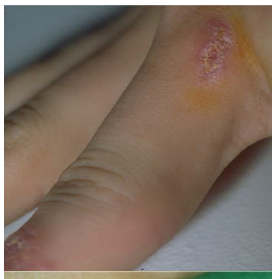
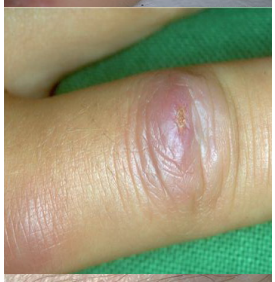
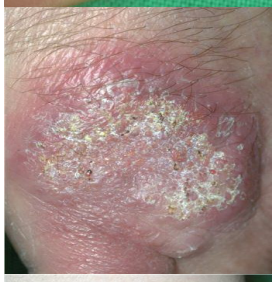
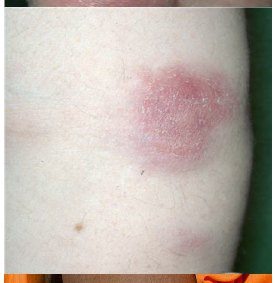
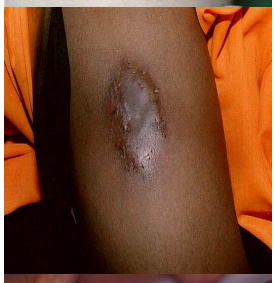
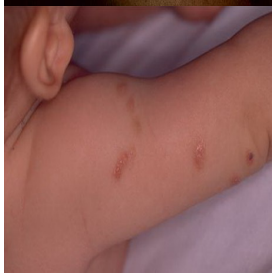


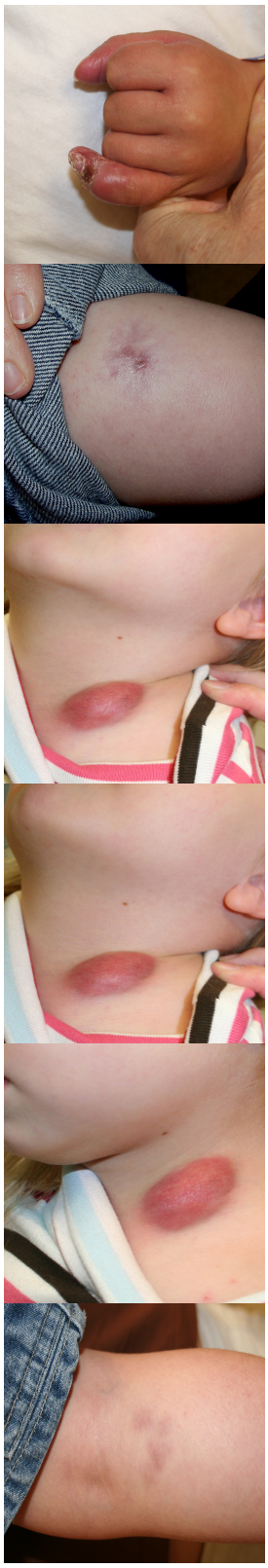


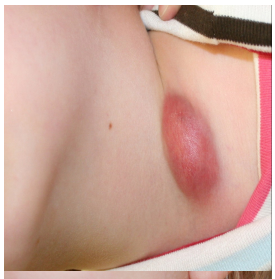


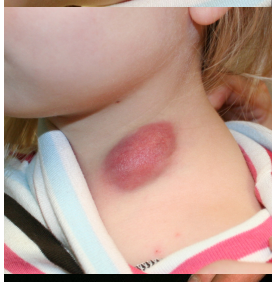







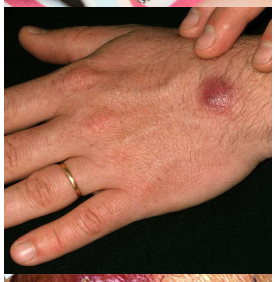







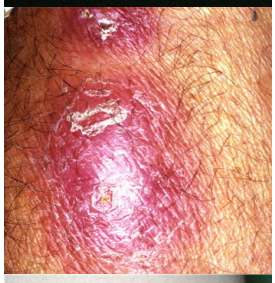







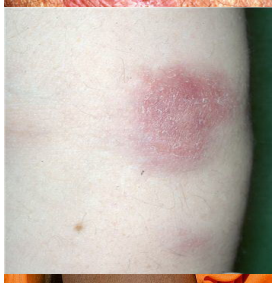


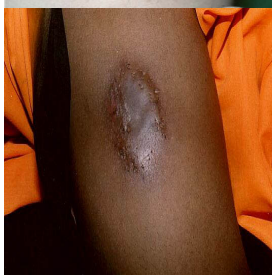


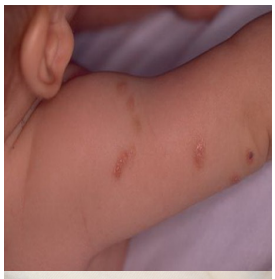
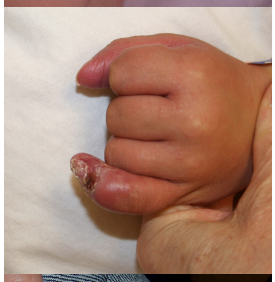
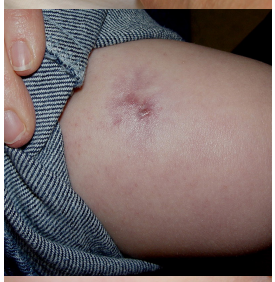
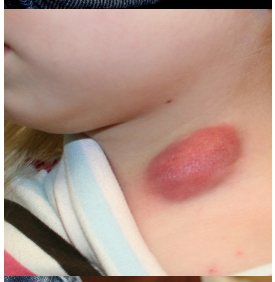
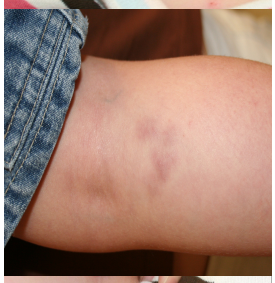
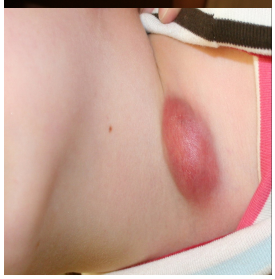


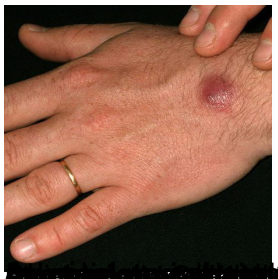










Pa

thophysiology

Infections with atypical mycobacteria usually occur in immunocompromised hosts due to host immunity and resistance factors. Pulmonary infections can occur in patients with impaired ventilation systems. These infections can also be introduced after surgery and through contaminated injections because atypical mycobacteria do not have the ability to pass through the mucosa or the integument.

Frequency

International

Cutaneous infections with atypical mycobacteria are rare in the United States and worldwide. They are much more common in immunocompromised hosts, in particular those with HIV or leukemia or those undergoing immunosuppressive therapy.

Mortality/Morbidity

Atypical mycobacteria infections cause little mortality. They can cause morbidity, especially when they are not diagnosed and not treated effectively. Often times, cutaneous atypical mycobacteria infection can resolve on its own without intervention. In children, cervical lymphadenitis caused by atypical mycobacteria can result in facial nerve injury, and the incidence of hypertrophic scarring varies among the different treatments.

Race

No apparent difference in race exists on the course of atypical mycobacteria infection.

Sex

Atypical mycobacteria infection is more common in men than in women. *M kansasii* infection is much more common in men than in women.

Age

Atypical mycobacteria infections are more commonly reported in older patients. This probably relates to the decline in health in such patients (eg, older patients who have smoked have poorer pulmonary function). Atypical mycobacteria diseases tend to affect adults and can rarely affect children. For example, a 6-year-old girl with a primary cutaneous form of *M kansasii* infection has been reported. She was successfully treated with surgical excision and oral erythromycin. The median age of patients with
M kansasii
infection is 43 years.

Clinical
History

Underlying diseases contribute to atypical mycobacteria infections, including pulmonary emphysema, diabetes mellitus, leukemia, collagen diseases, lung cancer, chronic kidney diseases, systemic lupus erythematosus (SLE),[2,3] carcinomatous pleurisy, bronchiectasis, and previously treated tuberculosis. Drug abuse is a risk factor for atypical mycobacteria infections.[4]

Anti–tumor necrosis factor therapy is another risk factor for atypical mycobacteria infections.[5]

Most patients with *M malmoense* infections are older people with lung disease. Cutaneous *M chelonae*
infection has occurred in a patient who underwent liver transplantation.

Some patients give a history of surgery. Surgery can provide a portal of entry of such infections. Procedures include cosmetic liposuction,[6] liposculpture,[6] breast augmentation mammaplasty, or median sternotomy.

In 2007, Sañudo et al[7] described nontuberculous mycobacterial infection after mesotherapy in 15 patients.

Breast implant infection with *M fortuitum* group was reported by Vinh et al[8] ; it required removal of the implant and a prolonged course of antibiotics. After the infection resolved, a new implant was successfully placed.

Infections with atypical mycobacteria following trauma have been reported.

In 2007, Murdoch and McDonald[9] reported *M avium-intracellulare* cellulitis occurring with septic arthritis after joint injection.

Nosocomial disease has become increasingly important; pseudoepidemics associated with contaminated, automated endoscopic washing machines are the most recently described manifestation. *M chelonae* has been found in the colonic mucous membranes, the respiratory tracts, and as a contaminant in the tap water used for diluting concentrated chlorhexidine. The organism happened to be isolated with the mucous membranes that were picked up while using the washed fiberscope in the colons of 6 patients. These findings suggest that
M fortuitum
and
M chelonae
groups, in spite of the fact that they rarely cause infection, have a significant risk of infecting older patients (those >60 y) in general hospitals with various underlying diseases attributable to infections.

Two patients were infected with *M smegmatis* after self-injection with a veterinary-grade anabolic steroid.

Most patients with *M kansasii* infection have some alteration of their immune status, but disseminated infection is relatively uncommon.

Patients can report systemic and constitutional symptoms that include productive cough/purulent sputum, hemoptysis, weight loss, weakness, fever, and night sweats.

Injection abscesses due to *M chelonei* var *abscessus* have been reported in a patient with

diabetes. *M chelonae* wound infections after plastic surgery using contaminated gentian violet skin-marking solution has also been reported. [10] Infection with *M abscessus* associated with intramuscular injection of adrenal cortex extract has been reported. [11]

Skin lesions due to *M chelonae* subsp *abscessus* associated with injections of lidocaine (lignocaine) given by a bioenergetic (a practitioner of alternative medicine) in Colombia have been reported. Megaesophagus and pulmonary infection with rapidly growing mycobacteria have been reported. [12]

M chelonae often occurs after puncture wounds and is a community-acquired disease. Infection can occur from scratches; road traffic accidents; and other trauma, such nails or wire.

A patient with *M gordonae* infection reported a rat bite.

In 2003, Sungkanuparph et al[13] reported a retrospective study of a series of patients infected with rapidly growing mycobacteria in Ramathibodi Hospital (Bangkok, Thailand) from January 1993 to June 1999. The following was reported:

Eighteen patients had no underlying disease, and 2 were infected with HIV. Reported physical findings were lymphadenitis (7), skin and subcutaneous abscess (7), eye infection (4), pulmonary infection (1), and chronic otitis media (1). Sweet syndrome manifested in 4 of 7 patients with lymphadenitis. The organisms isolated included *M chelonae/M abscessus* group (17 cases) and *M fortuitum* group (3 cases).

The atypical mycobacteria were susceptible to amikacin, netilmicin, and imipenem. The *M fortuitum* group was susceptible to more antibiotics than the *M chelonae/M abscessus* group.

Histology findings demonstrated pathology that ranged from nonspecific to suppurative or caseous granulomas.

Antimicrobial susceptibility defined the clinical response, which was good. A combination of 2 or more drugs provided effective therapy. Surgical resection was performed in apposite cases to reduce the load of the organism. Surgery was almost always used in cases with infections involving pan-resistant atypical mycobacteria.

Redboard et al[14] noted 4 cases of *M fortuitum* complex furunculosis after pedicures (in Cincinnati, Ohio and northern Kentucky) that manifested as nonhealing furuncles on the lower leg.

In 2007, Hoetzenecker et al[15] described dissemination of a localized cutaneous infection with *M chelonae*
in a patient undergoing immunosuppressive treatment.

A case of breast infection with combined *Prevotella melaninogenica* and *M fortuitum* infections following nipple piercing has been reported.
[16]

Bilateral sporotrichoid lymphocutaneous dermatosis in a drug abuser caused by *M fortuitum* cured by clarithromycin and ciprofloxacin has been noted.
[4]

M kansasii olecranon bursitis was reported in a woman treated with infliximab for Behçet disease. [5]

Toyoda et al report a case of a pediatric patient with squamous cell carcinoma who initially presented at age 1 year with an infection by atypical mycobacteria (ie, *M fortuitum*, *Mycobacteri um porcium*

).
[17]

Duraipandian et al report a patient with asthma and diabetes who presented with an exacerbation of chronic obstructive pulmonary disease; physical examination findings included 2 soft nodules in an axillary location. Testing reveal co-infection with *Aspergillus flavus* and *M fortuitum*

.
[18]

Physical

The lesions of atypical mycobacteria infection manifest in a variety of fashions. They can manifest with lymphadenitis, especially cervical lymphadenitis. Multiple or isolated skin nodules can present in a linear distribution. In this way, atypical mycobacteria infections can resemble sporotrichosis. This section reviews case reports related to specific types of atypical mycobacteria.

M genavense has caused disseminated disease in patients who are HIV positive.

In preschool-aged children who are immunocompetent, cervical lymphadenitis has been caused by *M malmoense.* It has caused cutaneous nodules on the hands.

Cutaneous infection has been caused by *M szulgai* in a boy who underwent a bone marrow transplantation with marrow from a matched unrelated donor.
[19]

M szulgai
has caused cellulitis, draining nodules, and plaques. It has also been related to bursitis and pneumonia. Only a handful of case reports on
M szulgai
have been published. A patient with SLE developed a cutaneous nodule caused by
M szulgai.
Another patient was on long-term corticosteroid therapy for sarcoidosis and exhibited

multicentric, purely cutaneous infection. Another patient had disseminated disease involving the skin, the bones, and the lungs and was shown to have a diminished proportion of T lymphocytes and a suppressed response to mitogens. Another patient had multiple inflammatory skin lesions and osteomyelitis and had been receiving prednisone therapy for desquamate interstitial pneumonitis. Finally, a patient aged 6 months with a carbuncle over the angle of the jaw has been reported.

M scrofulaceum is a slow-growing atypical mycobacteria that is found in environmental water sources, tap water, and the human respiratory tract. It causes scrofula, a granulomatous cervical adenitis in children and pulmonary disease in adults. It is usually unilateral. Few reports of it causing skin disease exist. It has caused an isolated red nodule on the finger. In 1987, Murray-Leisure et al [20] described a man with SLE who developed cutaneous abscesses due to *M scrofulaceum.* In 1982, Sowers[21] reported a case in which *M scrofulaceum* caused sporotrichoid infection of the hands of a woman who regularly cleaned fish aquariums.

A case series of disseminated *M simiae* infection with blood, pulmonary, and cutaneous localization has been reported. From the 11-year period from 1983-1993, 137 clinical isolates of *M simiae* were obtained from 75 patients at a university hospital in San Antonio, Texas. The sites of isolation of the 137 specimens varied. Of the isolates, 128 (93%) were from a pulmonary source, 4 (3%) were from a hematologic source, 1 (0.8%) was from a skin source, 1 (0.8%) was from urine, 1 (0.8%) was from a lymph node, 1 (0.8%) was from bone marrow, and 1 (0.8%) was from the brain. Of 62 patients in this series, 6 (10%) had definite infection, 9 (14%) had probable disease, and 48 (76%) were thought to be colonized. During the last 2 years of the study, 1992-1993, *M simiae* became the second most frequently isolated NTMB at this university hospital in San Antonio, Texas. The only atypical mycobacteria that infected more patients were of the *M avium* complex species.

M smegmatis has been linked to cutaneous disease.

M kansasii presents clinically in a manner most resembling tuberculosis. Most patients who present with localized primary cutaneous *M kansasii* infection are immunocompetent, whereas most patients with disseminated or pulmonary infection are immunocompromised. It may resemble cellulitis or sporotrichosis.

M kansasii
flexor tenosynovitis caused the development of carpal tunnel syndrome.
[22]
The diagnosis was made from synovial tissue specimens. It has also caused granulomatous synovitis and bursitis.
M kansasii
infection has been limited to the skin in a patient with AIDS with intracutaneous abscess formation and regional lymph node enlargement.
M kansasii
infection has presented as cellulitis in a patient with SLE.

Cutaneous and mediastinal lymphadenitis due to *M kansasii* is reported. *M kansasii* can cause septic arthritis.
[23]
About 50 cases have been published. Risk factors include local trauma; local or systemic corticosteroid therapy; chronic skin psoriasis; and immunodepression, especially that due to HIV infection. A clinical presentation similar to that expected in lupus profundus has been reported.
Cutaneous
M kansasii
infection associated with a papulonecrotic tuberculid reaction
[24]
and ulcerative perineal lesions
[25]
due to
M kansasii
have been reported.

Cutaneous *M chelonae* infection has occurred with a bilateral linear distribution that resembled sporotrichosis. [26]

M gordonae has caused granulomatous synovitis and bursitis. It is sometimes called tap water scotochromogen. It has also caused granulomatous nodules on the back of the hand.

M haemophilum can cause multiple, tender, cutaneous nodules. They can be purple and develop into ulcers or abscesses. They are often situated over the joints of the limbs. Wasting, tenosynovitis, and joint effusions can occur.

M fortuitum, M chelonae, and *M abscessus* can present as painful papular lesions, epitrochlear adenopathies, and erythematous nodular and ulcerating skin nodules. In people with end-stage renal disease who are on hemodialysis, atypical mycobacteria infection manifests as multiple abscesses on the lower legs. A dermatosis with a linear distribution, which resembles the dermatitis caused by sporotrichosis, and is caused by
M abscessus
has been reported. Disseminated nodules are rare. An infection due to atypical mycobacteria, acquired from a public bath, has been reported.
[27]

Cold abscesses can be present. Erythema at the site of a puncture wound can also occur as an initial manifestation of an atypical mycobacteria infection. Other findings present in patients infected with atypical mycobacteria can include osteomyelitis, lymphadenitis, and endocarditis. Atypical mycobacteria infections can result is keratitis and corneal ulcerations.

Causes

Exposure to contaminated water, injections, surgical procedures, and trauma has been linked to infection with atypical mycobacteria. Immunosuppression predisposes patients to infections with atypical mycobacteria.

In a hospital in Taiwan, 12 cockroaches (*Periplaneta americana*) were found to be infected with the following organisms:

- Four with *M kansasii*
- Three with *M xenopi*
- Two with *M gordonae*
- One with *M haemophilum*
- One with *M fortuitum*
- One with *M avium*

Because cockroach infestation commonly occurs in the hospital environment, cockroaches might be implicated as a cause of hospital-acquired infections due to atypical mycobacteria

Treatment

Medical Care

Infections with atypical mycobacteria can be treated with a variety of antibiotics. Clarithromycin has shown good efficacy against a broad range of atypical mycobacteria, but some organisms are resistant, and proper sensitivities must be obtained.

Effective treatment of *M kansasii* infection can usually be accomplished with a rifampin-based regimen, or a rifabutin-based regimen can be used for patients who are HIV seropositive and receiving antiretroviral therapy.

Jousse-Joulin et al [31] described skin and joint infection by *M chelonae* treated with rescue treatment with interferon gamma.

Han et al [32] analyzed clinical and microbiologic features of 115 cases involving rapidly growing mycobacteria isolated at the University of Texas M.D. Anderson Cancer Center from 2000-2005. Antimicrobial susceptibility test results demonstrated that *M abscessus* was the most resistant species and that *Mycobacterium mucogenicum* was most susceptible.

Surgical Care

A combined therapeutic approach, including surgical drainage, debridement, and prolonged (>3 mo) treatment with combined antimicrobial agents, has been used in some cases of atypical mycobacteria.

In some cases based on clinical assessment, successful treatment requires aggressive debridement of all infected subcutaneous tissues and skin.

Split-thickness skin grafting has been successfully used to cover large wounds. Grafting did not appear to foster recurrent infection.

Consultations

Consultations with infectious disease specialists, surgeons, dermatologists, and pulmonary specialists may be necessary.

Medication

The drug of choice depends on the sensitivity of an organism. *M kansasii* is most susceptible to antituberculosis medications and can be treated with minocycline.
M scrofulaceum
is not sensitive to medications, and surgical removal is often required. Combinations of medications based on sensitivities should also be used.
M szulgai
is sensitive to medications.
M haemophilum
may be sensitive to
p-
aminosalicylic acid and rifampin or rifabutin. For
M fortuitum
and
M abscessus,
combinations of medications that include ciprofloxacin, clarithromycin, amikacin, cefoxitin, and tobramycin among others have been used.

Antimycobacterial Agents

Therapy must cover all likely pathogens in the context of this clinical setting.