Tuberculosis: *A Resurging Health Care Issue*

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Health care workers (HCWs), particularly those frequently exposed to patients and their body fluids and secretions, are at risk for developing contagious infections. A contagion known to infect HCWs is *Mycobacterium tuberculosis*, which causes tuberculosis. Tuberculosis has begun to make a resurgence in the world, including the United States, due to several factors: an increase in the number of high-risk groups, mutated strains, incomplete treatment, and often inappropriate treatments. As a result, drug resistance has emerged.

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As HCWs, surgical technologists must be aware that they are increasingly exposed to tuberculosis. Information regarding tuberculosis has not been as widely disseminated as information on other infectious processes such as acquired immunodeficiency syndrome (AIDS). The purpose of this article is to share information on tuberculosis with those who may come in contact with tuberculotic patients.

Background

M tuberculosis is an acid-fast, nonmotile, gram-positive rod that does not produce capsules or spores. This organism is approximately 0.2 to 0.6 µm in width and 1.0 to 10.0 µm in length. The primary route of the organism into the body is through the lungs. If left untreated, the organism spreads through the lymph system into the lymph nodes and the circulatory system and then into any organ of the body. It is characterized by pulmonary infiltrates and granuloma formation with caseation, fibrosis, and cavitation.[1]

M tuberculosis is an opportunist. It may remain dormant for years after exposure. The body's immune system may rid itself of the organism after exposure without any signs of infection by killing it or walling it up in a nodule (tubercle). If it is not eliminated, health conditions may allow it to become active.

Tuberculosis is not isolated to one culture or nation. Nor is it relatively "new." Skeletal remains dating from 5000 to 3000 BC show evidence of lesions caused by tuberculosis.[2] *M tuberculosis* was first identified and described by Robert Koch in 1882. Tuberculosis has been referred to as the "White Plague," and "consumption" in the form of weight loss since this is a main symptom associated with the disease.

Mode of Transmission

Tuberculosis is spread primarily by droplets, either by coughing or through a ventilation system. Continued contact with an infected person will, of course, increase the risk of infection, which becomes active tuberculosis approximately 5% to 15% of the time.

Other means of transmission of the disease may be contact with infected monkeys imported from Indonesia or Asia. Drinking milk infected with *Mycobacterium bovis* can cause tuberculosis. Performing CPR on an infected person without a protective device is very risky and caused the death of a physician in England.

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It is uncommon to be infected by house pets or other farm animals. Infection from instrumentation (bronchoscopes, laryngoscopes, or anesthesia machines) is also uncommon.

Risk Factors and Incidence

The following conditions will put an individual at high risk for developing tuberculosis:

- Immunosuppression from:
  - Corticosteroids
  - Chemotherapy
  - Malnutrition
  - AIDS
- Diabetes mellitus
- Cirrhosis of the liver
- Alcoholism
- Silicosis
- Malignant diseases
- Constant exposure in endemic areas (eg, Asia)

Silicosis is a condition brought on by inhaling crystalline quartz particles. Several occupations, including mining, farming, and sandblasting, expose workers to the particles that

lead to nodules in the lungs. Those who are silicotic have a 30% higher chance of developing tuberculosis than nonsilicotics.[3]

Since 1985, tuberculosis has steadily increased in case numbers due to drug-resistant forms of the disease and an increase in human immunodeficiency virus (HIV)-positive patients. This increase comes after a 30-year decline. In the United States, increases are especially high in HIV-positive patients. Immunosuppressed patients are at a higher risk of contracting the disease while in a health care facility or from the reactivation of an earlier exposure. Of the one million HIV-positive patients around the country, as many as 10% may be infected with tuberculosis. The fatality rate for AIDS patients infected with tuberculosis is estimated to be as high as 72% to 89%, with death occurring 4 to 16 weeks after diagnosis. Consequently, AIDS patients are among the highest risk groups for contracting and dying from tuberculosis. In one study, several patients died before laboratory results were available to confirm their diagnosis. Some of their organisms were resistant to as many as seven antituberculosis drugs.[4]

Clinical Aspects

Symptoms include a dry cough, fever, and night sweats. Tuberculosis starts by mimicking a cold but persists and increases to chest pain, weight loss, hemoptysis, and cavities in the lung. Definitive diagnosis is established by documenting the growth of *M tuberculosis* in respiratory secretions, body fluids, or tissue samples.

Testing for Tuberculosis

Early screening and testing of high-risk patients and HCWs are essential to control the number of tuberculosis cases. Diagnostic tests include physical examination, chest x-ray films, sputum smears and cultures, and tuberculin skin test.[1]

The best test for tuberculosis is the Mantoux skin test rather than the multiple puncture test. The Mantoux test injects 0.1 ml of 5 TU (tuberculin units) on the smooth side of the forearm intradermally using a 27-gauge needle. The injection site is then ready for a reaction 48 to 72 hours later but can be read up to 1 week later. The injection site is read along the long axis of the forearm in millimeters.

HCWs should also be tested if they work in high-risk exposure areas such as jails, half-way houses, juvenile detention facilities, or in family or group foster homes.

A positive reaction of 5 mm or more in the following requires therapy:

- Patients with suspected or known HIV infection
- Persons with an abnormal chest x-ray film
- Persons in close contact with a patient known to have an infectious disease

A positive reaction of 10 mm or more in the following requires therapy:

- Persons with other high-risk medical conditions
- Foreign-born persons
- Low-income population
- High-risk minorities (African, Hispanic, and Native Americans)
- IV drug users
- Residents of long-term care facilities (eg, prisons, nursing homes)

A positive reaction of 15 mm or more is considered positive for everyone else who does not fall into the previous groups.

Testing should be done in the high-risk groups. HIV-positive patients should be tested as soon as the HIV diagnosis is made. There may be a 25% to 30% chance of a false negative in these patients because of their immunosuppression. HCWs should also be tested if they work in high-risk exposure areas such as jails, half-way houses, juvenile detention facilities, or in family or group foster homes. A positive skin test should be followed up with a chest x-ray film and 1-year prophylactic dose of chemotherapy. Other groups that may need to be screened are nonwhites in low-income areas, children adopted from overseas, and refugees.[5]

Pregnancy is not considered a contraindication for Mantoux testing. In fact, for a HCW, testing could be a health benefit to both mother and child. Tests performed on the mother have no effect on the fetus. If the mother tests positive, a chest x-ray film should be obtained while shielding the abdomen. If necessary, isoniazid treatment should be initiated after the first trimester. Treatment should be done based on the degree of positivity of the tests.

Treatment

Prior to 1950, treatment for tuberculosis was handled in sanitariums in clean air environments such as Colorado. Patients were treated using nonchemotherapy methods and hoped for a cure with help from the body's own defense system. Surgery was used only sparingly to remove affected parts of the lung. However, surgery carried its own risks. Therapeutic pneumothorax involved collapsing the affected lung to compress the cavitary lesions formed. The lack of oxygen supply to the collapsed lung inhibited the growth of *M tuberculosis*.

Chemotherapy was introduced in 1950. Two drugs developed were isoniazid and para-aminosalicylic acid. These drugs, in addition to streptomycin (developed in 1944), changed the course of treating tuberculosis from a lengthy isolation regimen to one that offered better results and allowed the patient to resume activities sooner.

Like other organisms, *M tuberculosis* mutates and may become resistant to a single-drug therapy. Therefore, it is necessary to institute multiple-drug chemotherapy. Even if a particular strain of *M tuberculosis* is resistant to one drug, the synergistic efficacy of multiple drugs will cure most cases of tuberculosis.

Several drugs are available for therapy. Most effective are isoniazid, rifampin, pyrazinamide, ethambutol, and streptomycin. The

second group, which has more side effects and is somewhat less efficacious, includes ethionamide, para-aminosalicylic acid, cycloserine, kanamycin, capreomycin, and amikacin. Side effects that may develop are renal insufficiency, hepatitis, dizziness, hearing loss, or nephrotoxicity.[6]

Chemotherapy for tuberculosis must be continually monitored to avoid toxicity and incomplete treatment. Sputum cultures will indicate colony numbers and the possible need for a change in drugs. Patients must be aware of the importance of stringently completing the treatment plans. A partially treated patient is prone to develop drug resistance. Drug therapy may be necessary for several months. Incomplete treatment results when the patient grows weary of taking medication and does not follow through with the treatment plan to completion.

Incomplete treatment may also result if follow-up cultures following chemotherapy are not obtained, by fault of either the patient or the physician. Treatment using chemotherapy alone in the United States and Canada has a failure rate of less than 8% and a relapse rate of less than 2%. Deaths that occur from tuberculosis do so in the elderly and chronically ill.[7]

A positive tuberculin skin test reaction indicates past or present infection, and in the absence of proof of active infection, may warrant prophylactic chemotherapy, usually 300 mg/day of isoniazid for 12 months. HCWs with a positive skin test reaction are required to have an annual chest x-ray film in most states. It is important to note that a skin test may be negative in 25% of the patients with active tuberculosis; it may also be negative in patients on steroids, with AIDS, and in those on chemotherapy for a malignancy.

Precautions

HCWs must be aware of precautions to be taken for infectious cases. Patients with tuberculosis have to be isolated and should wear a mask when being transported. Isolation procedures for tuberculosis patients on the ward should include a room with negative-pressure ventilation to prevent nosocomial infection of HCWs and other patients. Negative-pressure ventilation draws the room air outside the building, whereas positive pressure circulates it to another room or corridor. Homeless shelters, prisons, nursing homes, or other institutions that may not have negative-pressure ventilation pose a hazard to both HIV-infected patients and to HCWs. The Centers for Disease Control and Prevention (CDC) recommends that the isolation room air exchange be six times per hour with at least two air exchanges going outside the building. In addition to the negative-pressure circulation, ultraviolet lamps can be used sparingly in the room to kill organisms expelled into the air by a patient. Safety must be considered before using the lamps; small rooms or closets are normally a contraindication.[8]

On the patient ward, HCWs should wear gloves and high-filtration face masks to prevent exposure. Thorough hand washing should always be performed after patient contact. Simply instructing the patient to use a tissue when sneezing or coughing will reduce droplets expelled into the air.

High-filtration, tight-fitting masks are recommended protection for highly infectious cases, in addition to surgical laser cases that produce a smoke plume. High-filtration masks filter 75% of particles as small as 0.3 µm versus standard surgical masks that filter particles of about 3.0 to 5.0 µm. One type of high-filtration mask is made of non-fiberglass fibers and is molded in a cup shape with attachments at four points on the mask. Two elastic straps hold the mask closer to the face and prevent breathing around the edges as does a surgical mask.[8]

High-filtration masks worn by surgical personnel during procedures as well as masks worn by the infected patient during the preoperative and postoperative times help reduce droplet exposure produced by the patient.

At a recent national meeting, the National Institute for Occupational Safety and Health proposed using personal respirator (PR) devices for HCWs in infectious cases. The outcome is controversial because guidelines established in December 1990 recommending the high-filtration masks were not followed by some institutions in this country. High-filtration masks may eliminate the need for personnel to wear PR units.

Articles have been published on possible patient contamination by bronchoscopes involving *M tuberculosis*. If the bronchoscopes are not thoroughly cleaned and disinfected or sterilized, cross-contamination, though uncommon, could occur. Manual washing in tap water and a neutral detergent, followed by either disinfection in glutaraldehyde solution for 45 minutes at 25° C, or sterilization with ethylene oxide gas or peracetic acid, will kill 100% of *M tuberculosis*.

Prevention Guidelines

The CDC published guidelines for dealing with multidrug resistant tuberculosis.[8] The report dealt with a multitude of problems encountered with the drug-resistent form of tuberculosis. Included in their recommendations were the following:

1. HCWs with a positive skin test but with no signs of active disease should be given early testing and treated prophylactically.
2. Obtain early identification of potentially high-risk patients and treat them.
3. Properly isolate patients who test positive for tuberculosis.
4. Isolate procedures that produce cough (ie, bronchoscopy).[8]

Preventative Therapy

In France in 1921, Bacillus Calmette-Guerin (BCG) vaccine was first used in humans as a possible prophylactic to tuberculosis. The vaccine is a derivative of *M bovis*. The World Health Organization recommended its use in the 1950s in the hope of enhancing immunity. Mass vaccination of newborns was given to try to curb the infection rate in the future. However, studies showed that the effective rate ranged from 0% to 80% in different populations.

As a result, it was difficult to determine its effectiveness. Though the United States does not routinely use BCG vaccines, many countries still use it as part of their tuberculosis control programs. BCG vaccination may alter the tuberculin skin test positivity and must be taken into consideration when a positive Mantoux test reaction is obtained. A positive reaction after a BCG vaccination normally indicates infection, and treatment should be started. The effect of the vaccine is direct; in developing countries its benefit to children and young adults may be justified even though the vaccine has a limited duration.

BCG is recommended for children born HIV-positive but who show no clinical signs of AIDS. It is not recommended for children with visible symptoms of AIDS because of complications.

When the risk of tuberculosis is low, as it is in the United States compared with the rest of the world, vaccination with BCG is not recommended. Instead, a treatment using isoniazid for 6 to 12 months is suggested for the high-risk groups.

Taking isoniazid for 12 months will reduce the risk of developing tuberculosis by 70% in 90% of the patients who comply with the treatment plan. Six months of treatment will lower the risk of developing active tuberculosis by 65%.[9]

Prevention

With the increase in the number of patients with AIDS, the incidence of tuberculosis and other opportunistic infections will also increase. So as HCWs, *protect yourselves.* Maintain good health. Annual skin tests for tuberculosis should be conducted on those at risk for exposure, as well as follow-up chest x-ray films on those who are skin-test positive. Isolation procedures, set up by the institution, should be used when caring for the patient, and HCWs must be diligent about wearing protective eyewear, masks, gloves, and gowns. Δ

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