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**SPECTRUM HEALTH CARE, INC.**
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## SUMMARY

In December 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at Spectrum Health Care, Inc. in Newark, New Jersey. The request stated concerns regarding potential tuberculosis (TB) transmission due to contact with a client population with a high incidence of TB.

Spectrum Health Care, Inc. is a non-profit organization that operates an out-patient methadone maintenance and detoxification center and an acquired immunodeficiency syndrome (AIDS) day-care center. On March 9-11, 1993, NIOSH investigators evaluated the administrative and engineering control measures which are used to reduce potential exposures to TB. The written tuberculin skin test (TST) program and results of the testing were reviewed as well, and informal interviews with employees were conducted. A visual assessment of the ventilation and airflow patterns was performed, and random measurements of the supply airflows were made.

The results from initial and follow-up TST for health-care workers and clients over the past three years were reviewed. Of the 966 skin tests on clients which were reviewed, 67 skin tests were positive (defined as a reaction greater than 10 millimeter [mm] induration). It should be noted that the percentage of positive skin tests over this three year period may be underestimated for the following reasons: (1) some clients seen by Spectrum Health Care received multiple tests over this period; (2) a lower cut point (5 mm induration) was not used to define a positive test as recommended for persons with HIV infection or risk factors for HIV infection; and (3) there was no anergy testing by Spectrum Health Care. Of the 55 Spectrum Health Care employees, eight persons had a positive skin test prior to employment, and three others tested positive on the initial skin test (reaction greater than 10 mm induration). Of the remaining 44, three persons converted to a positive PPD during their employment (7%). These three employees, who worked in different locations within the facility, performed different job tasks, and converted at different times, were clinically evaluated and placed on preventive drug therapy. As the duration of employment was not fully available, NIOSH investigators were unable to calculate the incidence of positive skin tests among all employees.

Air mixing was occurring between all areas of the center. For example, the ventilation evaluation indicated that the methadone distributing area and examination rooms were under positive pressure with respect to the adjacent staff areas. In addition, the return air plenum was shared by the various ventilation systems. Finally, there was no provision for the introduction of outside air to the ventilation systems at the time of this NIOSH survey.

A potential hazard exists for Spectrum health care workers who are exposed to clients who have active TB. The ventilation system within the center recirculates 100% of the air and is therefore not an effective engineering control for reducing exposure to TB. Recommendations are made in the report to improve the ventilation systems, use appropriate personal protective equipment, and improve the TST program.

**KEYWORDS**: SIC 8093 (Specialty Outpatient Facilities, Not Elsewhere Classified), drug treatment center, methadone, tuberculosis, *Mycobacterium tuberculosis*, tuberculin skin test (TST), ventilation.

## INTRODUCTION

On December 12, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a management request to conduct a health hazard evaluation (HHE) at Spectrum Health Care Incorporated, a drug-treatment center (DTC) and day-care center for persons with acquired immunodeficiency syndrome (AIDS) in Newark, New Jersey. The request concerned the potential for tuberculosis (TB) transmission resulting from contact with a client population at high risk for TB.[1] Specifically, NIOSH was asked to evaluate administrative and engineering controls used to reduce the workers' exposures to *Mycobacterium tuberculosis* (*M. tuberculosis*). On March 9-11, 1993, a site visit, which included informal discussions with employees, an evaluation of the tuberculin skin testing (TST) program, and an assessment of the operational status of the ventilation systems and airflow patterns within the facility was conducted. Preliminary findings and recommendations were made at the closing conference held on March 11, 1993. This report describes the findings and recommendations from the NIOSH investigation.

## FACILITY DESCRIPTION

Spectrum Health Care Inc., a non-profit organization, operates an out-patient methadone maintenance and detoxification center which is open from 6 a.m. to 4 p.m., Monday through Friday. The center provides drug treatment for cocaine and heroin addicts. In the maintenance program, the methadone dosage is determined by the amount of drug-use and is maintained indefinitely, whereas the detoxification programs last either 21 or 90 days. In the detoxification programs, a maximum dose of 30 milligrams of methadone is distributed to the client, and the dosage is gradually decreased over time. The staff will provide methadone treatment at home should the client have active TB. Within the same building, Spectrum also operated an adult day-care center for persons with AIDS; however, as of September 15, 1993, the center was closed due to lack of funding.

In the past year, there have been over 700 clients utilizing the facility. There are approximately 60 workers employed at the center as physicians, social workers, nurses, and clerical staff.

## TUBERCULOSIS BACKGROUND

*M. tuberculosis*, a rod-shaped bacteria, is carried in airborne particles known as droplet nuclei. The droplet nuclei typically range from 1-5 microns (µm) in size. Since the droplet nuclei are small in size, normal air currents can disperse the infectious particles throughout a room or building. Once released from an infected person, the droplet nuclei can be inhaled by a susceptible host. The bacilli can become lodged within the alveoli of the lungs and can spread throughout the body. A majority of persons who become infected are asymptomatic and do not go on to develop active TB. However, the infected persons remain at risk of developing the clinical disease, especially if the immune system becomes compromised.[1,2]

In 1993, there were 26,673 cases of TB reported in the United States--a 1.5% increase from the previous year.[3] New Jersey has the seventh highest rate of the disease among the states, Newark has the country's second highest TB case rate nationally for cities larger than 250,000.[4] The risk for TB is higher among injecting drug-users than the general population.[5,6] According to a study conducted by the Centers for Disease and Prevention (CDC) at 114 DTCs, 9.7% of the 30,808 clients screened for TB had a TST reaction of 5 millimeters (mm) or greater. However, when persons with previously documented positive skin test reactions were included, the percentage increased to 13.3. The skin testing results suggest that more than 13% of the DTCs' clients may have latent TB infection and, therefore, are at increased risk of developing active disease. The study also suggests that HIV-induced anergy may be obscuring the true prevalence of positive tuberculin tests among the clients screened since the prevalence of positive skin tests was higher among HIV-seronegative persons than HIV-seropositive persons.[7] Other prospective and retrospective studies conducted support the CDC study's conclusion that the response to Mantoux testing has little sensitivity for detecting TB infection in HIV-seropositive clients. These studies also suggest that the risk of active TB was elevated in HIV-seropositive clients only.[8,9]

Tuberculosis transmission is not only a health risk for clients attending DTCs but is also an occupational health risk for health-care workers. The magnitude of the risk varies by type of health-care setting, population served, job category, and the area of the facility in which a person works. The risk may be higher for personnel who are routinely in close contact with infectious patients, or in areas where patients with TB are provided care before diagnosis, such as clinic waiting areas and emergency rooms.[1] The risk of transmission is dependent on the concentration of infectious droplet nuclei in the air and duration of exposure.

## PREVENTION OF TB TRANSMISSION IN HEALTH CARE FACILITIES

Many of the control measures used to prevent TB transmission are generally developed for hospitals and are not always applicable to other facilities. However, a discussion of the control measures is useful to understand the options available for controlling the transmission of TB. In an attempt to control exposures, the hierarchy of controls should be used. The logic of the hierarchy is to minimize the likelihood that preventive measures will fail, resulting in a hazardous exposure. Administrative measures, such as early identification and treatment of infected persons and those with active disease, and the use of effective work practices, should be used as the first approach to reduce the risk of exposure to persons with infectious TB. Engineering and environmental controls, including general and local ventilation and air cleaning mechanisms, can be used to prevent the spread and reduce the concentration of infectious droplet nuclei. Personal protective equipment should be used in high risk areas where administrative or engineering controls may not be sufficient to prevent TB transmission. These control measures are explained in further detail below.

In October 1993, the Occupational Safety and Health Administration (OSHA) issued an enforcement policy for inspections, based on CDC guidelines, concerning occupational exposure to TB in health care settings, correctional institutions, homeless shelters, and long-term facilities for the elderly.[10] OSHA is requiring: (1) a protocol for the early identification of individuals with active TB, (2) medical surveillance for employees using skin tests, (3) evaluation and management of workers with positive skin tests, skin test conversions, or symptoms of TB, (4) placement of individuals with confirmed or suspected TB in acid fast bacilli (AFB) isolation rooms, and performing high risk procedures in areas with negative pressure and appropriate exhausts, and (5) training and information for employees concerning issues such as TB transmission, signs and symptoms of the disease, medical surveillance and follow-up therapy, and proper use of controls. OSHA is citing facilities under Section 5(a)(1) - general Duty Clause of the Occupational Safety and Health Act of 1970.

In October 1993, CDC published a draft document entitled, *Guidelines for Preventing the Transmission of Tuberculosis in Health Care Facilities, Second Edition*, for public comment.[11] This document was developed to replace the previously published CDC guidelines for the prevention of TB in health-care facilities, and discussed, in detail, the importance of administrative and engineering controls, personal protective equipment, early identification and screening, risk assessment, and a written TB control plan, skin testing programs, and worker education.

### *A. Administrative Controls*

To minimize the transmission of *M. tuberculosis*, early identification and treatment of persons with TB infection as well as those with active disease is necessary. The identification of individuals with tuberculous infection is commonly accomplished using the tuberculin skin test (TST), in which a small amount of purified protein from *M. tuberculosis* is injected into the upper layers of the skin. If the test subject has previously been infected with *M. tuberculosis*, the immune system usually reacts against this protein, causing a reddish swelling at the site of the injection. If the subject has not been infected previously, there will be little or no reaction (a negative result). There are standardized guidelines for interpreting the test.[6] The injection does not contain live *M. tuberculosis* bacteria and cannot cause infection; furthermore, repeated skin testing will not cause a positive test in a person who has not been infected with TB.

Interpreting skin tests for tuberculous infection can be complicated by the fact that, over a period of years, some infected people test negative on the initial screening because their immune system has temporarily lost its sensitivity to the test. However, the initial test "reminds" the immune system to react and will cause a positive test result on a subsequent test. It might then be incorrectly believed that the person had been infected during the time interval between the two tests. To avoid this problem, a "two-step" test procedure is recommended by CDC for a person being enrolled in a TB surveillance program. If the first test is negative, a second skin test should be given about a week later. If the second test is also negative, the person is considered to be free of tuberculous infection and can then be enrolled in the periodic screening program. After the initial screening, a single skin test should be performed at each subsequent screening.[6]

Routine screening of health care workers at least annually is recommended by CDC; workers who routinely perform procedures with a high risk of exposure to *M. tuberculosis* (e.g., bronchoscopy, sputum induction, or aerosol treatments given to patients who may have TB) should be retested at least every six months.[6] If a person with a previously negative skin test converts to positive, the test should be followed by a chest X-ray to determine whether active TB disease has developed. The X-ray of an infected person without active disease may show no abnormalities, or show little more than a small spot on the lung where the infection has occurred, possibly with deposits in a nearby lymph node.[12] A series of prophylactic (preventive) drug therapies are generally prescribed upon diagnosis to prevent the infection from advancing to TB disease. The two drugs most commonly used for this purpose are isoniazid (INH) and rifampin.

In addition to identifying individuals for whom prophylactic treatment is appropriate, routine screening can also serve as a surveillance tool to identify areas or occupations for which there may be an increased risk of TB transmission. It should be noted that even if the drug treatment successfully kills the TB bacteria and prevents the development of active disease, the patient will continue to test positive on later TB skin testing because the immune system will "remember" the TB protein and react to the skin test.

When a patient develops active pulmonary TB, the infection in the lung destroys lung tissue as it grows, thus forming a cavity. When the cavity erodes into an airway, infectious material (which includes live *M. tuberculosis*) in the airway causes the patient to cough, which can aerosolize *M. tuberculosis*. A diagnosis of TB should be considered for any patient with persistent cough or other symptoms compatible with TB, such as weight loss, anorexia, or fever. Since diagnosing TB disease is generally based on recognizing symptoms, there is usually a time period before diagnosis in which the patient is infectious but has not been isolated. For this reason, early diagnosis of TB is critical for minimizing transmission. Upon diagnosis, drug therapy should be promptly initiated and the patient isolated until the patient is no longer infectious.

*B. Engineering and Environmental Controls*

1. Ventilation

There are two general categories of ventilation which may be of used to reduce *M. tuberculosis* exposures: general ventilation and local exhaust ventilation (LEV). General ventilation reduces the concentration of contaminants through dilution and removal of contaminated air. There are two basic designs for general ventilation systems. The first, a "single pass" system, exhausts all the room air to the outside. The second design recirculates most of the air, with a small portion being exhausted and replaced with outside air. The primary advantage of the single-pass design is that contaminated air is exhausted directly to the outside and not recirculated within the building; the principal disadvantage is the greater cost of heating or cooling the necessary additional outside air.

There are no ventilation recommendations that specifically address the prevention of disease transmission in drug treatment centers. However, there are guidelines for ventilation criteria for thermal comfort and for airflow specifications in health care facilities.[1,13,14,15]

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has published ventilation design criteria which specify minimum ventilation rates and thermal comfort guidelines that are intended to minimize the potential for adverse health effects. The ASHRAE standard 62-1989 recommends outside air (OA) supplies of 20 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges.[15]

Recommended ventilation rates for health care facilities are sometimes expressed in terms of air changes per hour (ACH). An ACH is defined as the theoretical number of times that the air volume of a given space will be replaced in an one-hour period. However, this terminology is misleading because the supply air is constantly mixed with room air and therefore, the air is not completely "changed." In addition, there is seldom perfect air mixing in a room.

ASHRAE and the American Institute of Architects (AIA) have published other ventilation guidelines for health care facilities.[13,14] These guidelines suggest airflow rates ranging from four to 25 ACH, depending on the functional area of the facility. The guidelines are provided in terms of pressure relationships to adjacent areas, minimum outdoor air, total air changes, exhaust locations, and air recirculation restrictions. For example, hospital isolation rooms, which are intended to reduce the airborne spread of disease, should be under negative pressure and have a minimum of six ACH (two ACH of OA), with all air exhausted directly to the outside. Hospital waiting areas in emergency departments should have a minimum of ten ACH, with all air exhausted directly to the outside. The recommendations provided by ASHRAE and AIA are based on comfort and odor control. There is no scientific data which supports the adequacy of these guidelines in protecting workers against *M. tuberculosis*. In fact, two hospital ventilation studies provide evidence that indicate that six ACH do not effectively control airborne bacteria.[16,17] Additionally, other published studies indicate that ventilation rates substantially higher than six ACH do improve dilution and removal of airborne bacteria.[16-18] The data indicate the need to have ventilation rates at the highest practical levels to reduce exposure to the droplet nuclei. Therefore, facilities should be designed to achieve the greatest ventilation airflow, striving for substantially greater than six ACH in areas where confirmed or potential active TB patients are present.

In addition to supplying the specified airflow, ventilation systems should also provide satisfactory directional airflow patterns both from area to area and within each room. Airflow should be from "clean" to "less clean" areas, such as from hallways to treatment rooms. This can be accomplished by creating negative (lower) pressure in the area into which flow is desired relative to adjacent areas by exhausting more air from the area. Negative pressure can generally be achieved by exhausting 10% (but no less than 50 cfm) more air than the amount supplied to that area. Pressure differentials are more easily maintained in closed rooms;[13] therefore, it is important that doors close tightly and are kept closed at all times.

Local exhaust ventilation is used to capture emissions near or at the source of generation, and thereby, prevent contamination of the general room air. The use of scavenging booths or hoods for sputum induction is an example of LEV which can be used to control *M. tuberculosis* exposures.[1] General guidelines for LEV are provided in *Industrial Ventilation, a Manual of Recommended Practice*.[19]

2. High Efficiency Particle Air Filtration and Ultraviolet Radiation

The use of high efficiency particulate air (HEPA) filtration and ultraviolet germicidal irradiation (UVGI) have been proposed as measures to control *M. tuberculosis* transmission. Although the ability of HEPA filters to remove TB bacilli has not been studied, HEPA filters are effective in capturing *Aspergillus* spores which are of a similar size range to aerosolized *M. tuberculosis* particles.[15,16,17] Therefore, HEPA filters should be effective in removing droplet nuclei. Additionally, HEPA filters can be used to clean air before it is recirculated into the facility or exhausted to the outside. In all cases, HEPA filtration systems require proper installation, periodic leak testing, and meticulous maintenance.

Ultraviolet germicidal irradiation can be used as a method of air cleaning in conjunction with other TB control measures. Two systems of UVGI can be used: duct irradiation and upper room air irradiation. Concerns that arise from the use of UV radiation for infection control include the potential health hazards from overexposure to UV radiation itself, which include keratoconjunctivitis (inflammation of the cornea and conjunctiva) and erythema (reddening) of the skin, and proper maintenance of the UV lamps and fixtures. Broad spectrum UV radiation has been associated with increased risk of skin carcinomas.[11] Ultraviolet - Type C (UV-C) radiation has been classified as "probably carcinogenic to humans" by the International Agency for Research on Cancer (IARC) based on animal studies that suggest UV-C radiation can cause skin cancers and damage genetic material.[11,20] Recent studies have demonstrated, in the laboratory, that UV radiation can activate human immunodeficiency gene promoters in human tissue cultures, but the implications of this for humans is unknown at this time.[11,20]

*C. Respiratory Protection*

In addition to engineering controls, NIOSH recommends that personal respiratory protection be used to reduce the risk of infection for health care workers. Recommendations for respiratory protection for workers exposed to *M. tuberculosis* are provided in the NIOSH document: NIOSH Recommended Guidelines for Personal Respiratory Protection of Workers in Health Care Facilities Potentially Exposed to Tuberculosis.[21] In this document, NIOSH specifies the type of respirator that should be used for various locations and procedures. For areas or procedures which NIOSH considers to have a medium potential for exposure to aerosolized *M. tuberculosis*, such as isolation rooms, NIOSH recommends a half-face powered air-purifying respirator with a HEPA-filter as a minimum level of respiratory protection. For areas or procedures which NIOSH considers to have a high potential for exposure, such as sputum induction, NIOSH recommends that half-face positive-pressure air-line respirators be used as a minimum level of respiratory protection. OSHA requires, at a minimum, the use of NIOSH-approved HEPA particulate respirators for entering isolation rooms, when performing medical procedures such as bronchoscopy and sputum induction, and while transporting patients in closed vehicles.

If respirators are used, a complete respirator program must be implemented that meets the requirements of OSHA respiratory protection standard (29 Code of Federal Regulations [CFR] 1910.134).[22] Guidelines for implementing a personal respiratory protection program are included in the NIOSH document referenced above.[21] The minimum requirements for a respiratory protection program include a written standard operating procedure for the selection and use of respirators; training and instructions on respirator usage, cleaning, repair, and housing of respirators; the continued surveillance of work area conditions for worker exposure and stress, and for the evaluation of the effectiveness of the respirator program; and the medical evaluation of employees to determine whether they are physically able to wear the respirator selected for use.

In addition to the health care professionals wearing respirators, the infectious patients may also reduce *M. tuberculosis* exposures by wearing respirators; however, it is important that respirators used for this purpose do not have an exhalation valve.

All of the above control measures may reduce a worker's exposure to TB to some extent; however, there are no available methods to date which will quantify the degree of reduction that may be achieved by each method. None of the control methods used alone or in combination can completely eliminate the risk of transmission.[1]

## REVIEW OF ADMINISTRATIVE CONTROLS AT SPECTRUM HEALTH CARE

*A. Description*

Upon entry into Spectrum Health Care, Inc., clients' medical histories, especially with regard to TB exposure, infection, disease, and treatment, are taken. A physical examination, along with HIV and TB screening, are performed. According to Spectrum's written policy, clients who do not have a history of infection or disease and do not have documentation of a negative skin test within the past six months are given a Mantoux skin test (0.1 milliliter of purified protein derivative [PPD] containing five tuberculin units) which is used as a screening test for tuberculous infection. Spectrum Health Care, Inc. uses the American Lung Association's criteria for evaluating the skin test results. If the test shows induration greater than 10 mm, the test is considered positive and the person is transferred to another site for a chest X-ray, smear and culture of sputum specimens, and appropriate medical care, possibly including preventive therapy (if there are no signs of active TB) or treatment of active disease. The staff at Spectrum will provide methadone treatment at the home of clients who have active TB. Additionally, all HIV infected persons are given a chest X-ray regardless of PPD status.

A surveillance program for the health care workers has also been established. Upon hiring, all staff, including those with a history of vaccination with Bacillus of Calmette and Guerin (BCG), are given a TST. The guidelines for reading the TST are similar to the ones described above. Retesting of PPD-negative workers is performed every six months. Also, health care workers who have a documented history of a positive Mantoux test or who have had adequate preventive therapy, are given a yearly chest radiograph. Although the records of skin test conversions among health care personnel are maintained, the records are not routinely analyzed to estimate the risk of TB transmission.

*B. Analysis*

A NIOSH medical investigator reviewed the TST records from July 1991 through March 1993. However, since persons who were excluded by Spectrum from the Mantoux skin testing due to a previous positive PPD reaction were not included in the records, an overall prevalence for the population could not be calculated.

The results from initial and follow-up TST for health-care workers and clients over the past three years were reviewed. Of the 966 skin tests on clients which were reviewed, 67 skin tests were positive (defined as a reaction greater than 10 millimeter [mm] induration). It should be noted that the percentage of positive skin tests over this three year period may be underestimated for the following reasons: (1) some clients seen by Spectrum Health Care received multiple tests over this period; (2) there was no anergy testing by Spectrum Health Care; and (3) a lower cut point (5 mm induration) was not used to define a positive test as recommended for persons with HIV infection or risk factors for HIV infection.
The records of the TB screening included 55 of the 58 current employees. Of the 55, eight persons had a positive skin test prior to employment, and three others tested positive on the initial skin test (reaction greater than 10 mm induration). Of the remaining 44, three persons converted to a positive PPD during their employment (7%). These three employees, who worked in different locations within the facility, performed different job tasks, and converted at different times, were clinically evaluated and placed on preventive therapy. As the duration of employment was not fully available, NIOSH investigators were unable to calculate the incidence of positive skin tests among all Spectrum employees.

## EVALUATION OF ENGINEERING CONTROLS AT SPECTRUM HEALTH CARE

*A. General Ventilation*

For the past five years, the clinic has been housed in a renovated warehouse in Newark, New Jersey. The 20,000 square feet facility is located on the first floor of the three-story building. There are five heating, ventilating, and air-conditioning (HVAC) units which service the clinic, but no information is available regarding the design specifications or capacity of the systems. Each air-handing unit is equipped with a single thermostat which controls the air supply to a specific area or zone; however, the unit does not supply air to the area when the thermostat is in the automatic mode and the temperature is satisfied, or when the system is manually turned off. The thermostats are set at approximately 68°F for cooling season and between 68 and 71°F for heating season.

Air from the clinic is 100% recirculated, meaning that there is no outside air provided to the ventilation systems. The space above the suspended ceiling acts as the return air plenum. This plenum is open throughout the facility, allowing for air mixing between the five systems. There are a few egg-crate type ceiling panels in the hallways which are open to the return air plenum. Also, there are exhaust vents located in the bathrooms; however, these vents are not ducted to the outside, but rather the bathroom exhaust air is mixed with the return air in the open ceiling plenum.

*B. Evaluation Methods*

A walk-through survey of the facility and visual assessment of the ventilation systems were conducted on March 9-11, 1992. The HVAC units and air filters were visually inspected.

Smoke tests were conducted to qualitatively evaluate the pressure relationships of the offices with respect to the hallways and methadone distribution area. For each office, the direction of smoke was observed at the gap between the floor and the bottom of the door, with the door closed.

The volume rate of airflow (in cfm) was measured at the supply diffuser using the Shortridge Airdata™ Multimeter/Flowhood ADM Model 860/8405 with an Electronic Micromanometer (Serial number 70480). All measurements made with the flowhood were performed with the flaps closed and with the use of a flow distribution grille. In addition, the measurements were compensated for supply air temperature and local barometric pressure. Therefore, the measurements were made in actual, rather than standard flow. Direct measurement for temperature and humidity were also collected at various locations throughout the facility.

*C. Evaluation Results*

The physical inspection of the HVAC units indicated that the systems were in good working condition and the air filters were clean. However, the fiberglass panel filters, which are similar to those used in home furnaces, only have an ASHRAE dust spot test efficiency of less than 20%.

The air flow relationships are indicated with arrows in Figures 1 and 2. According to the smoke tube tests, many of the office areas were under negative pressure with respect to the entrance of the facility and the methadone distribution area, meaning that the air flows from the entrance and distribution area into the staff offices. The AIDS Day Care was neutrally pressurized meaning that it was neither under positive nor negative pressure.

Airflow measurements are also shown in Figures 1 and 2. During the evaluation, HVAC units #2 and 3 were not calling for heat and therefore, a majority of the measurements read zero

since no recirculated air was being supplied to these areas. The air flow measurements ranged from -32 to +289 cfm. Since there were no design criteria available for the systems, a comparison of the measured values with design specifications was not possible.

## CONCLUSIONS AND RECOMMENDATIONS

The focus of the investigation was to assess the administrative and engineering controls used to control TB transmission at Spectrum Health Care, Inc. Based on the amount of person-to-person interaction and the fact that the general ventilation systems recirculate 100% of the air, there is a potential for TB transmission from clients with infectious TB to staff and vice versa. Specific recommendations regarding TST screening, and ventilation improvements, as well as respiratory protection usage are presented below.

*A. Administrative Controls*

1. The CDC guidelines recommend the use of the two-step skin testing method. This method should be used to initially screen the staff and clients. This will reduce the likelihood that a boosted reaction will be interpreted as a recent infection upon subsequent testing.[5]

2. Persons with HIV infection should be evaluated for anergy in conjunction with the PPD test. Two comparison antigens should be used. A person with a reaction greater than 2 mm of induration to any skin test antigen should be considered not anergic. In accordance with CDC guidelines, a person who is anergic should be considered for preventive therapy, even if the TST is negative.[23]

3. Records of persons who do not receive a Mantoux test due to a previously documented positive reaction (or other reasons) should be maintained so that the overall TB prevalence of the population can be determined.

4. In addition to semi-annual testing, all employees who are exposed to a client with active TB should receive a Mantoux TST as soon as possible after exposure, unless a negative TST has been documented within the past three months.[1] If the initial test is negative, the test should be repeated 12 weeks after the exposure.[1]

5. There should be strict adherence to the written program. According to records maintained by Spectrum, only 55 of the 58 employees were tested. Also, the results of the TST should be reviewed periodically to estimate the risk of acquiring infection and to evaluate the efficacy of the TB control program.[1]

6. Annual chest X-rays are not necessary for asymptomatic, tuberculin-positive persons. After the initial chest radiograph is taken, repeat chest radiographs are required only if symptoms associated with TB develop.[1]

*B. Engineering Controls*

1. Ideally, the single pass system, which would supply 100% conditioned outside air with no recirculation, should be installed to remove the potentially contaminated air. A less desirable, but alternative solution would be to install a HEPA filter, which removes 99.97% of particles which are greater than 0.3 µm in diameter to filter all of the recirculated air. Proper installation, testing, and maintenance are critical when using HEPA filtration systems. The filters should be installed to prevent leakage between the filter bed and its supporting frame. Also, a preventative maintenance (PM) schedule is required to monitor for leakage and filter loading. Whenever a HEPA filter is installed or replaced, a quantitative leakage and filter performance test using the dioctal

phthalate (DOP) penetration test must be performed.[24] A manometer should also be installed in the filter system to determine the need for filter replacement.

2. Filters should be changed only when Spectrum Health Care, Inc. is closed and the HVAC units are shut down. When the prefilters and HEPA filters are replaced, the old filters should be treated and discarded as infectious waste. The maintenance personnel performing these tasks should be properly trained and appropriate respiratory protection should be worn.

3. Outside air should be provided at all times during occupancy. Also, the ventilation system should be designed to achieve the best ventilation airflow possible, striving for substantially greater than six ACH in all areas since there is the potential for active TB clients present at center.

4. Since the ventilation systems have not been balanced, a test and balance firm who is certified by the National Environmental Balancing Bureau should be consulted. Also, the visual assessment of the current airflow patterns revealed that the air moved from methadone distribution area and examination rooms to the staff offices, instead of moving from clean to less clean areas. After balancing the system, the test and balancing consultant should confirm that the air is flowing from the staff offices into the methadone distributing area, and examination rooms.

5. Air from the bathrooms should not be recirculated within the building. A separate system which is directly exhausted to the outside should be installed.

6. All components of the mechanical system should be placed on a PM schedule. Written records should be maintained on PM and other maintenance activities.

7. During this NIOSH evaluation, the thermostats were set at 68 to 71°F in the winter. However, the temperatures ranged from 75 to 78°F throughout the day in the building. The thermostats should be calibrated to alleviate the thermal comfort problems. The relative humidity levels ranged from 26 to 34%. These levels are slightly below ASHRAE criteria of 30 to 60%. Relative humidities below 30% may produce discomfort from dryness; however, low humidities help restrict microbiological growth. Therefore, the concern regarding discomfort should be balanced against the risk of increased microbiological growth associated with humidification.

8. Since the staff is required to administer methadone to clients with active TB in their homes, the center should establish a policy for health-care workers regarding the use of respiratory protection against potential inhalation hazards when working with known or suspected TB infected clients. A respiratory protection program which meets the requirements set by OSHA (29 CFR 1910.134) should be developed and implemented. Under these circumstances, NIOSH recommends the use of a powered air-purifying respirator equipped with HEPA cartridges.[21]

9. The risk of exposure to infections agents for immunocompromised persons should be minimized. Ideally, an AIDS adult day-care center should not be housed in the same building as the methadone center. If this is not practical, the methadone center and the AIDS adults day-care area should have separate ventilation systems.

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