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44th STREET INDEPENDENCE SUPPORT CENTER
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SUMMARY

On July 8, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an employer representative at the 44th Street Independence Support Center (ISC) in New York City. The request stated concerns regarding the potential for tuberculosis (TB) transmission due to contact with homeless clients, a high-risk group for TB. NIOSH was requested to evaluate the operational status of the ISC's ventilation system and germicidal ultraviolet (GUV) lamps in preventing TB transmission, along with assessing the potential for *Mycobacterium tuberculosis* (Mtb) exposures from the Grand Central Multiservice Center (GCMC), a homeless center located within the same building as the 44th Street Independence Support Center. On October 13-14, 1992, NIOSH investigators conducted a site visit to assess the control measures used to prevent TB transmission at the two facilities.

At ISC, the written tuberculin screening program and results of the client and employee tuberculin skin tests (TST) were reviewed. A visual assessment of the ventilation system and airflow patterns were made, and measurements of the supply and exhaust airflows were obtained and compared to the design specifications. Although this evaluation did not address issues on the efficacy of ultraviolet (UV) radiation, measurements were made in the area where GUV lamps were used to disinfect potentially contaminated air in order to address issues regarding occupational health and safety from potential exposures to UV.

Of the 32 clients who were given the Mantoux skin test (0.1 milliliter of purified protein derivative [PPD]), 10 were PPD positive. However, the staff were PPD negative upon hiring, and there have not been any conversions reported to date.

The majority of the air in the center is recirculated and therefore, there is potential for airborne Mtb to be transmitted throughout the facility. Other deficiencies identified which may increase the potential for TB transmission included insufficient outside air supply, and inconsistent client screening techniques. However, UV overexposures were not documented on the day of the survey.

At the GCMC, a visual assessment of the ventilation system was performed and results of the employee tuberculin screening were reviewed. Of the part-time people in the worker training program 40% tested positive, whereas 56% of the full-time worker training employees were PPD positive. All of the 22 permanent staff were tested and one person tested positive. However, this person received Bacillus of Calmette and Guerin vaccination.

The only mechanical ventilation is the exhaust fans which are located in the bathrooms, gymnasium, and kitchen, and the cool-air recirculating system in the cafeteria. Since the center relies upon exhaust fans and natural ventilation for dilution and removal of air contaminants, there is a potential for TB exposures whenever an active TB client attends the center.

A potential health hazard exists for workers exposed to clients who have active TB in both facilities. In this report, there are recommendations to reduce the potential for TB transmission, including improved TST screening and ventilation at each facility.

Keywords: SIC 8399 (Social Services, Not Elsewhere Classified), tuberculosis, TB, *Mycobacterium tuberculosis*, germicidal ultraviolet radiation, GUV, skin testing, ventilation.

INTRODUCTION

On July 8, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a management request to conduct a health hazard evaluation (HHE) at the 44th Street Independence Support Center (ISC) in New York City (NYC). The request concerned the potential for tuberculosis (TB) transmission resulting from contact with homeless clients, a group at high risk for TB infection. In the past year, there have been at least two known incidents where a client with active TB has attended ISC or Grand Central Multiservice Center (GCMC), a homeless center located in the same building as the ISC. Specifically, NIOSH was asked to evaluate the operational status of the ISC's ventilation system and germicidal ultraviolet (GUV) lamps, and to assess the potential for *Mycobacterium tuberculosis* (Mtb) exposures at the GCMC. On October 13 and 14, 1992, a site visit was conducted to evaluate the administrative and engineering controls used to reduce the workers' exposures at both facilities.

BACKGROUND

Mtb, 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 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 1992, there were 26,673 cases of TB reported--a 1.5% increase from the previous year.[3] Among the populations at high risk for infection are the medically underserved; foreign-born persons from high prevalence countries; persons with low socioeconomic status, human immunodeficiency virus (HIV) infection, or living in long-term care facilities; alcoholics; intravenous drug users; and the homeless.[4,5,6]

Homeless persons are those who do not have customary and regular access to a conventional residence.[7] The number of homeless at any given time is unknown; however, the Urban Institute has estimated that there may have been as many as one million persons homeless in the United States in 1987.[8] TB in the homeless is not surprising since factors that may contribute to the disease, such as malnutrition and stress, are common among these individuals. The publicly funded solution for the homeless is mass shelters. Unfortunately, mass shelters place individuals who are at high risk of infection in close quarters, thereby potentially contributing to the high rate of disease transmission among this population. Previous epidemiological studies have revealed that the incidence of TB in the homeless population is 10 to 50 times that of the general population.[9,10,11] In one study, 1,853 men attending a shelter-based clinic in NYC were screened and found to have an overall infection rate of 42.8%, with 100 cases of active TB (6%). This study suggests that prolonged exposure to the shelter environment can lead to TB infection and potentially to the development of active disease.[12] In a survey of the NYC shelter system, 3% of 810 residents admitted that they had TB and were in treatment or supposed to be in treatment.[13] Shelter employees also appear to be at an increased risk of infection. In a recent outbreak, 23 of 118 staff tested had a documented recent conversion.[14]

Unfortunately, diagnosis and treatment of TB in this setting is difficult due to the transient nature of the population. However, a study of an outbreak of TB at a men's homeless shelter confirmed

that TB outbreaks may be reduced by control programs, such as mass screening and directly observed therapy.[15]

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. The following basic approaches are required: (1) early detection and treatment of persons with TB infection and active TB, (2) rapid isolation of persons with active disease, (3) prevention of the spread of infectious particles into the general air circulation by using source-control methods, (4) reduction of the number of infectious droplet nuclei in air by dilution and removal of air contaminants [trapping organisms by using high-efficiency particulate air (HEPA) filtration or inactivating the organisms with ultraviolet (UV) radiation], (5) appropriate personal protection, and (6) surveillance of staff personnel for infectious TB and active TB.

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]

FACILITY DESCRIPTION

GCMC, a non-profit organization, operates a number of centers for the homeless throughout NYC. Since 1989, GCMC has leased a renovated school on East 44th Street for a homeless center. The building, constructed in 1892, is owned by the Archdioceses and is attached to Saint Agnes Church. GCMC donates a portion of the building to the 44th Street Independence Support Center, a drop-in center for homeless clients who have a history of mental illness. In order to alleviate any confusion regarding the two organizations, each will be discussed separately.

44th STREET INDEPENDENCE SUPPORT CENTER

The ISC, which is affiliated with Gouverneur Diagnostic and Treatment Center, was developed to provide counseling and medical care, and to locate appropriate housing for qualified homeless clients. ISC is located on the third floor of the five-story building and consists of two medical examining rooms and staff offices, a waiting area, and a bathroom. In the waiting room, there is a small reception area. A floor plan of the facility is shown in Figure 1.

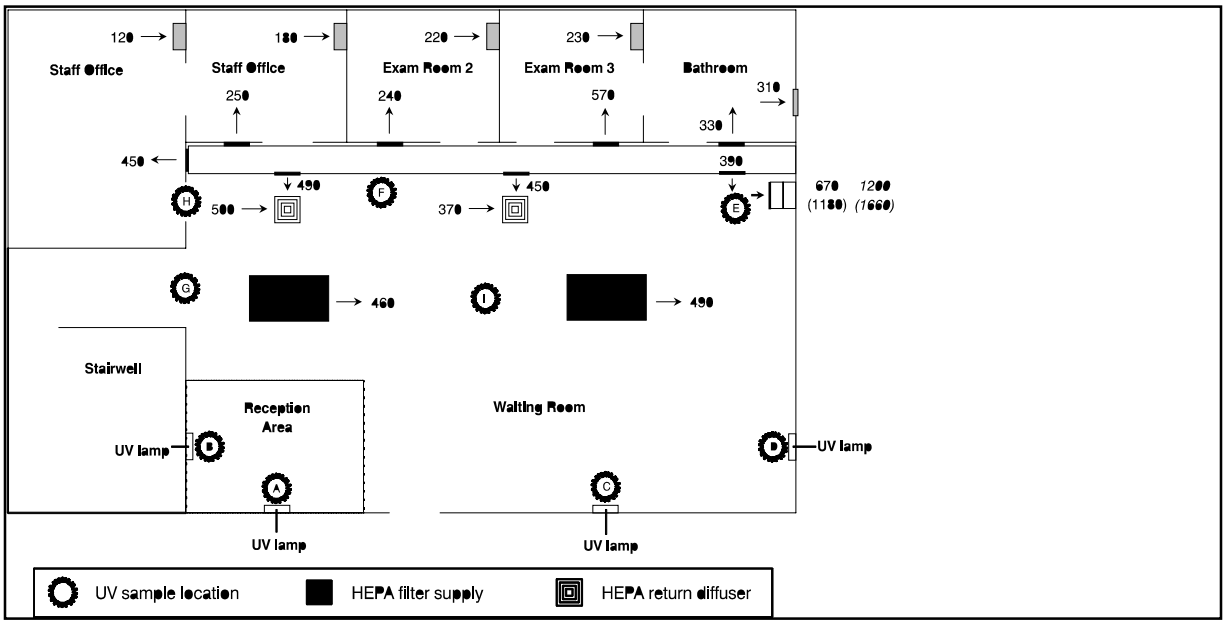


Fig.1. **Facility Lay-Out**

The ISC is open from 9 a.m. to 7 p.m., Monday through Friday, except for Wednesday afternoons. There are eight workers employed at the clinic as physicians, social workers, nurses, and clerical staff. The amount of time spent with the client varies. Approximately 300 clients have utilized the facility over the past year; however, this number includes clients who were briefly evaluated and then referred for housing administered by other organizations, inpatient or outpatient care, or to a different day program. Of these 300 clients, 62 people have had medical evaluations or intervention performed at this facility.

ADMINISTRATIVE CONTROLS

Screening

Since the clients have a history of mental illness, they are allowed to visit the Center during the regular business hours for a few days to settle-in prior to being evaluated by the staff. Once initial contact is made, the clients' medical histories, especially with regard to TB exposure, infection, disease, and treatment, are taken. According to the ISC's written policy, clients who do not have a history of infection or disease 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. If the test shows induration greater than 5 millimeters (mm), 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. Clients with 5 mm of induration are questioned to determine whether there has been a recent conversion or known exposure. Since it is difficult to determine whether a recent exposure or conversion has occurred, most of these persons are given preventive treatment with isoniazid. Prophylactic treatment is not administered to clients who have less than 5 mm of induration; however, such clients are referred for HIV testing. If a client refuses skin testing or preventive treatment, the person will no longer be allowed to visit the clinic.

A surveillance program has also been established for protecting the staff. Upon hiring, the staff are given a tuberculin skin test and retesting is performed every six months.

Results and Discussion of the Screening

Of the 62 clients who have had intervention or medical care at the ISC, 32 persons were administered skin tests (Table 1). Of these 32, 10 persons had positive reactions (greater than 5 mm induration), and 18 persons had negative results. Four other persons did not return for the reading of the test.

Of the 10 persons with positive PPD results, eight were placed on prophylaxis, one refused treatment, and the other person was transferred to another clinic, where another PPD and chest radiogram were administered and found to be negative.

Of the 18 PPD-negative clients, 14 underwent anergy testing to determine whether his/her reactivity to specific antigens was diminished (which would possibly indicate a false-negative PPD reading). Of these 14, 10 were positive for other skin test antigens, suggesting that their PPD readings were accurate. The other four individuals were either negative (three) or indeterminate (one), suggesting that there was the potential for a false-negative TB skin test result.

TABLE 1

Characterization of the Surveillance Program

Status	No. of Persons
PPD Performed	32
PPD Refused	5
History of Adequate Treatment	5
Currently Undergoing Treatment	2
Probable/Definite History of Positive PPD; No Treatment	6
Documented Negative PPD	12
TOTAL	**62**

All of the staff were PPD negative upon hiring, and there have not been any conversions reported to date.

VENTILATION EVALUATION

Description

The air handling unit (AHU) for the ISC is a constant volume system, designed to supply a total of 2,000 cubic feet per minute (cfm) of air with 400 cfm of outside air (OA). The OA intake is a 10-inch diameter circular duct, located on the side of the building, and is regulated by a manually-operated butterfly damper. Air supplied from the air handler is distributed to the clinic through rigid ducts which feed into rectangular diffusers. Air is filtered by a two foot by two foot wire mesh prefilter (ASHRAE estimated dust spot efficiency of less than 20%) immediately followed by an electrostatic precipator. Two thermostats are used to operate the ventilation systems. One controls the heating coils, while the other thermostat controls the AHU cooling coils and fan. A portion of the air from the staff offices and medical examination rooms is exhausted directly to the outside. The bathroom has a separate exhaust fan which is interlocked with the light switch.

There are also two stand-alone recirculating systems in the waiting area. The air is drawn into the ductwork above the suspended ceiling, past the HEPA filter, and then redistributed to the waiting area.

There are no balancing or airflow specifications available. Currently, there is no preventive maintenance (PM) schedule in place.

Ventilation Guidelines

There are no ventilation recommendations that specifically address the prevention of disease transmission in homeless centers, other than the recommendation by the Advisory Council for the Elimination of Tuberculosis which specify OA supply rates of 25 cfm/person or above.[16] However, there are guidelines for ventilation criteria for thermal comfort and for airflow specifications in health care facilities.[1,17,18,19]

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 OA supplies of 20 cfm/person for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges.[19]

Recommended ventilation rates are sometimes expressed as 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. 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.[17,18] 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 10 ACH, with all air exhausted directly to the outside. The recommendations provided by ASHRAE and AIA are provided to reduce exposures to airborne microorganisms; however, there is no scientific data which supports the adequacy of these guidelines in protecting workers against Mtb. In fact, two hospital ventilation studies provide evidence that indicate that six ACH do not effectively control airborne bacteria.[20,21] Additionally, other published studies indicate that ventilation rates substantially higher than six ACH do improve dilution and removal of airborne bacteria.[20-22] 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 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. Negative pressure can be achieved by exhausting 10% (but no less than 50 cfm) more air than the amount supplied to that area.

Ventilation Methods

Visual Inspection

A walk-through survey of the facility and visual assessment of the ventilation systems were conducted on October 13 and 14, 1992. The OA intake, AHU, cooling coils, and filters were visually inspected.

Smoke tests were conducted to qualitatively evaluate the pressure relationships of the examination and staff rooms relative to the waiting area, and waiting area relative to the GCMC. For each of the rooms, the direction of smoke was observed at the gap between the floor and the bottom of the door, with the door closed.

Measurements

Direct measurement of the outside airflow was not possible due to the configuration of the system. Therefore, the OA supply rate was estimated (in cfm) using the Shortridge Airdata™ Multimeter/Flowhood ADM Model 860/8405 with an Electronic Micromanometer (Serial number 70480) at the inlet of the electrostatic precipator with the intake dampers fully opened and then again with the dampers closed. The amount of OA was estimated as the difference between these two measurements. 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.

The volume rate of airflow was also measured at the supply air and exhaust diffusers using the flowhood. However, in many instances, it was necessary to measure the air velocity in the supply and exhaust ducts using a TSI VelociCalc Plus® velometer, due to the small size and

location of the diffusers which prevented the use of the flowhood. In these situations, the velocity measurements were made using a twelve-point center-line traverse in the horizontal direction only. Ideally, the measurement should be made 8-10 duct diameters from a disturbance, such as an elbow or branch, to ensure accurate readings;[23] however, due to the proximity of the diffusers or elbows, this was not always possible. The volumetric airflow was estimated by multiplying the average air velocity by the cross-sectional area of the duct at the point where measurements were made. The airflow measurements were then compared to the design specifications.

Results and Discussion of the Ventilation Assessment

Visual Inspection

A visual inspection of the AHU indicated that the OA damper was closed, resulting in a decrease in the amount of OA supplied to the center. Also, several potential contamination sources were observed near the OA inlet. Two sanitary exhaust vents were located within approximately three feet of the outside air intake, and algae growth was observed on the roof, suggesting that stagnant water had been present for an extended period of time.

The condensate pan was tilted toward the drain, and the drain was properly trapped. There was no water accumulation or debris within the AHU or compressor. However, the electrostatic precipator prefilters were heavily loaded with dust.

The pressure relationship of the waiting room with respect to the GCMC hallway is negative, meaning that the air flows from the GCMC into the waiting area of the ISC. The medical examination rooms and the bathroom were also under negative pressure with respect to the waiting area. However, the staff offices were under positive pressure.

Measurements

When the OA damper is closed, very little outside air is supplied to the Center. This is not consistent with either the Advisory Council for the Elimination of Tuberculosis (ACET) or ASHRAE recommendations of at least 25 cfm OA/person for homeless shelters and 20 cfm OA/person for office buildings, respectively.

During this survey, the OA dampers were fully opened and ventilation measurements were collected. The amount of OA supplied to the ISC is approximately 500 cfm when the damper is completely opened.

Airflow measurements are shown in the figure on page 5. One factor which influences the amount of air supplied by the system is the dust collected on the filters. As dust collects on filters, the system resistance increases, causing the airflow to decrease. The prefilters and electrostatic precipator panels were extremely dirty. Measurements were collected with and without the prefilters in place. The amount of total airflow increased approximately 480 cfm (~40%) when the filters were removed.

Supply airflow rates ranged from 240 to 570 cfm. The total airflow from the supply diffusers was approximately 3,200 cfm, indicating that approximately 16% of the total supply is outside air when the dampers are fully opened. The exhaust airflow rates ranged from 120 to 310 cfm, with a total airflow exhausted of 1,100 cfm, instead of the approximately 3,000 cfm as designed.

These measurements suggest that the waiting area, bathroom, and examination rooms areas should be under positive pressure; however, the visual assessment of the air pressure differentials at the doorways indicates that these areas are all under negative pressure with respect to the surrounding areas as they should be. Possible explanations for these differences are that two different instruments were used to evaluate the supply and exhaust airflow rates, and the accuracy of the reading varies somewhat with each instrument; the airflow measurements were collected near the diffusers which would reduce the accuracy of the velocity measurements; and there were losses due to leakage and conductive forces, such as a large crack next to the exhaust duct in the medical examination room which was pulling air out of the clinic and could not be measured by the instruments.

The flowhood was used to determine the amount of air recirculated through the HEPA filtration bank. In one of the stand-alone systems, there was approximately 500 cfm of air being supplied by the system, although only 400 cfm of air (measured at the return in the room) was being supplied back to the recirculating unit. After further investigation, the ductwork was found to be improperly joined using duct tape instead of sheet metal. Because of the leaks, air in the ceiling plenum was drawn into the return ductwork, filtered, and recirculated into the waiting room.

The ACH (theoretical) was calculated at nearly six for the large staff office, while the small office was 16. Examination rooms #2 and #3, and the bathroom were 24, 26, and 46 ACH, respectively.

GERMICIDAL ULTRAVIOLET RADIATION EVALUATION

Description

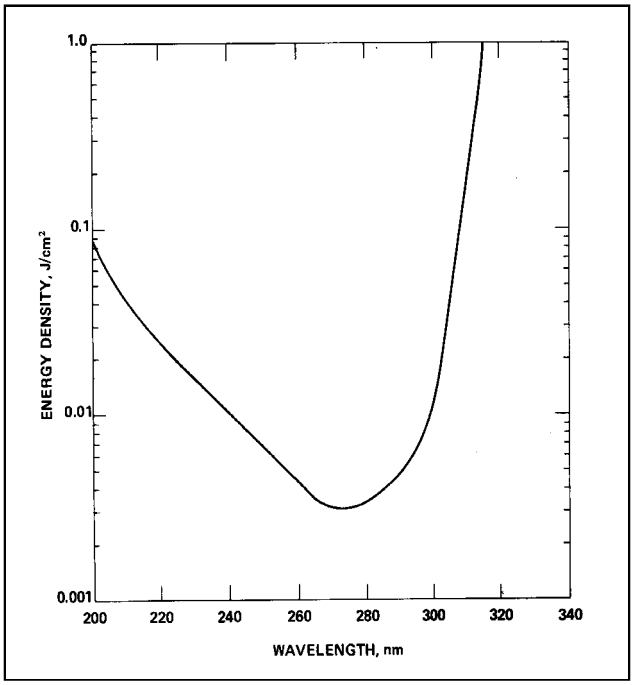
In July 1991, four GUV lamps with louvers were installed nine feet from the floor and 10 inches from the ceiling in the waiting room in an effort to disinfect the upper room air through indirect UV irradiation. The wall-mounted fixtures and 25 Watt lamps are manufactured by American Ultraviolet (Model #G25T6L). According to the manufacturer, these low-pressure mercury lamps allow 90% of the radiant emission at 253.7 nanometers (nm), which is within the germicidal radiation range of 200 to 300 nm; hence, the lamps are considered GUV lamps. GUV lamps have been used as an attempt in controlling exposures to TB for many years. However, this evaluation does not address issues on the efficacy of UV, but rather addresses issues regarding occupational health and safety from potential exposures to UV.

UV Guidelines

The critical organs of exposure for the 254 nm radiation are the eyes and skin. At this wavelength, the radiation is absorbed by the outer surface of the eye, and overexposure can result in inflammation of the cornea (photokeratitis) and/or conjunctiva (conjunctivitis).[24] Keratoconjunctivitis is a reversible injury, lasting 24-48 hours, but it is a debilitating condition while it runs its course. There is a latent period of a few hours, depending upon the dose, and therefore it is sometimes not recognized as an occupational injury by the worker. Skin exposure to UV radiation also can result in erythema (reddening). This is also a reversible injury and the time course depends on the severity of the burn. UV radiation in the UV-C range (100-290 nm) has been reported to cause sarcomas and squamous cell carcinomas in mice.[25,26] Some recent laboratory studies have also demonstrated that UV radiation can activate human immunodeficiency gene promoters (genes in HIV that prompt replication of the virus), however, the implications for humans are unknown.[27,28,29,30,31]

In 1972, NIOSH formulated criteria for a recommended standard for occupational exposure to UV radiation.[24] Because the biological effects from exposure to UV radiation are dependent on the intensity and energy distribution of the source, as shown in Figure 2, the NIOSH recommended exposure limit (REL) is wavelength-dependent in the spectral region of interest (200-315 nm). The REL is based on an action spectrum derived from thresholds for acute effects of erythema and keratoconjunctivitis from both human and animal studies. The REL for 8-hour exposures has a maximum permissible dose level of 0.003 Joules per square centimeter (J/cm^2) at 270 nm. At 254 nm, the predominant UV wavelength for germicidal lamps,[32] the REL is 0.006 J/cm^2. If the UV energy is from a broad-band source, the effective irradiance relative to a 270 nm monochromatic source must be calculated using a formula described in the NIOSH criteria document.[24] If the UV energy is from a narrow-band or monochromatic source, permissible dose levels for a daily 8-hour period can be read directly from Figure 2. Permissible exposure times in seconds can be calculated by dividing the 8-hour dose level (i.e., 0.006 J/cm^2 for UV exposure to 254 nm) by the measured UV irradiance in watts per square centimeter (W/cm^2).

Figure 2. Recommended Ultraviolet Radiation



UV Methods

Occupational exposures were measured using a model 1400A International Light (IL) radiometer connected to a SEL 240 detector that permitted the system to read UV levels directly in units of W/cm^2. The measurement range is 0 to 1 milliwatt per square centimeter (mW/cm^2) for emissions in the 200 to 320 nm range. The radiometer used in this evaluation was calibrated within six months of use by the manufacturer.

Ultraviolet radiation measurements were made at several locations in the waiting area where the ceiling-mounted GUV lamps are located. GUV lamp placement, along with the sampling locations (A through I) are shown in the figure on page 5. Since the employees move throughout the Center and the amount of time spent in the waiting area on a given day can vary tremendously based on the case load, it is not feasible to estimate the workers' actual daily exposure. UV measurements were made at a distance of four inches from the center of the lamp, which may represent an exposure received by a maintenance worker, and/or at 5.5 feet from the floor, which is an estimate of the exposure received at eye height for an average standing worker. These measurements can be used to estimate the allowable time that a worker can be in the area of the UV lights.

Results and Discussion of the UV Measurements

All lamps were operational, but all had dust build-up on the bulbs and had not been changed since their installation in July 1990. There is no PM schedule in place. The results of the UV radiation measurements are shown in Table 2.

Table 2

UV Radiation Levels and Recommended Exposure Times at Various Distances from Germicidal Lamps

Location	4" from Lamp (μW/cm^2)	Permissible Exposure Time (seconds)	5.5' from Floor (μW/cm^2)	Permissible Exposure Time (hours)*
A	460	13	0.06	> 8
B	570	11	0.25	6.7
C	370	16	0.15	> 8
D	450	13	0.15	**> 8**
E	---	---	0.16	**> 8**
F	---	---	0.24	6.9
G	---	---	0.24	6.9
H	---	---	0.22	7.6
I	---	---	0.15	**> 8**

*For workers with unprotected eyes and skin.

At a distance of four inches away from the lamp, the UV levels emitted ranged from 370 to 570 microwatts per square centimeter (μW/cm^2), showing a wide variation among the four lamps. It is unclear if this variation represents a variation in individual lamp characteristics or other factors. Permissible exposure times were calculated, and ranged from 11 to 16 seconds. The UV levels measured with the detector facing the ceiling and at 5.5' from the floor, ranged from 0.06 to 0.25 μW/cm^2, corresponding with permissible exposure times of 6.7 hours to greater than 8 hours, respectively (locations A - D). To further evaluate potential

UV exposures, levels were measured at five other locations at a height of 5.5 feet from the floor (locations E - I). Table 2 also lists the results of these measurements. The permissible exposure times ranged from 6.9 hours to greater than eight hours. It should also be noted that reflective paint was used on the walls and ceilings, possibly contributing to the level of exposure in the waiting area.

CONCLUSIONS AND RECOMMENDATIONS

NIOSH supports the Occupational Safety and Health Administration policy on the use of a hierarchy of controls in reducing exposures to hazardous substances in the workplace. While it is not possible to determine the effectiveness of each of the controls in the hierarchy, every effort should be made to prevent and remove emissions from the pathway between the source and the workers. This includes appropriate TB screening of clients and staff, reducing microbial contamination of the air by dilution ventilation, and using supplemental air cleaning devices, such as HEPA filtration.

The focus of this investigation was to assess the administrative and environmental controls used to minimize TB transmission at the ISC. Based on the amount of person-to-person interaction, there is a potential for TB transmission from homeless clients with infectious TB to staff and vice versa. Although the Center has an established TB screening program, a number of areas should be improved, such as enforcing strict adherence to the screening program, providing adequate diagnostic testing for persons with HIV infection, and implementing more effective TST evaluation and documentation procedures in health-care personnel.

Since much of the air is recirculated, there is the potential for Mtb to spread throughout the facility whenever a client with active TB enters the clinic. Problems identified during the investigation included insufficient amounts of outside air and air changes, and inadequate preventive maintenance. This evaluation addressed only the occupational health and safety issues regarding the UV lamps. Based on the UV measurements collected and the amount of time that the employees currently spend within the waiting area, the UV radiation levels are within an acceptable range. Specific recommendations regarding TB screening, ventilation, and UV improvements are presented in the following sections.

Administrative Control Recommendations

1. There are inconsistencies in adherence to ISC's written program. There were a number of occasions (approximately 50% of the time) when the clients were not tested, yet were allowed to visit the clinic. Ideally, screening should be performed as soon as possible to identify persons with TB infection and provide appropriate therapy.

2. The Centers for Disease Control and Prevention (CDC) recommends that homeless persons with HIV infection should be given a Mantoux skin test, even though false-negative results may occur.[16] The results of one study conducted in NYC revealed that 62% of 169 homeless men tested positive for HIV antibodies.[33] As the immune system of persons with HIV progressively weakens, the ability of the immune system to react to the tuberculin skin test decreases. Previous studies have found that persons with HIV infection are more likely to have false-negative skin tests than persons without HIV infection.[34,35,36] However, homeless persons with clinical AIDS or other HIV-related disease should receive a chest radiograph as part of the initial screening, regardless of their PPD status.[16]

3. In accordance with CDC guidelines, homeless clients who are anergic should be considered for preventive therapy, even if the TST is negative.[1]

4. Some of the clients may remain with the clinic for more than a year; therefore, all tuberculin-negative clients should be retested at 6- to 12-month intervals since their risk of exposure is high enough to justify the repeat testing.

5. CDC recommends the use of the two-step skin testing method. This method should be used to initially screen the staff and clients. If the first skin test is negative, 1-3 weeks later a second test should be given. This will reduce the likelihood that a boosted reaction will, upon subsequent testing, be interpreted as a recent infection.[5]

6. A written skin testing protocol for the staff should be prepared. The results of the semi-annual tuberculin skin tests should be maintained in a central confidential file and should be reviewed periodically to estimate the risk of acquiring infection and the efficacy of the TB control program. In addition to the semi-annual testing, all employees who are exposed to a client with active TB should be retested unless a negative tuberculin skin test has been documented within the preceding three months. If the initial test is negative, the test should be repeated 12 weeks after exposure.[1]

Ventilation Recommendations

1. Ideally, the single pass system, which would supply 100% conditioned OA 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. Although the ability of HEPA filters to remove tuberculosis bacilli has not been studied, HEPA filters have been effective in capturing *Aspergillus* spores[37,38,39], which are similar in size range to tuberculosis droplet nuclei and therefore, theoretically should be effective in removing the nuclei. A ventilation system engineer should be consulted to determine the feasibility of replacing the electrostatic precipator, presently used to remove contaminants from the recirculated air, with a HEPA filter. 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 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.[40] A manometer should also be installed in the filter system to determine the need for filter replacement.

2. Filters should be changed only when the ISC is closed and the AHU is 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. 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 ISC. An exhaust system should be installed in the waiting area to attain this criteria.

4. Airflow measurements indicate that the ventilation system is not balanced since there is not an even distribution of air throughout the facility. A test and balance firm who is certified by the National Environmental Balancing Bureau should be consulted to

perform this task. The visual assessment of the current airflow patterns revealed that the air moved from clean to less clean areas, which is appropriate. The test and balance firm should confirm this after balancing the system.

5. Outdoor air intakes should be located at least 30 feet from exhaust outlets to prevent re-entrainment of contaminated air.[17,19] Therefore, the exhaust outlet should be ducted to the roof, projecting upward or horizontally away from the outdoor intake.

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. All exhaust and recirculating filtration systems, including the bathroom exhaust, should run continuously while the building is occupied except during filter changes. The bathroom exhaust fan should be disconnected from the light switch and placed on an independent control switch.

8. The ductwork for the HEPA recirculating system should be repaired. To aid in the removal of contaminants, the system should run for a few hours prior to and after occupancy, instead of being shut down at the end of the day.

UV Recommendations

1. Based on the UV measurements collected, the UV radiation levels were within an acceptable range; however, the bulbs had not been changed in over a year. Using an UV radiometer, measurements should be made whenever new bulbs are installed or changes are made in the location or design of the fixtures to determine the UV levels. UV radiation levels should not exceed the recommended guidelines. Also, the equipment used to measure UV radiation should be maintained and calibrated on a regular basis.

2. In areas where UV lamps are used, non-reflective paint should be used to further reduce the UV exposures.

3. A PM program should be established outlining the schedule and procedures for cleaning and replacing UV bulbs.

4. Warning signs should be posted wherever germicidal UV irradiation is present to alert people of the hazard.

5. All workers should be trained in the hazards associated with UV radiation.

GRAND CENTRAL MULTISERVICE CENTER

GCMC is a drop-in center which provides food, shelter, limited social services, housing, and job placement for homeless persons. GCMC is a non-profit organization which is funded by the Human Resource Administration (HRA). There are approximately 85 employees, more than half of whom are in a worker training program which provides employment for persons using the homeless facility. The Center is open 24 hours per day, seven days per week.

The cafeteria, gymnasium, and three classrooms on the fifth floor are the areas in which the homeless congregate. Also, there are bathrooms, a kitchen, and a number of office areas for administrative and counseling services.

ADMINISTRATIVE CONTROLS

Screening

There are approximately 250 people who visit the facility each day. A log of each person's name and social security number is recorded and cross-referenced, once a month, with a centralized file of all suspected or confirmed active TB cases maintained by the NYC Department of Health (DOH), Bureau of TB Control.

In March 1992, 84 employees were given a Mantoux skin test to detect tuberculous infection. According to GCMC's policy, a person with a PPD reaction (greater than 5 mm of induration) was considered positive and the person was referred to the NYC DOH for follow-up evaluation. No baseline tests were previously performed, and no future screenings were scheduled.

Results of Screening

Of the 35 part-time people in the worker training program, 90% were tested and approximately 40% of these tested positive. Twenty-five of the 27 full-time worker training employees were tested, and 56% were PPD positive. All 22 permanent staff were tested. One person tested positive; however, this person received Bacillus of Calmette and Guerin (BCG) vaccination, which can be the cause of a positive reaction.

VENTILATION EVALUATION

Description

Exhaust fans located in the kitchen, bathrooms, and gymnasium are used to remove contaminants in these areas. The fans are manually controlled by an on-off switch. Natural ventilation, such as through windows and doors, along with leakage through the building envelope, are relied upon for outside and make-up air, and for distribution of air to the facility. A boiler located in St. Agnes Church regulates the steam heat delivered to the baseboards throughout the facility. The system is thermostatically controlled to deliver heat when the outside temperature is less than 35°F. Each office area has a window air-conditioning unit which cools and recirculates the air in that room. Also, a recirculating system provides cooling to the kitchen and cafeteria in the basement. At the time of the survey, the system was not functioning properly. Upon further investigation, it was discovered that the system was malfunctioning because the cooling coils were frozen.

CONCLUSIONS AND RECOMMENDATIONS

Since the GCMC relies upon the NYC DOH centralized file of all suspected or confirmed active TB cases and uses natural ventilation and exhaust fans to remove air contaminants, there is a potential for TB exposures whenever a client with active TB attends the GCMC. Specific recommendations regarding administrative and engineering controls are presented in the following sections.

Administrative Controls Recommendations

1. Ideally, all persons entering the facility should be given a PPD skin test for TB upon entry to the facility. At a minimum, shelter staff should have more interaction with the homeless persons and should be identifying and isolating persons with symptoms suggestive of TB. Also, the staff should ensure that any suspected cases are referred for medical evaluation and treatment.

2. To increase the probability that a person with active disease will still be at GCMC, the lag time between gathering the individual's information and referencing it with the NYC DOH records should be reduced.

3. Educational material on TB, such as the mode of transmission, common signs and symptoms, and method of treatment and prevention should be provided to the staff and clients.[16]

4. A written skin testing protocol for the staff should be prepared. Staff should receive a Mantoux tuberculin skin test when they start work and every six months thereafter. The

two-step skin testing method is recommended by CDC. The results of the semi-annual tuberculin skin tests should be maintained in a central confidential file and should be reviewed to evaluate the effectiveness of infection-control and screening practices.[5]

5. In addition to the semi-annual testing, all employees who are exposed to a client with active TB should be retested unless a negative tuberculin skin test has been documented within the preceding three months. If the initial test is negative, the test should be repeated 12 weeks after exposure.[1]

Ventilation Recommendations

1. A single pass system which would supply 100% conditioned OA with no recirculation would provide the most effective method of removing the potentially contaminated air. A less desirable, but alternative solution would be to install a recirculating system equipped with a HEPA filter. 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 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 DOP penetration test must be performed.[40] A manometer should also be installed in the filter system to determine the need for filter replacement.

2. When the prefilters and HEPA filters are replaced, the used 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. 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 of active TB clients present at the Center. In addition to supplying the specified airflow, ventilation systems should also provide satisfactory 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 the gymnasium. This can be accomplished by creating negative (lower) pressure in the area into which flow is desired relative to adjacent areas. Negative pressure can be achieved by exhausting 10% (but no less than 50 cfm) more air than supplied to that area. A test and balance firm should consulted to perform this task.

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

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