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Tuberculosis Isolation Cell Infection Control	ACA Standards: 2-CO-4E-01, 5-ACI-6A-14M		
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Tuberculosis Isolation Cell Infection Control

The Oklahoma Department of Corrections (ODOC) has implemented administrative and engineering controls for the prevention and to combat the spread of tuberculosis (TB) in facilities under its jurisdiction. These controls comply with guidelines established by the Centers for Disease Control and Prevention (CDC) and the Oklahoma State Department of Health. (2-CO-4E-01, 5-ACI-6A-14M)

I. Purpose

A. Goal

1. To provide an environment that will allow reduction of the concentration of droplet nuclei.

2. To prevent the escape of droplet nuclei from such rooms into the corridor and other areas of the facility using directional airflow.

3. To capture and remove airborne contaminants without exposing person(s) in the area to infectious agents.

4. To separate inmates who are likely to have infectious tuberculosis from other persons. (5-ACI-6A-14M, b# 3)

B. Definition

TB is a bacterial infection caused by a rod-like organism called Mycobacterium tuberculosis (M. tuberculosis). M. tuberculosis is carried in airborne particles or droplet nuclei that can be generated when a person who has pulmonary or laryngeal TB sneezes, coughs, speaks, or sings. The particles are an estimated 1-5 µm (microns) in size, and normal air current can keep them air borne for prolonged time periods and spread them throughout a room or building.

II. Control

Transmission of M. tuberculosis is a recognized risk in healthcare facilities. The magnitude of the risk varies by the type of healthcare facility and the effectiveness of TB infection-control intervention. The probability that a person who is exposed to M. tuberculosis will become infected depends primarily on the concentration of infectious droplet nuclei in the air and the duration of exposure. The TB infection-control program will be based on a hierarchy of control measures:

A. Administrative Controls

1. Develop and implement effective written policies and protocols to ensure the rapid identification, isolation, diagnostic evaluation, and treatment of persons likely to have TB;

2. Implement effective work practices among healthcare workers and security staff transport officers in the health care facility;

3. Educate, train and counsel healthcare workers and security staff transport officers about TB; and

4. All inmates who have completed reception TB testing and all employees working in a facility who have completed the new hire TB testing will be screened annually for exposure, as outlined in OP-140301 entitled “Tuberculosis Control Program.”

B. Engineering Controls

Engineering controls are used to prevent the spread and reduce the concentration of infectious droplets nuclei through:

1. Direct source control using local exhaust ventilation;

2. Control direction of airflow to prevent contamination of air in areas adjacent to the infectious source;

3. Dilute and remove contaminated air via general ventilation; and

4. Air cleaning via air filtration or ultraviolet germicidal irradiation.

C. Effect of Administrative and Engineering Controls Hierarchy

The two levels of the hierarchy minimize the number of areas in the healthcare facility where exposure to infectious TB may occur. They will reduce, but may not eliminate, the risk in those few areas where exposure to M. tuberculosis can still occur.

III. Physical Plant Essentials

A. Housing

1. Rooms used for TB isolation will be single-occupant rooms with negative pressure relative to the corridor or other areas connected to the room.

2. Doors between the isolation room and other areas will remain closed except for entry into or exit from the room. The room's openings (e.g., windows, electrical and plumbing entries) will be sealed as much as possible. However, a small gap of 1/2 to 3/4 inch will be at the bottom of the door to provide a controlled airflow path. Proper use of negative pressure will prevent contaminated air from escaping the room.

B. Air Discharge

1. Recommended general ventilation rates for healthcare facilities are usually expressed in number of Air Changes per Hour (ACH). This number is the ratio of the volume of air entering the room per hour (Q cubic feet per minute), divided by the room volume (V- cubic feet) and multiply by 60:

$$ACH = Q / V \times 60$$

2. To reduce the concentration of droplet nuclei, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American Institute of Architects (AIA), and the Health Resources and Services Administration (HRSA) recommend a minimum of 12 Air ACH for TB isolation rooms and treatment rooms.

3. Air from TB isolation rooms and treatment rooms in which inmates with infectious TB may be examined will be exhausted directly to

the outside of the building and away from air intake vents, persons, and animals.

a. Exhaust ducts will not be located near areas that may be populated (i.e., near sidewalks or windows that could be opened).

b. Ventilation system exhaust discharges and inlets will be designed to prevent reentry of exhausted air.

c. Wind blowing over a building creates a highly turbulent re-circulation zone, which can cause exhausted air to re-enter the building. Exhaust flow will be discharged above this zone.

IV. Air Control Procedure

A. Ventilation

General ventilation is used for several purposes, including diluting and removing contaminated air, controlling airflow patterns within the rooms, and controlling the direction of airflow throughout the healthcare facility.

1. Dilution and Removal

a. In this process, the supply (uncontaminated) air mixes with the contaminated room air (dilution), which is subsequently removed from the room by exhaust system. This process reduces the concentration of the nuclei droplets in the air.

b. The supply air is either outside air that has been conditioned or air from a central system that supplies a number of areas. After air passes through the contaminated room or area, 100% of that air is exhausted to the outside air.

2. Airflow Patterns within Rooms (Air Mixing)

To provide optimum airflow patterns and prevent both stagnation and short-circuiting of air:

a. General ventilation systems should be designed to provide optimal patterns of airflow within rooms and prevent air stagnation or short-circuiting of air from the supply to the exhaust (i.e., passage of air directly from the air supply to the air exhaust).

b. To provide optimal airflow patterns, the air supply and exhaust should be located in such a way that clean air first flows to parts of the room where healthcare workers are

likely to work, and then flows across the infectious source and into the exhaust. In this way, the healthcare worker is not positioned between the infectious source and the exhaust location. Although this configuration may not always be possible, it should be used whenever feasible. Airflow patterns are affected by large air temperature differentials, the precise location of the supply and exhausts, the location of furniture, the movement of healthcare workers and inmates, and the physical configuration of the space. There are two ways to achieve this airflow pattern:

(1) To supply air at the side of the room opposite the occupant and exhaust it from the side where the occupant is located; or

(2) When the supply air is cooler than the room air, it should be supplied near the ceiling and exhausted near the floor.

3. A reasonably good qualitative measure of mixing can be estimated by releasing smoke from smoke tubes at a number of locations in the room and observe the movement of the smoke. Smoke movement in all areas of the room indicates good mixing. Stagnation of air in some areas of the room indicates poor mixing and movement of the supply and exhaust openings or redirection of the supply air is necessary.

B. Airflow Directions in the Facility

To contain contaminated air in localized areas in a facility and prevent its spread to uncontaminated areas:

1. Directional Airflow

The general ventilation system should be designed and balanced so that air flows from less contaminated (i.e., more clean) to more contaminated (less clean) areas. For example, air should flow from corridors (cleaner areas) into TB isolation rooms (less clean areas) to prevent spread of contaminants to other areas.

2. Negative Pressure for Achieving Directional Airflow

The direction of airflow is controlled by creating a lower (negative) pressure in the area into which the flow of air is desired. For air to flow from one area to another, the air pressure in the two areas must be different. Air will flow from a higher-pressure area to a lower-pressure area. The lower-pressure area is described as being at negative pressure relative to the higher-pressure area.

Exhausting air from an area at a higher rate than air is being supplied attains negative pressure. The level of negative pressure necessary to achieve the desired airflow will depend on the physical configuration of the ventilation system and area, including the airflow path and flow openings, and should be determined on an individual basis by an experienced ventilation engineer.

C. Achieving Negative Pressure in a Room

To control the direction of airflow between the room and adjacent areas, thereby preventing contaminated air from escaping from the room into other areas of the facility:

1. Pressure Differential

a. The minimum pressure difference necessary to achieve and maintain negative pressure that will result in airflow into the room is very small (0.001 inch of water). Higher pressures (greater than or equal to 0.001 inch of water) are satisfactory; however, these higher pressures may be difficult to achieve. The actual level of negative pressure achieved will depend on the difference in the ventilation exhaust and supply flows and the physical configuration of the room, including the airflow path and flow openings. If the room is well sealed, negative pressures greater than the minimum of 0.001 inch of water may be readily achieved. However, if rooms are not well sealed; as may be the case in some older facilities, achieving higher negative pressures may require exhaust/supply flow differentials beyond the capability of the ventilation system.

b. To establish negative pressure in a room that has a normally functioning ventilation system, the room supply and exhaust airflow must first be balanced to achieve an exhaust flow of either 10% or 50 cubic feet per minute (CFM) greater than the supply (whichever is the greater). In most situations, this specification should achieve a negative pressure of at least 0.001-inch of water. If the minimum 0.001 inch of water is not achieved and cannot be achieved by increasing the flow differential (within the limits of the ventilation system), the room should be inspected for leakage (e.g., through doors, windows, plumbing, and equipment wall penetrations) and corrective action will be taken to seal the leaks.

c. Negative pressure in a room can be altered by changing the ventilation system operation or by the opening and closing of the room's doors, corridor doors, or windows. When an operating configuration has been established, it is essential that all doors and windows remain properly closed in the

isolation room and other areas (i.e., doors in corridors that affect air pressure) except when persons need to enter or leave the room or area.

2. Alternate Methods for Achieving Negative Pressure

If the existing ventilation system is incapable of achieving the desired negative pressure because the room lacks a separate ventilation system or the room's system cannot provide the proper airflow, steps should be taken to provide a means to discharge air from the room. The amount of air to be exhausted will be the same as discussed previously

3. Monitoring Negative Pressure

The negative pressure in a room can be monitored by visually observing the direction of airflow (i.e., using smoke tubes) or by measuring the differential pressure between the room and its surrounding area.

a. Smoke from a smoke tube can be used to observe airflow between areas or airflow patterns within an area.

(1) To check the negative pressure in a room by using a smoke tube, initiate the test just outside of the room by holding the smoke tube near the bottom of the door and approximately 2 inches in front of the door, or at the face of a grille or other opening if the door has such a feature, and generate a small amount of smoke by gently squeezing the bulb. The smoke tube should be held parallel to the door, and the smoke should be issued from the tube slowly to ensure the velocity of the smoke from the tube does not overpower the air velocity.

(2) The smoke will travel in the direction of airflow. If the room is at negative pressure, the smoke will travel under the door and into the room (i.e., from higher to lower pressure). If the room is not at negative pressure, the smoke will be blown outward or will stay stationary.

(3) This test must be performed while the door is closed. If room air cleaners are being used in the room, they should be running.

(4) The smoke is irritating if inhaled, and care should be taken not to inhale it directly from the smoke tube. However, the quantity of smoke issued from the tube

is minimal and is not detectable at short distances from the tube.

b. Differential pressure-sensing devices also can be used to monitor negative pressure; they can provide either periodic (non-continuous) pressure measurements or continuous pressure monitoring. The continuous monitoring component may simply be a visible and/or audible warning signal that air pressure is low. In addition, it may also provide a pressure readout signal, which can be recorded for later verification or used to automatically adjust the facility's ventilation control system.

c. Pressure-measuring devices should sense the room pressure just inside the airflow path into the room (i.e., at the bottom of the door). Unusual airflow patterns within the room can cause pressure variations; for example, the air can be at negative pressure at the middle of a door and at positive pressure at the bottom of the same door. If the pressure-sensing ports of the device cannot be located directly across the airflow path, it will be necessary to validate that the negative pressure at the sensing point is and remains the same as the negative pressure across the flow path.

d. Pressure-sensing devices should incorporate an audible warning with a time delay to indicate that a door is open. When the door to the room is opened, the negative pressure will decrease. The time-delayed signal should allow sufficient time for persons to enter or leave the room without activating the audible warning.

e. Periodic checks are required to ensure that the desired negative pressure is present and that the continuous monitoring devices, if used, are operating properly. If smoke tubes or other visual checks are used, TB isolation rooms and treatment rooms should be checked frequently for negative pressure.

(1) Rooms undergoing changes to the ventilation system should be checked daily.

(2) TB isolation rooms will be checked and logged daily for negative pressure while being used for TB isolation.

(3) If these rooms are not being used for inmates who have suspected or confirmed TB, but potentially could be used for such patients, the negative pressure in the rooms should be checked monthly.

(4) The designated infection control nurse is responsible for ensuring the performance of these negative air pressure checks. If pressure-sensing devices are used, negative pressure should be verified at least once a month by using smoke tubes or taking pressure measurements.

D. High-Efficiency Particulate Air (HEPA) Filtration

1. For the purposes of these guidelines, high-efficiency particulate air (HEPA) filters are defined as air-cleaning devices that have a demonstrated and documented minimum removal efficiency of 99.97% of particles, greater than or equal to 0.3 Micro meter (µm) in diameter.

2. HEPA filtration can be used as a method of air cleaning that supplements other recommended ventilation measures wherever exhaust air could possibly reenter the system.

3. Proper installation and testing and meticulous maintenance are critical if a HEPA filtration system is used. HEPA filters will be installed to prevent leakage between filter segments and between the filter bed and its frame. A regularly scheduled maintenance program is required to monitor the HEPA filter for possible leakage and for filter loading.

4. Installation of the filter should allow for maintenance that will not contaminate the delivery system or the area served. For general infection-control purposes, special care will be taken to not jar or drop the filter element during or after removal.

5. The scheduled maintenance program will include installation, removal, and disposal of filter elements. Only adequately trained personnel will perform HEPA filter maintenance. Appropriate respiratory protection will be worn while performing maintenance and testing procedures. In addition, filter housing and ducts leading to the housing will be labeled clearly with the words "Contaminated Air" (or a similar warning).

6. When a HEPA filter is used, one or more lower-efficiency disposable pre-filters installed upstream will extend the useful life of the HEPA filter. A disposable filter can increase the life of a HEPA filter by 25%. If the disposable filter is followed by a 90% extended surface filter, the life of the HEPA filter can be extended almost 900%. These pre-filters should be handled and disposed of in the same manner as the HEPA filter.

E. Ultraviolet Light Germicidal Irradiation

Ultraviolent germicidal irradiation (UVGI) can be used as a method of air disinfection to supplement other engineering controls. Two systems of UVGI can be used for this purpose: duct irradiation and upper-room air irradiation.

1. Duct irradiation — used to inactivate tubercle bacilli without exposing persons to UVGI. In this method, UV lamps are placed inside ducts that remove air from rooms to disinfect the air before it is re-circulated. When UVGI duct systems are properly designed, installed, and maintained, high levels of UV radiation may be produced in the ductwork. The only potential for human exposure to this radiation occurs during maintenance operations.

2. Upper-room air irradiation — used to inactivate tubercle bacilli in the upper part of the room, while minimizing radiation exposure to persons in the lower part of the room. In upper-room air irradiation, UVGI lamps are suspended from the ceiling or mounted on the wall. The bottom of the lamp is shielded to direct the radiation upward, not downward. The system depends on air mixing to take irradiated air from the upper to the lower part of the room, and non-irradiated air from the lower to the upper part. The irradiated air space is much larger than that in a duct system. Upper-room air UVGI irradiation may be used:

    a. In isolation or treatment rooms, as a supplemental method of air cleaning; and

    b. In other patients' rooms and in waiting rooms, emergency rooms, corridors, and other central areas of a facility where patients with undiagnosed TB could potentially contaminate the air.

3. Determinants of UVGI effectiveness include room configuration, UV lamp placement, and the adequacy of airflow patterns in bringing contaminated air into contact with the irradiated upper-room space. Air mixing may be facilitated by supplying cool air near the ceiling in rooms where warmer air (or a heating device) is present below. The ceiling should be high enough for a large volume of upper-room air to be irradiated without health care workers and patients being overexposed to UV radiation.

4. Limitations

    Because the clinical effectiveness of UV systems varies, and because of the risk for transmission of M. tuberculosis if a system malfunctions or is maintained improperly, UVGI is not recommended for the following specific applications:

a. As a substitute for HEPA filters if air from isolation rooms must be re-circulated to other areas of a facility.

b. As a substitute for HEPA filtration or local exhaust of air to the outside from booths, tents, or hoods used for cough-inducing procedures.

The use of UV lamps and HEPA filtration in a single unit would not be expected to have any infection-control benefits not provided by use of the HEPA filter alone.

c. For negative pressure.

The effectiveness of UVGI in killing airborne tubercle bacilli depends on the intensity of UVGI, the duration of contact the organism has with the irradiation, and the relative humidity. Old lamps or dust-covered UV lamps are less effective; therefore, regular maintenance of UVGI systems is crucial.

If proper procedures are not followed, healthcare workers performing maintenance on such fixtures are at risk for exposure to UV radiation. Because UV fixtures used for upper-room air irradiation are present in rooms, rather than hidden in ducts, safety may be much more difficult to achieve and maintain. Fixtures must be designed and installed to ensure that UV exposure to persons in the room (including healthcare workers and inpatients) are below current safe exposure levels.

5. If UV lamps are used, the general TB education of affected healthcare workers will include:

a. The basic principles of UVGI systems (i.e., how they work and what their limitations are);

b. The potential hazardous effects of UVGI if overexposure occurs;

c. The potential for photosensitivity associated with certain medical conditions or use of some medications; and

d. The importance of general maintenance procedures for UVGI fixtures.

6. Maintenance and Monitoring

a. Labeling and posting

Warning signs will be posted on UV lamps and wherever high-intensity germicidal UV irradiation is present (i.e., upper-room air space and accesses to ducts if duct irradiation is used) to alert maintenance staff or other health care workers of the hazard. Examples include:

(1) Caution;

(2) Ultraviolet Energy;

(3) Turn Off Lamps Before Entering Upper Room; and

(4) Protect Eyes and Skin.

b. Maintenance

Because the intensity of UV lamps fluctuates as they age, a schedule for replacing the lamps will be developed.

(1) The schedule can be determined from either a time/use log or a system based on cumulative time.

(2) The tube will be checked periodically for dust build-up, which lessens the output of UVGI. If the tube is dirty, it should be allowed to cool then cleaned with a damp cloth. Tubes will be replaced if they stop glowing or if they flicker to an objectionable extent.

(3) Maintenance personnel must turn off all UV tubes before entering the upper part of the room or before accessing ducts for any purpose.

(4) Only a few seconds of direct exposure to the intense UV radiation in the upper-room air space or in ducts can cause burns. Personal protective equipment (e.g., gloves and goggles and/or face shields) will be worn if exposure greater than the recommended standard is anticipated.

(5) For duct irradiation systems, the access door for servicing the lamps will have an inspection window through which the lamps are checked periodically for dust build-up and malfunctioning. The access door will have a warning sign written in languages appropriate for maintenance personnel to alert them to the health hazard of looking directly at bare tubes. The lock for this door will have an automatic electric switch or other device that turns off the lamps when the door is opened.

c. Types of fixtures

(1) Two types of fixtures are used in upper-room air irradiation: wall-mounted fixtures that have louvers to block downward radiation and ceiling-mounted fixtures that have baffles to block radiation below the horizontal plane of the UV tube. The actual UV tube in either type of fixture must not be visible from any normal position in the room. Light switches that can be locked should be used, if possible, to prevent injury to personnel who might unintentionally turn the lamps on during maintenance procedures.

(2) In most applications, properly shielding the UV lamps to provide protection from most, if not all, of the direct UV radiation is not difficult. However, radiation reflected from glass, polished metal, and high-gloss ceramic paints can be harmful to persons in the room, particularly if more than one UV lamp is in use. Surfaces in irradiated rooms that can reflect UVGI into occupied areas of the room will be covered with non-UV reflecting material.

V. Certification of TB Isolation Cells

A. Certification Requirements

TB isolation cells are required to be certified as follows:

1. Prior to initial occupancy of a cell (new construction);

2. When any structural or environmental changes are made to a cell;

3. When a deficiency is noted during the routine biannual inspections of the cell by the Environmental Health and Safety unit; and

4. Periodically, as determined by the director of Environmental Health and Safety.

B. Requests for Certification

Facilities requiring initial certification and/or when any of the events noted above occur, must request the certification/recertification in writing to the Environmental Health and Safety unit prior to occupying/re-occupying the cell.

VI. TB Transport Vehicle

A. Transport Vehicle

In accordance with the Centers for Disease Control and Prevention (CDC) recommendation and reports, precautions will be taken when transporting inmates between correctional facilities or to medical care. TB transport vehicles will, at a minimum, be equipped with the following:

1. The ventilation system set on the fresh air setting (air will NOT be re-circulated).

2. The cab is to be physically isolated from the rest of the vehicle and the inmates should be placed in the rear seat.

3. The vehicle will be equipped with a rear exhaust fan.

4. If there is a separate re-circulating system, it will be equipped with a HEPA filter.

B. Additional Safety Precautions

1. Staff conducting a transport of inmates with suspected or confirmed TB will be in accordance with OP-140301 entitled “Tuberculosis Control Program.”

VII. References

OP-140301 entitled “Tuberculosis Control Program”

Centers for Disease Control and Prevention (CDC)

Oklahoma State Department of Health

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

American Institute of Architects (AIA)

Health Resources and Services Administration (HRSA)

VIII. Action

The director of Environmental Health and Safety is responsible for compliance with this procedure.

The chief medical officer is responsible for the daily administrative operations of this procedure.

The chief compliance officer is responsible for the annual review and revisions.

Any exceptions to this procedure will require written approval of the agency director.

This procedure is effective as indicated.

Replaced: Operations Memorandum No. OP-150501 entitled “Tuberculosis Isolation Cell Infection Control” dated September 9, 2019

Distribution: Policy and Operation Manuals
Agency Website