Conducting Sputum Induction Safely

INSTITUTIONAL
CONSULTATION
SERVICES
effective TB solutions

FRANCIS J. CURRY NATIONAL TUBERCULOSIS CENTER

The Francis J. Curry National Tuberculosis Center is a joint project of the San Francisco Department of Public Health and the University of California, San Francisco, funded by the Centers for Disease Control and Prevention. Institutional Consultation Services is also partially funded by the California Department of Health Services.

Suggested Citation:
Francis J. Curry National Tuberculosis Center, Institutional Consultation Services. Conducting Sputum Induction Safely. 1999: [inclusive page numbers].

This guideline is available on the Francis J. Curry National Tuberculosis Center Web site:
http://www.nationaltbcenter.edu/ics.html

Acknowledgments

The following California hospitals and clinics are gratefully acknowledged for their participation, assistance, and support of this project:

Asian Health Services, Asian Medical Center, Oakland

Central Health Center, Alameda County Health Care Services Agency, Oakland

Eastern Health Center, Alameda County Health Care Services Agency, Oakland

Hayward Health Center, Alameda County Health Care Services Agency, Hayward

Hollywood-Wilshire Health Center, Los Angeles County Department of Public Health, Hollywood

La Clinica de la Raza, Oakland

Lompoc Clinic, Santa Barbara County Health Care Services, Lompoc

Mercy Healthcare – **San Diego**, San Diego

Newark Health Center, Alameda County Health Care Services Agency, Newark

O'Connor Hospital, San Jose

Olive View – **UCLA Medical Center**, Sylmar

Primary Care and Chest Clinics, Sacramento County Department of Health and Human Services, Sacramento

Public Health Clinic, Imperial County Health Department, El Centro

St. Rose Hospital, Hayward

San Francisco Department of Public Health, Tuberculosis Control Section, San Francisco

San Joaquin General Hospital, French Camp

Santa Barbara Clinic, Santa Barbara County Health Care Services, Santa Barbara

Santa Maria Clinic, Santa Barbara County Health Care Services, Santa Maria

South of Market Health Center, San Francisco

Tuberculosis Chest Clinic, Fresno County Health Services Agency, Fresno

Tuberculosis Chest Clinic, Kern County Department of Public Health, Bakersfield

Tuberculosis Clinic, Santa Clara Health and Hospital System, San Jose

Washington Hospital, Fremont

White Memorial Medical Center, Los Angeles

The following individuals are gratefully acknowledged for their participation, assistance, and support of this project:

Janet Abernathy, RN, Catholic Healthcare West

Catherine Cao, Francis J. Curry National Tuberculosis Center

Patrick MacArdle, PE, Institutional Consultation Services, Francis J. Curry National Tuberculosis Center

Joan Sprinson, MPH, CIH, Tuberculosis Control Branch, California Department of Health Services

The following individuals are gratefully acknowledged for their invaluable suggestions:

Ken Beutler, CIH, County of Sacramento

Charles Daley, MD, Francis J. Curry National Tuberculosis Center

Charlene Gliniecki, RN, El Camino Hospital

Michael Mahlmeister, MS, RRT, RCP, Cardio-Pulmonary Department, San Mateo County General Hospital

James Marx, RN, MS, CIC, Broad Street Solutions, San Diego

Sarah Royce, MD, **MPH**, Tuberculosis Control Branch, California Department of Health Services

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Abbreviations

Organizations

Cal/OSHA	California Division of Occupational Safety and Health (California OSHA)
CDHS	California Department of Health Services
CDC	Centers for Disease Control and Prevention
ICS	Institutional Consultation Services
MMWR	Morbidity and Mortality Weekly Report
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (federal)

Terms

ACH	air changes per hour
AFB	acid-fast bacilli
CFM	cubic feet per minute
FPM	feet per minute
HEPA	high efficiency particulate air
HIV	human immunodeficiency virus
IVDA	intravenous drug abuse
LEV	local exhaust ventilation
PA	posteroanterior
PPD	purified protein derivative
RIPT	rapid identification of pulmonary tuberculosis
TB	tuberculosis
UVGI	ultraviolet germicidal irradiation

Contents

Preface

A What is Institutional Consultation Services?

Institutional Consultation Services (ICS), a component of the Francis J. Curry National Tuberculosis Center, is funded by the Centers for Disease Control and Prevention (CDC) and the California Department of Health Services (CDHS). ICS staff have expertise and practical experience in infection control, occupational health, and mechanical engineering. Telephone and on-site consultations are provided to tuberculosis control staff of high-risk institutions, including health-care facilities, correctional facilities, and shelters.

B Purpose and Content of Sputum Induction Guideline

This guideline provides practice-based guidance on conducting sputum induction safely. The following issues are addressed:

- Safe sputum induction for suspected or known infectious tuberculosis (TB) patients
- Administrative controls, including signage and a sample sputum induction procedure
- Appropriate engineering controls

For a complete review and discussion of early identification of suspected or known infectious TB patients in a variety of health-care settings, two TB triage tools are appended and additional reading is suggested. (See list of additional materials in *References and Resources*.)

C Background

During 1997 and 1998, ICS provided 24 on-site consultations to 7 acute care hospital emergency departments, 14 public health clinics, and 3 community clinics. Twenty of the 24 patient care facilities visited performed sputum induction on patients at risk for TB disease.

D Common Findings of On-Site Consultations

- Sputum induction was performed on high-risk patients at many facilities without a written procedure. A written procedure should include safety measures such as identifying suspected or known infectious TB patients,

using a respirator correctly, placing cautionary door signage, and verifying negative room pressure.

- Nursing and respiratory therapy staff were not always trained or authorized to begin triage or identification of patients who were coughing or had other signs and symptoms of TB.
- Engineering controls for sputum induction in county and community clinics were not always adequate or maintained. Simple checks to assess ventilation system operation often were not performed.
- The majority of patients undergoing sputum induction at county or community clinics belonged to groups at high risk for TB infection and disease. Some of these groups included: persons with HIV infection or risk factors for HIV but unknown HIV status; persons who inject drugs; foreign-born persons from areas of the world where TB is common; medically underserved, low-income populations, including high-risk racial and ethnic groups; and locally identified high-prevalence groups (e.g., migrant farm workers or homeless persons).
- Acute care emergency departments frequently used no engineering controls or respiratory precautions when inducing sputum.
- The majority of patients in emergency departments had pulmonary complaints, were not well known to physicians and staff, and had not been definitively evaluated or triaged for TB symptoms.
- Rooms in emergency departments used for sputum induction on suspected or known infectious TB patients were not regularly checked for negative pressure or adequate ventilation. The doors of these rooms had no signs to alert staff to the presence of a suspected or known infectious TB patient.
- Hospital emergency departments with access to local exhaust ventilation devices often failed to use them for sputum induction.

Identified Facility Needs

ICS consistently found health-care staff in need of support and assistance with:

- Writing and implementing an effective procedure for safe sputum induction on suspected or known infectious TB patients
- Assessing and maintaining TB engineering controls such as local exhaust ventilation (LEV), negative pressure, and ultraviolet germicidal irradiation (UVGI)

1 Introduction

Sputum induction is used to obtain sputum for diagnostic purposes when patients are unable to spontaneously expectorate a specimen. The procedure uses sterile water or hypertonic saline to irritate the airway, increase secretions, promote coughing, and produce a specimen. The CDC and the Occupational Safety and Health Administration (OSHA) both classify sputum induction as a high-risk procedure when performed on a suspected or known infectious TB patient. This procedure induces coughing, resulting in a greater likelihood that infectious droplet nuclei are expelled into room air. Because of this increased risk, *it is recommended that sputum induction be performed on suspected or confirmed infectious TB patients only if absolutely necessary. All appropriate precautions must be used whenever sputum induction is performed.*

Elements that are essential for a safe sputum induction program include:

- A triage program to identify suspected or known infectious TB patients prior to sputum induction
- A written sputum induction procedure that includes TB exposure control instructions
- Employee training on safe and effective sputum induction procedures
- Appropriate signage for high-risk procedure rooms
- Engineering controls meeting OSHA requirements and CDC recommendations, which may include use of the following:
    a) LEV
    b) Negative pressure isolation
    c) Supplementary UVGI
- Monitoring and maintenance programs for engineering controls
- A respiratory protection program

Effective TB control programs are based on a hierarchy of control measures. In the order of priority, the three levels of the hierarchy are administrative controls, engineering controls, and respiratory protection for employees.

2 Administrative Controls for Sputum Induction

Administrative controls, the first level of the hierarchy, are designed to reduce the risk of exposure to persons with infectious TB. These controls include policies and procedures for early identification, evaluation, isolation, and treatment of patients likely to have TB. Administrative controls essential to safe sputum induction on high-risk patients include:

- Educating employees about TB and the risk of *Mycobacterium tuberculosis (M. tb)* transmission during sputum induction
- Developing a sputum induction policy and procedure that includes patient care measures and staff safety issues, and is easily followed by staff
- Identifying persons likely to have TB prior to the sputum induction procedure
- Implementing work control practices for sputum induction
- Monitoring compliance with and evaluating sputum induction procedures on a periodic basis

A Educating Staff

A system should be developed to inform staff of new or updated policies and procedures; education should be provided as necessary. One simple way of documenting that staff have read a new policy is to post it in a staff-only area. Staff are asked to initial the posted copy after reading it. After a 30-day posting, the document is placed in a binder that remains available to staff. The information should also be included in department-specific orientation for new employees who will be assisting in sputum induction.

Product sales representatives will often train facility staff when equipment such as a local exhaust hood or booth has been purchased from their company. After the initial training session, a brief review of important safety issues can be presented periodically at staff meetings.

B Written Sputum Induction Procedure

High-risk procedures such as sputum induction must have up-to-date, understandable written procedures for staff to follow. One copy should be filed in the policy and procedure manual. A second, simplified set of instructions should be

posted within view of the employee performing the sputum induction. These instructions can be placed on the door of the sputum induction room or attached to the sputum induction hood. The following are suggested topics to include in a sputum induction procedure:

- Patient instructions and education
- Instructions for operating sputum induction equipment
- Instructions for confirming room negative pressure or properly functioning hood or booth
- Instructions for safe use of UVGI, if applicable
- Specimen handling instructions
- Use of respirators by staff
- Use of other personal protective equipment such as gloves and face shields
- Cleaning and disinfection requirements
- Instructions for placing signage during procedure
- Instructions for assuring adequate removal of airborne contaminants between patients

Highlights of a sputum induction procedure are included in *Appendix A*.

C Early Identification of a Suspected Infectious TB Patient

Early identification of patients who have active TB is especially important prior to high-risk procedures such as sputum induction. All facilities should have written criteria and a protocol in place to rapidly identify and implement precautions for suspected infectious TB patients. In out-patient settings or emergency departments, efforts to identify infectious TB patients should begin as soon as the patient enters the facility and approaches the admission or registration desk. In both in-patient and out-patient settings, the following patients warrant additional screening or action:

- Patients presenting with TB symptoms (e.g., cough, fever, night sweats, weight loss, hemoptysis)
- Patients who have risk factors for TB (e.g., HIV infection, birth in country where TB is endemic, homelessness, injection drug use, recent incarceration, recent exposure to an infectious TB case, a new positive tuberculin skin test, or a history of TB infection or disease)

Cal/OSHA requires that health-care facilities develop criteria to identify individuals who are “suspect” TB cases.[1] These criteria must include identification of the following individuals:

- Any person who is known, or with reasonable diligence should be known, by the employer to be infected with TB and has signs or symptoms of pulmonary or laryngeal TB

- Any person who has a positive AFB smear, or any other positive test result, obtained for the purpose of diagnosing pulmonary or laryngeal TB
- Any person who meets the facility's criteria for identification based only on signs and symptoms when PPD and laboratory-generated information is not available

An identified suspected or known infectious TB patient waiting for a sputum induction procedure should wear a surgical mask when not in a negative pressure isolation room or complete enclosure. The purpose of the mask is to block aerosols produced by coughing, talking, and breathing. A surgical mask on a cooperative patient may provide adequate short-term protection. A mask is not effective for extended periods of time, however, and should be changed if damp.

All patients having sputum induced for diagnostic purposes should first be screened for TB. If the minimum criteria for a suspected infectious TB case are met, the sputum induction procedure is considered a high-risk procedure, and must be performed using LEV or in a room that meets the ventilation requirements for TB isolation.

Two tools are included in *Appendix B* to assist in the early identification of suspected or known infectious TB patients. The first is the Rapid Identification of Pulmonary Tuberculosis (RIPT) protocol developed by Roger Lewis, MD, PhD, Department of Emergency Medicine at Harbor-UCLA Medical Center. The second tool, "Early Detection of Tuberculosis Questionnaire," is an adaptation of a questionnaire developed by OSHA. See *References and Resources* for additional articles and information on the early identification of suspected infectious TB patients.

D Implementing Safe Work Practices

The sputum induction procedure included in this guideline outlines and discusses important issues for patient and employee safety. After adapting the procedure to fit your facility, practice, and equipment, you must educate all employees who may participate in sputum induction procedures. This may involve interdepartmental meetings, educational sessions, and product demonstrations by product sales representatives. Periodic monitoring is essential to ensure that the sputum induction procedure is fully implemented by all staff. Periodic updating and refresher sessions will be necessary as staff or equipment change.

3 Engineering Controls for Sputum Induction

Engineering controls are the second level in the TB control hierarchy. They help to reduce the risk of *Mycobacterium tuberculosis (M. tb)* transmission during sputum inductions by removing infectious particles from the air and controlling the direction of airflow. Two main types of engineering controls for sputum induction are local exhaust ventilation devices and rooms that have the same ventilation characteristics as negative pressure isolation rooms. Sputum induction should not be done in facilities that do not have these devices or rooms with these characteristics. Patients should be referred to facilities that are appropriately equipped.

A comparison chart showing the advantages and disadvantages of different sputum induction engineering controls is included as *Appendix C*.

A Local Exhaust Ventilation Devices

Local exhaust ventilation (LEV) devices provide the most efficient method of capturing infectious particles. By capturing these particles close to the point of generation, dispersion of particles to other areas of the building is prevented. If particles are not captured at the source, they become more difficult to control due to the larger space they will occupy. Removal of particles from room air requires longer periods of time, special exhaust or filtration systems, and higher operating costs than if particles were captured at the source.

Local exhaust units can be placed in any room that meets patient care requirements; they do not require an isolation room for safe installation or use. However, the effective operation of these units requires that staff know how to set up, use, and maintain them. Respiratory protection for staff is not necessary if LEV devices exhaust air to the outdoors or discharge HEPA-filtered air back to the room.

There are two basic types of local exhaust devices:

1. Complete Enclosures (Booths and Tents)

Complete Enclosure

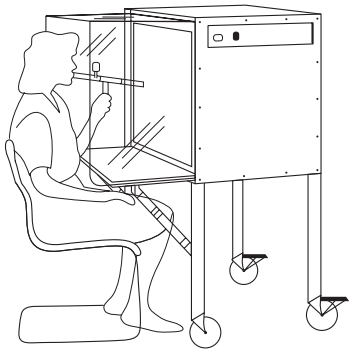
A fully enclosed booth or tent is the preferred type of local exhaust device. These devices physically separate the patient from others during sputum induction. Air from booths and tents is usually HEPA-filtered and discharged back into the room, but can also be exhausted outdoors. Some booths and tents can be easily assembled, dismantled, folded, and stored. Others are more difficult to assemble and disassemble, requiring greater installation time and effort.

Booths typically have rigid walls and are less portable than tents and partial enclosures. Some units require assembly in the room, while others come already assembled and can be used immediately.

Tents have flexible walls with rigid frames. They require some minor assembly prior to use and disassembly prior to storage.

2. Partial Enclosures (Hoods)

Partial enclosures are hoods that do not fully enclose the patient. These devices are open on one side, where the patient sits. Air is drawn across the patient's breathing zone, then HEPA-filtered and discharged back into the room. Some units discharge exhaust air directly outdoors.



Partial Enclosure

Patients must be instructed to sit as far as possible inside the hood opening when coughing. The hood should maintain an air velocity of at least 200 feet per minute (FPM) at the patient's breathing zone to capture droplet nuclei. Air currents from open windows and doors, or people moving about the room, can adversely impact the effectiveness of these devices. Partial enclosures are commonly mounted on carts that can be moved to any room for sputum induction procedures.

Since partial enclosures do not physically separate the patient from others, these devices may not be as effective as fully enclosed units.

B Sputum Induction Rooms

When local exhaust devices are not available, a room with special ventilation can be used for sputum induction. Although not as efficient as local exhaust ventilation, use of such rooms can prevent infectious particles from escaping to other areas of the facility.

The *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Facilities, 1994*[2] (the CDC Guidelines) recommend that sputum induction rooms have the following characteristics:

- Negative pressure relative to adjacent areas (exhaust airflow rate greater than supply airflow rate by 50 CFM or 10% of the supply, whichever is greater).
- Exhaust air change rate of at least 6 air changes per hour (ACH) for existing isolation and procedure rooms. However, the CDC Guidelines also recommend, "Where feasible, this airflow rate should be increased to ≥12 ACH by adjusting or modifying the ventilation system or by using auxiliary means (e.g., recirculation of air through fixed HEPA filtration units or portable air cleaners)."
- Exhaust air change rate of at least 12 ACH for new or renovated isolation and procedure rooms.
- Supply and exhaust grilles should be positioned on opposite sides of the room to promote good air mixing. The exhaust grille should be positioned near the patient.
- Air from the room should be exhausted directly outdoors, away from ventilation intakes, operable windows, and people. The CDC Guidelines allow for recirculation into the general ventilation system, only if unavoidable and the air is HEPA-filtered before recirculation. Local codes and regulations should be checked, as even HEPA-filtered air cannot be recirculated in many localities.

Local codes and regulations should be consulted to determine specific ventilation system requirements for your area. For example, Cal/OSHA will not accept an air change rate of 6 ACH for sputum induction rooms: at least 12 ACH is required.

C Air Exhausted Outdoors from Sputum Induction Booths, Hoods, and Rooms

Air exhausted outdoors from complete enclosures, partial enclosures, and isolation rooms should be discharged at a safe location in accordance with local regulations. ICS recommends that this air be discharged a minimum of 25 feet from operable doors and windows or air intakes.[3] If this is not possible, the air removed from the room should be HEPA-filtered prior to being exhausted.

D Maintenance of Sputum Induction Devices and Rooms with HEPA Filters

The maintenance of partial and complete enclosures includes inspecting and replacing pre-filters and final HEPA filters. Many of these devices are equipped with filter gauges that indicate when filters are dirty and need replacement. Pre-filters (used to prolong the life of HEPA filters) need to be changed more often

than final HEPA filters. Filters should be changed and disposed of in accordance with local requirements. Some localities may require that staff wear respirators and treat the discarded filters as medical waste.

Recommendations on scheduled maintenance may vary with each manufacturer. A staff person or facility engineer should be assigned to monitor the maintenance of the sputum induction device. This person should be trained in the basic principles of the unit's operation, including recommended periodic checks.

E Location of Sputum Induction Rooms

Sputum induction rooms and local exhaust devices should be placed near patient care areas, where staff can monitor and assist patients as needed. The room should be located away from waiting rooms and other areas where patients or visitors are likely to enter and risk exposure.

If LEV is not being used, choose a room where room exhaust can easily be routed outdoors. Air should be discharged away from other outdoor air intakes or openings into the building (such as operable windows and doors, and outdoor air intakes into building ventilation systems).

Local sputum induction tents, booths, or hoods can be used in any patient care room. There is no need to place these devices in a negative pressure room since all air from the procedure is HEPA-filtered or exhausted directly outdoors.

F Signage

It is essential to place a warning sign on the door of any room being used for sputum induction. Signage should:

- Warn patients and family members not to enter the room
- Remind clinic staff that a respirator is required for entrance when the room is, or has recently been, occupied by a suspected or known infectious TB patient
- Indicate when the room was last occupied by a suspected or known infectious TB patient and at what time the room will be safe to enter without a respirator

The sign's message should be clear to non-English speaking individuals and children. One suggestion is a sign that combines a stop sign symbol with the message, "Do not enter, N-95 respirator required." A second sign should state, "Room will be safe to enter without a respirator at _____." The clearance time period needed to attain 99% clearance of airborne particles in the room should be indicated on the sign. This will make it easier for staff to determine when it is safe to enter the room.

Signs can be developed in-house or purchased from a company that specializes in medical signs and labels. Professionally made signs tend to be more readily noticed, and therefore are generally more effective. Sample signs are included in *Appendix D*.

G Clearance Time Between Patients in Sputum Induction Rooms or Complete Enclosures

Adequate time must elapse between patients to allow for the removal of at least 99% of airborne contaminants by the exhaust system.[4] *Exhaust fans serving the rooms or enclosures must always be left on during the clearance period to remove the airborne particles*. Staff entering before sufficient time has elapsed must wear a respirator.

A step-by-step worksheet is included as *Appendix E* to help determine the time required to achieve a 99% removal efficiency in a room or enclosure.

The degree of air mixing directly affects the time required to remove infectious particles from the room. For example, if two rooms have the same air change rate, the room with good air mixing will have a shorter clearance time than the room with poor mixing. The clearance times listed in Table S3-1 of the CDC Guidelines (see *Appendix E* of this guideline) assume perfect air mixing. When air mixing in the room is not ideal, mixing factors should be used to correct room clearance times listed in this table. Mixing factors vary from one (for perfect air mixing) to ten (for poor air mixing). As a rule of thumb, a mixing factor of three can be assumed for a room with 12 ACH and good air movement.

The relatively small size of complete enclosures makes high air changes in these devices readily achievable. The manufacturer's instructions should be consulted for recommended clearance times for complete enclosures.

H Verifying Negative Pressure in Rooms, Booths, and Tents

The CDC Guidelines recommend the confirmation of negative pressure with velometer measurements, smoke tubes, or other reliable indicators. Confirmation should be done daily whenever a sputum induction room is used for high-risk procedures. Negative pressure in LEV devices, such as partial or complete enclosures, should also be verified daily. This testing can be done with tissue paper or incense sticks if the other instruments are not available.

To use smoke or incense, release the smoke parallel to the door about 2 inches in front of the gap under the closed door outside the room. The smoke should be observed moving under the door into the isolation room, or into the enclosure.

To use tissue paper, hold a thin strip of tissue parallel to the door outside the room, extending across the gap under the closed door. The tissue should be drawn towards the room by the airflow under the door. Tissue is not as sensitive to air movement as smoke or incense.

For additional information on confirming negative pressure, see the ICS Frequently Asked Question (FAQ) titled *How Do We Know If Our Isolation Room Is Under Negative Pressure?* (available on the Francis J. Curry National Tuberculosis Center Web site: http://www.nationaltbcenter.edu/ics.html).

4 Respiratory Protection for Sputum Induction

In the absence of LEV, administrative and engineering controls will reduce, but not eliminate, the risk of exposure to *M. tb* in rooms used to perform sputum induction procedures on suspected or known infectious TB patients. The third level of the TB control hierarchy is the use of respiratory protection. Health-care workers present during a high-risk procedure, such as sputum induction, must wear N-95 NIOSH-approved respirators, unless the patient produces the sputum while isolated in a properly functioning LEV device. Since LEV devices capture infectious particles at their source, respirators are not required.

Staff entering a room or booth after sputum induction must wear respiratory protection until at least 99% of airborne contaminants have been removed from the air.[5] This time period will vary depending on the size of the area, the number of air changes per hour, and the estimated amount of air mixing. This same time period should be used when calculating the time interval that must pass before another patient can use the enclosure or room. See *Appendix E* for a form to calculate clearance times.

References and Resources

References

1. Cal/OSHA Interim Tuberculosis Control Enforcement Guidelines. CPL 2.106, March 1, 1997.
2. Centers for Disease Control and Prevention. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. *MMWR* 1994;(No. RR-13):87.
3. 1995 California Mechanical Code. Title 24, Chapter 4: Ventilation Air Supply, section 412:48.5.
4. See reference 2, pg. 70.
5. Ibid.

Resources

Additional Information

(a) Mathur P, Sacks L, Auten G, et al. Delayed diagnosis of pulmonary tuberculosis in city hospitals. *Arch Intern Med* 1994;154:306-310.

(b) Moran G, McCabe F, Morgan M, et al. Delayed recognition and infection control for tuberculosis patients in the emergency department. *Ann Emerg Med* September 1995;26:290-295.

(c) El-Solh A, Mylotte J, Sherif S, et al. Validity of a decision tree for predicting active pulmonary tuberculosis. *Am J Respir Crit Care Med* 1997;155:1711-1716.

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(e) Bock N, McGowan J Jr, Ahn J, et al. Clinical predictors of tuberculosis as a guide for a respiratory isolation policy. *Am J Respir Crit Care* 1996;154: 1468-1472.

(f) American Association for Respiratory Care (AARC). Clinical Practice Guideline. *Respiratory Care* 1996;41(7):647-653.

(g) Association for Professionals in Infection Control and Epidemiology, Inc. (APIC). *Infection Control and Applied Epidemiology, Principles and Practice*. Mosby Year Book, 1996, St. Louis, Missouri.

(h) Cal/OSHA Interim Tuberculosis Control Enforcement Guidelines. CPL 2.106, March 1, 1997.

(i) Cal/OSHA Standard on Occupational Exposure to Bloodborne Pathogens. 29 CFR 1910.1030.

(j) Centers for Disease Control and Prevention (CDC). Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. *MMWR* 1994;(No. RR-13).

(k) OSHA Enforcement Procedures and Scheduling for Occupational Exposure to Tuberculosis. CPL 2.106, February 9, 1996.

Additional ICS Guidelines

The following guidelines were also developed by ICS:

- A Guideline for Establishing Effective Practices: Identifying Persons with Infectious TB in the Emergency Department
- Isolation Rooms: Design, Assessment, and Upgrade
- Tuberculosis Exposure Control Plan: Template for the Clinic Setting
- Policy and Procedures for Tuberculosis Screening of Health-Care Workers

An order form for these guidelines can be obtained by calling (415) 502-4600. These guidelines are also available on the Francis J. Curry National Tuberculosis Center Web site: http://www.nationaltbcenter.edu/ics.html

Appendices

Appendix A

Sputum Induction for Acid-Fast Bacilli (AFB) Smear and Culture

Sputum Induction for Acid-Fast Bacilli (AFB) Smear and Culture

Purpose

Sputum induction is used to obtain sputum for diagnostic purposes when patients are unable to spontaneously expectorate a specimen. The procedure uses sterile water or hypertonic saline to irritate the airway, increase secretions, promote coughing, and produce a specimen.

Contraindications

Bronchoconstriction

History of hyper-responsive airway

Potential Complications

Wheezing or bronchospasm

Infection

Over-hydration

Patient discomfort

Infection Control

- Sputum induction on a suspected or known infectious TB patient is considered a high-risk procedure because it can expose health-care workers to droplet nuclei containing *Mycobacterium tuberculosis*. Local exhaust ventilation devices (LEV) should be used to capture airborne contaminants at or near their source so they do not enter the general air circulation.
- If sputum induction is performed without LEV, the CDC Guidelines recommend a minimum of 6 air changes per hour (ACH) in the sputum induction room. However, at least 12 ACH are preferred and may be required by local codes. The room should be exhausted directly outdoors at least 25 feet away from air inlets and operable windows and doors. The room should be under negative pressure, which should be monitored daily when sputum induction procedures are being performed.
- Partial LEV devices should be monitored daily to confirm airflow when being used for known or suspected infectious TB patients.
- Partial LEV devices should maintain an air velocity of at least 200 feet per minute at the patient's breathing zone. This velocity should be checked monthly.

- Complete LEV enclosures should be monitored daily when being used for known or suspected infectious TB patients to assure that the device is operating correctly.
- Standard precautions for body substance isolation must be followed in all patient care activities. Gloves must be worn when hand contact with blood or other potentially infectious materials is anticipated. Masks and eye protection must be worn if the face may be splashed, sprayed, or splattered with blood or other potentially infectious material. Gowns or aprons must be worn if clothing or skin may be splashed or splattered with blood or other potentially infectious material.
- A properly fitted NIOSH-approved respirator must be worn by any employee who enters a sputum induction room or other complete enclosure during a procedure, or before 99% of the airborne particles are removed from the space.
- Disposable nebulizers, corrugated tubing, and mouthpiece are preferred. Reusable items must be washed and disinfected by:
  - Pasteurization (75ºC water for 30 minutes) **or**
  - High-level disinfection with a glutaraldehyde product following manufacturer's label instructions
- Aseptic technique must be used when placing sterile water or hypertonic saline in the nebulizer chamber. While some ultrasonic devices have a tap water reservoir, only sterile solutions should be placed in the cups or nebulizers that produce the mist inhaled by the patient.
- Disposable tubing, cups, and tissues may be disposed of in regular trash containers. Only blood-containing body fluids, which may drip or splash, must be disposed of in special biohazard containers.

Equipment

Aerosol generator/nebulizer

Clear plastic zip-lock bag with biohazard label

Corrugated aerosol tubing (disposable preferred)

Cup of water

Disinfectant (household bleach 1-10 dilution or tuberculocidal quaternary ammonium compound)

Gloves

Lab slip

Mouthpiece (disposable preferred)

Respirator (N-95 for health-care worker)

Sterile sputum collection container

Sterile water or sterile hypertonic saline

Surgical mask (for patient)

Tissues

PROCEDURE	KEY POINTS
1. Explain the procedure to the patient	• Purpose of procedure • Disinfection or disposal of equipment after patient use • When results will be available • How to use the nebulizer • How to open and expectorate into sputum container • How to place container in plastic bag • How to notify nurse if assistance is needed or when procedure is completed • Importance of staying in the room or booth until coughing has stopped • Importance of replacing surgical mask before leaving room or booth (if appropriate)
2. Instruct patient in sputum induction technique	• Remind patient not to begin the sputum induction procedure until staff member has left the room and closed door (where applicable) • Rinse mouth or drink water prior to beginning procedure • Inhale mist with deep breaths • Cough vigorously if spontaneous coughing does not occur. Cover mouth with tissue when coughing, unless expectorating into a jar • Continue attempts until 5-10 ml of sputum have been obtained. (Show patient how much is needed on specimen container). Confirm quantity of sputum with your testing laboratory

PROCEDURE	KEY POINTS
3. Prepare nebulizer for patient use	• Two types of nebulizers are commonly used for sputum induction: - Compressor devices that create an aerosol with compressed air - Ultrasonic devices that use sound waves in a tap water reservoir to create aerosol • Test nebulizer to ensure that adequate mist is produced
4. Ensure patient has all necessary equipment and understands all instructions	• Patient should remain in booth or room after procedure begins • Turn on LEV and/or verify that air is flowing into device or room (room or device is at negative pressure)
5. Patient must be observed at all times during the procedure	• Watch carefully for signs of respiratory distress and ensure that patient does not leave the room until coughing has stopped • A view window in the door should be provided to monitor the patient, unless LEV is used
6. Wear properly fitted, NIOSH-approved respirator if entering or remaining in sputum induction room	• Infectious droplet nuclei may be dispersed into the air during the procedure • Staff standing outside properly functioning local exhaust booth or negative pressure isolation room do not need to wear respirators
7. Ensure that patient remains in the room/enclosure until coughing has stopped	• Contain infectious particles in the room/enclosure

Procedure	Key Points
8. If it is necessary for the patient to leave before coughing has stopped, ensure patient is masked	• Prevent dispersion of infectious particles
9. If sputum induction is performed on a suspected or confirmed infectious TB patient, the patient should be masked continuously when not in the LEV device or sputum induction room	• Prevent dispersion of infectious particles
10. Ensure that door is closed after patient completes the procedure and leaves the room or complete enclosure	• Prevent contaminated air from escaping into the corridor (if room is used) or room (if complete enclosure is used)
11. Place a sign on the door indicating when the room will be safe to enter	• Adequate time must be allowed for removal of at least 99% of airborne contaminants. This time period will vary, depending on the amount of air exhausted from the room, room air mixing, and the size of the room (see *Appendix E*)
12. Prepare room for next patient	• Wait required time for room to clear of infectious airborne particles (see #11) or wear properly-fitted, NIOSH-approved respirator when entering room • Remove and discard disposable items. If reusable components are used, soak in detergent or enzyme solution to prevent drying of secretions • Wipe counter with approved disinfectant between procedures and at the end of the day. If preferred, an imperviously-backed absorbent paper may be placed on counter and changed between patients

Appendix B

Tools for Early Identification of Persons with Infectious TB

HARBOR-UCLA TRIAGE CRITERIA FOR RESPIRATORY ISOLATION TUBERCULOSIS PRECAUTIONS (RIPT)

Chief Complaint _____ Date _____

CHECK ALL APPLICABLE RISK FACTORS, SYMPTOMS, OR COMPLAINTS:

Risk Factors

- ❑ (2) HIV Positive
- ❑ (1) Male Homosexual
- ❑ (1) Foreign-Born
- ❑ (2) Homeless or in Shelter
- ❑ (1) Intravenous Drug User
- ❑ (4) History of Active TB Now or at Any Time In the Past (even if on meds)
- ❑ (2) In Jail Within Last 2 Years
- ❑ (2) Newly PPD Positive (within 2 years) or History of Recent TB Exposure

Symptoms/Complaints

- ❑ (3) Cough (any duration)
- ❑ (2) Fever or Chills or Night Sweats
- ❑ (2) Weight Loss > 10 Pounds
- ❑ (5) Hemoptysis

Total Points _____

RIPT FOR 5 OR MORE POINTS

Add up points. Respiratory Isolation scale scores of 5 or more points indicate a need for immediate mask and respiratory isolation packet (RIPT Packet). For patients meeting criteria, please order a PA and lateral chest x-ray and have an emergency medicine senior resident or emergency medicine attending physician record their reading of the chest x-ray and their decision regarding the need for continued isolation below. This form should be attached to the nursing notes for the patient and, when the chart is broken down, returned to the envelope by the clerk's desk. All patients with scores of 5 or more must be entered in the RIPT logbook.

COMPLETE BELOW ONLY FOR PATIENT MEETING **RIPT** CRITERIA:

Name _____
Last First MI

Assigned RIPT Number _____

CHEST X-RAY RESULT (TO BE RECORDED BY PHYSICIAN READING FILM, CHECK ALL THAT APPLY):

- ❑ Upper Lobe Infiltrate(s)
- ❑ Diffuse Infiltrate or Interstitial Pattern
- ❑ Mediastinal Lymphadenopathy
- ❑ Other Findings (hyperinflation, rib fractures, etc.)
- ❑ Normal
- ❑ Infiltrate Not in Upper Lobe(s)
- ❑ Pleural Effusion
- ❑ Mass or Coin Lesion (not cavitary)
- ❑ Cavitary Lesion

Early Detection of Tuberculosis Questionnaire

This questionnaire will help identify patients who meet this facility's definition of "suspected infectious tuberculosis" so that appropriate precautions can be taken. An individual with two or more symptoms of TB, in addition to a prolonged cough, will be considered a suspected infectious TB patient unless this diagnosis has been ruled out by the physician.

History/Symptoms	Yes	No	Don't Know
1. Do you have a cough that has lasted longer than 3 weeks?			
2. Have you lost your appetite?			
3. Have you lost weight without dieting?			
4. Have you had fever, chills, or night sweats?			
5. Have you coughed up mucous or blood?			
6. Have you been feeling very tired?			
7. Have you ever had a positive TB skin test?			
8. Have you ever had an abnormal chest x-ray?			
9. Have you recently had the mucous you coughed up tested for TB?			
10. Have you ever been told you had TB?			
11. Have you ever taken medicine for TB?			
12. Have you ever lived with or had close contact with someone who had TB?			

Evaluator's Comments

_____

_____

_____

Exposure Control Methods Implemented

Surgical mask on patient ❑ Given tissues and instructions ❑

Segregated in room _____ ❑ Placed in isolation room _____ ❑

Sign placed on door ❑ No action required ❑

Evaluator's signature _____ Date _____

Appendix C

Summary of Sputum Induction Engineering Controls Advantages and Disadvantages

Summary of Sputum Induction Engineering Controls Advantages and Disadvantages		
TYPE OF CONTROL	**ADVANTAGES**	**DISADVANTAGES**
Complete Enclosure Booth or Tent	• Complete physical separation between patient and staff • Provides highest degree of safety for staff • Airborne particles quickly captured due to high air change rates. Short airborne particle clearance times (vs. sputum induction room) • Devices with HEPA-filtered exhaust can be used in any room regardless of room ventilation system • Can be moved to accommodate room function changes • Tents can be folded for compact storage • Tents are more portable than booths	• Cost is higher than partial enclosures and ranges from approximately $3000 for a fully enclosed portable tent to $7500 or greater for a booth • Requires routine maintenance such as changing the HEPA filter and pre-filter • Tents require some assembly prior to use • Booths are not as portable as partial hoods

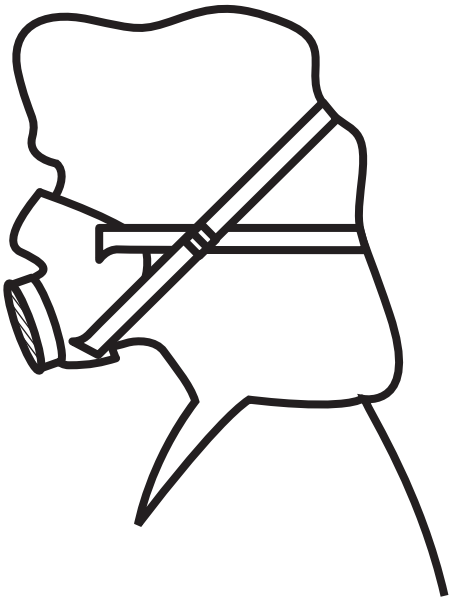
Summary of Sputum Induction Engineering Controls Advantages and Disadvantages (continued)		
TYPE OF CONTROL	**ADVANTAGES**	**DISADVANTAGES**
Partial Enclosures Partial hood is enclosed on all sides except side where patient sits	• Provides a high degree of safety for staff • Commercially available devices are equipped with HEPA filters (do not require special exhaust systems) • Units with HEPA filters can be used in any room regardless of room ventilation system • Cost is relatively low compared to complete enclosures, approximately $1500 to $3000 • Portable, small enough to be used at patient's bedside, and easy to store	• Does not provide complete physical separation between patient and staff • Requires more supervision of patient to ensure proper placement than complete enclosures • Open windows or doors, or people moving in the area can create drafts which disrupt the capture of airborne particles • Air velocity (minimum 200 feet per minute) at the side of patient's head must be verified monthly • Requires routine maintenance such as changing the HEPA filter and pre-filter • Noise of operating unit may be annoying to patient
Sputum Induction Rooms Room meeting all recommendations (see Section 3.B) and/or requirements for negative pressure isolation rooms	• Provides complete separation between staff and patients • If a negative pressure isolation room is available, sputum induction can be done in this room with no additional ventilation equipment	• Separate designated room required • If a negative pressure isolation room is not available, these rooms require installation of dedicated exhaust systems or HEPA filtration systems prior to recirculation of air (local codes should be checked for requirements) • Airborne particle clearance times will be high due to lower ACH rates (vs. booths and tents) • Room ventilation system must be monitored to ensure proper operation • Operation can be affected by general building ventilation systems • Most expensive option if an existing negative pressure isolation room is not available

Appendix D

Sample Signs

STOP

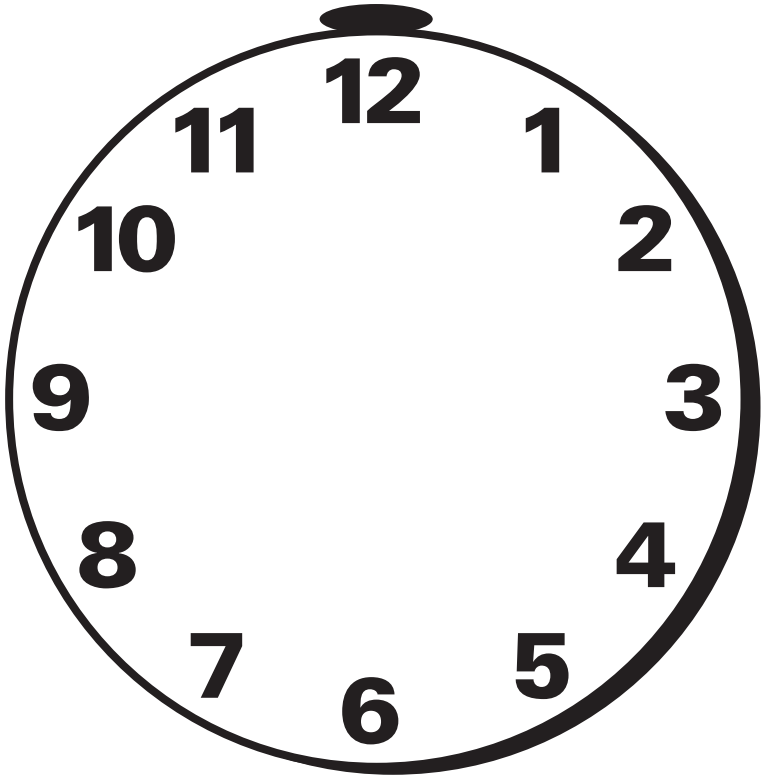
CHECK WITH NURSE BEFORE ENTERING



WEAR RESPIRATOR TO PROTECT YOUR LUNGS

N-95 RESPIRATOR MUST BE WORN WHEN ENTERING THIS ROOM UNTIL

set clock for___hour and___minutes
clearance time between patients



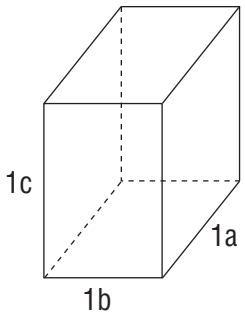
Appendix E

Clearance Time Calculation Worksheet

Clearance Time Calculation Worksheet

Room or Booth # _____

1. Calculate Room Volume



1a. Room Length **1a.** _____ ft

1b. Room Width **1b.** _____ ft

1c. Room Height **1c.** _____ ft

1d. **1a** x **1b** x **1c** = volume **1d.** _____ ft^3

2. Calculate Air Changes per Hour (ACH)

2a. Measured exhaust airflow rate **2a.** _____ CFM

2b. **2a** x 60 minutes **2b.** _____ ft^3 per hr

2c. **2b** ÷ **1d** **2c.** _____ ACH

3. Calculate Room Clearance Time

3a. **Find the Uncorrected Clearance Time**

Using Table S3-1 of the CDC Guidelines (see next page), follow the first column down until the ACH value on line 2c is found. Follow this row horizontally to the third column (99% removal efficiency). Record this value (the number of minutes).

3a. _____ min.

3b. **Estimate the Mixing Factor**

Mixing factors can vary from one, for ideal mixing, to ten for poor mixing. As a rule of thumb, a mixing factor of three can be assumed for a room with 12 ACH and good air movement.

3b. _____

3c. **Estimate Room Clearance Time**

3a x **3b** **3c.** _____ min.

This is the amount of time that should elapse before staff or other patients enter a sputum induction area (booth, hood, or room) after sputum has been induced on a suspected or known infectious TB patient and the patient has left.

TABLE S3-1. Air changes per hour (ACH) and time in minutes required for removal efficiencies of 90%, 99%, and 99.9% of airborne contaminants*

	Minutes Required for a Removal Efficiency of:		
ACH	90%	99%	99.9%
1	138	276	414
2	69	138	207
3	46	92	138
4	35	69	104
5	28	55	83
6	23	46	69
7	20	39	59
8	17	35	52
9	15	31	46
10	14	28	41
11	13	25	38
12	12	23	35
13	11	21	32
14	10	20	30
15	9	18	28
16	9	17	26
17	8	16	24
18	8	15	23
19	7	15	22
20	7	14	21
25	6	11	17
30	5	9	14
35	4	8	12
40	3	7	10
45	3	6	9
50	3	6	8

*This table has been adapted from the formula for the rate of purging airborne contaminants. Values have been derived from the formula $t_1 = [\ln (C_2 \div C_1) \div (Q \div V)] \times 60$, with $T_1 = 0$ and $C_2 \div C_1 = 1 - (\text{removal efficiency} \div 100)$, and where:

t_1 = initial timepoint

C_1 = initial concentration of contaminant

C_2 = final concentration of contaminants

Q = air flow rate (cubic feet per hour)

V = room volume (cubic feet)

Q ÷ V = ACH

The times given assume perfect mixing of the air within the space (i.e., mixing factor = 1). However, perfect mixing usually does not occur, and the mixing factor could be as high as 10 if air distribution is very poor. The required time is derived by multiplying the appropriate time from the table by the mixing factor that has been determined for the booth or room. The factor and required time should be included in the operating instructions provided by the manufacturer of the booth or enclosure, and these instructions should be followed.

Excerpted from the Centers for Disease Control and Prevention's *Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care facilities, 1994*, page 72.