



NIOSH HEALTH HAZARD EVALUATION REPORT

**HETA #2006-0357-3041
Denver Sheriff's Department
Denver, Colorado**

April 2007

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health**



PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Yvonne Boudreau and Steven A. Lee of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Robin Smith. Editorial assistance was provided by Ellen Galloway.

Copies of this report have been sent to employee and management representatives at the Denver Sheriff's Department and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. The report may be viewed and printed from the following Internet address: <http://www.cdc.gov/niosh/hhe>. Copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161.

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.

Highlights of the NIOSH Health Hazard Evaluation

This NIOSH Health Hazard Evaluation (HHE) was requested by employees at the Denver Sheriff's Department in Denver, Colorado. In September 2006, we investigated employee concerns about the potential for employees to develop various infectious diseases from exposure to inmates.

What NIOSH Did

- We visited the Denver Sheriff's Department to evaluate the ventilation system and review procedures for infection control.
- We met with management and employee representatives to discuss the issues of concern in the HHE request.
- We conducted a tour of the facility.
- We interviewed employees and medical providers about workplace health concerns.

What NIOSH Found

- No employees were identified with illnesses reported in the HHE request.
- Employee medical evaluations do not include tuberculosis screening or hepatitis B vaccination.
- Employees reported receiving limited training on infectious disease issues.
- All of the air in the inmate housing areas is vented out of the building without recirculation.
- Ventilation maintenance records were not available for review.

What Sheriff's Dept. Managers Can Do

- Provide employees with detailed training about how to prevent exposures to infectious diseases.

- Implement a program so employees can get prompt answers to health and safety questions; ensure that they can do this anonymously, if desired.
- Ensure that tuberculosis screening and hepatitis B vaccination are offered to employees when they are hired and that ongoing tuberculosis screening is conducted in accordance with published guidelines.
- Develop a written infection control plan in accordance with published guidelines.
- Disseminate reports of ventilation system service and maintenance to all employees.
- Ensure that employees with possible work-related health problems are evaluated by a physician familiar with occupational conditions.

What Sheriff's Dept. Employees Can Do

- Attend all health and safety training.
- Ask questions about health and safety issues of concern to you.
- Get a hepatitis B vaccination and participate in recommended tuberculosis screening.
- Practice appropriate personal infection control activities while at work.
- Report to your physician any health problems that you think might be work-related.



What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2006-0357-3041



**Health Hazard Evaluation Report 2006-0357-3041
Denver Sheriff's Department
Denver, Colorado
April 2007**

**Yvonne Boudreau
Steven A. Lee**

SUMMARY

In September 2006, employees at the Denver Sheriff's Department, Denver, Colorado, requested that the National Institute for Occupational Safety and Health (NIOSH) evaluate potential employee exposures to infectious agents from inmates housed at the facility. The specific diseases listed in the employee request included tuberculosis (TB), methicillin-resistant *staphylococcus aureus* (MRSA), and *Serratia marcescens* (serratia).

During the NIOSH visit in September 2006, employee and management representatives provided information about the Denver Sheriff's Department infection control procedures and ventilation system and participated with NIOSH representatives in a walk-through tour of the facility. Confidential employee requesters and Department medical providers were interviewed by phone at another time.

There were no reports of infections with TB, MRSA, or serratia among any of the Denver Sheriff's Department employees. Employee exposures to potentially ill inmates were limited by procedures followed at the Denver Sheriff's Department. These included: medical screening of incoming inmates, transfer of sick inmates to an offsite medical location, preventing inmate presence on the first-floor administrative area by moving inmates directly from the basement entry area to the housing areas on the second-fourth floors, regular cleaning of inmate housing areas, and exhausting of 100% of the air in the inmate housing areas to the outdoors.

Although our evaluation did not document occupationally-acquired infections with TB, MRSA, or serratia in employees of the Denver Sheriff's Department, correctional facilities are considered to be workplaces where the risk of certain infectious disease exposures is greater than in the general population. These include TB, the human immunodeficiency virus, and hepatitis B and C. Recommendations to decrease the likelihood of these exposures to employees at the Denver Sheriff's Department are provided in this report.

Although no occupationally-acquired TB, MRSA, or *serratia* infections were identified in Denver Sheriff's Department employees, our evaluation found areas where improvements are warranted. Correctional facilities are considered to be work environments with an elevated risk for occupational exposure to TB, hepatitis B and C, and the human immunodeficiency virus, and consensus infection control standards and guidelines have been established to prevent disease transmission in these facilities. We recommend that additional infection control procedures, including hepatitis B vaccination and TB screening in employees, be implemented per established standards and guidelines and that current inmate transport policies and 100 percent exhaust ventilation in the inmate holding areas be continued to help limit the risk of infectious-disease exposure to employees.

Keywords: NAICS 922140 (Correctional Institutions) Sheriff's Department, tuberculosis, indoor environmental quality, human immunodeficiency virus, hepatitis, bloodborne pathogens, infection control, methicillin-resistant *staphylococcus aureus*, *serratia*.

Table of Contents

Preface	ii
Acknowledgments and Availability of Report	ii
Highlights of Health Hazard Evaluation	iii
Summary	iv
Introduction	1
Methods	1
Evaluation Criteria	1
Infection Control	1
Tuberculosis	2
Methicillin-resistant Staphylococcus aureus	3
Serratia	3
Indoor Environmental Quality	3
Results	4
Discussion & Conclusions	5
Recommendations	5
References	6

INTRODUCTION

In September 2006, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employees at the Denver Sheriff's Department, Denver, Colorado. The requesters wanted NIOSH to evaluate potential employee exposures to infectious diseases from inmates housed at the facility. The specific diseases listed in the HHE request included tuberculosis (TB), methicillin-resistant *staphylococcus aureus* (MRSA), and *Serratia marcescens* (serratia). The main routes of exposure of concern in the HHE request were through the ventilation system (airborne) and via direct skin and mucous membrane contact with contaminated surfaces.

METHODS

To address the concerns in the HHE request, NIOSH personnel conducted a site visit to the Denver Sheriff's Department on September 27, 2006. We held an opening meeting with management and employee representatives, including a person specifically identified by the requesters as someone familiar with the ventilation system in the areas of concern, and conducted a walk-through survey of the facility and visual inspection of its ventilation system. Employee requesters and medical staff were interviewed at another time by phone.

EVALUATION CRITERIA

Infection Control

Persons incarcerated in correctional systems are more likely to have certain infectious diseases than the general population of the United States.¹ Specifically, acquired immune deficiency syndrome (AIDS), TB, and hepatitis are more prevalent among correctional inmates than in the general population.² Correctional employees have reported injuries from human bites, needles, and other sharp instruments. They

have also reported skin and mucous membrane exposures to blood and body fluids.^{3,4}

The Centers for Disease Control and Prevention (CDC) recommends that measures to prevent occupational exposures to infectious agents be integrated into correctional facilities' infection control plans according to Occupational Safety and Health Administration (OSHA) requirements.⁵ The plans should mandate standard (i.e., universal) precautions for all contact with blood or body fluids. They should also include the administration of hepatitis B vaccination to all previously unvaccinated persons whose work duties involve exposure to blood or other potentially infectious body fluids.^{6,7}

Guidelines are available for cleaning and disinfecting environmental surfaces in areas that could be contaminated with infectious blood or other body fluids.^{8,9,10,11,12,13,14,15,16,17} These include:

- Promptly clean and decontaminate spills of blood or other potentially infectious material.
- Use protective gloves and other personal protective equipment appropriate for this task.
- If the spill contains large amounts of blood or body fluids, clean the visible matter with disposable absorbent material and discard the used cleaning materials in appropriate, labeled containers.
- Swab the area with a cloth or paper towel moderately wetted with disinfectant and allow the surface to dry.
- Use germicides registered by the Environmental Protection Agency (EPA) for use as disinfectants in accordance with the label.¹⁷ An EPA-registered sodium hypochlorite product is preferred. If such a product is not available, a generic sodium hypochlorite solution (e.g., household chlorine bleach) may be used. Use a 1:100 dilution to decontaminate nonporous surfaces after cleaning a spill of either blood or body fluids. If a spill involves large amounts of blood or body fluids, use a 1:10

dilution for the first application of germicide before cleaning.

In addition, personal hand hygiene is important in preventing infection.^{18,19,20,21,22,23,24,25,26,27,28} The CDC recommends the following:²⁹

- When hands are visibly dirty or are visibly soiled with blood or other body fluids, wash hands with soap and water.
- When washing hands with soap and water, wet hands first with water, apply a generous amount of soap to hands, and rub hands together vigorously for at least 15 seconds covering all surfaces of the hands and fingers. Rinse hands with water and dry thoroughly with a disposable towel. Use the towel to turn off the faucet. Avoid using hot water because repeated exposure to hot water may increase the risk of dermatitis.
- If hands are not visibly soiled, it is acceptable to use an alcohol-based hand rub for routinely decontaminating hands.
- When decontaminating hands with an alcohol-based hand rub, apply the product to the palm of one hand and rub hands together, covering all surfaces of hands and fingers, until hands are dry.
- Decontaminate hands after contact with body fluids, excretions, mucous membranes or non-intact skin, even if hands are not visibly soiled.
- Before eating and after using a restroom, wash hands with soap and water.

Tuberculosis

Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacteria tuberculosis* (*M. tuberculosis*). *M. tuberculosis* is carried in airborne particles (called droplet nuclei) that can be generated when persons with TB of the lungs or throat cough, sneeze, or speak.³⁰ The droplet nuclei are so small that normal air currents can keep them airborne for hours and can spread them throughout a room or building. Infection occurs when a person inhales aerosolized *M. tuberculosis* and the bacteria become established in the alveoli (small air sacs) of the lungs and spread throughout the body. Within 2 to 10 weeks, the immune system of a

person infected with *M. tuberculosis* usually acts to prevent further multiplication and spread of the bacteria. At this point, a person will usually have a positive tuberculin skin test (TST). *M. tuberculosis* bacteria may remain dormant and survive for many years.^{30,31}

There are no occupational exposure limits for *M. tuberculosis*. Neither the smallest infectious dose nor the highest level of exposure at which transmission will not occur has been defined conclusively. Therefore, any airborne concentration of *M. tuberculosis* is assumed to present some risk of infection.^{32,33}

In general, people who become infected with *M. tuberculosis* have about a 10% risk for developing active pulmonary TB disease during their lifetimes, but the risk is considerably higher for persons who are immunosuppressed, including those infected with the human immunodeficiency virus (HIV). Groups of persons known to have a higher prevalence of TB infection include contacts of persons who have active TB, foreign-born persons from areas with a high prevalence of TB, medically underserved populations, homeless persons, current or former correctional inmates, alcoholics, injecting drug users, and the elderly.

Recent publications report that, because TB can be problematic in correctional and detention facilities, precautions should be taken to ensure minimal risk of transmission to employees working in these settings.^{34,35} Recommendations include:

- Evaluate all entering inmates for symptoms of TB.
- Place inmates with symptoms suggestive of TB in an airborne infection isolation room and evaluate them promptly for TB disease.
- Evaluate all employees for TB disease at the time of hire and provide a TB screening test [TST or QuantiFERON®-TB Gold test (QFT-G)] to all employees who do not have a documented history of a positive TB screening test result.
- Provide follow-up testing at least annually for all at-risk employees who do not have a

documented history of a positive TB screening test result.

- Provide TB training and education to all employees at hire and at least annually thereafter.

Methicillin-resistant Staphylococcus aureus

Staphylococcus aureus, often referred to simply as "staph," is a bacterium commonly carried on the skin or in the nose of healthy people.³⁶ Between 25 and 30% of the population is colonized (bacteria are present, but not causing an infection) with staph. Staph bacteria are one of the most common causes of skin infections in the United States. Most of these skin infections are minor, such as pimples and boils, and can easily be treated with antibiotics.³⁶

Some staph bacteria are resistant to antibiotics. MRSA is a type of staph that is resistant to certain antibiotics called beta-lactams.³⁶ Beta-lactam antibiotics include methicillin and other more common antibiotics such as oxacillin, penicillin and amoxicillin. Approximately 1% of the population is colonized with MRSA.

Staph infections, including MRSA, occur most frequently among persons in hospitals and healthcare facilities (such as nursing homes and dialysis centers) who have weakened immune systems. These healthcare-associated staph infections include infections in surgical wounds, the urinary tract, the bloodstream and the lungs.^{37,38}

Staph and MRSA can also cause illness in persons outside of hospitals and healthcare facilities. MRSA infections acquired by persons who have not been hospitalized within the past year or have never had a medical procedure (such as dialysis, surgery, catheters) are known as community-acquired (CA) MRSA infections.³⁹ Staph or MRSA infections in the community are usually manifested as skin infections, such as pimples and boils, and occur in otherwise healthy people. Factors that have been associated with the spread of MRSA skin infections include: close skin-to-skin contact, openings in the skin such as cuts or abrasions,

contaminated items and surfaces, crowded living conditions, and poor hygiene.^{40,41,42}

The following activities can help prevent infection with staph:

- Keep your hands clean by washing thoroughly with soap and water or using an alcohol-based hand sanitizer.
- Keep cuts and scrapes clean and covered with a bandage until healed.
- Avoid contact with other people's wounds or bandages.
- Avoid sharing personal items such as towels or razors.

Serratia

Serratia is caused by a bacterium called *Serratia marcescens*. Until the 1950s, this bacterium was generally considered harmless, but since the 1960s, it has been recognized to cause disease in humans.^{43,44,45} The main risk factor for developing an infection with serratia is hospitalization and in 90% of cases, patients have a history of recent surgery of the urinary tract.^{46,47,48} Important risk factors for infection with serratia are diabetes, urinary tract obstruction, and renal failure.⁴⁹ Symptoms of infection may include fever, frequent urination, and pain with urination.⁵⁰ Serratia infections can be treated with antibiotics.

Indoor Environmental Quality

Over 70 million American workers spend their workday in indoor environments, and a number of published studies have reported symptoms among occupants of office buildings, schools, healthcare facilities, and other indoor work locales.^{51,52,53,54,55,56,57} Since 1972, NIOSH has received approximately 3700 requests for assistance related to indoor environmental quality (IEQ); far more than half (over 2800) of the requests were received since 1990. In response, NIOSH staff have conducted over 1250 HHEs and sent over 1850 informative letters. We learned from these activities that significant IEQ improvements can be achieved

by following standard recommendations related to the following areas:

- Operation and maintenance of ventilation system and other building components.
- Addressing employee issues through administrative controls.
- Expanding opportunities for workers to participate in decision making.

One of the most common deficiencies in the indoor environment is the improper operation and maintenance of heating, ventilation, and air-conditioning (HVAC) systems. The majority of studies of ventilation rates and building occupant symptoms have shown that rates below 10 liters per second per person ($l s^{-1}/person$), which equates to 20 cubic feet per minute per person (cfm/person), are associated with one or more health symptoms.⁵⁸ Moreover, higher ventilation rates, from 10 $l s^{-1}/person$ up to 20 $l s^{-1}/person$, have been associated with further significant decreases in the prevalence of symptoms. Thus, improved HVAC operation and maintenance, higher ventilation rates, and comfortable temperature and relative humidity can all potentially serve to improve symptoms without ever identifying any specific cause-effect relationships.

The American National Standards Institute (ANSI)/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation and thermal comfort guidelines.^{59,60} The American Conference of Governmental Industrial Hygienists (ACGIH®) has also developed a manual of guidelines for approaching investigations of building-related symptoms that might be caused by airborne living organisms or their effluents.⁶¹ Other resources that provide guidance for establishing acceptable IEQ are available through the EPA at <http://www.epa.gov/iaq>, especially the joint EPA/NIOSH document, Building Air Quality, A Guide for Building Owners and Facility Managers at <http://www.epa.gov/iaq/largebldgs/baqtoc.html>, and the EPA Indoor Air Quality Building Education and Assessment Model (I-BEAM) software available for downloading at

http://www.epa.gov/iaq/largebldgs/ibeam_page.htm.

General ventilation and air cleaning should be relied on for environmental control of airborne infectious agents, such as *M. tuberculosis*.^{34,62} General ventilation can be used to dilute the air and remove air contaminants and to control airflow patterns in correctional facility settings. Ventilation systems for correctional facility settings should be designed, and modified when necessary, by ventilation engineers in collaboration with infection-control practitioners and occupational health staff. Recommendations for designing and operating ventilation systems in correctional facilities have been published.^{60,63,64,65,66}

RESULTS

Our walk-through of the facility included visual examination of the westside catwalk on the fourth floor and inspection of all air outlets and vents on the third and fourth floors, intake vents on the roof of the facility, and the filters in the ventilation mechanical room. The air-handling units were inspected for integrity and cleanliness and we verified all air from the inmate holding cells had direct exhaust to the outside. Hand sanitizer gel was available on all floors for use by employees.

The following information was reported to NIOSH staff during the site visit to the Denver Sheriff's Department and during interviews with employees and medical personnel:

- There are approximately 156 sheriffs employed by the Denver Sheriff's Department. There have been no reports of occupationally acquired infections with TB, MRSA, or serratia in any of the sheriffs. There is no written infection control plan or formal infection control training for the sheriffs. Their medical evaluations at hire include a general physical examination and hearing evaluation, but do not include TSTs, or any vaccinations. Follow-up regular medical screening is not conducted as part

of the Denver Sheriff's Department employee medical care.

- The Denver Sheriff's Department facility is a pre-arraignment detention facility. Prisoners are temporarily housed there until they make bond or are given a court advisement. Prisoners are usually held at this facility no more than 72 hours. The inmate capacity of the Denver Sheriff's Department is 220-260. Prisoners are brought in from the basement and taken by elevator to the housing units located on the second-fourth floors. They are not brought to the first floor, where administration activities are conducted.
- Holding cells for prisoners all have 100% exhaust ventilation; none of the air from these areas is recirculated into any area of the building.
- Upon arrival to the Denver Sheriff's Department facility, prisoners are medically assessed by a nurse; this includes screening for TB infection. If they are found or suspected to be ill, they are immediately sent to an offsite medical facility with the capacity for airborne infection isolation. Ill prisoners are not admitted to the Denver Sheriff's facility.
- If a prisoner develops illness after admission into the Denver Sheriff's Department facility, they are sent to the offsite medical facility. If the prisoner's illness is considered to be potentially infectious, an information memo is sent to all employees. This memo provides the areas and times that the prisoner was in the facility and necessary medical details, such as infectious agents of concern. Employees are encouraged to seek medical follow-up at the facility of their choice for any related health concerns.
- The ventilation system at the Denver Sheriff's Department was reportedly cleaned by Excel Mechanical Systems in June 2006. A written report of this was not available.
- The ventilation system reportedly receives monthly maintenance by Public Office Buildings services, but details of the maintenance activities were not available.

- The facility is cleaned by inmates. Daily maintenance cleaning is performed as well as more immediate cleaning of surfaces contaminated with blood, urine, feces, sputum, or other human contaminants.

DISCUSSION & CONCLUSIONS

The HHE request listed TB, serratia and MRSA as being of concern. TB is a known disease risk in correctional facility employees and infection control policies specific for TB should be followed in such facilities. Regular TB screening of employees can provide important information about potential occupationally-acquired TB infections. Since TB infection is transmitted through the air, the ventilation system is important in preventing TB transmission. There are published guidelines for designing and operating ventilation systems in correctional facilities.^{60,63,64,65,66} Serratia has not been associated with infections in workplaces; it primarily causes infections in hospital patients. Therefore, no specific precautions against serratia are needed in the Denver Sheriff's Department building. MRSA, although not commonly associated with workplace exposures, can be transmitted from close skin-to-skin contact or contact with contaminated items or surfaces. In addition, infections transmitted from contact with blood or other body fluids (HIV, hepatitis B, and hepatitis C) are more common in persons incarcerated in correctional systems. In order to decrease the risk of transmission of these diseases to employees, appropriate infection control practices should be followed.

RECOMMENDATIONS

1. Conduct annual employee training on infectious disease transmission, including TB, hepatitis B and C and other infectious diseases for which employees may have concerns.
2. Develop and maintain a written infection control plan that incorporates requirements

of the OSHA Bloodborne Pathogens Standard and provide training on this plan for employees at hire and at least annually thereafter.

3. Provide TB screening to employees at hire and on a regular basis in accordance with published guidelines.
4. Offer the hepatitis B vaccination to newly-hired employees in accordance with published guidelines.^{1,7}
5. Provide an ongoing program for employees to ask questions about health and safety issues and get answers from a health care professional. Ensure the system allows for questions to be asked and answered anonymously, if desired.
6. Make available to all employees reports of ventilation system service and maintenance.
7. Make available to all employees the cleaning and disinfecting protocol used at the Denver Sheriff's Department for general cleaning as well as for cleaning of blood and other body fluids.
8. Encourage employees with health concerns to be evaluated by a physician. Those employees found to have potential work-related health effects should be referred to a physician knowledgeable in occupational medicine.

REFERENCES

1. Centers for Disease Control and Prevention [2003]. Prevention and control of infections with hepatitis viruses in correctional settings. *MMWR* 52(no. RR-1). [http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5201a1.htm] Date accessed: 3/23/2007.

2. National Commission on Correctional Health Care [2002]. Health status of soon-to-be-released inmates: a report to Congress. Vol 1. Washington, DC: National Commission on

Correctional Health Care. [http://www.ncchc.org/pubs/index.html] Date accessed: 3/23/2007.

3. Gershon RR, Karkashian CD, Blahov D, et al [1999]. Compliance with universal precautions in correctional health care facilities. *J Occup Environ Med* 41:181-9.

4. Hessel SM [2001]. Police and corrections. *Occup Med* 16:39-49.

5. Occupational Safety and Health Administration. Title 29 of the Code of Federal Regulations (29 CFR). Bloodborne Pathogens Standard (29 CFR 1910.1030). [http://www.osha.gov/pls/oshaweb/owadispl.show_document?p_table=STANDARDS&p_id=10051] Date accessed: 3/23/2007.

6. Centers for Disease Control and Prevention [1991]. Hepatitis B virus: a comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination – recommendations of the Immunization Practices advisory Committee (ACIP). *MMWR* 40(No. RR-13). [http://www.cdc.gov/mmwr/preview/mmwrhtml/00033405.htm] Date accessed: 3/23/2007.

7. Centers for Disease Control and Prevention [1997]. Immunization of health-care workers: recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee (HICPAC). *MMWR* 46(No. RR-18). [http://www.cdc.gov/mmwr/preview/mmwrhtml/00050577.htm] Date accessed: 3/23/2007.

8. Spire B, Montagnier L, Barré-Sinoussi F, Chermann JC [1984]. Inactivation of lymphadenopathy associated virus by chemical disinfectants. *Lancet* 2:899-901.

9. Martin LS, McDougal JS, Loskiski SL [1985]. Disinfection and inactivation of the human T lymphotropic virus type-III/lymphadenopathy-associated virus. *J Inf Dis* 152:400-3.

10. Hanson PJ, Gor D, Jeffries DJ, Collins JF [1989]. Chemical inactivation of HIV on surfaces. *Br Med J* 298:862-4.
11. Bloomfield SF, Smith-Burchnell CA, Dalgleish AG [1990]. Evaluation of hypochlorite-releasing disinfectants against the human immunodeficiency virus (HIV). *J Hosp Inf* 15:273-8.
12. Druce JD, Jardine D, Locarnini Sa, Birch CJ [1995]. Susceptibility of HIV to inactivation by disinfectants and ultraviolet light. *J Hosp Inf* 30:167-80.
13. Van Bueren J, Simpson RA, Salman H, Farrelly HD, Cookson BD [1995]. Inactivation of HIV-1 by chemical disinfectants: sodium hypochlorite. *Epi Inf* 115:567-79.
14. Prince DL, Prince HN, Thraehart O, et al [1993]. Methodological approaches to disinfection of human hepatitis B viruses. *J Clin Microbiol* 31:3296-3304.
15. Centers for Disease Control and Prevention [1987]. Recommendations for prevention of HIV transmission in health-care settings. *MMWR* 36(Suppl No 2S). [<http://www.orasure.com/uploaded/336.pdf>] Date accessed: 3/23/2007.
16. Sattar SA, Springthorpe VS [1991]. Survival and disinfectant inactivation of the human immunodeficiency virus: a critical review. *Rev Inf Dis* 13:430-47.
17. EPA-registered disinfectants. [<http://www.epa.gov/oppad001/chemregindex.htm>] Date accessed: 3/23/2007.
18. Larson E [1988]. A causal link between handwashing and risk of infection? Examination of the evidence. *Inf Cont Hosp Epi* 9:28-36.
19. Pitter D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S [2000]. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 356:1307-12.
20. Larson EL, Eke PI, Laughon BE [1986]. Efficacy of alcohol-based hand rinses under frequent-use conditions. *Antimicrob Agents Chemother* 30:542-4.
21. Larson EL, Aiello AE, Bastyr J, et al [2001]. Assessment of two hand hygiene regimens for intensive care unit personnel. *Crit Care Med* 29:944-51.
22. Widmer AF [2000]. Replace hand washing with use of a waterless alcohol hand rub? *Clin Inf Dis* 31:136-43.
23. Doebbeling BN, LiN, Wenzel RP [1993]. An outbreak of hepatitis A among health care workers: risk factors for transmission. *Am J Pub Hlth* 83:1679-84.
24. Standaert Sm, Hutcheson RH, Schaffner W [1994]. Nosocomial transmission of *Salmonella gastroenteritis* to laundry workers in a nursing home. *Inf Cont Hosp Epi* 15:22-6.
25. Taylor LJ [1978]. An evaluation of handwashing techniques -1. *Nursing Times* 54-55.
26. Larson EL, Eke PI, Wilder MP, Laughon BE [1987]. Quantity of soap as a variable in handwashing. *Inf Cont* 8:371-75.
27. Larson E, Leyden JJ, McGinley KJ, Grove GL, Talbot GH [1986]. Physiologic and microbiologic changes in skin related to frequent handwashing. *Inf Cont* 7:59-63.
28. Larson EL, Eke PI, Laughon BE [1986]. Efficacy of alcohol-based hand rinses under frequent-use conditions. *Antimicrob Agents Chemother* 30:542-4.
29. Centers for Disease Control and Prevention [2002]. Guidelines for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *MMWR* 51(No. RR-16).

[<http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5116a1.htm>] Date accessed: 3/23/2007.

30. Questions and Answers About TB [2005]. Centers for Disease Control and Prevention. National Center for HIV, STD and TB Prevention. [http://www.cdc.gov/nchstp/tb/faqs/qa_introduction.htm#Intro1] Date accessed: 3/23/2007.

31. Centers for Disease Control and Prevention [2005]. Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings. *MMWR* 54 (No. RR-17, 1-141). [<http://www.cdc.gov/mmwr/PDF/rr/rr5417.pdf>] Date accessed: 3/23/2007.

32. Nardell EA [1990]. Dodging droplet nuclei: reducing the probability of nosocomial tuberculosis transmission in the AIDS era. *Am Rev Respir Dis* 142: 501-503.

33. Broom BR, Murray C [1992]. Tuberculosis: commentary on a reemerging killer. *Science* 257: 1055-1064.

34. Centers for Disease Control and Prevention [2006]. Prevention and Control of Tuberculosis in Correctional and Detention Facilities: Recommendations from CDC. *MMWR* 55(No. RR-9). [<http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5509a1.htm>] Date accessed: 3/23/2007.

35. MacNeil J, Lobato MN, Moore M [2005]. An unanswered health disparity: tuberculosis among correctional inmates, 1993-2003. *Am J Public Health* 95:1800-5.

36. Methicillin-resistant staphylococcus aureus [2003]. Centers for Disease Control and Prevention. National Center for Infectious Diseases. [<http://www.cdc.gov/ncidod/aip/research/mrsa.html>] Date accessed: 3/23/2007.

37. Buckingham S, McDougal L, Cathey L, et al [2004]. Emergence of Community-Associated Methicillin-Resistant *Staphylococcus aureus* at a Memphis, Tennessee Children's Hospital. *Ped Inf Dis J* 23(7):619-624.

38. Embil J, Ramotar K, Romance L, et al [1994]. Methicillin-resistant *Staphylococcus aureus* in tertiary care institutions on the Canadian prairies 1990-1992. *Infect Control Hosp Epidemiology* 15:646-51.

39. Naimi, TS, LeDell, KH, Como-Sabeti, K, et al [2003]. Comparison of Community- and Health Care-Associated Methicillin-Resistant *Staphylococcus aureus* Infection. *JAMA* 290(22):2976-2984.

40. Centers for Disease Control and Prevention [2001]. Methicillin-resistant *Staphylococcus aureus* skin or soft tissue infections in a state prison—Mississippi. *MMWR* 50(42):919-22. [<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5042a2.htm>] Date accessed: 3/23/2007.

41. Centers for Disease Control and Prevention [1981]. Community-acquired methicillin-resistant *Staphylococcus aureus* infections—Michigan. *MMWR* 30:185-7.

42. Goetz A, Posey K, Fleming J, et al [1999]. Methicillin-resistant *Staphylococcus aureus* in the community: a hospital-based study. *Infect Control Hosp Epidemiol* 20:689-91.

43. Alonso Fernandez R, Baquero Mochales F [1994]. The genus *Serratia*: its biology, clinical effects and epidemiology. *Rev Clin Esp* 194(4):294-9.

44. Johnson DH, Cunha BA, Klein NC [1993]. *Serratia*. *Infect Dis Pract* 17: 6-8.

45. Yu VL [1979]: *Serratia marcescens*: historical perspective and clinical review. *N Engl J Med* 300(16):887-93.

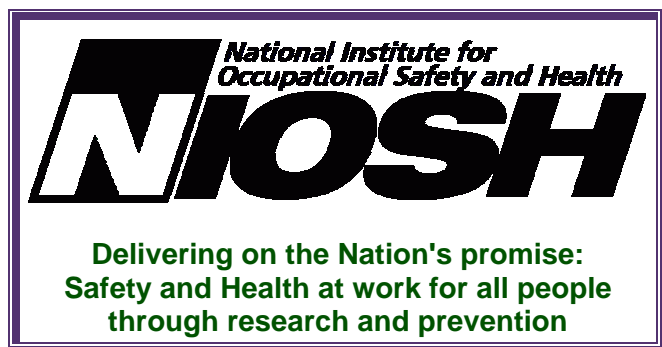
46. Bosi C, Davin-Regli A, Charrel R, et al [1996]: *Serratia marcescens* nosocomial outbreak due to contamination of hexetidine solution. *J Hosp Infect* 33(3):217-24.

47. Cohen SM, Flynn HW Jr, Miller D [1997]. Endophthalmitis caused by *Serratia marcescens*. *Ophthalmic Surg Lasers* 28(3):195-200.

48. Edmond MB, Wallace SE, McClish DK, et al [1999]. Nosocomial bloodstream infections in United States hospitals: a three-year analysis. *Clin Infect Dis* 29(2):239-44.
49. Gurevich I, Tafuro PA, Cunha BA [1987]. Serratia peritonitis in hemodialysis patients. *Clinical Microbiology Newsletter* 9:55-56.
50. Basilio J Anía [2007]. Serratia. In WebMD emedicine. [<http://www.emedicine.com/med/topic2103.htm>] Date accessed: 3/23/2007.
51. Rosenstock L [1996]. NIOSH Testimony to the U.S. Department of Labor on indoor air quality. *Applied Occupational and Environmental Hygiene* 11(12):1365-1370.
52. Mendell MJ [1993]. Non-specific symptoms in office workers: a review and summary of the epidemiologic literature. *Indoor Air* 3:227-236.
53. Malkin R, Wicox T, Sieber WK [1996]. The National Institute for Occupational Safety and Health indoor environmental evaluation experience. Part two: symptom prevalence. *Applied Occupational and Environmental Hygiene* 11(6):540-545.
54. Gammage RR, Kaye SV, eds [1985]. Indoor air and human health: Proceedings of the Seventh Life Sciences Symposium. Chelsea, MI: Lewis Publishers, Inc.
55. Burge S, Hedge A, Wilson S, Bass JH, Robertson A [1987]. Sick building syndrome: a study of 4373 office workers. *Ann Occup Hyg* 31:493-504.
56. Kreiss K [1989]. The epidemiology of building-related complaints and illness. *Occupational Medicine: State of the Art Reviews* 4(4):575-592.
57. Norbäck D, Michel I, Widstrom J [1990]. Indoor air quality and personal factors related to the sick building syndrome. *Scan J Work Environ Health* 16:121-128.
58. Seppanen OA, Fisk WJ, Mendell MJ [1999]. Association of ventilation rates and CO2 concentrations with health and other responses in commercial and institutional buildings. *Indoor Air* 9:226-252.
59. ANSI/ASHRAE [2004]. Thermal environmental conditions for human occupancy. American National Standards Institute/ASHRAE standard 55-2004. Atlanta, GA: American Society for Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
60. ANSI/ASHRAE [2004]. Ventilation for acceptable indoor air quality, standard 62.1-2004. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
61. ACGIH® [1999]. Bioaerosols: assessment and control. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
62. Institute of Medicine [2001]. Tuberculosis in the workplace. Washington, DC: National Academy Press.
63. National Commission on Correctional Health Care [2003]. Standards for health services in jails. Chicago, IL: National Commission on Correctional Health Care.
64. National Commission on Correctional Health Care [2003]. Standards for health services in prisons. Chicago, IL: National Commission on Correctional Health Care.
65. American Correctional Association [2003]. Standards for adult correctional institutions, 4th ed. Lanham, MD: American Correctional Association.
66. American Correctional Association [2004]. 2004 standards supplement. Lanham, MD: American Correctional Association.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

OFFICIAL BUSINESS
Penalty for private use \$300



To receive NIOSH documents or information
about occupational safety and health topics
contact NIOSH at:

1-800-35-NIOSH (356-4674)
Fax: 1-513-533-8573
E-mail: pubstaff@cdc.gov
or visit the NIOSH web site at:
<http://www.cdc.gov/niosh>

SAFER • HEALTHIER • PEOPLE™