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Risk of infection and tracking of work-related infectious diseases in the funeral industry

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This review demonstrates that funeral service professionals (FSPs) have a risk of exposure to bacterial and viral pathogens as well as to prion-mediated diseases. It reveals a lack of published studies focusing on the implementation and effectiveness of infection control policies for this occupational group as well as the difficulty involved in determining actual infection rates related to workplace exposure events. Possible reasons for this lack of data include the categorization of these workers by the Bureau of Labor Statistics Standard Occupational Classification System as service providers rather than health care professionals. (Am J Infect Control 2006;34:655-60.)

The routine tasks carried out by funeral service professionals (FSPs) would seem to put them at significant risk of exposure to several infectious agents. Exposure by way of splashes to the mucus membranes, inhalation of aerosolized body fluids, and direct inoculation can result in infectious diseases caused by multiple species of bacteria, viruses, and prions. The purpose of this review is to determine what is known of the risk of exposure to infectious agents that FSPs experience in the workplace, identify prevention and post-exposure strategies utilized in the funeral business, and determine occupationally acquired infection rates among this group.

METHODS

A literature search was carried out using the PubMed service of the National Library of Medicine (April 2006). Abstracts were reviewed, and applicable articles were obtained. Internet sources included the Web sites of the Centers for Disease Control and Prevention (CDC), the United States Department of Labor, the US Census Bureau, the National Funeral Directors Association (NFDA), and the American Board of Funeral Service Education.

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RESULTS

Risk of exposure

The risk of exposure to infectious agents in the health care setting is well documented; however, one occupational group that appears to be underrepresented in the infectious disease literature is FSPs. A recent literature review sponsored by the British Institute of Embalmers found that the risk of exposure is well documented but that there is a need for additional studies focusing on the suggested link between reported infections and the embalming procedure.[1] That review, as well as this one, also found a lack of studies in the literature focusing on the implementation and effectiveness of infection control practices in the funeral business.[1]

There were 2,448,288 reported deaths in the United States during 2003, the majority of which was followed by embalming according to the NFDA.[2,3] An infectious disease was the reported cause of death in 99,232 of these individuals and is recognized as a frequent contributor to mortality, even when not documented as the primary cause of death.[2] The infectious nature of cadavers, regardless of their cause of death, has been documented.[1,4-8] The routine transport and embalming of cadavers place the FSP in a position to be exposed to multiple infectious agents that are transmissible by mucocutaneous contamination, aerosolization, and direct inoculation.[1,8-15]

Two common bacterial pathogens that may be contracted through mucocutaneous contamination are methicillin-resistant *Staphylococcus aureus* (MRSA) and *Streptococcus pyogenes*. Long recognized as a nosocomial pathogen, MRSA is establishing itself as a community-acquired infectious agent with increasing frequency.[10,16,17] Because of the prevalence of MRSA in the population both as a commensal and as a pathogen, the FSP has a potential exposure risk from

the remains of individuals who expired in health care facilities and those who died in other settings.[18,19] Group A streptococcus has been shown to survive on the cadavers of victims of invasive disease, presenting a serious infectious risk to the FSP because it may be transmitted by direct contact and as a result of direct inoculation following even minor nicks to the skin during autopsy.[8,12,17,20-22]

FSPs may be exposed to gastrointestinal organisms through direct contact with leaking fecal material when manipulating corpses, which can lead to transmission via the fecal-oral route.[8] The 2 microorganisms of greatest concern for transmission are nontyphi Salmonella and hepatitis A, whereas *Salmonella typhi*, *Shigella* species, *Cryptosporidia*, *Helicobacter pylori*, and other microorganisms are less of a risk in the developed world.[12,23-25] Another group of Enterobacteriaceae that have the potential to present a risk to FSPs are the extended-spectrum β-lactamase producers (ESBLs) because of their growing prevalence and refractoriness to treatment, resulting in higher mortality rates when responsible for bacteremia.[26-28]

Infectious agents transmitted primarily by the airborne route that should be of concern to the FSP include *Mycobacterium tuberculosis* and the virus responsible for severe acute respiratory syndrome (SARS).[1,8,13,29,30] Tuberculosis is a leading cause of disease and death, with more than one third of the global population being infected. Attempts to control the infections are complicated by the high prevalence of multiple drug-resistant strains, which are common in some populations.[31] The risk of exposure to *Mycobacterium tuberculosis* experienced by FSPs is documented for airborne transmission and through direct inoculation.[1,6-8,10,32-34] SARS is a newly recognized infectious disease, and there are no published reports of transmission from cadavers to FSPs. Moore et al analyzed the data available on SARS and published guidelines for infection control in the health care setting, which were tested in Toronto.[30] Others have also published reviews of the infection control literature concerning SARS, and the World Health Organization (WHO) has released guidelines addressing management of known or suspected cases.[29,30,35,36] Because of the virulent and contagious nature of the SARS virus, it is of special concern to both the health care worker (HCW) and the FSP.[29]

The 3 most common bloodborne pathogenic viruses FSPs are at risk of exposure to are the hepatitis B virus (HBV), the hepatitis C virus (HCV), and the human immunodeficiency virus (HIV).[1,8,9,11,12,15,37-42] The risk of exposure to blood and other body fluids for this occupational group has been the subject of a limited number of studies.[9,11,37,42,43] Studies focusing on the occurrence of HBV among FSPs show that members of this occupational group have a higher rate of infection than control groups.[1,6,9,12,37] However, widespread implementation of vaccination programs has dramatically lowered the infection rate among HCWs and FSPs.[39,41,44] HCV is the most prevalent bloodborne pathogen in health care settings, with many chronically infected individuals being asymptomatic. Currently, there is no HCV vaccine available.[12,45-48] The long-term viability of HIV in cadaver tissue is recognized, and the literature reports a documented case of seroconversion in a pathologist following necropsy, along with 2 possible and 1 documented seroconversions in FSPs.[12,38,49-54] Thus, the importance of the prevention of transmission of HCV and HIV during the embalming procedure is clear, especially in light of these documented cases of transmission of HIV.

The Marburg and Ebola hemorrhagic fever viruses are not endemic in the United States, but the continuing sporadic outbreaks on the African continent, the previous occurrence of infection in European countries, the ease and speed of international travel, and their classification as category A bioterrorism agents warrant their inclusion in a discussion of potential exposure risks for FSPs.[7,55-57] Secondary transmission of these 2 viruses is known to occur following unprotected exposure to patients and cadavers through mucocutaneous contact and blood and body fluid exposure.[7,58,59] Aerosolization cannot be definitively excluded as a mode of transmission.[58,60] Guidelines have been published for the management of suspected or confirmed cases of these viral infections and include postmortem instructions.[7,56-58,61]

Another important group of infectious diseases of concern to FSPs are the transmissible spongiform encephalopathies (TSEs) or Creutzfeldt-Jakob disease (CJD) in humans, including kuru, iatrogenic, and new variant CJD (vCJD).[62-64] The mode of transmission of prions is not completely understood, with 85% of patients showing no recognizable pattern of transmission, but it is known that iatrogenic CJD has been passed from cadavers to recipients of human growth hormone, dura mater, and corneal grafts as well as between living patients following use of contaminated neurosurgical equipment.[62-64] Bloodborne transmission has been implicated in 2 cases of secondary vCJD infections in the United Kingdom, prompting concern that the blood supply could be contaminated with the responsible prion because of asymptomatic donor contributions.[63-68] Because prions are not destroyed by formaldehyde or glutaraldehyde and because their concentration is highest in cerebrospinal fluid and nervous system tissue, embalming is not recommended for autopsied or traumatized bodies, but, if the procedure is necessary, the CDC suggests following the WHO guidelines.[62,69]

Although most cases of TSE have been located in countries other than the United States, the government is

vigilant in monitoring CJD and vCJD cases and has taken steps to prevent an outbreak.[64] Transmission of TSE between patients, to HCW, and to FSP is a major concern because supportive treatment is all that can be done for victims because these diseases are invariably fatal.[63,64]

The potential for transmission of multiple infectious agents while engaging in the routine tasks of FSPs has been demonstrated. The nation's primary source of occupational information is the Occupational Information Network (O*NET) sponsored by the US Department of Labor Employment and Training Administration, and their Summary Report for Embalmers and Funeral Directors provides a detailed description of the tasks performed by FSPs that place them at risk.[70] There have been a limited number of published studies documenting actual exposure events.[1,9,11,42,55] The use of sharp implements during the embalming procedure places the FSP at risk of bloodborne pathogen exposure via needlestick, cuts, and splashes. The routine aspiration of blood and other body fluids carries the risk of aerosolization of droplet nuclei. The collection of fluid in the chest cavity of the deceased because of the putrefaction of tissue can lead to frothing and gurgling through the nose and mouth of the corpse.[1,9-11]

Exposure prevention and management strategies

Evaluation of exposure prevention and postexposure strategies utilized in the funeral business is difficult. There are few published references focusing on infection control in this setting.[1,9-11,37,42] Funeral homes fall under the mandates of the Occupational Safety Hazard Association's Bloodborne Pathogens Standard (number 1910.13100), which requires that employers have a written exposure control plan and meet the methods of compliance.[71] These methods include the practice of universal precautions, the implementation of engineering and work practice controls, and the provision of personal protective equipment. There does not appear to be a monitoring system in place to determine the effectiveness of adherence to the standard by tabulating exposure events or infection rates among FSPs.[71] The CDC maintains the National Surveillance System for Health Care Workers, which is a voluntary program that monitors exposure events among hospital-based HCWs to HIV, HBV, HCV, and *Mycobacterium tuberculosis* to assess trends, prevention strategies, and postexposure prophylaxis, but funeral homes are not part of this surveillance program.[72]

A further reason evaluation is difficult is the absence of infection control activities in funeral homes analogous to those found in most health care facilities. These activities are implemented to analyze policies and procedures to control infectious disease transmission. Although compliance among FSPs has not been studied to the degree that it has for HCWs, much of the data from the HCWs can be applied to the funeral business. It is known that compliance is greater if employees feel that their organization is interested in safety, if they have current and correct knowledge of the availability of personal protective equipment, and if they perceive that compliance is mandatory.[30] There has been speculation concerning the usefulness of disclosing to FSPs the specific infectious nature of particular cadavers, but it has been shown that this knowledge does not affect compliance in a significant percentage of employees.[10] The autonomous nature of the work performed by FSPs might be a factor contributing to noncompliance issues. Postexposure actions followed by the FSP might be less than those of the HCW because of the expectation and relative ease of reporting exposure events and receiving postexposure care in most health care settings.

The role continuing education plays in compliance among FSPs is another area that appears not to have been evaluated fully. The American Board of Funeral Service Education, the accrediting agency for schools offering degrees in funeral service, requires students to complete successfully the basic science courses, including microbiology and pathophysiology, and the examinations for licensure administered by each state include sections covering these subjects.[73,74] More than 30 states require annual continuing education credits for licensed funeral directors and embalmers, but there are no specific requirements for infection control subject matter.[73,74] Studies have suggested a need for continuing education to ensure adherence to infection control policies.[29,30,75]

Occupationally acquired infection rates

It is difficult to determine the occupationally acquired infection rate among FSPs. One possible explanation for the apparent underrepresentation of FSP in the infection control literature could be that embalmers and funeral directors are placed under the Personal Care and Service Occupations group rather than being included in the Healthcare Practitioners and Technical Occupations or Healthcare Support Occupations groups in the Bureau of Labor Statistics Standard Occupational Classification (SOC) System.[76] This SOC system is consistent with the Census 2000 Alphabetical Indexes of Industries and Occupations used in coding information gathered by governmental and private agencies for statistical reporting programs.[76,77] Another contributing factor is the lack of standardized coding on death certificates for the occupation of the decedent, although multiple governmental agencies are working together to make improvements in the

coding system to standardize this data.[78] Underreporting of exposure events by individual employees along with the lack of infection control oversight programs in the funeral business could also be factors making this determination difficult.

An additional topic that is worthy of mention is the exposure risk experienced in countries other than the United States and Canada, which are the only 2 countries that routinely embalm the deceased. Other countries have various types of funeral services available, but embalming is reserved for cases requiring a prolonged viewing period or for shipment of the corpse. In most areas, family members wash the dead and prepare them for internment, and only rudimentary steps are taken to prevent the spread of communicable disease if it is known to be present.[79] According to the WHO mortality records, worldwide, there were 10,903,977 deaths attributed to infectious and parasitic diseases in 2002, and the majority of these deaths occurred in areas other than the United State and Canada.[80] Thus, as with many issues related to infectious diseases, the developing world could benefit from better surveillance as well as implementation of controls to prevent transmission related to handling of the dead.

DISCUSSION

This review of published literature demonstrates that FSPs have a risk of exposure to bacterial and viral pathogens as well as to prion-mediated diseases. It reveals a lack of published studies focusing on the implementation and effectiveness of infection control policies for this occupational group as well as the difficulty involved in determining actual infection rates related to workplace exposure events. Questions that should be the focus of future studies include determining the level of employee compliance with existing infection control policies, accessing factors that influence compliance, and evaluating the effectiveness of existing policies in preventing exposure events and actual infections as well as implementing better systems to determine the infection rates of the various agents in this occupational group.

References

1. Creely KS. Infection risks and embalming. Institute of Occupational Medicine. 2004. Available at: http://www.iom-world.org/pubs/IOM_TMO401.pdf. Accessed April 1, 2005.
2. National Center for Health Statistics. Death: final data for 2003. National Vital Statistics Reports 2006. Available at: http://www.cdc.gov/nchs/data/hestat/finaldeaths03_tables.pdf#2. Accessed January 28, 2006.
3. National Funeral Directors Association. National Funeral Directors Association fact sheet 2005. Available at: http://www.nfda.org/nfdafactsheets.php. Accessed July 27, 2005.
4. Rose GW, Hockett RN. The microbiologic evaluation and enumeration of postmortem species from human remains. Health Lab Sci 1971;8:75-8.
5. Hinson MR. Final report on literature search on the infectious nature of dead bodies for the Embalming Chemical Manufactures Association. Embalming Chemical Manufacturers Association 1968. In: Mayer RG, editor. Embalming history, theory, and practice. 3rd ed. New York: McGraw Hill; 2000. p. 649-52.
6. Rendon LR. Dangers of infection. In: Mayer RG, editor. Embalming history, theory, and practice. 3rd ed. New York: McGraw Hill; 2000. p. 652-4.
7. Nolte KB, Taylor DG, Richmond JY. Biosafety considerations for autopsy. Am J Forensic Med Pathol 2002;23:107-22.
8. Healing TD, Hoffman PN, Young SE. The infection hazards of human cadavers. Commun Dis Rep CDR Rev 1995;5:R61-8.
9. Gershon RR, Vlahov D, Farzadegan H, Alter MJ. Occupational risk of human immunodeficiency virus, hepatitis B virus, and hepatitis C virus infections among funeral service practitioners in Maryland. Infect Control Hosp Epidemiol 1995;16:194-7.
10. Gershon RR, Vlahov D, Escamilla-Cejudo JA, Badawi M, McDiarmid M, Karkashian C, et al. Tuberculosis risk in funeral home employees. J Occup Environ Med 1998;40:497-503.
11. Nwanyanwu OC, Tabasuri TH, Harris GR. Exposure to and precautions for blood and body fluids among workers in the funeral home franchises of Fort Worth, Texas. Am J Infect Control 1989;17:208-12.
12. Burton JL. Health and safety at necropsy. J Clin Pathol 2003;56:254-60.
13. Morgan O. Infectious disease risks from dead bodies following natural disasters. Rev Panam Salud Publica 2004;15:307-12.
14. Hanzlick R. Embalming, body preparation, burial, and disinterment: an overview for forensic pathologists. Am J Forensic Med Pathol 1994;15:122-31.
15. Claydon SM. The high-risk autopsy: recognition and protection. Am J Forensic Med Pathol 1993;14:253-6.
16. Fridkin SK, Hageman JC, Morrison M, Sanza LT, Como-Sabetti K, Jernigan JA, et al. Methicillin-resistant *Staphylococcus aureus* disease in three communities. N Engl J Med 2005;352:1436-44.
17. O'Brien KL, Beall B, Barrett NL, Cieslak PR, Reingold A, Farley MM, et al. Epidemiology of invasive group A streptococcus disease in the United States, 1995-1999. Clin Infect Dis 2002;35:268-76.
18. Kuehnert MJ, Hill HA, Kupronis BA, Tokars JI, Solomon SL, Jernigan DB. Methicillin-resistant-*Staphylococcus aureus* hospitalizations, United States. Emerg Infect Dis 2005;11:868-72.
19. Lowy FD. *Staphylococcus aureus* infections. N Engl J Med 1998;339:520-32.
20. Greene CM, Van Beneden CA, Javadi M, Skoff TH, Beall B, Facklam R, et al. Cluster of deaths from group A streptococcus in a long-term care facility—Georgia, 2001. Am J Infect Control 2005;33:108-13.
21. Centers for Disease Control and Prevention. Active Bacterial Core Surveillance (ABCs) Report Emerging Infections Program Network: group A streptococcus, 2004—provisional. 2005. Available at: http://www.cdc.gov/ncidod/dbmd/abcs/survreports/gas04prelim.pdf. Accessed January 28, 2006.
22. Hawkey PM, Pedler SJ, Southall PJ. *Streptococcus pyogenes*: a forgotten occupational hazard in the mortuary. Br Med J 1980;281:1058.
23. Sepkowitz KA. Occupationally acquired infections in health care workers. Part II. Ann Intern Med 1996;125:917-28.
24. Swaminathan B, Barrett TJ, Fields P. Surveillance for human Salmonella infections in the United States. J AOAC Int 2006;89:553-9.
25. Niyogi SK. Shigellosis. J Microbiol 2005;43:133-43.
26. Schwaber MJ, Navon-Venezia S, Kaye KS, Ben-Ami R, Schwartz D, Carmeli Y. Clinical and economic impact of bacteremia with extended-spectrum-β-lactamase-producing Enterobacteriaceae. Antimicrob Agents Chemother 2006;50:1257-62.
27. Tumbarello M, Spanu T, Sanguinetti M, Citton R, Montuori E, Leone F, et al. Bloodstream infections caused by extended-spectrum-β-lactamase-producing *Klebsiella pneumoniae*: risk factors, molecular epidemiology, and clinical outcome. Antimicrob Agents Chemother 2006;50:498-504.
28. Moolman GJ, Jankowits CE, Bezuidenhout S, Pitout JD. Beta-lactamases in Enterobacteriaceae—an ever-present threat. S Afr Med J 2006;96:331-4.

29. Gamage B, Moore D, Copes R, Yassi A, Bryce E. Protecting health care workers from SARS and other respiratory pathogens: a review of the infection control literature. Am J Infect Control 2005;33:114-21.
30. Moore D, Gamage B, Bryce E, Copes R, Yassi A. Protecting health care workers from SARS and other respiratory pathogens: organizational and individual factors that affect adherence to infection control guidelines. Am J Infect Control 2005;33:88-96.
31. Centers for Disease Control and Prevention. Tuberculosis in the United States. 2004. Available at: http://www.cdc.gov/nchstp/tb/surv/surv2004/default.htm. Accessed October 1, 2005.
32. Lauzardo M, Lee P, Duncan H, Hale Y. Transmission of *Mycobacterium tuberculosis* to a funeral director during routine embalming. Chest 2001;119:640-2.
33. Sterling TR, Pope DS, Bishai WR, Harrington S, Gershon RR, Chaisson RE. Transmission of *Mycobacterium tuberculosis* from a cadaver to an embalmer. N Engl J Med 2000;342:246-8.
34. Demiryurek D, Bayramoglu A, Ustacelebi S. Infective agents in fixed human cadavers: a brief review and suggested guidelines. Anat Rec 2002;269:194-7.
35. World Health Organization. Hospital infection control guidance for severe acute respiratory syndrome (SARS). 2003. Available at: http://www.who.int/csr/sars/infectioncontrol/en/. Accessed October 1, 2005.
36. World Health Organization. Consensus document on the epidemiology of severe acute respiratory syndrome (SARS). 2003. Available at: http://www.who.int/csr/sars/en/WHOconsensus.pdf. Accessed October 1, 2005.
37. Turner SB, Kunches LM, Gordon KF, Travers PH, Mueller NE. Occupational exposure to human immunodeficiency virus (HIV) and hepatitis B virus (HBV) among embalmers: a pilot seroprevalence study. Am J Public Health 1989;79:1425-6.
38. Douceron H, Deforges L, Gherardi R, Sobel A, Chariot P. Long-lasting postmortem viability of human immunodeficiency virus: a potential risk in forensic medicine practice. Forensic Sci Int 1993;60:61-6.
39. Beltrami EM, Williams IT, Shapiro CN, Chamberland ME. Risk and management of blood-borne infections in health care workers. Clin Microbiol Rev 2000;13:385-407.
40. Riddell LA, Sherrard J. Blood-borne virus infection: the occupational risks. Int J STD AIDS 2000;11:632-9.
41. Twitchell KT. Bloodborne pathogens: what you need to know. Part II. AAOHN J 2003;51:89-97.
42. Beck-Sague CM, Jarvis WR, Fruehling JA, Ott CE, Higgins MT, Bates FL. Universal precautions and mortuary practitioners: influence on practices and risk of occupationally acquired infection. J Occup Med 1991;33:874-8.
43. McDonald L. Blood exposure and protection in funeral homes. Am J Infect Control 1989;17:193-5.
44. Mahoney FJ, Stewart K, Hu H, Coleman P, Alter MJ. Progress toward the elimination of hepatitis B virus transmission among health care workers in the United States. Arch Intern Med 1997;157:2601-5.
45. Memon MI, Memon MA. Hepatitis C: an epidemiological review. J Viral Hepat 2002;9:84-100.
46. Williams I. Epidemiology of hepatitis C in the United States. Am J Med 1999;107:S2-9.
47. Alter MJ, Kruszon-Moran D, Nainan OV, McQuillan GM, Gao F, Moyer LA, et al. The prevalence of hepatitis C virus infection in the United States, 1988 through 1994. N Engl J Med 1999;341:556-62.
48. Lanphear BP. Transmission and control of bloodborne viral hepatitis in health care workers. Occup Med 1997;12:717-30.
49. Henry K, Dexter D, Sannerud K, Jackson B, Balfour H Jr. Recovery of HIV at autopsy. N Engl J Med 1989;321:1833-4.
50. de Craemer D. Postmortem viability of human immunodeficiency virus—implications for the teaching of anatomy. N Engl J Med 1994;331:1315.
51. Johnson MD, Schaffner W, Atkinson J, Pierce MA. Autopsy risk and acquisition of human immunodeficiency virus infection: a case report and reappraisal. Arch Pathol Lab Med 1997;121:64-6.
52. Bankowski MJ, Landay AL, Staes B, Shuburg R, Kritzler M, Hajakian V, et al. Postmortem recovery of human immunodeficiency virus type 1 from plasma and mononuclear cells: implications for occupational exposure. Arch Pathol Lab Med 1992;116:1124-7.
53. Nyberg M, Suni J, Haltia M. Isolation of human immunodeficiency virus (HIV) at autopsy one to six days postmortem. Am J Clin Pathol 1990;94:422-5.
54. Do AN, Ciesielski CA, Metler RP, Hammett TA, Li J, Fleming PL. Occupationally acquired human immunodeficiency virus (HIV) infection: national case surveillance data during 20 years of the HIV epidemic in the United States. Infect Control Hosp Epidemiol 2003;24:86-96.
55. Centers for Disease Control and Prevention. Brief report: outbreak of marburg virus hemorrhagic feve—Angola, October 1, 2004-March 29, 2005. MMWR 2005;54:308-9.
56. Centers for Disease Control and Prevention. A guidebook for surveillance medical examiners, coroners, and biologic terrorism and case management. MMWR 2004;53:RR08.
57. Ligon BL. Outbreak of Marburg hemorrhagic fever in Angola: a review of the history of the disease and its biological aspects. Semin Pediatr Infect Dis 2005;16:219-24.
58. Borio L, Inglesby T, Peters CJ, Schmaljohn AL, Hughes JM, Jahrling PB, et al. Hemorrhagic fever viruses as biological weapons: medical and public health management. JAMA 2002;287:2391-405.
59. Peters CJ. Marburg and Ebola—arming ourselves against the deadly filoviruses. N Engl J Med 2005;352:2571-3.
60. Leffel EK, Reed DS. Marburg and Ebola viruses as aerosol threats. Biosecur Bioterror 2004;2:186-91.
61. Centers for Disease Control and Prevention. Management of patients with suspected viral hemorrhagic fever. MMWR 1988;37:1-16.
62. Centers for Disease Control and Prevention. CDC. Questions and answers: Creutzfeldt-Jakob disease infection control practices. Available at: http://www.cdc.gov/ncidod/dvrd/cjd/infection_control_cjd.htm. 2005. Accessed October 1, 2005.
63. Chesebro B. Introduction to the transmissible spongiform encephalopathies or prion diseases. Br Med Bull 2003;66:1-20.
64. Belay ED, Schonberger LB. The public health impact of prion diseases. Annu Rev Public Health 2005;26:191-212.
65. Brown P, Will RG, Bradley R, Asher DM, Detwiler L. Bovine spongiform encephalopathy and variant Creutzfeldt-Jakob disease: background, evolution, and current concerns. Emerg Infect Dis 2001;7:6-16.
66. Llewelyn CA, Hewitt PE, Knight RS, Amar K, Cousens S, Mackenzie J, et al. Possible transmission of variant Creutzfeldt-Jakob disease by blood transfusion. Lancet 2004;363:417-21.
67. Peden AH, Head MW, Ritchie DL, Bell JE, Ironside JW. Preclinical vCJD after blood transfusion in a PRNP codon 129 heterozygous patient. Lancet 2004;364:527-9.
68. Brown P. Pathogenesis and transfusion risk of transmissible spongiform encephalopathies. Dev Biol (Basel) 2005;120:27-33.
69. World health Organization. WHO infection control guidelines for transmissible spongiform encephalopathies: report of a WHO consultation, Geneva, Switzerland, 23-26 March 1999. Available at: http://www.who.int/csr/resources/publications/bse/WHO_CDS_CSR_APH_2000_3/en/. Accessed October 1, 2005.
70. Occupational Information Network. Summary report for: 11-9061.00 Funeral Directors. 2004. Available at: http://online.onetcenter.org/link/summary/11-9061.00. Accessed October 1, 2005.
71. Occupational exposure to bloodborne pathogens—OSHA. Final rule. Fed Regist 1991;56:64004-182.
72. Centers for Disease Control and Prevention. Surveillance system for hospital health care workers. 2005. Available at: http://www.cdc.gov/niosh/docs/chartbook/. Accessed October 1, 2005.
73. National Funeral Directors Association. Careers in funeral service. 2005. Available at: http://www.nfda.org/careers.php. Accessed April 6, 2005.

74. Bureau of Labor Statistics, US Department of Labor. Occupational outlook handbook, 2004-05 edition. Available at: http://www.bls.gov/oco/ocos011.htm. Accessed May 21, 2005.
75. Berhe M, Edmond MB, Bearman GM. Practices and an assessment of health care workers' perceptions of compliance with infection control knowledge of nosocomial infections. Am J Infect Control 2005;33: 55-7.
76. US Department of Labor Standard Occupational Classification System. Available at: http://www.bls.gov/soc/home.htm. Accessed May 21, 2005.
77. US Census Bureau, Housing and Household Economics Statistics Division. 2004. Available at: gov/hhes/www/ioindex/overview.html. Accessed May 13, 2005.
78. Department of Health and Human Services. Mortality by occupation, industry, and cause of death: 24 reporting states (1984-1988). 1997. Available at: http://www.cdc.gov/niosh/bk97114.html. Accessed March 25, 2005.
79. Habenstein RW, Lamers WM. Funeral customs the world over. 4th ed. Milwaukee, WI: Bulfin Printers, Inc; 1994.
80. WHO. Burden of disease estimates by region in 2002. World Health Report; 2004.