Editorial

Selection and Use of Vaccines for Healthcare Workers

David J. Weber, MD, MPH; William A. Rutala, PhD, MPH;
Kristen Weigle, MD, MPH

Exposure to multiple infectious agents with the potential for disease acquisition is a well-recognized risk for healthcare workers (HCWs).[1-15] Important infectious risks may be classified by their route of transmission and include airborne (eg, tuberculosis, influenza, varicella, measles), droplet (eg, pertussis, meningococcal infection, respiratory syncytial virus), skin contact (eg, ectoparasites, *Herpes simplex,* colonization with methicillin-resistant *Staphylococcus aureus*); contact with feces (eg, salmonellosis, hepatitis A virus [HAV], cryptosporidiosis); and parenteral or mucosal exposure to blood or contaminated body fluids (eg, hepatitis B, hepatitis C, human immunodeficiency virus).

Minimizing the risk of disease acquisition is based on strict adherence to three key recommended interventions: handwashing,[16] rapid institution of appropriate isolation precautions for patients with known or suspected communicable diseases,[17] and appropriate immunizations. Other important occupational health interventions include an accessible health service; periodic tuberculin skin tests; evaluation of ill employees with potential communicable diseases, with appropriate treatment and work restrictions; evaluation of employees following infectious disease exposures for postexposure prophylaxis and work restrictions; and education of employees, focusing on general infection control guidelines in addition to Occupational Safety and Health Administration-mandated training in the prevention of exposure to bloodborne pathogens and tuberculosis.

General recommendations regarding vaccination of HCWs have been published by the Centers for Disease Control and Prevention (CDC),[1] the Advisory Committee for Immunization Practices,[18,19] the American College of Physicians,[20] the American College of Pediatrics,[21] and infectious disease experts.[22-24] It is recommended that all HCWs be immune to mumps, measles, rubella, and varicella. All HCWs with potential exposure to blood or body fluids should be immune to hepatitis B. Influenza vaccine should be offered to all HCWs yearly. Detailed recommendations have been published regarding mumps,[25] measles,[26] rubella,[27] varicella,[28,29] hepatitis B,[30] and influenza[31] vaccines. Immunization of HCWs should be included by all healthcare facilities as part of a comprehensive occupational health program (Table 1). All new employees should receive a prompt review of their immunization status for vaccine-preventable diseases, and their immunization status also should be reviewed yearly. All HCWs should be included in these recommendations, including employees with direct patient-care responsibilities (eg, nurses, respiratory therapists, physical therapists), physicians, students, employees without direct patient-care responsibilities (eg, environmental service workers, security), contract workers, and

From the Adult and Pediatric Infectious Disease Divisions, University of North Carolina School of Medicine; the Department of Epidemiology, University of North Carolina School of Public Health; and the Department of Hospital Epidemiology, University of North Carolina Hospitals, Chapel Hill, North Carolina.

Address reprint requests to David Jay Weber, MD, MPH, 547 Burnett-Womack Bldg, CB #7030, Division of Infectious Diseases, UNC at Chapel Hill, Chapel Hill, NC 27599-7030.

97-ED-070. Weber DJ, Rutala WA, Weigle K. Selection and use of vaccines for healthcare workers. Infect Control Hosp Epidemiol *1997;18:682-687.*

TABLE 1
VACCINES STRONGLY RECOMMENDED FOR ALL HEALTHCARE WORKERS

Vaccine	Administration*	Demonstration of Immunity	Indication(s)*
Mumps	One dose SC†; no booster	Born before 1957; physician-diagnosed disease‡; positive serology‡; prior receipt of vaccine‡	All HCWs
Measles	One dose SC†; second dose at least 1 mo later	Born before 1957§; physician-diagnosed disease‡; positive serology‡; prior receipt of vaccine‡ (two doses of live vaccine on or after first birthday)	All HCWs
Rubella	One dose SC†; no booster	Born before 1957‖; physician-diagnosed disease‡; positive serology‡; prior receipt of vaccine‡	All HCWs
Varicella	Two doses SC, second dose 4-8 wk apart if ⩾13 y of age	History of varicella-zoster virus infection; positive serology if history negative or uncertain‡; prior receipt of two doses of vaccine, at least 1 mo apart‡	All HCWs
Hepatitis B¶	Two doses IM 4 wk apart; third dose 5 mo after second; booster not necessary	Positive serology‡,#,**; prior receipt of three doses of vaccine with an appropriate schedule‡,††	HCWs with potential blood or body fluid exposure
Influenza	Annual single dose IM with current (either whole- or split-virus) vaccine	Yearly immunization	All HCWs

Abbreviations: HCWs, healthcare workers; IM, intramuscularly; SC, subcutaneously.
* The package insert always should be consulted for specific recommendations regarding storage, administration, precautions, and contraindications.
† Measles-mumps-rubella vaccine preferred.
‡ Written documentation should be required.
§ During an outbreak, unvaccinated individuals born prior to 1957 should not be assumed to be immune and should be vaccinated.
‖ Adults born before 1957 may be considered immune, except for women of childbearing age (consideration should be given to serologically testing or immunizing all individuals born before 1957).
¶ May be indicated for postexposure prophylaxis.
# Immunity is indicated by an anti-HBsAg level of ⩾10 mIU/mL.
** Immunity should be assessed 1-2 mo after the third dose. If not immune, an additional three doses should be provided and immunity reassessed. If still not immune, provide hepatitis B immune globulin as postexposure prophylaxis when indicated.
†† If immunity was not assessed 1-6 months after completion of primary series and employee sustains an exposure to blood or a potentially contaminated fluid, the employee should be managed according to current CDC guidelines.

emergency medical personnel. Healthcare workers should be provided vaccines that are recommended for adults, including diphtheria-tetanus,[32] and pneumococcal vaccines,[33] or they should be referred to their local medical provider. In special circumstances, healthcare workers or laboratory personnel should be offered immunization with other vaccines (Table 2), including polio,[34] quadrivalent meningococcal vaccine,[35,36] bacille Calmette-Guérin,[37] rabies,[38] plague,[39] typhoid,[40] and vaccinia (smallpox).[41]

How should healthcare facilities decide which vaccines to provide at institutional expense to their employees? We believe that the following guidelines should be used. First, the vaccine should be demonstrated to be effective and safe in adults. Second, HCWs either should be at increased risk for acquiring the vaccine-preventable disease or, if infected, pose a material risk of transmitting infection to patients. The risk of disease acquisition can be quantitated best by cohort studies demonstrating an increased relative risk of disease acquisition or by case-control studies, using an appropriate control population, that demonstrate an increased odds ratio for infection. Outbreak investigations demonstrate that disease acquisition is possible, but do not allow determination of the degree of population-based risk. Similarly, the risk of an infected HCW transmitting disease to patients may be quantitated by cohort studies using look-back designs, although almost all data are derived from outbreak investigations. Finally, if the first two criteria are fulfilled, the best mechanism of implementing an immunization program should be assessed. Key questions include the desirability of preimmunization or postimmunization serological screening, cost of

TABLE 2
VACCINES AVAILABLE FOR HEALTHCARE WORKERS AND LABORATORY PERSONNEL IN SPECIAL CIRCUMSTANCES

Vaccine	Administration*	Indication(s)*
BCG† (for tuberculosis)	One percutaneous dose; no booster recommended	HCWs in locales where (1) multidrug-resistant tuberculosis is prevalent, (2) a strong likelihood of infection exists, and (3) full implementation of infection control precautions have been inadequate in controlling the spread of infection
Meningococcal (A, C, Y, and W135)	One dose; need for boosters unknown	Not routinely indicated; may be useful during type-C outbreaks
Pneumococcal polysaccharide	One dose IM or SC; revaccination recommended for high-risk persons ⩾6 years after first dose	Adults at increased risk of pneumococcal disease and its complications due to underlying health conditions; adults ⩾65 years of age
Tetanus-diphtheria‡	If not previously primed, two doses IM 4 wk apart; third dose 6-12 mo after second dose; booster as young adult and at age 50	All adults; tetanus prophylaxis still required in wound management
Rabies‡	Primary: HDCV or RVA IM on days 0, 7, and 21 or 28, or HDCV ID on days 0, 7, and 21 or 28	Personnel working with rabies virus or infected animals in diagnostic or research activities; postexposure prophylaxis boosters may be required despite primary immunization
Polio	If not previously primed, two doses of eIPV, two doses SC given 4-8 wk apart, followed by a third dose at 6-12 mo after the second dose. If previously primed, one supplemental dose (no boosters needed)	HCWs in close contact with persons who may be excreting wild virus; laboratory personnel handling specimens that may contain wild virus
Typhoid	Depending on vaccine: one dose IM and booster doses every 2 y or two doses SC, 4 or more wk apart, with booster doses every 3 y if exposure continues or four oral doses on alternate days, with revaccination with entire 4-dose series every 5 y	Laboratory personnel who frequently work with *Salmonella typhi*
Vaccinia	One dose administered with a bifurcated needle, booster dose every 10 y	Personnel who directly handle cultures of, or animals contaminated with, recombinant vaccinia viruses or orthopox viruses (monkeypox, cowpox) that infect humans
Plague	Three doses IM; first dose 1.0 mL; second dose 0.2 mL 1-3 mo after first dose; third dose 0.2 mL 5-6 mo after second dose; boosters 0.2 mL at 1-2 y intervals if exposure continues	Laboratory personnel who frequently work with *Yersinia pestis*
Hepatitis A	Two doses IM either 6-12 mo apart (VAQTA, Merck & Co, Inc, West Point, PA) or 6 mo apart (Havrix, SmithKline Beecham Biologicals, Philadelphia, PA)	Not routinely indicated for HCWs; persons who work with HAV-infected primates or HAV in a laboratory setting

Abbreviations: BCG, bacille-Calmette-Guérin; eIPV, enhanced inactivated polio vaccine; HAV, hepatitis A virus; HCWs, healthcare workers; HDCV, human diploid cell vaccine; ID, intradermal; IM, intramuscularly; RVA, rabies vaccine adsorbed; SC, subcutaneously.
* The package insert always should be consulted for specific recommendations regarding storage, administration, precautions, and contraindications.
† BCG should be used only as a last resort after consultation with local or state health department.
‡ May be indicated for postexposure prophylaxis.

implementing the program, and comparison of immunization versus other interventions to protect the HCW. Decision and cost-effectiveness analyses may be used to assess scientifically the utility of serological screening and to compare immunization versus other alternative interventions.

The hepatitis B and varicella vaccines clearly have met the previous criteria. Both the hepatitis B and varicella vaccines have been demonstrated to be safe and effective in adults. In the prevaccine era, HCWs were demonstrated to have a three- to fivefold greater risk for hepatitis B markers.[42,43] Further, this increased risk was associated with the extent and duration of exposure to blood.[43,44] For varicella, cohort studies have demonstrated frequent exposure of susceptible HCW workers to the varicella-zoster virus, with the need to furlough these employees. Reviews have summarized multiple instances of HCW-to-patient transmission of hepatitis B virus[45-49] or varicella-zoster virus.[29] Cost-benefit analysis has demonstrated that providing varicella vaccine to susceptible employees is less expensive than furloughing exposed susceptible personnel during the incubation period of varicella.[50,51]

HEPATITIS A IMMUNIZATION

Should HCWs be immunized against HAV? In this issue, Smith and colleagues[52] provide the results of a cost-effectiveness study of HAV vaccination in HCWs. Using a Markov model based on the cohort of students currently in medical school, the cost per life-year saved would be $58,000, and the cost per quality-adjusted life-year saved would be $47,000. Should HAV vaccine therefore be provided routinely by medical schools or healthcare facilities? French and Belgian researchers have reported in letters that HCWs had higher-than-expected rates of seropositivity to HAV.[53,54] However, three peer-reviewed studies have reported that HCWs had rates of HAV at or below levels in control populations,[55-57] and a cohort study failed to find evidence of patient-to-patient transmission.[58] Multiple nosocomial outbreaks of HAV have been reported,[59-74] most in one of the following settings. First, the source patient was not jaundiced, and hepatitis was inapparent at the time of hospitalization.[61-65,67,68,71-74] Second, the HAV-infected patient was fecally incontinent or had diarrhea.[61,63-65,67,68,73] Nosocomial HAV also has been associated with contaminated blood transfusions[66,69,70] and contaminated food.[59,60] Risk factors for HAV transmission to personnel have included activities that increase the risk of fecal-oral contamination, including caring for a person with unrecognized HAV infection[61-65,67,68,71-74]; sharing food, beverages, or cigarettes with patients, their families, or the staff[64,68,69,74]; nail biting; handling bile without proper precautions[74]; and not washing hands or wearing gloves when providing care to an infected patient.[69,71,72,74]

PROGRAM EVALUATION

Hospital epidemiologists frequently use the basic tools of epidemiology, including cross-sectional, case-control, and cohort studies. Increasingly, they are using more sophisticated methods including meta-analysis, decision analysis, and cost analysis (cost-effectiveness, cost-utility, or cost-benefit analysis). Cost-analysis techniques require that the following data be available: true costs (rather than charges), frequency of all relevant outcomes, and costs associated with all outcomes including death. All costs must be standardized to a base year, and discounting should be applied to future costs. Discounting takes into account the fact that people are risk-adverse and place higher value on immediate benefits compared with temporally remote benefits. Such analyses also should include a sensitivity analysis to determine if varying key assumptions affect the overall result; the use of utility functions (ie, worth the employee places on varying outcomes); and inclusion of quality adjustment for years of life lost. Standards have been published both for performing cost-effectiveness studies[75-77] and for evaluating such studies.[78]

Investigators who have evaluated single nosocomial outbreaks, and other commentators, have recommended that healthcare facilities should consider providing HAV vaccine to intensive-care unit staff[74] or to all HCWs.[79] Currently, the CDC recommends HAV vaccine only for population groups at increased risk for HAV, which is not understood to include HCWs.[80] We believe that immunization recommendations should be based on population-based studies and not analysis of case reports. Analyses such as that by Smith and colleagues[52] are helpful and should be encouraged by policymakers. The use of HAV vaccine as a universal vaccine should be evaluated in a cost-effectiveness study. Given the age distribution of infection and the assumption by Smith and coworkers that HCWs have a low risk of infection, providing vaccine at an earlier age will only improve the cost-effectiveness of immunization. When combined hepatitis A and B vaccines become available, administration and compliance is likely to be improved. Although the cost-effectiveness of providing HAV vaccine to medical students is in range with many other public health interventions, the lack

of increased acquisition risk for HCWs does not justify providing HAV vaccine to HCWs at institutional expense. HCWs should consult with their local medical practitioner regarding the risks and benefits of optional vaccines, including HAV.

REFERENCES

1. Williams WW. CDC guideline for infection control in hospital personnel. *Infect Control* 1983;4:326-349.
2. Omenn GS, Morris SL. Occupational hazards to health care workers: report of a conference. *Am J Ind Med* 1984;6:129-137.
3. Patterson WB, Craven DE, Schwartz DA, Nardell EA, Kasmer J, Noble J. Occupational hazards to hospital personnel. *Ann Intern Med* 1985;102:658-680.
4. Gestal JJ. Occupational hazards in hospitals: risk of infection. *Br J Ind Med* 1987;44:435-442.
5. Moore RM, Kaxzmarek RG. Occupational hazards to health care workers: diverse, ill-defined and not fully appreciated. *Am J Infect Control* 1991;18:316-327.
6. Hoffmann KK, Weber DJ, Rutala WA. Infection control strategies relevant to employee health. *American Association of Occupational Health Nurses Journal* 1991;39:167-181.
7. Valenti WM. Selected vaccines of nosocomial importance. In: Bennett JV, Brachman PS, eds. *Hospital Infections.* 3rd ed. Boston, MA: Little, Brown and Co; 1992:789-821.
8. Gerberding JL. Management of occupational exposures to blood-borne viruses. *N Engl J Med* 1995;332:444-451.
9. Diekema DJ, Doebbeling BN. Employee health and infection control. *Infect Control Hosp Epidemiol* 1995;16:292-301.
10. Clever LH, LeGuyader Y. Infection risks for health care workers. *Annual Review of Public Health* 1995;16:141-164.
11. Sepkowitz KA. Occupationally acquired infections in health care workers: part II. *Ann Intern Med* 1996;125:917-928.
12. Sepkowitz KA. Occupationally acquired infections in health care workers: part I. *Ann Intern Med* 1996;125:826-834.
13. Falk P. Infection control and the employee health service. In: Mayhall CG, ed. *Hospital Epidemiology and Infection Control.* Baltimore, MD: Williams & Wilkins; 1996:1094-1099.
14. Sebazco S. Occupational health. *APIC—Infection Control and Applied Epidemiology.* St Louis, MO: Mosby; 1996.
15. Doebbeling BN. Protecting the healthcare workers from infection and injury. In: Wenzel RP, ed. *Prevention and Control of Nosocomial Infections*. 3rd ed. Baltimore, MD: Williams & Wilkins; 1997:397-435.
16. Larson EL. APIC guideline for handwashing and hand antisepsis in health care settings. *Am J Infect Control* 1995;23:251-269.
17. Gardner JS, Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. *Infect Control Hosp Epidemiol* 1996;17:53-80.
18. Centers for Disease Control. Update on adult immunization: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1991;40(RR-12):1-94.
19. Centers for Disease Control and Prevention. General recommendations on immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1994;43(RR-1):1-38.
20. ACP Task Force on Adult Immunization and Infectious Disease Society of America. *Guide for Adult Immunization*. 3rd ed. Philadelphia, PA: American College of Physicians; 1994.
21. Committee on Infectious Diseases, American Academy of Pediatrics. *1997 Red Book.* 24th ed. Elk Grove Village, IL: American Academy of Pediatrics; 1997.
22. Williams WW, Preblud SR, Reichelderfer PS, Hadler SC. Vaccines of importance in the hospital setting. *Infect Dis Clin North Am* 1989;3:701-722.
23. Poland GA, Haiduven DJ. Adult immunizations in the healthcare worker. *APIC Infection Control and Applied Epidemiology.* St Louis, MO: Mosby; 1996:24.1-24.34.
24. Beekmann SE, Doebbeling BN. Frontiers of occupational health: new vaccines, new prophylactic regimens, and management of the HIV-infected worker. *Infect Dis Clin North Am* 1997;11:313-329.
25. Centers for Disease Control. Mumps prevention: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1989;38:388-392,397-400.
26. Centers for Disease Control. Measles prevention: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1989;(S-9):1-18.
27. Centers for Disease Control. Rubella prevention: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1989;39(RR-15):1-18.
28. Centers for Disease Control and Prevention. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1996;45(RR-1):1-36.
29. Weber DJ, Rutala WA, Hamilton H. Prevention and control of varicella-zoster infections in healthcare facilities. *Infect Control Hosp Epidemiol* 1996;17:694-705.
30. Centers for Disease Control. Protection against viral hepatitis: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1990;39(RR-2):1-26.
31. Centers for Disease Control and Prevention. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1997;46(RR-9):1-25.
32. Centers for Disease Control. Diphtheria, tetanus, and pertussis: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1991;40(RR-10):1-28.
33. Centers for Disease Control. Pneumococcal polysaccharide vaccine. Recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1989;38:64-68,73-76.
34. Centers for Disease Control and Prevention. Poliomyelitis prevention in the United States: introduction of a sequential vaccination schedule of inactivated poliovirus vaccine followed by oral poliovirus vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1997;46(RR-3):1-25.
35. Centers for Disease Control and Prevention. Control and prevention of meningococcal disease. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1997;46(RR-5):1-11.
36. Centers for Disease Control and Prevention. Control and prevention of serogroup C meningococcal disease: evaluation and management of suspected outbreaks: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1997;46(RR-5):13-21.
37. Centers for Disease Control and Prevention. The role of BCG vaccine in the prevention and control of tuberculosis in the United States: a joint statement by the Advisory Committee for the Elimination of Tuberculosis and the Advisory Committee on Immunization Practices. *MMWR* 1996;45(RR-4):1-18.
38. Centers for Disease Control. Rabies prevention—United States, 1991: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR* 1991;46(RR-3):1-19.
39. Centers for Disease Control and Prevention. Prevention of plague: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1996;45(RR-14):1-15.
40. Centers for Disease Control. Typhoid immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1990;39(RR-10):1-5.
41. Centers for Disease Control. Vaccinia (smallpox) vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1991;40(RR-14):1-10.
42. Denes AE, Smith JL, Maynard JE, Doto IL, Berquist KR, Finkel AJ. Hepatitis B infection in physicians: results of a nationwide seroepidemiologic survey. *JAMA* 1978;239:210-212.
43. Hadler SC, Doto IL, Maynard JE, et al. Occupational risk of hepatitis B infection in hospital workers. *Infect Control Hosp Epidemiol* 1985;6:24-31.
44. Panlilio AL, Shapiro CN, Schable CA, et al. Serosurvey of human immunodeficiency virus, hepatitis B virus, and hepatitis C virus infection among hospital-based surgeons. *J Am Coll Surg* 1995;180:16-24.
45. Weber DJ, Rutala WA. Hepatitis B immunization update. *Infect*

Control Hosp Epidemiol 1989;10:541-546.
46. Bell DM, Shapiro CN, Gooch BF. Preventing HIV transmission to patients during invasive procedures. *J Public Health Dent* 1993;53:170-173.
47. Harpaz R, Siedlein LV, Averhoff FM, et al. Transmission of hepatitis B virus to multiple patients from a surgeon without evidence of inadequate infection control. *N Engl J Med* 1996;334:549-554.
48. Incident Investigation Team and others. Transmission of hepatitis B to patients from four infected surgeons without hepatitis B e-antigen. *N Engl J Med* 1997;336:178-184.
49. AIDS/TB Committee of the Society of Healthcare Epidemiology of America. Management of healthcare workers infected with hepatitis B virus, hepatitis C virus, human immunodeficiency virus, or other bloodborne pathogens. *Infect Control Hosp Epidemiol* 1997;18:349-363.
50. Nettleman MD, Schmid M. Cost-effectiveness of varicella vaccination in hospital employees. In: Program and Abstracts of the Sixth Annual Meeting of the Society for Healthcare Epidemiology of America; April 21-23, 1996; Washington, DC. Abstract 70.
51. Hamilton HA. *A cost minimization analysis of varicella vaccine in health care workers.* Chapel Hill, NC: University of North Carolina; 1996. Thesis.
52. Smith S, Weber S, Wiblin T, Nettleman M. Cost-effectiveness of hepatitis A vaccination in healthcare workers. *Infect Control Hosp Epidemiol* 1997;18:695-698.
53. Van Damme P, Cramm M, Van der Auwera J-C, Meheus A. Hepatitis A vaccination for health care workers. *BMJ* 1993;306:1615.
54. Germanaud J. Hepatitis A and heath care personnel. *Arch Intern Med* 1994;154:820,822.
55. Kashiwagi S, Hayashi J, Ikematsu H, et al. Prevalence of immunologic markers of hepatitis A and B infection in hospital personnel in Miyazaki Prefecture, Japan. *Am J Epidemiol* 1985;122:960-969.
56. Gibas A, Blewett DR, Schoenfeld DA, et al. Prevalence and incidence of viral hepatitis in health care workers in the prehepatitis B vaccination era. *Am J Epidemiol* 1992;136:603-610.
57. Abb J. Prevalence of hepatitis A virus antibodies in hospital personnel [German]. *Gesundheitswesen* 1994;56:377-379.
58. Papaevangelou GJ, Roumeliotou-Karayannis AJ, Contoyannis PC. The risk of hepatitis A and B virus infections from patients under care without isolation precaution. *J Med Virol* 1981;7:143-148.
59. Eisenstein AB, Aach RD, Jacobsohn W, Goldman A. An epidemic of infectious hepatitis in a general hospital: probable transmission by contaminated orange juice. *JAMA* 1993;185:171-174.
60. Meyers JD, Romm FJ, Tihen WS, Bryan JA. Food-borne hepatitis A in a general hospital: epidemiologic study of an outbreak attributed to sandwiches. *JAMA* 1975;231:1049-1053.
61. Goodman RA, Carder CC, Allen JR, Orenstein WA, Finton RJ. Nosocomial hepatitis A transmission by an adult patient with diarrhea. *Am J Med* 1982;73:220-226.
62. Krober MS, Bass JW, Brown JD, Lemon SM, Rupert KJ. Hospital outbreak of hepatitis A: risk factors for spread. *Pediatr Infect Dis J* 1984;3:296-299.
63. Klein BS, Michaels JA, Rytel MW, Berg KG, Davis JP. Nosocomial hepatitis A: a multinursery outbreak in Wisconsin. *JAMA* 1984;252:2716-2721.
64. Reed CM, Gustafson TL, Siegel J, Duer P. Nosocomial transmission of hepatitis A from a hospital-acquired case. *Pediatr Infect Dis J* 1984;3:300-303.
65. Skidmore SJ, Gully PR, Middleton JD, Hassam ZA, Singal GM. An outbreak of hepatitis A on a hospital ward. *J Med Virol* 1985;17:175-177.
66. Azimi PH, Roberto RR, Guralnik J, et al. Transfusion-acquired hepatitis A in a premature infant with secondary nosocomial spread in an intensive care nursery. *Am J Dis Child* 1986;140:23-27.
67. Baptiste R, Koziol DE, Henderson DK. Nosocomial transmission of hepatitis A in an adult population. *Infect Control* 1987;8:364-370.
68. Drusin LM, Sohmer M, Groshen SL, et al. Nosocomial hepatitis A infection in a pediatric intensive care unit. *Arch Dis Child* 1987;62:690-695.
69. Rosenblum LS, Villarino ME, Nainan OV, et al. Hepatitis A outbreak in a neonatal intensive care unit: risk factors for transmission and evidence of prolonged viral excretion among preterm infants. *J Infect Dis* 1991;164:476-482.
70. Lee KK, Vargo LR, Le CT, Fernando L. Transfusion-acquired hepatitis A outbreak from fresh frozen plasma in a neonatal intensive care unit. *Pediatr Infect Dis J* 1992;11:122-123.
71. Watson JC, Flemming DC, Borella AJ, et al. Vertical transmission of hepatitis A resulting in an outbreak in a neonatal intensive care unit. *J Infect Dis* 1993;167:567-571.
72. Doebbeling BN, Li N, Wenzel RP. An outbreak of hepatitis A among healthcare workers: risk factors for transmission. *Am J Public Health* 1993;83:1679-1684.
73. Burkholder BT, Coronado VG, Brown J, et al. Nosocomial transmission of hepatitis A in a pediatric hospital traced to an anti-hepatitis A virus-negative patient with immunodeficiency. *Pediatr Infect Dis J* 1995;14:261-266.
74. Hanna JN, Loewenthal MR, Negel P, Wenck DJ. An outbreak of hepatitis A in an intensive care unit. *Anaesth Intensive Care* 1996;24:440-444.
75. Russell LB, Gold MR, Seigel JE, Daniels N, Weinstein MC, for the Panel on Cost-Effectiveness in Health and Medicine. The role of cost-effectiveness analysis in health and medicine. *JAMA* 1996;276:1172-1178.
76. Weinstein MC, Seigel JE, Gold MR, Kamlet MS, Russell LB, for the Panel on Cost-Effectiveness in Health and Medicine. Recommendations of the panel on cost-effectiveness in health and medicine. *JAMA* 1996;276:1253-1258.
77. Seigel JE, Weinstein MC, Russell LB, Gold MR, for the Panel on Cost-Effectiveness in Health and Medicine. Recommendations for reporting cost-effectiveness analysis. *JAMA* 1996; 276:1339-1344-1258.
78. Detsky AS, Naglie G. A clinician's guide to cost-effectiveness analysis. *Ann Intern Med* 1990;113:147-154.
79. Brewer MA, Edwards KA, Decker MD. Who should receive hepatitis A vaccine? *Pediatr Infect Dis J* 1995;14:258-260.
80. Centers for Disease Control and Prevention. Prevention of hepatitis A through active or passive immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 1996;45(RR-15):1-30.