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INFECTIOUS RISKS FOR HEALTH CARE WORKERS

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ABSTRACT

Although health care has been practiced for eons and although hundreds of thousands of workers are engaged in it, we know distressingly little about ways to prevent work-related infectious illnesses in this important group. Assumptions may be dangerous and expensive: Are "universal precautions" effective; when are respirators necessary? These kinds of questions have taken on particular urgency in the face of multiple-drug resistant tuberculosis and the spread of human immunodeficiency virus and other blood-borne pathogens. Furthermore, health care has moved from the traditional hospital setting into ambulatory, home, and other noninstitutional settings, thus increasing the complexity of worker protection measures. Steps to ensure the safety and health of health care workers must therefore include research and action that lead to identifying workers at risk; planning; education; providing necessary equipment and assuring adequate staffing; using appropriate techniques and precautions; immunizing workers; appropriately isolating patients; record-keeping; and evaluation. Curricula in schools for health professionals should include material on ways to achieve good health for health care workers. Public health officials and regulators should pay more attention to this arena.

INTRODUCTION

Health care workers through the ages have been plagued by infectious diseases. During the eras of greatest risk, the most prevalent and serious infections such

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as syphilis, hepatitis, human immunodeficiency virus (HIV), tuberculosis (TB), and influenza have been incurable. Although these diseases pale in importance by comparison with occupational injuries in terms of numbers, cost, and suffering, they deserve attention because of their effects on people, policies, and the professions.

In 1700, the astute Bernadino Ramazzini, noting the frequency of syphilis among midwives, said, "How, then, shall the medical profession safeguard ... [midwives], how to assist them to follow their calling with all possible impunity? The only way is for them to wash the hands and arms in water or wine when they have a breathing spell; when their work is done they should wash the face and rinse the throat with vinegar and water, put on clean clothes when they go home, in short be very careful to keep themselves clean. I was told by an aged midwife that, whenever she attended a woman who was either suspected of suffering from French disease or was in any way sickly, she used to wait till the patient was in the very last throes before she placed on the [birthing] chair; this was to shorten the time in which her own hands would be wetted by the contaminated lochia" (104, p. 167). Characteristically, Ramazzini urged prevention, since there was no cure. And prevention needed to be technological, since there was no vaccine. A century ago, recognition of the problem, rigorous antisepsis, hand washing, avoidance of breaks in skin, and, finally, use of rubber gloves, essentially eliminated work-related syphilis for health professionals (89).

That tuberculosis is contagious has been known since Aristotle. After years of conflicting data and debate, opinion coalesced in the 1960s that tuberculosis can be a work-related disease (110). Somewhat earlier, recommendations for tuberculin skin testing, chest X-rays, isolation of patients, asepsis, and, finally, effective treatment and prophylaxis of tuberculosis, decreased the risk for health care workers, at least temporarily.

HIV was recognized as a threat to health care workers early in its course (12), and a stream of recommendations followed (13, 14, 16–18). Regulations were later developed (95). The effectiveness of these measures remains to be seen, although instituting techniques to isolate body fluids reliably can decrease spread of at least some organisms (83), and universal precautions can decrease incidents of exposure (120). As is so often the case, more good occupational research is urgently needed to assure the health of health care workers. The focus should be on benefit-cost. That is, if applied as directed, do universal precautions or body substance isolation techniques decrease or prevent transmission of infectious diseases from patients to health care workers and beyond? If so, what is the cost in money, time, and effort? Some analysts have estimated millions of dollars and billions of gloves (53). Immediate attention must be given to these questions, because therapeutic approaches are wanting (91, 116).

RISKS

What risks of HIV infection do health care workers face? The consensus is that, after a needle stick or sharps cut from an HIV antibody-positive patient, a health care worker has a chance of about 1 in 250 of being infected (19, 64, 87, 105). That amounts to a loss of life expectancy of 39 days for a 30 year-old female health care worker (97). Factors other than the incident itself affect the outcome. The frequency of needle sticks varies by specialty, experience, and job title (65, 71, 85, 98, 102). The HIV titer seems to be higher in patients with more severe illness, so the chance of infecting a health care worker is correspondingly greater with sicker patients (97). The picture with hepatitis B (HBV) is more alarming, given its higher prevalence. About 1 in 20 health care workers will be infected after a percutaneous injury if the patient is hepatitis Be antigen (HBe Ag) negative; more than 1 in 4 will be infected if the patient is HBe Ag positive (97).

The consequences of exposures go beyond mere microbiology. Whether or not a health professional is actually infected by an injury, there is a period of anxiety, guilt, worry, fear, anger, sadness, and perhaps depression. Relationships may founder; pregnancy may be deferred. If infection is transmitted, sickness or death may ensue. Infection can also be passed along to patients, family members, and others. Professional lives may be threatened or ended by breaches of privacy and by the need for sick leave, restrictions of practice (10, 35, 49, 93), disability, or death. Thus, these incidents have poignant human dimensions that have meaning beyond numbers and models. As Sir Richard Doll has been quoted, "Statistics are people with the tears wiped away."

DEFINITION OF HEALTH CARE WORKER

Before discussing selected infections and proposed risk modifications, we need to define "health care workers." The Centers for Disease Control and Prevention (CDC) definition is inclusive: "any persons, including students or trainees, whose activities involve contact with patients or with blood or other body fluids from patients in a health-care setting" (17, p. 3S). Thus, clinical clerks in medical schools, geriatric workers, aides, and psychiatric and drug rehabilitation technicians may be included in the definition. Some of these workers may be considered more social service than health care workers, but the exposure potential is real. The exposure is real, too, for emergency workers and public safety workers, and protection guidelines have been published for them as well (21). The CDC does not refer to volunteers, but volunteers should be included if they are at risk. Family members should be of concern as well, because they provide an enormous amount of care, and because in-home transmission of tuberculosis, hepatitis B, influenza, HIV (15,44, 59), and cytomegalovirus (CMV) (99) is well recognized.

Counting only persons who touch patients for whom they are paid to care, 8.5 million people in the United States are health care workers (8). This number is expected to rise; indeed, four of the top six fastest-growing occupations are in health: home health aides, personal and home-care aides, medical assistants, and radiologic technologists and technicians (9).

High costs of in-patient services, increasing numbers of older persons who require chronic care, and the desire of many patients with acquired immunodeficiency syndrome (AIDS) and cancer to die in noninstitutional surroundings are forces expanding and dispersing health care work and sites. Hospices, day care and rehabilitation centers, and private homes are joining the ranks of hospitals, clinics, and nursing homes as "health care facilities." More than one half of health care workers are employed outside of hospitals (8). Physicians' offices, also possible sites for worker exposure, are covered by occupational safety and health administration (OSHA) regulations and CDC recommendations (95, 121). Assuring safe and healthy workplaces for tens of millions of paid and unpaid workers providing an array of services in countless sites is daunting but doable.

RISK MODIFICATION

In medicine, health care, and life, *decreasing* risk to a practical minimum is desirable, necessary, and feasible. As Murray noted, "Epidemics of nosocomial diseases in health care settings can be costly and tragic." Epidemics are even more unfortunate since diseases can be prevented with vaccines (92, p. 5), respiratory isolation, and placing susceptible hospital personnel on leave (39).

The question is how to achieve the ideal under conditions that occasionally include worker indifference or resistance and always include relentlessly tightening resources. First, an employer must know formal and informal local, state, and national standards and practices. Official guidelines (20, 24, 32, 41, 43) have almost the same force as formal rules and regulations (95) since following them lessens liability, enhances recruitment and satisfaction of employees, and helps mitigate the harsh glare of media attention in case of nosocomial transmission of disease (i.e. in the health care setting). Second, a robust alliance between workers and employer is essential. Acknowledging and working toward shared goals, beginning with a healthy, productive workforce, is essential. A good foundation is needed for the structure requisite to lessen risk and adverse events, and to deal with them when they happen. Creating this structure involves crafting a beneficent philosophy and assembling a coalition to develop and approve guidelines for handling serious incidents such as needle sticks (68). A straightforward checklist of steps includes (84, 95):

- Identifying workers at risk
- Planning
- Educating—now and forever

- Providing necessary *equipment*, such as respirators; barrier *supplies*, such as gloves; and assuring *adequate staffing*
- Using appropriate precautions, including hand-washing and disposal methods
- Immunizing workers against work-related illness without charge to the workers
- Appropriately isolating patients
- Keeping records of training and of workers' health (for 30 years after exposure)
- Evaluating the program

Although this checklist seems clear, each item can be fraught with frustration. Differing priorities, cultures and languages; low morale secondary to uncertainty or layoffs; insufficient time, money, storage space, or computer experience and equipment can complicate the establishment of a sound program. Underestimates or denial of risk, fear of adverse reactions, or inconvenience can interfere even with *free* immunizations. Resistance, disagreements, and disputes can delay progress. Leadership (61) and conflict resolution skills (58) as well as profound knowledge of occupational health, public health, and individual and organizational behavior are necessary to move ahead. Progress would be more certain if schools for health professionals set the tone with inspired, leading-edge curricula on infection control, and requirements for immunizations of students (10).

REVIEW OF REGULATIONS

Information regarding infectious diseases designated as "reportable" must be sent to local health departments and eventually to the Centers for Disease Control and Prevention (CDC). The CDC collects weekly, monthly, and yearly statistics on many infectious disease and makes recommendations about disease control. Because of the recognized risk and the negative consequences to health care workers, some infectious diseases are now considered reportable to the Occupational Safety Health Administration (OSHA), as work-related conditions. For example, the bloodborne pathogen standard, 29CFR 1910.30, in effect since 1992, mainly encompassing hepatitis B and HIV, mandates that the hepatitis and HIV status of the source patient be discoverable in case of a health care worker's exposure. Some states require an authorization from the source patient before studies are done. In October, 1993, OSHA issued mandatory guidelines for protecting exposed workers against tuberculosis (24). All persons with positive TB skin tests (except pre-placement tests) and all employees with clinical TB are presumed to have employment-related conditions to be recorded on the OSHA 200 Log (24).

The purpose of the Occupational Safety and Health Act of 1970 is to "ensure safe and healthful working conditions for every working man and woman" (94, p. 1). The Act also protects workers who exercise their rights under the Act from being fired or discriminated against by their employer. OSHA, an agency of the Department of Labor, is responsible for promulgating and enforcing standards in most workplaces, whereas the primary role of the National Institute for Occupational Safety and Health in the Department of Health and Human Services is to support education and research in occupational health and recommend new standards for OSHA. NIOSH has no enforcement authority.

INFECTIONS SELECTED FOR DISCUSSION

We selected infectious agents for this review based on their frequency in patients, likelihood for health care worker exposure, seriousness of effects, and new information. We focus on hepatitis, HIV, influenza, measles, meningococcal disease, mumps, rubella, tuberculosis, and varicella. For a variety of reasons, herpes simplex, hantavirus, *Coxiella burnetii,* cytomegalovirus, diphtheria, tetanus, Legionellosis, rabies, and zoonoses have been excluded.

HEPATITIS

Hepatitis A and Other Fecal-Oral Infections

Hepatitis A (HAV) can be transmitted by the fecal-oral route to health care workers (81). Good hand-washing practices and glove use discourage transmission. A report of an outbreak of acute gastroenteritis in a geriatric convalescent facility highlighted the pervasiveness of the fecal-oral transmission. Since 25% of 57 affected employees had no routine stool or patient contact, the question of airborne or multiple viruses was raised, especially since both stool and vomitus have plentiful organisms and can be projectile (81). Face shields may therefore be advisable in some settings. Although most researchers have found similar prevalence of hepatitis A antibodies in health care workers and in the general public, Germanaud recently suggested that breaks in technique could account for the significantly higher prevalence of hepatitis A IgG antibodies among nursing staff over 30 years of age compared to hospital office workers and technicians (67), but job analysis, history of immunization, and length of service were not described, so firm conclusions are not possible. When postvaccination immunity lasting 5 to 10 years is established, inactivated hepatitis A vaccine will be a boon for health care workers who work in long-term care facilities and in areas where the disease is highly endemic (75). But eternal vigilance and precautions will remain necessary against other agents transmitted by the fecal-oral route.

Hepatitis B

Hepatitis B is a bloodborne pathogen that, via a variety of injections and inseminations, infects about 300,000 new people in the United States per year (62). Three injections of the yeast-based, genetically engineered vaccine now in use, available since 1986, prevents infection in about 90% of healthy young people. Boosters are customarily given to health care workers every five to seven years, or if testing after exposure shows an inadequate antibody titer. Attention to these details is important. One study recently showed that only 35% of employees who reported parenteral exposures had completed hepatitis B vaccination (82). Another reported that 23% of health care workers were unvaccinated altogether (113). The consequences of this lack of immunity and failed universal precautions are immense: 10,000 to 12,000 health care workers are infected with hepatitis B every year, and 200 to 300 die of it. The most recent report available, which does not reflect use of liver transplantation, cites fulminant liver necrosis, chronic liver disease (cirrhosis), and hepatocellular carcinoma as the primary causes of death (21).

Hepatitis B vaccine must be given to all health care workers, using every legal persuasion. If health care workers cannot or prefer not to have the vaccine, they should not be assigned to patient contact responsibilities. Protection against disease is important for careers as well as health purposes. For example, because of the low but measurable risk of health care workers transmitting hepatitis B *to* patients, applicants to medical school in the United Kingdom are now being rejected if they are HBeAg positive (79). This new recommendation is being protested and has no counterpart in the U.S. (28).

Hepatitis C

Some studies have found the risk of health care workers developing hepatitis or becoming hepatitis C antibody (HCVAb) positive after percutaneous exposure to HCVAb-positive patients is low, but worrisome (73). One study found the prevalence of HCVAb in hospital workers with patient care responsibilities to be 0.9%, compared to 1.7% in hospital office workers (66). On the higher side, another population study found that 0.7% of health care workers were HCVAb positive compared to 0.4% of local blood donors ($P = 0.10$) (113). Prospective evaluation found that 4 of 110 (4%) hospital workers with percutaneous injuries from HCVAb-positive patients developed hepatitis with alanine aminotransferase (ALT) levels over ten times the upper limit of normal; three of these four workers became HCVAb positive, and two had elevated ALT for at least one year (80). Even more striking is the report by Mistui et al, which showed seven of 68 (10%) medical personnel who had needle sticks from HCV RNA- and antibody-positive patients developed evidence of hepatitis and/or a positive HCV core antibody test; ALT levels ranged from two

to 50 times normal; all seven became HCV RNA positive, and one had persistently abnormal liver function tests and positive antibody for two years (90). The relatively low, but real, risk of seroconversion may be secondary to a low circulating virus titer in patients. Strict precautions are reasonable because of the propensity of hepatitis C infection to become chronic and because of its link to hepatocellular cancer. Unlike hepatitis A and B, no good prophylaxis is available. Administering immunoglobulin immediately after exposure receives only an ambiguous endorsement by the Advisory Committee for Immunization Practices (27). HBIG has no place in prophylaxis. Safety, efficacy, and cost of after-exposure interferon need evaluation (109).

Hepatitis D

Hepatitis D (HDV) causes havoc in the form of chronic active hepatitis only in the presence of hepatitis B infection (32). It is most devastating when superinfection occurs in a HBV carrier, but fulminant hepatitis D can also occur with hepatitis B coinfection (32). Although the virus is uncommon, risk after exposure is high. HDV has by far the highest infectivity titer of any bloodborne hepatitis: 10^2 chimpanzee-infection units for human non A–non B hepatitis-positive sera; 10^8 for HBeAg-positive sera, and 10^{11} for hepatitis D virus-positive sera (80).

HUMAN IMMUNODEFICIENCY VIRUS

As the human immunodeficiency virus (HIV) epidemic relentlessly disperses beyond high-incidence urban areas (42), as heterosexual spread increases and women and young people are affected at an alarming rate (42, 46), and as health care is given more often in ambulatory, hospice, and home settings, work-related exposures of health care workers to HIV increase. Untamed by vaccine or behavior change, the prevalence of HIV infection is rising in the United States (about one in 250 persons) (42) and around the world. In 1991, the World Health Organization (WHO) estimated that 8 to 10 million adults worldwide were infected (31, 42); in mid-1994, it estimated that over 16 million adults were infected (WHO Global Programme on AIDS, July 1994). Coupled with the lack of certain means to prevent progression of infection to AIDS, this pattern leads to the inexorable conclusion that the health of health care workers is threatened by the imperative to care for an ever-growing number of patients with HIV-related illness. According to information available to the CDC, nearly 50 health care workers in the United States already have clear-cut documentation of HIV infection from work (42a). Almost 100 others are HIV Ab positive after work-related accidents and have no other known risk factors but did not have baseline HIV titers done, so the time of seroconversion cannot be established. More laboratory workers and nurses have occupational HIV than any other health care workers, but physicians,

therapists, technicians, and environmental services workers have also been infected on the job. Most of the incidents involved punctures or cuts, but a few were mucocutaneous splashes or spills (42a). Creative new equipment may decrease the number of accidents secondary to manipulating intravenous lines. Injunctions against recapping used needles may also decrease needle sticks. Nevertheless, using and disposing of needles and other sharps can present a special problem in homes, for example. Complacency, born of denial or outdated information about prevalence and risk groups, may lull employers into providing inadequate supplies and equipment and may lull workers into inappropriate work habits. Time constraints and inexperienced house officers (and students) unfamiliar with the procedures and risks may lead to tragic injuries (74). Furthermore, it is not possible always to know if a sample (70) or a patient is infected with any bloodborne pathogen, including HIV (76, 77). A recent study involving urban and suburban emergency rooms of teaching hospitals found that the HIV status of 69% of HIV antibody-positive patients was not known to the staff (86). Another study from the emergency department of an urban university hospital showed that about 30% of patients who were bleeding or who had procedures done were positive for HBV, HCV, and/or HIV antibodies. Screening for HIV alone would have detected only 13% of HBsAg positive patients and 20% of HCV antibody-positive patients (78). These kinds of data reinforce worker health and safety dicta: *Think* and *be prepared* at all times because we will never know all of the hazards that a patient may present. As already noted, despite fears raised by the specter of occupational HIV infection, health care workers are far more likely to be infected with and die of hepatitis B. Compared to HIV, many more patients have occult hepatitis B viremia and are far more likely to be infectious (19, 64, 80, 87, 97, 105). It has been estimated, for example, that the annual cumulative risk for dentists to become infected at work is 50 times greater with HBV than with HIV, and they are 1.7 times more likely to die from HBV than from HIV (11).

One of the knottiest problems for a health care worker after exposure to HIV concerns prophylaxis. Unfortunately, despite hopes to the contrary, there is no encouragement that zidovudine (AZT) is effective in preventing occupational infection (29, 72, 103). Proof of efficacy is wanting because controlled studies have been impossible to complete and the risk of infection is low. Furthermore, despite immediate, intensive, and prolonged administration of zidovudine, health care workers have become infected with HIV after punctures from needles, lancets, and intravenous cannulas (115). At this time, most experienced programs continue to offer zidovudine after exposure, but not with enthusiasm. Workers who have injuries involving more than a needle prick and/or those who are particularly anxious tend to start the drug, but most do not complete a full course because of side effects, including "nausea, malaise,

fatigue, and headache" (115, p. 915). Insomnia can also be a problem for professionals already short on sleep and hematocrits can drop substantially (115). In contrast, psychological prophylaxis is essential. In our experience, counseling for injured workers should be done as soon as possible and should be available during the entire medical surveillance period, since fear and anger may flare with each HIV antibody test. Material to cover includes estimates of risks, methods of safer sex, coping with guilt and fear, and discussions of safer work practices. Formal psychotherapy is rarely needed but should be undertaken without hesitation, if necessary, while protecting the worker's confidentiality within the workers' compensation system. Families may need to be involved.

The resurgence of tuberculosis has led to heightened concerns and recommendations about the interactions of HIV and tuberculosis (24, 45, 50). As HIV and tuberculosis spread on intersecting paths, and multiple drug-resistant tuberculosis (MDR) becomes more prevalent (7, 54), risks to health care workers increase (5, 57). Nearly 12,000 health care workers are HIV positive (8) for life-style reasons. They are at special risk for developing MDR tuberculosis, because of prolonged exposure to infectious patients and infection-control challenges (41). For the protection of these and other workers and patients, TB infection-control practices must be mandatory, vigorous, and rigorous. The efficacy of using respirators and environmental ultraviolet (UV) radiation to control tuberculosis spread remains to be established; studies of efficacy, costs and interference with patient care are urgently needed.

RUBELLA

Significant numbers of hospital personnel are susceptible to rubella; rates vary from 14% to 20% (96). Because a history of rubella alone does not indicate immunity, health care workers need to show serologic testing for rubella-specific antibodies (6, 107). Ten to 20 percent of young adults in the U.S. are at risk for contracting rubella (69). About 98% to 99% of susceptible persons will show antibody response following attenuated rubella vaccine (6).

Reporting of all cases of rubella to local health authorities is mandatory. Medical personnel should be excluded from work for seven days after onset of rash. The benefit of immunization with immunoglobulin has not been proved.

Health departments in the U.S. reported an all-time low of 225 cases of rubella in 1988, but there were 1093 cases reported to the National Notifiable Disease Surveillance System (NNDSS) for 1990 (33), plus 10 confirmed cases of congenital rubella syndrome reported to CDC's National Congenital Rubella Syndrome Registry (33). Of the 26 rubella outbreaks in 1990, some occurred in the workplace (33). The goal of rubella vaccination is to prevent intrauterine rubella infection that can result in miscarriage, stillbirth, or congenital rubella

syndrome. The sudden increase in the congenital rubella syndrome (CRS) emphasizes the need for proof of immunity of susceptible health care workers. The immunity provided by the vaccine may persist for a long time.

MUMPS

Transmission of mumps from patient to health care workers has occurred (39). In Tennessee between 1986 to 1987, six health care workers in three different hospitals contracted mumps after nosocomial exposure (119). Most adults, however, particularly those born before 1957, may be considered to be immune. Preventive vaccination is administered as a live attenuated vaccine as single vaccine or in combination with rubella and measles live virus vaccine (MMR), and provides long-lasting immunity in 95% of persons vaccinated. Vaccine is contraindicated if a person is immunosuppressed or pregnant (6). Relative contraindications include sensitivity to egg or neomycin.

Reporting to local health authority is selective (6). Susceptible medical personnel should be excluded from the workplace from the 12th through the 25th day of exposure.

MEASLES

Measles can be a serious public health and work place problem. More than 18,000 cases were reported in 1989, whereas there were only 1497 cases in 1983 (25, 33). The cost of controlling a single outbreak ranges from $26,000 to more than $100,000 (33). Between 1985 and 1989, 3.5% of all reported cases of measles were acquired in a medical setting, including 28 cases in health care workers (2). A group of four health care workers who contracted measles represented secondary measles vaccine failure. Three of the health care workers had proof of having received one live measles vaccine, and one had received a second dose; furthermore, their pre-illness sera had shown immunity to measles (1).

The Centers for Disease Control and Prevention recommend verification of two live measles vaccinations, documentation of physician-diagnosed measles, or laboratory evidence of measles immunity to prove health care worker immunity to measles (22). Persons born in or after 1957 who have no documentation of vaccination or other evidence of measles immunity should be vaccinated. Contraindications to the use of live vaccine include pregnancy and suppressed immune responses. HIV-infected individuals and AIDS patients may develop severe complications from measles and therefore should be vaccinated. It should not be given to people with known allergies to eggs, and it should be given 14 days before blood transfusion or immunoglobulin or deferred. Recommendations for the immunization of health care personnel are summarized in Table 1 and work restrictions in Table 2.

Table 1 Vaccines used in adults

Vaccine	Type	Schedule	Indications	Precautions and contraindications	Side effects
Attenuated, live-bacteria vaccine					
Bacille Calmette-Géurin	—	Primary: 1 dose i.d. or s.c.	Debatable benefits for selected adult groups	Immunocompromised host	Local progression; disseminated infection
Attenuated, live-virus vaccines					
Measles	—	Primary: 2 doses s.c.	For adults born after 1956 without measles (diagnosed by a physician or immunologic test) or live virus immunization; for revaccination of persons given killed measles vaccine, 1963 to 1967	Pregnancy; immunocompromised host; history of anaphylaxis to eggs or neomycin	Temperature of ≥39.4°C, 5 to 21 days after vaccination in 5 to 15%; transient rash in 5%; local reaction in 4 to 55% of persons previously immunized with killed vaccine 1963 to 1967
Mumps	—	Primary: 1 dose s.c.	For susceptible adults	Pregnancy; immunocompromised host; history of anaphylaxis to eggs or neomycin	Mild allergic reactions uncommon; rare parotitis
Rubella	—	Primary: 1 dose s.c.	For adults, particularly women of childbearing age, without documented illness or live vaccine on or after first birthday	Pregnancy; immunocompromised host; history of anaphylaxis in response to neomycin	Joint pains, transient arthralgias in up to 40%, beginning 3 to 5 days after vaccination, persisting 1 to 11 days; frank arthritis in <2%

Inactivated-virus vaccines

Hepatitis B	Recombinant hepatitis B surface antigen	Primary dose: 2 doses (10 g/dose) i.m. in deltoid, 1 month apart; third dose 5 months after second	For health workers in contact with blood; persons residing 6 months in areas of high endemicity of hepatitis B surface antigen; others at risk	Safety to fetus unknown; pregnancy not a contraindication in high-risk persons	Mild local reaction in 10 to 20%; occasional systemic symptoms of fever, headache, fatigue, and nausea
Influenza	Inactivated whole and split	Annual vaccination with current vaccine	For adults with high-risk conditions; healthy persons more than 65 years old; medical care personnel	First trimester of pregnancy a relative contraindication; anaphylaxis in response to eggs	Mild local reaction in less than one third; occasional systemic reaction of malaise, myalgia, beginning 6 to 12 h after vaccination and lasting 1 to 2 days; rare allergic reaction

Data are from the Centers for Disease Control and Prevention and the American College of Physicians Task Force on Adult Immunization

Table 2 Work restrictions for hospital personnel exposed to or infected with certain vaccine-preventable diseases

Disease	Relieve from direct patient contact	Duration
Mumps		
Active	Yes	Until 9 days after onset of parotitis
Postexposure*	Yes	From day 12 through 26 after exposure, or until 9 days after onset of parotitis
Measles		
Active	Yes	Until 7 days after rash appears
Postexposure*	Yes	From day 5 through 21 after exposure and/or 7 days after rash appears
Rubella		
Active	Yes	Until 5 days after rash appears
Postexposure*	Yes	From day 7 through 21 after exposure and/or 5 days after rash appears

*Susceptible personnel

Modified from Williams WW. Preblud SR, Reichelderfer PS, Hadler SC. *Infect. Dis. Clin. North Am.* 3:701–21 (with permission).

Most states require case reporting and cases should be reported to the local health authority (6). In hospitals, respiratory isolation during the most infectious period reduces the exposure to susceptible patients and health care workers (6). Protection after contact may be achieved by live vaccine, which must be given within 72 hours of exposure. Passive immunization with immunoglobulin (IG) can be used for susceptible contacts when measles vaccine is contraindicated or to avoid risk of complications. When given, it must be used within six days of exposure (6).

INFLUENZA

Unfortunately, health care workers generally do not comply with the recommendations from the US Public Health Services for "physician, nurse, and other personnel in both hospital and out patient care settings who have contact with high risk persons among all age groups including infants" to receive annual influenza vaccination (34). Among the reasons for poor compliance in health care and the general public are doubts about the efficacy and safety of vaccine and inadequate reimbursement (52). In addition, there seems to be more emphasis even from the US Public Health Service to immunize high-risk

patients rather than health care workers. Stress on vaccination of health care workers appears to be more to protect patients than the health care workers themselves. For health care workers to comply to the recommendations, educational efforts about the benefits of the vaccine should be emphasized, and access to vaccination should be easy.

The use of inactivated influenza virus vaccine, which may protect up to 80% of the population, depending on the strain, is considered to be safe. Worldwide surveillance and current antigenic characterization of strains provide the basis for selecting the two strains of influenza A and one strain of influenza B in each year's vaccine. Chemoprophylaxis is not a substitute for vaccination (34), but unvaccinated health care workers may be protected by administering amantadine hydrochloride, which is effective in the chemoprophylaxis of influenza A but not B (6, 56). Central nervous system side effects occur in 5% to 10% of those who receive amantadine. The side effects are more severe in older persons and in those with chronic renal disease.

VARICELLA-HERPES ZOSTER

Varicella is transmitted mainly via airborne spread or direct contact. When varicella is prevalent, only personnel with known immunity should be assigned to varicella patients to avoid transmission. The incubation period is usually from two to three weeks. Communicability occurs one to two days before the onset of rash and up to five days afterwards. Infectiousness occurs for 10 to 20 days after exposure. Varicella zoster immunoglobulin (VZIG), if given within 96 hours of exposure, may prevent or modify disease in susceptible close contacts of cases.

Herpes zoster (shingles) is the skin manifestation of reactivated varicella virus. Susceptible contacts will develop varicella. Because the immune status of health care workers is reported to vary from 50% to 97% (88), varicella zoster virus is an infectious risk for hospital health care workers, especially pregnant workers. Varicella infection during pregnancy may be associated with complications as well as risk, albeit low, of congenital varicella syndrome (88). Employees who are seronegative are considered infectious from 10 to 21 days after exposure, and need to be removed from work if they have no proof of immunity. Many states do not require that the disease be reported to the local authorities (6).

MENINGOCOCCAL DISEASE

Although the transmission of *Neisseria meningitidis* to health care workers is rare, it has occurred following mouth-to-mouth resuscitation (117). Meningo-

coccal pneumonia is also dangerous to health care workers, especially if the patient has a productive cough (106).

Use of proper precautions is important, and in health care personnel who have had significant unprotected exposure, prophylaxis is indicated (117).

SCABIES

Scabies is a pruritic disease of the skin caused by a mite, *Sarcoptes scabiei*. It is transmitted primarily by skin-to-skin contact and, less commonly, by infected fomites (3). It presents as papules, vesicles, or tiny linear burrows, and causes intense itching at night. In immunosuppressed patients, it presents as generalized dermatitis and is highly infectious (3). It is also known as Norwegian scabies, disseminated scabies, crusted scabies, or hyperkeratotic scabies. An outbreak has been described (3) that involved six nursing staff and one medical resident who developed scabies after being exposed to a patient whose scabies was not initially recognized because of its unusual presentation. Another similar hospital outbreak occurred from a patient with AIDS involving eleven nurses, two radiology technicians, and one resident (108). Isolation precautions should be instituted until 24 hours after the start of effective treatment. Official reporting to local health authorities is not required (6).

TUBERCULOSIS

After a steady decline from 84,000 cases reported to CDC in 1953 to 22,000 in 1984, there were 39,000 cases of tuberculosis above the expected downward trend from 1985 through 1991 (37). Contributory factors to the increase in tuberculosis include immigration of persons from TB-prevalent countries, drug abuse, overcrowding and homelessness (60, 114). An even more important factor is the HIV epidemic, since HIV-infected individuals are more likely to develop active disease (114). HIV-infected patients often present with normal chest X-rays and are more likely to develop extra-pulmonary disease (37).

Tuberculosis is spread by airborne transmission. Primary infection is usually acquired through inhaled droplet nuclei containing the acid fast bacilli (AFB) during "coughing, singing, or sneezing," (6, p. 459), as well as during prolonged exposure to an infected case. Anyone inhaling the bacteria may become infected. The infection can remain latent in persons with a healthy immune system, and causes disease when the immune system declines (37, 114). A positive TB skin test may be the only evidence of infection.

Communicability of the disease depends on the number and viability of bacilli in the air and their virulence, as well as the adequacy of ventilation (6, 24). Communicability is rapidly decreased with effective antimicrobial chemotherapy. HIV infection and immunosuppression increase the risk of developing the disease (6). Methods of control are mainly preventive measures and are summarized in Table 3 (24, 30).

Table 3 Summary of recommendations for preventing the transmission of tuberculosis in health-care settings*

1. Early identification and treatment of persons with active tuberculosis (TB)
   - Maintain a high index of suspicion for TB to identify cases rapidly.
   - Promptly initiate effective multidrug anti-TB therapy based on clinical and drug-resistance surveillance data.
2. Prevention of spread of infectious droplet nuclei by source control methods and by reduction of microbial contamination of indoor air
   - Initiate acid-fast bacilli (AFB) isolation precautions immediately for all patients who are suspected or confirmed to have active TB and who may be infectious. AFB isolation precautions include use of a private room with negative pressure in relation to surrounding areas and a minimum of six air exchanges per hour. Air from the room should be exhausted directly to the outside. Use of ultraviolet lamps and/or high-efficiency particulate air filters to supplement ventilation may be considered.
   - Persons entering the AFB isolation room should use disposable particulate respirators that fit snugly around the face.
   - Continue AFB isolation precautions until there is clinical evidence of reduced infectiousness (i.e., cough has substantially decreased, and the number of organisms on sequential sputum smears is decreasing). If drug resistance is suspected or confirmed, continue AFB precautions until the sputum smear is negative for AFB.
   - Use special precautions during cough-inducing procedures.
3. Surveillance for TB transmission
   - Maintain surveillance for TB infection among health-care workers (HCWs) by routine, periodic tuberculin skin testing. Recommend appropriate preventive therapy for HCWs when indicated.
   - Maintain surveillance for TB cases among patients and HCWs.
   - Promptly initiate contact investigation procedures among HCWs, patients, and visitors exposed to an untreated, or ineffectively treated, infectious TB patient for whom appropriate AFB procedures are not in place. Recommend appropriate therapy or preventive therapy for contacts with disease or TB infection without current disease. Therapeutic regimens should be chosen based on the clinical history and local drug-resistance surveillance data.

*Reproduced from *Morbid. Mortal. Wkly. Rep.* Aug. 30, 1991, p. 586

Patients with active pulmonary tuberculosis and with sputum positive for pulmonary tuberculosis need to be placed in a private room with air pressure negative to adjacent areas. Hand washing and universal precautions should always be observed. Routine PPDs are administered to health care personnel at risk every 6 to 12 months. In addition, if unprotected exposure to a potentially infectious patient occurs, the CDC recommends, "Unless a negative skin test has been documented within the preceding 3 months, each exposed health care facility worker (except those already known to be positive reactors) should receive a Mantoux tuberculin test as soon as possible after exposure and should be managed in the same way as other contacts. If the initial skin test is negative, the test should be repeated 12 weeks after the exposure ended. Exposed persons with skin test reaction more than 5 millimeters or with symptoms suggestive of tuberculosis should receive chest radiographs. Persons with previously

known positive skin test reactions who have been exposed to an infectious patient do not require repeat skin test or chest radiograph unless they have symptoms suggestive of tuberculosis" (24, pp. 18–19).

In addition to the upsurge of tuberculosis cases, there also has been an increase in drug-resistant tuberculosis (30). In the past, drug resistance was the result of intermittent compliance or noncompliance, but now drug resistance can be the result of primary infection with a multiply drug-resistant strain. In a recent survey carried out in New York City, 33% of cases had organisms resistant to at least one drug and 19% had organisms resistant to two (37). Drug resistance is not limited to New York City; it occurs nationwide. From 1982 to 1986, only .5% of new cases were resistant to both isoniazid and rifampin. By 1991, this resistance had increased to 3.1% (37). In addition, there have been outbreaks of multidrug-resistant TB (mDRTB) in institutional settings (30a, 37, 101). Seven outbreaks were investigated in Florida and New York City. Although nosocomial transmission of *Mycobacterium tuberculosis* to health care workers has been recognized, the outbreak in a large Florida hospital was the first documentation of transmission of drug-resistant tuberculosis in a hospital setting (30a). Eight health care workers had tuberculin skin test conversion from January through April 1990 (30a). There has been further documentation of work-related MDR TB in at least nine health care workers and prison guards. Of nine affected, five have died (37, 55, 101). In these outbreaks, more than 200 multiple drug-resistant cases occurred. Most were resistant to isoniazid and rifampin, and some were resistant to seven anti-tuberculosis drugs. Most patients were also infected with HIV. Mortality was high, ranging from 72% to 89%; the median time from diagnosis to death ranged from 4 to 16 weeks (37). Despite tripling the length of the course of treatment, effectiveness has declined from 100% to 70% in immunocompetent hosts (114). These outbreaks are thought to be caused mainly by delay in diagnosis of TB in HIV-infected patients because of unusual clinical and radiographic appearance, as well as by delayed recognition of drug resistance attributable to the lengthy time required for laboratory identification, confirmation, and reporting. As a result, AFB isolation procedures were sometimes delayed (5, 30). Control measures that were carried out were believed to have decreased the number of MDR TB cases substantially. Recommendations for preventing the transmission of tuberculosis in health care settings are summarized in Table 3. In addition to the CDC guidelines for preventing the transmission of tuberculosis in health care settings (24), in October, 1993, the Occupational Safety and Health Administration issued an enforcement policy and procedures for occupational exposure to tuberculosis which are based upon the CDC 1990 guidelines (51). OSHA has the authority under the General Duty Clause of the OSHA Act of 1970 to enforce compliance with existing industrial standards such as CDC guidelines, even if a final standard has not been established.

BCG Vaccine

Although the BCG vaccine has been in use since 1921, its efficacy, duration of protective immunity, and the effect of age of vaccination are still debated. A meta-analysis based on data from 14 prospective trials and 12 case control studies concluded that BCG vaccination significantly reduces the risk of active TB cases and death with an overall protective effect of 50% (48). Vaccination with BCG is still controversial, but may be considered where there is unprotected and prolonged exposure to patients who are sputum positive for TB (48).

SUMMARY

Infectious risks for health care workers continue. As the population ages, and as HIV and TB spread and amplify each other, health care workers will come into contact with sicker patients in unusual settings. Challenges mount as more and more persons become "health care workers"; the definition should include students, volunteers, and family members. Care of patients is no longer centered in hospitals, where safe equipment may easy to find and dispose of. Although hepatitis B, influenza, measles, mumps, and rubella vaccines usually prevent infection, a substantial number of health care workers remain unvaccinated. HIV transmission at work can only be prevented by behavior change and safer equipment; no prevention or cure is available or in sight. Scabies is far from life-threatening but can spread like wildfire, especially in immunosuppressed individuals, and has become resistant to lindane. Health care itself is undergoing revolutionary changes, and health professionals may be distracted, discouraged, exhausted, and undertrained. Human factors in preventing occupational infection are little understood. Data are lacking in crucial areas: use of zidovudine to prevent HIV infection; use of specific types of masks and respirators, plus UV light, to decrease the spread of tuberculosis. Schools where health professionals train, public health officials, researchers, and practitioners themselves will need to lead the way to a healthier future for health care workers.

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