Chapter 7
Promoting Health for Working Women—Communicable Diseases

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Concepts and Introduction

Any person is exposed to communicable diseases on the job site. Employees in certain professions, such as health care workers, may be at a higher risk for exposure to such diseases. The identification of communicable diseases in the area of work has led to the establishment of specific procedures concerning appropriate prevention and intervention measures (Al-Saden & Wachs 2004; Baussano et al. 2006; Chen et al. 2004; Dettenkofer & Block 2005; El-Masri Williamson & Fox-Wasylyshyn 2004; Keller, Daley, Hyde, Greif & Church 2005; Koh, Lim, Ong & Chia 2005; Lateef, Lim & Tan 2004; P. W. Stone, Clarke, Cimiotti & Correa-de-Araujo 2004). During recent years, increasing attention has been paid to emerging infectious diseases that may affect the workplace, such as avian influenza and SARS (Halpin 2005; Koh et al. 2005; Swayne 2006). Global traveling has affected the epidemiology of communicable diseases (Singer 2005) and a veterinarian in the United States may now be exposed to an infectious disease identified in an exotic pet coming from abroad (Johnson-Delaney 2005).

Occupational communicable diseases affecting women should not differ from those affecting men, although by means of tradition certain occupations are primarily occupied by men (e.g., slaughterers/butchers) whereas others by women (Su, Wang, Lu & Guo 2006; Ward & Day 2006). By virtue of her profession, a woman that practices veterinary medicine may be exposed to zoonoses because all vets and their staff do (Nienhaus, Skudlik & Seidler 2005). There have been reports of a greater percentage of women being affected by occupational infectious diseases (Brhel & Bartnicka 2003). There maybe a pattern of communicable diseases affecting female workers that relates to specific professions (Gyorkos et al. 2005), the status of the worker (e.g., immigrants) (Fitzgerald, Chakraborty, Shah, Khuder & Duggan 2003; Krejci-Manwaring et al. 2006), and geographical locations, because not only the epidemiology of some of the infectious diseases differs from country to country but also the professional activities where women are engaged (Brhel & Bartnicka 2003; Cinco et al. 2004; Golshan, Faghihi & Marandi 2002; Krejci-Manwaring et al. 2006; Reimer et al. 2002; Vilaichone, Vilaichone, Nunthapisud & Wilde 2002; Werner, Nordin, Arnholm, Elgefors & Krantz 2001). Moreover,

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women maybe exposed to infectious hazards in their occupation during the prenatal and the maternity period. Some exposures may harm the embryo (Crane 2002; Gilbert 2000), whereas others may actually reduce the risk of certain childhood diseases such as diabetes (Fear, McKinney, Patterson, Parslow & Bodansky 1999). Certain exposures may be more important than infectious diseases in affecting the well-being of female workers (Krejci-Manwaring et al. 2006; Selvaratnam, de Silva, Pathmeswaran & de Silva 2003; Ward & Day 2006).

The current chapter discusses the available knowledge of communicable diseases in the workplace, and attempts to elucidate certain features of these entities that are more relevant to the female population.

Definitions

Infectious diseases arising from the workplace define the term *occupational communicable diseases*. A subtle difference that is not well-specified may exist between infectious diseases (any disease that can be caused by an infectious agent—e.g., tetanus) and communicable diseases (any infectious disease that can be transmitted directly or indirectly by an infected person). The dynamics of infection may be different from the dynamics of the clinical disease itself. Thus, the incubation period for a clinically visible infectious disease may overlap with the infectious period (period of transmissibility). Moreover, infections may frequently be subclinical but may be transmitted from an infected person. An infectious disease is the result of interactions within a dynamic system consisting of the pathogen, the environment, and the characteristics of the host. Several factors may influence the transmission dynamics related to the pathogen (e.g., antigenic stability, virulence, reservoir), the environment (e.g., occupational setting, climatic conditions) and finally the host (e.g., age, gender, genetic predisposition, immunity, behavior).

The list of occupational communicable infectious diseases is huge. In a formal recommendation (Commission Recommendations 19-09-2003 concerning the European schedule of occupational diseases) the European Commission defined occupational infectious diseases as any infectious or parasitic (sic) disease that can be transmitted to man by animals or remains of animals, as well as other infectious diseases caused by work in disease prevention, healthcare, domiciliary assistance, and other comparable activities for which an infection risk has been proven. These definitions are added in a short list of five agents, including tetanus, tuberculosis, brucellosis, amoebiasis, and viral hepatitis. A classification of communicable occupational diseases can be made according to the pathogen involved—i.e., bacterial, viral, fungal, parasitic (see Table 7.1). Other classification schemes relative to the mode of transmission may be used, such as contact- (direct or indirect, interhuman vs. zoonotic), vector- (mechanical or biological), or vehicle- (air, food, or water) borne. In this regard, the difference between a reservoir (the agent multiplies within the host) and a vector (just carrier of the pathogen) of an infectious agent may be important. Biological terrorism agents may form a specific subcategory themselves.

Table 7.1 Significant representative pathogens/diseases causing communicable diseases that may be occupationally acquired

Bacteria	
Anaplasma phagocytophilum	Ehrlichiosis
Anthrax spp.	Cutaneous and inhalational anthrax
Bordetella pertussis	Pertussis
Borrelia burgdorferii	Lyme's disease
Brucella spp	Brucellosis
Burkholderia mallei	Glanders
Burkholderia pseudomallei	Melioidosis, pseudo-glanders
Campylobacter spp.	Gastroenteritis
Capnocytophaga spp	Dog bite infection
Chlamydia spp	Psittacosis
Clostridium tetani	Tetanus
Corynebacterium diphtheriae	Diphtheria
Eryspelothrix rhusiopathiae	Erysipeloid
Francinsella tularensis	Tularemia
Legionella spp	Legionellosis
Leptospira interrogans	Leptospirosis
Mycobacterium marinum	Fish-tank granuloma
Mycobacterium tuberculosis	Tuberculosis
Neiserria meningitides	Meningococcal meningitis
Pasteurella multocida	Cat or dog bite infection
Ricketssiae spp, *Coxiella burnettii*	RMSF, Q fever, murine typhus, scrub typhus
Streptobaccilus moniliformis	Rat bite fever
Steptococcus suis	Severe infection, meningitis, sepsis in pig owners
Vibrio vulnificus	Skin lesion after exposure to marine waters
Yershinia pestis	Plague
Viruses	
Adenovirus spp	Adenoviral infections
Hantaviruses	Hantavirus pulmonary syndrome
Hemorrhagic fever group viruses (e.g., Ebola, Marburg, Lassa)	Hemorrhagic fever, Lassa fever, Omsk fever, Crimean Congo fever, Rift Valley fever
Henipavirus spp	encephalitis
Hepatitis A, B, C, B	Hepatitis
Herpes simplex viruses type 1 and 2	Herpetic infections, herpetic whitlow
Human immunodeficiency virus	HIV-AIDS
Influenza viruses types A and B	Influenza – avian influenza
Lymphocytic choriomeningitis virus	Meningitis
Lyssaviruses	Rabies
Measles virus	Measles
Monkey B Virus	B virus infection
Monkeypox virus	Monkeypox
Mumps virus	Mumps
Newcastle disease virus	Newcastle disease
Parapox virus	Orf -contagious pustular dermatitis
Parvovirus	*Parvovirus* infection
SARS coronavirus	SARS
Varicella zoster virus	Chickenpox - shingles
West Nile virus	West Nile virus encephalitis

(continued)

Table 7.1 (continued)

Fungi	
Aspergillus spp	Mold infections
Candida spp	Candidal infections - paronychia
Coccidioides immitis	Coccidioidomycosis
Dematiaceous fungi *Fonsecaea* spp, *Phialophora* spp, *Cladosporium carrionii*, *exophiala* spp)	Chromomycosis
Histoplasma spp	Histoplasmosis
Paracoccidioides spp	Paracoccidioidomcosis (S. American blastomycosis)
Sporothrix spp	Sporotrichosis
Trichophyton spp, *microspum* spp	Tinea – ringworm infections
Parasites	
Amoeba spp	Amebiasis
*Avian schistosome*s	Avian schistosomiasis – swimmer's itch
Ancylostoma spp	Cutaneous larvae migrans
Babesia spp	Babesiosis
Cryptosporidium parvum	Cryptosporidiosis
Echinococcus granulosus	Echinococcosis – hydatid cyst
Echinococcus multilocularis	Alveolar echinococcosis
Giardia lamblia	Giardiasis
Leishmania spp	Cutaneous leishmaniasis
Naegleria fowleri	Primary amoebic meningoencephalitis
Sarcoptes scabei	Scabies

Basic epidemiologic characteristics

The prevalence of communicable diseases affecting the workplace depends on the specific occupation examined. In work presented by the International Labor Organization, it is estimated that between 1.9–2.3 million work-related deaths occurred worldwide in 2000 (data available at www.ilo.org/safework). In the same work, the lower limit of work-related diseases was 1.6 million and approximately 320,000 (20%) were attributed to communicable diseases (data available at www.ilo.org/safework). The epidemiology appears to differ per country and depends on gross domestic product (GDP) per sector. The type of profession is also very important. The healthcare professions are characteristically associated with an occupational risk from blood-borne pathogens that has led to the implementation of specific protection measures (Beekmann & Henderson 2005; Brunetti et al. 2006; Puro et al. 2005; Sadoh, Fawole, Sadoh, Oladimeji & Sotiloye 2006). A large study from the Netherlands examining data from a region with a half-million people (and two major hospitals) discovered an incidence of exposure to blood-borne pathogens of 1.2 cases per day—both in the hospital and the community setting (van Wijk et al. 2006). Athough the incidents were split between the hospital and the community setting, they were related to occupational activities 95 percent of the time and, more specifically, healthcare activities in 84 percent of the cases (van Wijk et al. 2006). High-risk incidents predominantly involved hospital personnel (van Wijk et al. 2006). In another large study from the United Kingdom, known hepatitis C virus or human immunodeficiency virus (HIV) transmissions to health care workers was reported to be at the rate of 1.43 per year. In the same study, HIV and hepatitis C transmissions were occurring at an approximate rate of 0.009 per 1,000 hospital beds per year. The risk of infection when exposure involved sources with no risk factors was significantly lower (less than one in one million for HIV transmission).

More work is necessary to correctly identify prevalence and incidence of specific disease entities according to profession, and recent studies have shown unexpected observations (Olsen, Axelsson-Olsson, Thelin & Weiland 2006). In particular, health care workers have an increased risk from occupational infectious diseases that may occasionally lead to death. The annual death rate for occupational events, including communicable diseases has been calculated around 17-57 deaths per 1 million workers, however more accurate estimations are necessary (Sepkowitz & Eisenberg 2005).

There is no clear gender-specific predisposition to certain infectious diseases in relation to the frequency of their appearance in women in comparison with the general population. Harmonized case definitions should be used for surveillance purposes and may help in clarifying issues such as an increased prevalence of confirmed cases in the male vs. female population (Stefanoff, Eidson, Morse, & Zielinski 2005). Occupational communicable disease statistics relevant to women are urgently needed.

The epidemiology of a specific infectious disease in different countries varies and affects its prevalence if it is occupationally acquired, such as is the case with HIV infections (Ghys, Kufa, & George 2006). Several other examples exist depending on infectious entity, professional activity, and country (Brhel & Bartnicka 2003; Cinco et al. 2004; Golshan et al. 2002; Krejci-Manwaring et al. 2006; Reimer et al. 2002; Vilaichone et al. 2002; Werner et al. 2001). For example, serological evaluation disclosed antibodies *Borrelia burgdorferi sensu lato* in 41 percent of the tested forestry workers in Poland, compared to only 7 percent of the control blood donor population. The corresponding figures for the also tick-borne *Anaplasma phagocytophilum* were 17 percent vs. 5 percent, respectively (Cisak et al. 2005). A high proportion of asymptomatic cases was noted in the same study. Much lower rates of seropositivity have been described in similar studies examining forestry rangers from Italian regions (Santino et al. 2004), although regional variations for some of the pathogens may exist within the same country (Cinco et al. 2004).

Occupational communicable diseases may have a pronounced economical effect. Costs burden not only the affected population but also the respective industry. They include costs for leave of absence and lost work hours, costs for diagnosis and treatment, and indirect costs (e.g., via family transmission). Countries with poor economical resources experience a more significant financial burden.

Other factors may contribute to the epidemiological characteristics of certain communicable diseases. Climate and climatic changes, for example, may play an important role in the geographical distribution of pathogens. For example, colder than usual temperatures were blamed for the recent H5N1 avian influenza epidemic in Turkey (Giesecke 2006). Other infections whose epidemiology is especially affected by climatic changes are those that are vector-borne (e.g., malaria, dengue, leishmaniasis), and tick-borne diseases (Kovats, Campbell-Lendrum, McMichael, Woodward & Cox 2001; Lindgren & Gustafson 2001; Lindgren, Talleklint & Polfeldt 2000; Lindsay & Birley 1996). This is not due to effects of the climate on the microorganism itself, but rather to the vectors of the microorganism. Disease incidence for tick-borne encephalitis significantly increased in a Northern European country, and was highly related to factors such as consecutive mild winters and higher temperatures that favored tick activity (Lindgren & Gustafson 2001). Climatic changes may have more pronounced effects in vulnerable populations that are protected by low-quality health services (Lindsay & Birley 1996; Lindsay & Martens 1998). The detection and attribution of changes in the epidemiology of certain communicable diseases to climate change is a difficult emerging task for epidemiologists around the world.

A specific legislative framework has been established to address the issue of occupationally acquired communicable diseases, but several gaps still exist. The European Commission has established a framework for communicable diseases (Commission Decision 2002/253/EC), which lays down case definitions for reporting communicable diseases to the community network. This decision should be further harmonized with decisions or recommendations relevant to occupational diseases (Commission Recommendations 19-09-2003 concerning the European schedule of occupational diseases). The difficulties in comparing the data collected for statutory and nonstatutory surveillance networks should be further addressed. The newly established European Center for Disease Control and its activities (founding regulation 851/2004/EC) may be of paramount importance in this regard.

Activities that include surveillance of health, choice and correct use of personal protective equipment (PPE), environmental monitoring, and adequate education and training of workers potentially exposed to communicable diseases should be among the first priorities set during the establishment of an institutional or legislative framework. According to the framework, the occupational physician will establish priorities in his/her environment. Of great importance in controlling communicable diseases in the working environment are institutional guidelines and standard operating procedures regarding exposure to certain pathogens. Such guidelines have been established, especially for the health care environment, and especially with regard to blood-borne pathogens and agents of biological terrorism. Competent occupational physicians, together with other available specially trained personnel (e.g., infectious disease specialists or infection control nurses for the healthcare environments), implement guidelines and intervention measures when required. Although harmonization of procedures at a global level has not been established yet, guidelines for specific exposures from organizations with an established expertise—e.g., Occupational Safety and Health Administration (OSHA) or other similar organizations and committees (Puro et al. 2005)—are universally accepted and incorporated into infection control manuals in hospitals and other institutions around the globe.

Specific legislation is required to protect workers from exposure to communicable diseases. Several key actions should be incorporated into relevant legislation, including

- There must be adequate health care staffing at all levels of work to provide assistance to the worker
- Regulations covering biohazards and communicable diseases in the workplace are necessary for all countries and a harmonization procedure should be discussed at a political level
- Settlement of claims related to communicable diseases acquired in the workplace
- Establishment of minimum standards to protect air crew members from outbreaks of communicable diseases either of domestic or international origin—e.g., SARS (Breugelmans et al. 2004; Lee, Tsai, Wong & Lau 2006; Vogt et al. 2006)

Risk Factors

Risk factors for communicable diseases in working women appear not to be gender-related. Rather, there is an association with certain occupations where female workers are traditionally employed (Su et al. 2006; Ward & Day 2006).

All women occupied in professions where there is chance for high-risk exposure are considered *at-risk*. These include, but are not limited to, health care personnel, workers in research laboratories, workers in the food industry, animal husbandry workers, forest and field workers, construction workers, workers who handle human waste, sex workers, and even funeral service practitioners (Gershon, Vlahov, Farzadegan & Alter 1995). Other at-risk populations emerge according to epidemiological characteristics specific to certain geographical locations, as is the case with the HIV-1 infection in subSaharan Africa (Zelnick & O'Donnell 2005). Causal factors include, among others, inadvertent accidents and failure to institute appropriate preventive measures.

Conditions such as overworking and poor socioeconomic status may promote exposure to communicable diseases. Social conditions may affect the risk of occupational infections. Infection with HIV and AIDS has been associated with social class differences in highly affected areas (Ugwu et al. 2006). The working conditions of vulnerable populations (e.g., migrant workers, sex workers) may promote the acquisition of sexually transmitted infections (Yang et al. 2005).

Certain risk factors, such as failure to institute appropriate preventive measures may reflect a lack of education and training. Frequent exercises using real life scenarios are important in eliminating such factors, especially in the healthcare environment (Ganczak, Milona & Szych 2006; van Gemert-Pijnen, Hendrix, Van der Palen & Schellens 2006). The implementation of specific standard operating procedures according to guidelines is a prerequisite in such efforts. Recent research shows that compliance may be influenced by risk perception of the worker (Ganczak et al. 2006; van Gemert-Pijnen et al. 2006). Primary prevention is of paramount importance in instances of vulnerable populations where low rates of use of such measures have been reported (Yang et al. 2005); however, one should not underscore the importance of education and training in such populations. In a cohort study of 600 female bar workers, a simple intervention consisting of regular screening for sexually transmitted infections, together with syndromic management and relevant information and counseling was offered—it was not only well-received, but also resulted in significant reductions in the prevalence of gonorrhea, HIV, and other sexually transmitted infections (Riedner et al. 2006).

Communicable Diseases and Working Women

Several worksite factors may contribute to occupationally acquired infections. Women working in direct exposure to communicable diseases, or vectors of certain pathogens, have a significantly higher risk for acquiring the disease (e.g., working with animals creates exposure to certain zoonoses like avian influenza and brucellosis). On the other hand, women who work indoors maybe more exposed to airborne communicable diseases such as tuberculosis. Women working under conditions of extreme stress, and in areas where communicable diseases such as HIV-1 are endemic, may experience lapses in appropriate preventive measures and may fail to receive adequate post-exposure prophylaxis (Zelnick & O'Donnell 2005). Addressing the dramatic shortage of nurses in such environments, as well as involving them in the policy processes, could contribute to a better occupational health and improved quality of patient care (Zelnick & O'Donnell 2005).

Communicable diseases and even exposure to communicable diseases may have a profound effect on the professional life of affected women. Psychological stress, health impairment with its consequences, and the resulting absence from the work environment, are among the important adverse effects of an occupational communicable disease. In the worst case scenario, such a disease may lead to a permanent event such as chronic illness, loss of employment (Dray-Spira et al. 2006), or even death (Sepkowitz & Eisenberg 2005). Female gender (adjusted odds ratio 3.1; 95 percent confidence interval 1.1–8.5), together with a nonpermanent job and poor accommodation, were independent risk factors for employment loss in a study of patients with HIV infection in the highly aggressive antiretroviral therapy era (Dray-Spira et al. 2006). In the same study, patients with hierarchically higher positions had a lower chance of losing their job (Dray-Spira et al. 2006), while recent hospitalization and the presence of a chronic comorbidity conferred a higher risk (Dray-Spira et al. 2006).

Furthermore, in countries with poor recourses, extended unpaid leave from work or job loss may have significant implications on household income. This is particularly true for HIV infections observed in African countries, where failure of the patients to meet basic needs such as food, education, and access to healthcare both in the short and long-term is an undesirable consequence.

Examples of Occupational Communicable Diseases Affecting Women

A few examples, together with a short description of communicable diseases that could affect women in their work environment, are listed below with representative bacterial, viral, fungal, and parasitic pathogens. The list is not inclusive, as evidenced from the data depicted in Table 7.1.

Bacterial Infections

Anthrax

Anthrax is caused by *Bacillus anthracis*, and is one of the most important biological terrorism agents (Bossi et al. 2004a). *Bacillus anthracis* produces spores that can be inhaled or ingested, leading to the pulmonary and gastrointestinal forms of the disease, respectively (Bossi et al. 2004a). Inhalational anthrax is of particular interest for possible deliberate release (Bossi et al. 2004a), and it was observed during the most recent outbreak in the United States relating to a bioterrorist attack. It affected workers in processing and distribution centers of the United States postal service who handled envelopes contaminated with anthrax spores (Greene et al. 2002; Holtz et al. 2003; Jernigan et al. 2001). The most commonly seen occupationally acquired form of anthrax is the cutaneous form that occurs through direct skin exposure of people working with sick animals (Oncu & Sakarya 2003). It presents with the characteristic black eschar. This form of the disease was observed in wool-sorters in the past (Carter 2004), and occupations at risk include agricultural workers, herdsmen, and those handling sick animals or their products—e.g., hair, meat, bone and bone products, and wool (Oncu & Sakarya 2003; Smego, Gebrian & Desmangels 1998). In nonendemic areas, imported goat hair, hides (Need author names here, not article name 2006) and wool may be implicated in human cases. If left untreated, all forms may lead to sepsis and death. Treatment consists of supportive care and appropriate antimicrobials that can also be used for prophylaxis over an extended duration (Bossi et al. 2004a). Vaccines focusing on the protective antigen of the microorganism are available and are used especially in military vaccination programs (Grabenstein, Pittman, Greenwood & Engler 2006). A lot of research in newer vaccines is ongoing (Baillie 2006; Scorpio, Blank, Day & Chabot 2006).

Brucellosis

Brucellosis is probably the most common zoonosis worldwide (Pappas, Akritidis, Bosilkovski & Tsianos 2005), and the causative microorganism is *Brucella* spp (Pappas, Papadimitriou, Christou & Akritidis 2006). Occupations at risk include those involving direct exposure to contaminated animals (Pappas et al. 2005; Reid 2005), or dairy products (Pappas et al., 2005), such as livestock producers, slaughterers, (Karimi, Alborzi, Rasooli, Kadivar & Nateghian 2003), butchers (Karimi et al. 2003), meat packers, inspectors, veterinarians, and researchers and microbiology personnel working with the organism (Fiori, Mastrandrea, Rappelli & Cappuccinelli 2000; Memish & Mah 2001; Yagupsky & Baron 2005). In a recent epidemiological study from Ireland, veterinarians, laboratory staff, and workers based in meat plants were at increased risk of exposure to the bacteria (Reid 2005). Clinically, it can be a multisystemic disease manifesting with fever, hepatic and skeletal involvement, and other systemic signs and symptoms (Pappas et al. 2005). Clinicians should make clinical laboratory workers aware when brucellosis is suspected to avoid exposure (Gruner et al. 1994), especially in endemic areas (Yagupsky, Peled, Riesenberg & Banai 2000).

Plague

Plague is caused by *Yershinia pestis* (Bossi et al. 2004b). The bacterium is transmitted from infected animals (most frequently rodents or other wild animals—such as infected rabbits (von Reyn, Barnes, Weber & Hodgin 1976)—to humans by its critical vector the flea bite (Bossi et al. 2004b). After the bite, the microorganism spreads to the regional lymph nodes and causes acute inflammation and pain (buboes). Close contact between humans, rats, and shrews has been described in areas with frequent epidemics (Boisier et al. 2002). It also belongs to Class A of bioterrorism agents (Bossi et al. 2004b) because infection with the bacterium may lead to a very serious pulmonary infection and sepsis (Bossi et al. 2004b). At-risk occupations include farmers, people herding sheep, rabbit hunters, geologists, and other professionals working in the field in endemic areas.

Rickettsial Infections

Diseases caused by *rickettsia* spp are well-known occupational pathogens (Fox 1964) and have been associated with certain field exposures to the tick vectors carrying the pathogen, or research laboratories handling the pathogen (Johnson & Kadull 1967). More specifically, foresters, rangers, farmers, ranchers, trappers (Heidt, Harger, Harger & McChesney 1985), and hunters are at risk for contracting Rocky Mountain Spotted Fever—a disease characterized by fever, headache, and a maculopapular rash after a tick bite (Lacz, Schwartz & Kapila 2006; Sexton & Kaye 2002). Possible disease transmission through needle stick exposure has been described (Sexton, Gallis, McRae & Cate 1975).

Other ricckettsiae such as *Coxiella burnettii*—the etiologic agent of Q fever—can be occupationally transmitted. Humans are infected either through direct contact or inhalation of contaminated dust (Carrieri et al. 2002) and develop Q fever an influenza-like illness with pneumonia and hepatic involvement (Parker, Barralet & Bell 2006), whereas chronic infection is characterized by endocarditis (Parker et al. 2006). The microorganisms are shed by the genital material of infected animals (e.g., placental tissue) and may exist in the environment for months (Parker et al. 2006). Professionals at risk include veterinarians (Abe et al. 2001), meat processing plant workers, sheep and dairy workers, cattle and livestock handlers (Sadecky 1981), and staff working in research laboratories using sheep (Simor et al. 1984). Zoo workers also may be at risk (Ohguchi et al. 2006). In a recent epidemiological study, two high-risk village areas for positive Q fever serology were identified (Psaroulaki et al. 2006). Use of manure in the garden, ownership of animals (especially goats), and the presence of tick-infested or aborting animals were identified as important risk factors for Q fever seropositivity (Psaroulaki et al. 2006). Outbreaks in slaughter houses have been described (Carrieri et al. 2002;

Gilroy et al. 2001). An effective whole-cell vaccine is licensed in Australia (Parker et al. 2006).

Tuberculosis

Tuberculosis is caused by the microorganism *Mycobacterium tuberculosis*. It is one of the most frequent infectious diseases worldwide, and its transmission is airborne. The disease can be extremely contagious. During an occupational outbreak, a single patient working in a shipyard (with an eight-month delay in diagnosis) was the source of a huge outbreak in a small town in Maine (Allos et al. 1996). Those at highest risk were the ones working closest to the infected person (Allos et al. 1996). Unfortunately, tuberculosis infections may not be recognized early (de Vries, Sebek & Lambregts-van Weezenbeek 2006). The infection usually involves the lung parenchyma, but can also present in extra-pulmonary forms such as lymphadenopathy, bone and joint infections, and serious meningoencephalitis. Occupations at risk include health care workers and correctional workers. Nurses are among the professions at highest risk (Tzeng 2005). Rates of latent infection in health care workers may be extremely high, especially in endemic areas with poor quality of protection (Kayanja, Debanne, King & Whalen 2005). Transmission, however, has been found to be strongly associated with health care work, even in settings with low incidence of tuberculosis (Diel, Seidler, Nienhaus, Rusch-Gerdes & Niemann 2005). From 2510 reported cases of tuberculosis during a 10-year study in San Fransisco (1993–2003), 31 (1.2%) occurred in healthcare workers (Ong et al. 2006). Work-related transmission was documented in about one in three of these healthcare workers, but rates of such acquisition gradually decreased over the study period (Ong et al. 2006). Delayed diagnosis of tuberculosis (especially if the index case is an older patient) may be one of the main causes of transmission from patient to health care worker (de Vries et al. 2006). Although several outbreaks have been described in prisons (Bergmire-Sweat et al. 1996; Drobniewski 1995; Jones, Craig, Valway, Woodley & Schaffner 1999; Laniado-Laborin 2001; McLaughlin et al. 2003; Ruddy et al. 2004; Skolnick 1992; Valway, Greifinger et al. 1994), a recent study identified mainly demographic (rather than occupational) factors associated with the disease in correctional health care workers (Mitchell et al. 2005). Nevertheless, continued vigilance to control occupational exposure is warranted (Mitchell et al. 2005).

Unfortunately, conventional contact tracing alone may not suffice to discover recent transmission chains for health care-associated tuberculosis (Diel et al. 2005). Thus, improved control strategies in the health care environment are necessary (Diel et al. 2005). The transmission of multidrug-resistant strains in recent years (Portugal et al. 1999; Ruddy et al. 2004; Valway et al. 1994), and the emergence of HIV infection as an important epidemiological comorbidity emphasizes such a need (Masur, Kaplan & Holmes 2002; Mohle-Boetani et al. 2002; Moro et al. 1998; Sonnenberg et al. 2005; "Tuberculosis outbreaks in prison housing units for HIV–infected inmates–California, 1995-1996" 1999). New guidelines have been developed to this effect (Jensen, Lambert, Iademarco & Ridzon 2005).

Tularemia

Tularemia is caused by *Francinsella tularensis*. The pathogen can be directly transmitted though animal handling, insect bites, or inhalation. The disease is characterized by a febrile syndrome, characteristic skin ulcers, and possibly a serious pulmonary infection with high fatality rates. It is also considered a Class A biological agent. At-risk occupations include farmers and agricultural workers (especially in endemic areas), butchers, cooks, and professional hunters.

Viral Infections

Human Immunodeficiency Virus Type 1 Infections

The Human Immunodeficiency Virus Type 1 (HIV-1) has been one of the most important pathogens recognized during the twentieth century. The progression of the infection from HIV to the acquired immunodeficiency syndrome (AIDS), and the high mortality associated with AIDS, has dramatically changed our approach to infectious diseases during the last two decades. Professions with a higher risk of exposure to the virus include healthcare workers, emergency response personnel, police, waste handlers, and (last but not least) professional sex workers. The risk depends on the prevalence and other epidemiological characteristics of the disease (e.g., social class) in specific countries, and may be less than that of Hepatitis B (Ugwu et al. 2006).

Occupationally acquired HIV-1 infection continues to be a rare event independent of the source of the data examined (Rapparini 2006). Iatrogenic infection has been estimated to occur once in every 8-52 procedures involving HIV-infected individuals. It has been estimated that the rate of seroconversion after percutaneous injury with a sharp device is only around 0.3 percent (Bell 1997; Case-control Study of HIV Seroconversion in Health-care Workers after Percutaneous Exposure to HIV-infected blood 1995; Gisselquist, Upham & Potterat 2006; McCray 1986). From the largest report so far, 56 health care workers were reported to have occupationally acquired HIV-1 infection, of whom 25 developed AIDS through exposure to blood or blood products (CDC HIV/AIDS Surveillance Report 2000).

The probability of HIV seroconversion after exposure to an infected patient depends on the type of exposure and the HIV status of the source patient. Deep injuries, a high volume of visible blood, and an uncontrolled HIV infection increase the risk of seroconversion (Cardo et al. 1997). Thoracotomy in the emergency department in a population with a prevalence of 7 percent has been estimated to carry a probability of 0.00004 for HIV seroconversion (Sikka, Millham & Feldman 2004).

Occupations traditionally occupied by women, such as nurses, have a high risk of exposure to blood-borne pathogens, including HIV. In one study examining 601 nurses from surgical wards, operating rooms, and emergency departments, almost half reported a percutaneous exposure during the year prior to the study (Ganczak et al. 2006). Employment conditions may be associated with HIV-1 acquisition, especially in vulnerable populations, such as immigrants. In a study from China examining 1,543 female migrant workers, those that were sexually experienced (43.2 percent), and either worked in entertainment establishments (e.g., nightclubs, dancing halls) or provided personal service (e.g., beauty salons, massage parlors), were two times more likely to have engaged in risky sexual practices compared to those employed in non-entertainment establishments like restaurants or factories (Yang et al. 2005). Unfortunately the rate of consistent condom use in the same study was less than 15 percent (Yang et al. 2005).

Molecular diagnosis has greatly enhanced our preventive and therapeutic efforts for HIV-1 infection, and may shorten the window period for accurate diagnosis. The introduction and increasing use of rapid-HIV testing will assist in future preventive efforts (Franco-Paredes, Tellez & del Rio 2006). Limitations, however, still exist. A cluster of infections in workers within the legal multibillion adult film industry is the most recent best example. Infection with HIV-1 appeared in 3 out of 13 female partners (attack rate of 23%) of a previously uninfected HIV positive male partner who was undergoing frequent testing for the virus (Taylor et al. 2007). This observation underscores the significance of primary prevention for HIV-1 infection (Taylor et al. 2007).

Suspicion of an occupational exposure to HIV should lead to the immediate application of protocols investigating the incident and providing prophylactic antivirals to those involved in high-risk scenarios, as well as psychological support. Guidelines for management have been published and are widely available (Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis 2001). Careful discussion of adverse effects associated with prophylactic antiviral regimens is necessary (Kiertiburanakul et al. 2006). These actions reduce the likelihood of HIV disease, as well as concomitant stress and anxiety from the exposure.

Hepatitis B

Occupational exposure to blood or other potentially infectious material is considered the main risk factor for HBV acquisition in the workplace. Thus, professions with such exposure (and especially healthcare workers) comprise the main risk groups. Hepatitis B has been associated with a higher risk for transmission to health care workers in comparison with HIV or Hepatitis C. The risk of transmission relates to the degree of contact, the Hepatitis B e antigen (HBeAg) status of the source patient, and the serological conversion, which is estimated around 30 percent (Werner & Grady 1982). The risk appears to be higher during the first five years of employment (Snydman et al. 1984). Prevaccination with HBV vaccine, and the application of universal precautions in dealing with blood or other potentially infectious material, is paramount in preventive efforts against HBV. Recommendations for postexposure measures have been published, and HBV vaccine (if unvaccinated or with low serological titers), Hepatitis B immunoglobulin, or both, must be started as soon as possible (within 1-7 days) (Puro et al. 2005; Updated U.S. Public Health Service

Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis 2001).

Hepatitis C

Hepatitis C is also acquired through exposure to blood or other potentially infectious material. Health care workers are again the primary risk group for exposure. The risk of transmission after a percutaneous exposure is in between that of Hepatitis B and HIV, and estimated around 1.8 percent (Range: 0%–7%)(Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis 2001). The risk depends on the type of procedure and the prevalence of the disease in the general population. For emergent thoracotomy and a prevalence in the population of 17 percent, a probability of 0.0027 for chronic Hepatitis C seroconversion has been calculated (Sikka et al. 2004). Following exposure, close follow-up and treatment of acute seroconversion is indicated because there is no immediate prophylactic action (Puro et al. 2005; Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis 2001).

Avian Influenza H5N1

Direct exposure to poultry infected with the H5N1 subtype of Influenza A has been identified as the main risk factor associated with infection in humans. Professions with increased risk for exposure include veterinarians, cullers and poultry workers, farmers or those exposed to commercial poultry, people involved in litter management and carcass disposal in affected areas, zoo and nature reserve workers, gamekeepers, biologists, laboratory technicians, and health workers caring for possible human cases. Poultry workers, especially those involved in activities such as butchering and contact with ill birds in the affected areas, seem to carry the highest risk (Bridges et al. 2002). The role of occupational exposure for health care workers has not been well established. Serological data from the 1997 Hong Kong epidemic indicate that subclinical H5N1 infections may occur (Swayne 2006), however others have failed to prove such an association during the recent phases of the outbreak in Southeast Asia (Apisarnthanarak et al. 2005). Person-to-person transmission is probable and requires close and extensive contact (Ungchusak et al. 2005). The disease has milder forms that present with influenza-like illnesses and/or symptoms from other systems (e.g., conjunctivitis) (Swayne 2006) and severe forms associated with respiratory distress and death (Beigel et al. 2005; de Jong et al. 2005; Shu, Yu & Li 2006; Tran et al. 2004; Yu et al. 2006). Occupational medicine has its own role and can significantly contribute in reducing the risk of transmission of avian flu to workers at risk via prevention and prophylactic measures (Halpin 2005; Stone 2006; Whitley & Monto 2006). Such efforts are of paramount importance because humanity is preparing to face a pandemic caused by a novel influenza strain and the first target group with the highest risk is poultry workers (Stone 2006; Swayne 2006; Whitley & Monto 2006).

Hantavirus Pulmonary Syndrome

People exposed to infected rodents or their droppings are at risk for contracting the new and old world viral agents of hantavirus pulmonary syndrome (Sin Nombre virus) (Mills et al. 2002). Exposure in closed spaces to active infestations of infected rodents seems to be the most important factor for infection (Mills et al. 2002). This probably explains the observations of no serological evidence of infection in workers widely exposed to rodents (Fritz et al. 2002). The virus was first recognized in the United States during 1993 (Duchin et al. 1994). Farmers appear to be at an increased risk through exposure to rodents or their excreta (Mills et al. 2002; Vapalahti, Paunio, Brummer-Korvenkontio, Vaheri & Vapalahti 1999), and farm and timber workers were most frequently affected in an epidemic in Chile (Castillo, Naranjo, Sepulveda, Ossa & Levy 2001). People occupied in hand plowing or planting (Mills et al. 2002), harvesting field crops (Mills et al. 2002), or involved in cleaning or other activities of rodent-infested buildings (e.g., barns, vacant dwellings) (Mills et al. 2002) are considered at risk. The disease is a laboratory hazard for personnel working with the virus (Mills et al. 2002; Shi, McCaughey & Elliott 2003).

The disease may progress to fatal pulmonary infection with or without renal involvement and hemorrhagic manifestations. Person-to-person transmission in the healthcare setting during outbreaks has not been confirmed (Chaparro et al. 1998). Risk reduction through the use of appropriate PPE and hygiene practices that deter rodents from colonizing the home and work environment is an appropriate control measure(Mills et al. 2002).

Rabies

This disease may affect workers exposed to infected animals harboring the virus in their nervous system and their salivary glands (Brookes & Fooks 2006; Warrell & Warrell 2004). It takes the form of an acute encephalitis, usually with a fatal outcome (Warrell & Warrell 2004). Occupations at risk include those exposed in infected rodents (Mendes et al. 2004; Warrell & Warrell 2004), veterinarians (Warrell & Warrell 2004; Weese, Peregrine & Armstrong 2002), animal handlers such as farmers (Brookes & Fooks 2006; Tariq, Shafi, Jamal & Ahmad 1991; Warrell & Warrell 2004), and people exposed to bats (Brookes & Fooks 2006; Warrell & Warrell 2004). Although a vaccine is available, animal rabies control and the provision of accessible and appropriate human prophylaxis worldwide remains a challenge (Warrell & Warrell 2004).

Fungal Infections

Coccidioidomycoses

Coccidioidomycoses belongs to the endemic mycoses. It is caused by the fungus *Coccidioides immitis* (Anstead & Graybill 2006), and is endemic in the southwestern United States (Anstead & Graybill 2006; Pappagianis 1988). The disease is transmitted through inhalation and has myriad manifestations (Anstead & Graybill 2006). It may begin as a flu-like illness that may progress to pneumonia and shock especially in immunocompromised subjects (Anstead & Graybill 2006). At-risk occupations include farmers and migrant farm workers, construction and excavation workers, as well as workers in archeological sites (Coccidioidomycosis in Workers at an Archeologic Site 2001; Werner, Pappagianis, Heindl & Mickel 1972) because the organism is found in the soil in endemic areas (Schmelzer & Tabershaw 1968). Physicians should keep this entity in the differential diagnosis in people who developed a respiratory infection after traveling to affected endemic areas (Desai et al. 2001).

Histoplasmosis

Histoplasmosis is caused by the fungus *Histoplasma capsulatum* found in the Americas, Asia, and Africa (Kauffman, 2006; Wheat 2006). The organism grows in soils enriched by bird and chicken droppings, as well as the guano of bats (Sorley, Levin, Warren, Flynn & Gersenblith 1979; Stobierski et al. 1996). People exposed to bats during spelunking activities are also considered at-risk (Lottenberg et al. 1979). During an outbreak at a bridge construction site, seeing or having contact with a bat and disposal of bat waste were the main risk factors for acquiring the disease (Huhn et al. 2005). Infection ranges from a mild self-limiting infection to a more systemic disease characterized by pulmonary involvement that reminds tuberculosis (Kauffman 2006; Wheat 2006). Occupational risk is observed in laborers at landfills or building construction (Huhn et al. 2005; Jones, Swinger et al. 1999), as well as people working in the agricultural industry (Outbreak of Histoplasmosis among Industrial Plant Workers 2004).

Dermatophytose—Tinea infections

Professions that require extensive manual work or activities with exposed skin surfaces, such as farming and other field work, have been associated with fungal infections of the skin. Fungal skin disease was the most prevalent infection in a study of migrant Latino farmworkers in the United States (Krejci-Manwaring et al. 2006). In a study of 467 forestry workers and farmers in Turkey, anywhere from 8-20 percent of the study population was affected by *tinea pedis et manus* infections and/or *onychomycosis* (Sahin, Kaya, Parlak, Oksuz & Behcet 2005). *Tinea corporis* and *tinea inguinalis* were also observed (Sahin et al. 2005). *Trichphyton rubrum* was the most frequently isolated fungus, and farmers had higher frequencies of superficial mycoses that was likely attributed to the wearing of rubber shoes and nylon socks, and the practice of animal husbandry (Sahin et al. 2005). Nevertheless, dermatophytoses have a worldwide prevalence and have been described in association with other occupations, including healthcare workers—such as those working in nursing homes (Smith et al. 2002)—or professional ice hockey players (Mohrenschlager, Seidl, Schnopp, Ring & Abeck 2001).

Parasitic infections

Echinococcosis

Humans serve as the intermediate host of the tapeworm (*Echinococcus granulosus*) of dogs and other carnivores. Evidence of infection is occasionally found among sheep workers, especially in endemic areas (Moro et al., 1994; Sotiraki, Himonas & Korkoliakou 2003) or veterinary workers (Biffin, Jones & Palmer 1993). It is the cause of the hydatid disease characterized by formation of cysts in the liver and other body sites. Alveolar echinococcosis is another zoonosis caused by *Echinococcus multilocularis* (McManus, Zhang, Li & Bartley 2003)that can be transmitted to farmers in endemic areas (Craig et al. 2000).

Giardiasis

Caused by the parasite *Giardia lamblia*, giardiasis is a parasitic disease (Huang & White 2006) that can infect farmers using untreated wastewater in agriculture (Ensink, van der Hoek & Amerasinghe 2006; Srikanth & Naik 2004) as well as other occupational groups exposed to human waste (Hoque, Hope, Kjellstrom, Scragg & Lay-Yee 2002; Sehgal & Mahajan 1991). Field workers that drink water from contaminated sources (e.g., wells, streams, or lakes) are also at-risk, and prevention efforts focusing on water hygiene should be effective (Rose, Haas & Regli 1991).

The Two-Fold Role of Working Women

Women should participate at all levels of decision-making in local, national, and international institutions and mechanisms for the prevention and management of infectious diseases in the workplace. The integration of a gender perspective is of essential importance in all activities aimed at communicable diseases in the working environment for successful outcomes, especially with regard to prevention. Occupationally acquired communicable diseases are not limited by the borders of the working environment. Working mothers will be role models for their young, not only during private discussions in the household environment, but also by their participation in community campaigns and efforts against communicable diseases aimed at more widely implemented measures for such diseases, such as during a pandemic. Well-informed and trained women may convey healthier lifestyles to their families regarding ways of handling exposure to communicable diseases and appropriate preventive and protective measures. They will also focus on maintaining a high level of health in their offspring by maintaining a complete vaccination schedule and scheduling regular health check-ups. Furthermore, instituting healthier nutritional habits, together with other activities targeting communicable diseases, may lead to an overall healthier lifestyle at home and will be of paramount importance in this regard.

Prevention

Examples of Best Practice, Case Studies

The control of communicable diseases resulting from health care worker exposure to blood-borne pathogens and other potentially infectious material remains the best example. Preventive measures against Hepatitis B acquisition involve vaccination and other prophylactic measures— e.g., administration of the specific immunoglobulin—and have been proven safe and effective in large trials (Grady et al. 1978; Prince et al. 1978; Prince et al. 1975; Szmuness, Stevens, Zang, Harley & Kellner 1981).

Reduction in HIV transmissions after percutaneous exposure has been shown in small studies as a result of post-exposure prophylaxis with antivirals (Cardo et al. 1997). Failures, however, have been described (Ippolito et al. 1998; Jochimsen 1997; Jochimsen et al. 1999; Pratt, Shapiro, McKinney, Kwok & Spector 1995) and the administration of prophylaxis and follow-up should be instituted by experienced staff according to national guidelines (Ippolito, Puro, Petrosillo & De Carli 1999) and recommendations from internationally acknowledged organizations (Puro et al. 2005; Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis 2001).

Administration, together with the occupational health department, should ensure the availability of policies and procedures relevant to occupational infections affecting specific job environments. These policies and procedures should adhere to legislative requirements and published literature and guidelines. Surveillance of exposures (even if only potential exposures) and analysis of collected data, together with the communication of the results, should be established in high-risk professions. Confidentiality and maintenance of a secure medical record in affected female workers is essential in following such infections. A referral process for exposed female workers and for further diagnostic and clinical evaluation and management is necessary in all environments.

Ongoing evaluation of strategies to minimize exposure to occupational infections is a continuous challenge in the workplace. The occupational health department should develop indicators that can assist in the evaluation of any preventive strategy instituted in the work environment. These could include, for example: a) rates of immunization for vaccine-preventable diseases, b) availability of engineering controls for sharp-related injuries, c) rates of percutaneous injuries for blood-borne pathogens, d) impact of training programs for use of newer preventive technologies for any relevant communicable diseases, e) product evaluation before and after implementation, and f) periodic screening of female workers for acquisition of infection, and so forth. To ensure consistency, collaboration with a more central authority such as the local public health authority may be preferable when assessing these indicators. The collection, analysis, interpretation, and finally the dissemination of such epidemiological information on occupational infections will enhance infection prevention and control at work.

Avoidance of Exposure to Risk Factors

Working women should be educated via training and information sessions provided by experts in occupational diseases and infectious diseases specialists to avoid exposure to risk factors associated with communicable diseases in the working environment. It is the primary responsibility of the health care department and occupational physician, however, to organize risk-reduction strategies to this effect and implement appropriate control measures, as well as institute appropriate educational activities. For example, a working woman could not have prevented transmission of legionellosis to herself from an infected water source in her work environment (Muraca, Stout, Yu & Yee 1988) ,and b) if engineering controls are not instituted, a female health care worker is at a much higher risk for a sharp-related injury.

Furthermore, the appropriate analysis of surveillance data collected at work will help in establishing safer work practices or identify groups at highest risk for contraction of an occupational infection.

Developing and Preserving Healthy Lifestyles

Prevention of exposure and acquisition of an infectious disease contributes to the well-being of a woman and assists in developing and preserving an overall healthier lifestyle. Through such prevention efforts, healthier habits are also acquired and become a part of the woman's life and are sometimes passed along to her immediate environment (e.g., preventive measures for transmission of a sexually transmitted infection, Hepatitis B vaccinations, and others).

General Guidelines on the Subject for Working Women

Women, and especially working women, should be aware of a large list of communicable pathogens that can be transmitted in the workplace (see Table 7.1). They should also participate in preventive efforts concerning these entities in their environment under the close collaboration and expert guidance of an occupational physician supervising their health. Diseases they encounter may differ according to the type of occupation and the overall prevalence of the disease in the general population, thus preventive measures will vary from one working environment to the other and between different countries. Guidelines have been established for specific infection control measures for occupational infections in the health care setting. According to the working environment and relevant infections, similar guidelines should be established for other professions. For global threats such as an influenza pandemic, the world should stand united in its preventive efforts (Whitley & Monto 2006), and special measures for the workplace should be incorporated in national pandemic plans. More education and training together with real-life exercises will be necessary for the successful implementation of preventive policies.

Resources on the Health Issue

Useful Links and Websites with Educational Materials

Useful web links about communicable diseases affecting women in their workplace include the following:

- http://www.osha.gov
- http://osha.europa.eu/OSHA
- http://www.ecdc.eu.int/
- http://www.efsa.eu.int
- http://www.cdc.gov
- www.haz-map.com
- www.occupationaldiseases.nl/ondex.php
- http://www.phac-aspc.gc.ca/noise-sinp/index.html
- www.ilo.org/safework
- www.ttl.fi (Finnish Institute of Occupational Health)

Related Published Material

Published and educational material can be found readily on the Web. Examples include the following:

- OSHA Guidance update on protecting employees from avian flu (avian influenza) viruses. Available at: http://www.osha.gov
- Hand hygiene quick card available at: http://www.osha.gov/pls/publications/pubindex.list
- Mold quick card available at: http://www.osha.gov/pls/publications/pubindex.list

Educational Material

Table 7.1 lists significant representative pathogens/diseases causing communicable diseases that may be occupationally acquired.

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