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Occupational Infections

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KEY CONCEPTS

- Occupational sources of infection should be considered and actively sought in the evaluation of a patient with an infection.
- Attributing an infection to an occupational source requires knowledge of the details of the patient's job duties, as well as pathogen reservoirs and likely routes.
- Controlling occupational infections requires controlling the source of the infection as well as interrupting its route of transmission.
- Most countries have regulations in place to minimize the risks of occupational diseases through safe work practice guidance, protective equipment use and immunizations.
- Detailed information is provided in the chapter tables.

Introduction

The traditional model of infectious disease causation is the epidemiologic triangle. It has three components: an external agent, a susceptible host and environmental factors that bring the host and the agent together to produce an infection.[1]

Occupational infections are defined by two of these components. Particular infectious agents or organisms may be associated with a workplace or occupational setting and specific work activities may predispose the worker to exposure, resulting in an occupational infection.

The Importance of Occupational Infections

Although difficult to quantify, occupational infections are probably uncommon when compared to those that result from non-occupational activities or environments.

Infections can only be confidently attributed to occupational exposure as a result of careful epidemiologic investigation. Case reports, surveillance data and cross-sectional surveys may lead to a hypothesis that a particular infection is diagnosed more commonly in one or other group of workers. However, in order to accurately estimate an odds ratio or relative risk, a carefully designed, adequately powered, case-control or cohort study will be required. Assuming that bias and confounding factors can be adequately controlled, it may then be possible to satisfy the Bradford Hill criteria for causation.[2] Few infections have been subject to this rigorous approach.

In the individual case where an occupational infection is suspected or when a source of infection is unclear, it is important to take an adequate occupational history. A workplace visit to assess the system of work can help confirm the likelihood of the infection being acquired through workplace factors.[3] A high index of suspicion will ensure that occupational infections are not missed. If an occupational source is not recognized there will be a continuing risk to other workers in the same work area, and the affected individual may be at risk of re-infection on return to work, especially if full immunity following the initial infection does not occur.

A number of occupational infections that are of historical interest in higher-income countries are still found in low- and middle-income countries (LMIC), and staff who are traveling to work in those areas may acquire these infections. As the working environment becomes ever more complex, there is the potential for new occupational infections to emerge.

Infections acquired occupationally may spread to other workers or the workers' families or social contacts. As with any infection, occupational infections are controlled by controlling the source of infection, its route of transmission and by protecting susceptible persons. Most occupational infections can be prevented if appropriate measures are implemented. Some occupational infections, especially those for which vaccines are available (e.g. hepatitis B), are more amenable to prevention than others (e.g. hepatitis C). Health education and preventive programs in the workplace provide a good system for minimizing the risk of occupational infections.

The largest employer in the United Kingdom – the National Health Service – has a requirement for every healthcare facility to have access to an occupational health service. In the USA, both voluntary guidance and regulatory and certification requirements for healthcare facilities set standards for practices to protect employees from infectious hazards in the workplace, through infection prevention and occupational health programs. This has helped reduce the burden of occupationally-acquired infections in the healthcare community.[3,4] In the US, the Occupational Safety and Health Administration (OSHA) also provides guidance and regulatory requirements for worker safety in other industries. These systems are not as well developed in some other industries where there is a recognized risk of occupational infections (e.g. in farming).

This chapter includes primarily perspectives from the USA and UK and describes some of the guidance and structures for public health and occupational health practice that will be found there. Similar arrangements can be expected in most industrialized countries.

The Centers for Disease Control and Prevention (CDC) in the USA have published guidelines for preventing the transmission of infectious diseases in the healthcare workplace. These are available at http://www.cdc.gov/hicpac/2007ip/2007isolationprecautions.html and http://www.cdc.gov/hicpac/pdf/infectcontrol98.pdf.

The US National Institute for Occupational Safety and Health (NIOSH), which is part of CDC, has also published research and recommendations on most aspects of work-related injury and illness including infections (see http://www.cdc.gov/niosh/topics/diseases.html). In the UK, the Health and Safety Executive (HSE) has a useful website that provides valuable guidance (http://www.hse.gov.uk/health-surveillance/).

The Australian Safety and Compensation Council (ASCC) provides policy advice on all aspects of occupational health and safety to allow local legislators to enact and enforce laws. Reports of occupational diseases are published frequently that demonstrate decreasing trends in most reportable occupationally-acquired infections in Australia.[5]

Classification of Occupational Infections

Mode of transmission, occupations and examples of infections are outlined in Table 72-1.

Surveillance of Occupational Infections

Surveillance of occupationally-acquired infection is problematic. The interval between exposure and disease can vary, and some infections

TABLE 72-1 Occupational Infections

Mode of Transmission	Occupations	Examples of Infections
Contact with animals and animal products (zoonoses)	*Source of infection and route of transmission:* Contact with material from infected animals, by inhalation, ingestion, bite or scratch Contact with contaminated animal product (carcasses, placental tissue, hair, wool or hides) from endemic area Contact with animal excreta by fecal–oral or percutaneous route or in water *Occupation types:* Farm worker Poultry worker Veterinarian Butcher Slaughterer Wool and leather worker Zoo worker Animal handler Sewage worker	**Ingestion** *Salmonella* *Cryptosporidiosis* *Escherichia coli* O157 *Campylobacter* *Yersinia* *Echinococcus* **Bites/Scratches** Cat-scratch fever Pasteurellosis *Capnocytophaga canimorsus* Rabies Rat bite fevers B-virus infection **Inhalation** Avian influenza Psittacosis Anthrax Q fever **Skin Contact** *Streptococcus suis* Brucellosis Leptospirosis Newcastle disease Monkeypox Glanders Hendra and Nipah viral diseases **Rodents Main Reservoir, Transmission by Inhalation of Excreta** • arenaviral hemorrhagic fevers • hantavirus infection • lymphocytic choriomeningitis Exposure to sewage is not a risk factor for hepatitis A or E viruses in sewage workers who are properly trained and provided with personal protective equipment[3]
Exposure to vectors	*Source of infection and route of transmission:* Exposure to tick, flea, or mites through work in infested area or in rodent-infested building *Occupation types:* Farm worker Forestry worker Some international aid workers Pest control worker	*Borrelia* infections (Lyme disease, relapsing fever) Babesiosis Ehrlichiosis Tularemia Plague Scrub typhus Typhus Tick-borne rickettsial infections *Bartonella* infection Arthropod-borne viral fevers (over 100 arboviruses cause disease in humans, often as an incidental host in a zoonotic cycle. Infection can occur in those working in endemic areas and also through laboratory exposure) (see Chapter 175)
Care of patients	*Source of infection and route of transmission:* Contact with patients, respiratory or blood-borne Contact with human excreta Skin-to-skin contact with infected patient *Occupation types:* Healthcare worker Dental worker Embalmer Teacher Daycare provider Laboratory worker	**Blood-borne** HIV Hepatitis B Hepatitis C Ebola–Marburg viral infection **Skin-to-Skin Contact** Scabies Varicella Staphylococcal infection, e.g. methicillin-sensitive (MSSA) or resistant *Staphylococcus aureus* (MRSA) Adenovirus **Contact with Human Excreta** Typhoid/paratyphoid Hepatitis A Cryptosporidiosis Norovirus Cytomegalovirus There is some evidence that working in a child daycare center is associated with higher seroprevalence of antibodies to cytomegalovirus and varicella-zoster virus and possibly parvovirus B19, although all of these infections are common in the general population[6,7]

TABLE 72-1 Occupational Infections (Continued)

Mode of Transmission	Occupations	Examples of Infections
		Respiratory Tuberculosis *Mycoplasma* infection Influenza Measles Mumps Meningococcus Parvovirus Pertussis Rubella Diphtheria Monkeypox Severe acute respiratory syndrome (SARS)
Environmental sources, exposure to soil	*Source of infection and route of transmission:* Ploughing, digging or excavating soil in endemic area Contact with dust containing rodent feces, bird roosts, chicken coops or bat-inhabited caves in endemic area *Occupation types:* Building cleaning worker Construction worker Archaeologist Farm worker	Tetanus Listeria Histoplasmosis Coccidioidomycosis Paracoccidioidomycosis Blastomycosis
Occupational skin infections	*Source of infection and route of transmission:* Cleaning pools or aquariums Dental work in patients' mouths Barefoot contact with contaminated soil in endemic area Working continuously with wet hands Touching infected farm animals, plants containing thorns, splinters or sphagnum moss, infected meat or poultry, infected fish or shellfish *Occupation types:* Dental worker Farm worker Veterinarian Florist Slaughterer Butcher Fisherman Aquarium worker	Orf Ringworm Herpetic whitlow Erysipeloid *Mycobacterium marinum* skin infection Viral warts Hookworm *Candida* paronychia Chromomycosis Cutaneous larva migrans Sporotrichosis *Vibrio vulnificus* infection Cutaneous anthrax

can be acquired both at work and in the community, making attribution difficult. A range of data sources are available. The examples described here are from the USA and UK but similar systems may be found in other countries.

It is a legal requirement in the USA and the UK for clinicians to report certain specified infectious diseases to local health authorities. In the USA, there are both national and state reporting requirements. The list of notifiable infections covers common infections (including viral hepatitis and tuberculosis) that may be occupationally acquired, as well as rarities such as rabies, anthrax and plague. Microbiology laboratories must also report micro-organisms of public health significance to local health authorities. Outputs from these surveillance schemes can be viewed at http://www.hpa.org.uk/infections/topics_az/noids/menu.htm for the UK and http://wwwn.cdc.gov/nndss/ for the USA.

In neither of these systems is the occupation of the case patient requested or recorded. Local and national health authorities may enhance the data that are collected as part of case investigation and management, and this may include occupation and other relevant risk factors. However, such additional data are not consistently collated, analyzed or disseminated and, when available, are susceptible to ascertainment and reporting bias. An exception is occupationally-acquired HIV in the US for which there is surveillance through a voluntary reporting system (http://www.cdc.gov/HAI/organisms/hiv/Surveillance-Occupationally-Acquired-HIV-AIDS.html). Other occupational surveillance schemes in the UK also occasionally report occupational infections. Outputs from these surveillance schemes can be viewed at http://www.hse.gov.uk/statistics/tables/.

In the UK, the Industrial Injuries Disablement Benefit (IIDB) Scheme provides benefits to employees if they develop a prescribed occupational disease. Diseases are prescribed when there is a recognized risk to workers in an occupation and where the risk is uncommon or absent in the general population. For some occupational diseases there is a strong association with occupation and the disease rarely occurs outside work (e.g. mesothelioma, coal miner's pneumoconiosis). However, most infections are common in the general population and it is difficult to establish a causal link with the occupation. In lay terms an infection will be attributed to an occupation if it is *more likely than not* to be caused by that occupation. In epidemiologic terms this means an attributable fraction (the proportion of the additional risk that can be attributed to the exposure in the exposed population) of 50% or more, which equates to a relative risk of two (a doubling of the background risk caused by exposure).

Prescribed infections include:

- anthrax where work involves contact with animals infected with anthrax, or the handling of animal products or residues;

- glanders where work involves contact with equine animals or their carcasses;
- leptospirosis where work involves places liable to be infested by rodents or other small mammals, handling dogs, or contact with pigs or bovine animals or meat products;
- hepatitis A virus infection where work involves contact with raw sewage; and
- hepatitis B or C virus infection where work involves contact with human blood products or other sources.

A complete list of prescribed infections can be viewed at http://www.pkc.gov.uk/CHttpHandler.ashx?id=19670&p=0.

Prevention and Control of Occupational Infections

The control of any occupational infection requires a detailed knowledge of its epidemiology, clinical features, reservoir, mode of transmission, incubation period and communicable period. To prevent and control infection, measures are necessary to eliminate the source of infection and the route of transmission. Susceptible workers can be offered protection with personal protective equipment (e.g. masks, gloves), antibiotics or immunization.

Many higher-income countries require employers to assess the risks from exposure to all hazardous substances (including biologic agents) and to implement measures to protect workers and others from those risks as far as is reasonably practicable. Following a workplace risk assessment, exposure to potential infection should be eliminated by changing working practices and removing hazardous products or waste. Residual risk is controlled by promoting good occupational hygiene and environmental hygiene, and by focusing on design and engineering controls. Staff training and provision and use of personal protective equipment (PPE) are key measures (Table 72-2).

IMMUNIZATION

All workers should be fully immunized according to the routine immunization schedule of their country.

In addition, selective immunization may be recommended for groups of workers at increased risk[9,11,12] (Table 72-3).

TABLE 72-2 Control of Occupational Infection

Controlling the source of infection	In the case of zoonoses, best practices should be observed with respect to animal husbandry, biosecurity of animal houses, feed and water, hygiene of animal houses and equipment, inspection, testing and certification and quarantine. Codes of practice are available and some of these are backed by legal measures In the case of human sources, prompt action is needed to isolate the case while infectious and to treat if possible to render the case noninfectious
Controlling the route of transmission	Guidelines are available which detail the measures that should be implemented to prevent transmission, including handwashing and use of appropriate PPE. In the healthcare workplace, standard precautions are widely promoted for the care of all patients in addition to enhanced measures for specific infections[8] (http://www.cdc.gov/hicpac/2007ip/2007isolationprecautions.html)
Protecting susceptible workers	Appropriate PPE should be provided. Antibiotic or antiviral chemoprophylaxis may be required. All staff should be up to date with their routine immunizations (tetanus; diphtheria; pertussis, polio; measles, mumps and rubella) as well as ones recommended for specific occupations.[9,10] Education about risks and measures to take to minimize those risks should be provided on an ongoing basis

PPE, personal protective equipment.

TABLE 72-3 Immunizations for Groups of Workers at Increased Risk

Specific recommendations or requirements may vary by country

Immunization	Occupational Groups
Anthrax	Laboratory staff working with anthrax. Those handling imported infected animal products or working with infected animals
Cholera	Not available in the USA. An oral vaccine is available in the UK and may be considered for aid/relief workers going to areas with a current cholera outbreak
Hepatitis A	Workers traveling to areas with increased rates of hepatitis A. Laboratory workers who work with hepatitis A virus or with hepatitis A-infected primates. Consider for staff of large residential institutions, sewage workers, food packagers and handlers, and staff in daycare facilities based on community risk assessment
Hepatitis B	Healthcare workers, including students and trainees who have direct contact with patients' blood or tissues, laboratory staff who handle material that may contain the virus, staff of residential accommodation for those with learning difficulties. Consider for other staff groups such as the police and fire and rescue services, morticians and embalmers, and prison service staff in contact with prisoners, based on risk of exposure
Influenza	Healthcare workers and social care staff directly involved in patient care. In the USA, recommended for everyone over the age of 6 months
Japanese encephalitis	Laboratory staff who may be exposed to the virus
Measles, mumps, rubella (MMR)	Healthcare staff should be immune to measles, mumps and rubella for their own benefit and also to prevent them from spreading infection to patients
Rabies	Pre-exposure immunization should be offered to laboratory workers handling the virus, animal control and wildlife officers, people who regularly handle bats, those working or traveling abroad whose work may bring them into contact with rabid animals
Smallpox	Workers in laboratories where pox viruses (such as monkeypox or genetically modified vaccinia) are handled
Tick-borne encephalitis (TBE)	No TBE vaccines licensed or available in the USA. Vaccines available in Europe and Russia. In endemic areas recommended for those engaged in forestry, woodcutting, farming and the military. Recommended for laboratory workers who may be exposed to TBE
Tuberculosis	Not recommended routinely in the USA or Canada. In some countries, Bacille Calmette–Guérin (BCG) is recommended for unvaccinated, tuberculin-negative persons aged under 35 with increased risk of exposure to persons with tuberculosis, including healthcare workers, laboratory staff, prison staff, staff of care homes, staff of hostels for homeless people and refugees

IMMUNIZATION FOR LABORATORY AND PATHOLOGY STAFF

Laboratory and pathology staff handle pathogens or potentially infected specimens, and mortuary staff are potentially exposed to infected cadavers.[13] Other laboratory personnel include cleaners, and administrative staff. UK guidelines for morticians and embalmers can be viewed at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.484.2062&rep=rep1&type=pdf.

All staff should have had all routinely recommended immunizations. Additional recommendations for laboratory and pathology staff are summarized in Table 72-4.

Conclusions

There are many infections that can be acquired through work activities or from workplaces (Table 72-5). The recognition of occupational factors as an important component in the transmission of these infections will aid in the management of affected cases, and in prevention. Continuing vigilance for new occupational infections, advances in preventive measures and an experienced occupational health team working with infection control specialists are key to the successful prevention of these infections.

References available online at expertconsult.com.

TABLE 72-4 Immunization of Laboratory and Pathology Staff Against Specific Occupational Infections

Bacille Calmette–Guérin (BCG)	Not recommended in the USA. In some countries, recommended for microbiology and pathology staff, mortuary staff and others at high risk of exposure
Hepatitis B	Recommended for laboratory staff that have direct contact with patients' blood or tissues. Antibody levels should be checked after immunization
Meningococcal vaccine (quadrivalent)	Recommended for microbiology lab workers. Revaccination every 5 years if potential for ongoing exposure
Hepatitis A, Japanese encephalitis, cholera, smallpox, tick-borne encephalitis, typhoid, yellow fever, influenza, varicella, anthrax, rabies	Recommended for staff handling or carrying out research on specific organisms

TABLE 72-5 Selected Infections with Occupational Significance

Infection	Description of Infection in Humans and Public Health Importance	Risk Factors, Source and Route of Transmission	Surveillance/Ocurrence	Prevention and Control
Brucellosis	Zoonosis. Acute febrile illness, fever of unknown origin or chronic bone or joint infection	Different species found in goats, sheep, cattle, pigs, dogs Contact with infected animals, animal tissues or consumption of unpasteurized milk Infectious aerosols occur in slaughterhouses No human-to-human spread	Approximately 100 cases reported annually in the USA in recent years but still common worldwide Farmers, veterinarians, slaughterhouse workers and meat packers at risk Laboratory workers also at risk[14,15]	Eliminate infection from domestic animals by testing, slaughter and immunization Pasteurize milk Precautions for those handling infected animals No immunization for humans
Varicella	Viral infection producing characteristic rash Occurs mainly in children; may have serious sequelae in adults, pregnancy and the immunocompromised	Direct contact and respiratory spread from human cases	Varicella incidence in US declined 82% from 2000–2010 due to the vaccine, introduced in 1995[16]	Healthcare staff with varicella and nonimmune healthcare staff who have been exposed to varicella require active management (with vaccination, furlough and possibly postexposure prophylaxis) to prevent spread to vulnerable patients[17,18] Immunization is available and is recommended for all nonimmune HCP
Human seasonal influenza	Acute viral respiratory illness caused by influenza A or B viruses New strains may produce winter epidemics of varying size and severity Outbreaks can occur in hospitals, schools, prisons and other closed communities High attack rate with potential for staff absenteeism	Spread by respiratory secretions from human cases by large droplet or direct spread Spread by airborne aerosol may also occur	Worldwide distribution	Affected staff should stay away from work during the infectious period (approximately 5 days in adults) Hygiene measures such as covering coughs and good hand hygiene may reduce spread through coughing and contaminated hands and environmental surfaces Guidelines on PPE should be followed Vaccines active against prevalent strains are manufactured each year and are recommended for all, especially HCP Antivirals are available for treatment and prophylaxis and guidelines on their use are updated annually

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TABLE 72-5 Selected Infections with Occupational Significance (Continued)

Infection	Description of Infection in Humans and Public Health Importance	Risk Factors, Source and Route of Transmission	Surveillance/Ocurrence	Prevention and Control
Avian influenza	Zoonosis mainly affecting wild waterfowl and domestic poultry, caused by avian strains of influenza A virus Potential for transformation of avian strains into new human pandemic strain by genetic intermixing with seasonal human strains	Spread to humans occurs rarely, through close contact with material from affected poultry or other birds Disease may be a severe respiratory illness (H5N1, H7N9) or conjunctivitis (H7N2, H7N3)	Since 2003, H5N1 has been endemic in poultry worldwide The disease is rare in humans, albeit with a high case-fatality rate. To date 16 countries have reported 650 human cases of H5N1 with 386 deaths H7N9 also periodically affects humans in close contact with poultry, most recently over 300 cases of a new strain have been reported in China	Avian influenza is controlled in poultry by surveillance, testing and culling affected flocks Workers involved in culling activities should be provided with appropriate PPE, antiviral prophylaxis, seasonal influenza immunization and medical follow-up Updated information is available at http://www.cdc.gov/flu/avianflu/ and at http://www.hpa.org.uk/guidance/avian-influenza-bird-flu
Pandemic influenza	Pandemic influenza occurs when a virus with a new hemagglutinin or neuraminidase surface protein emerges. These strains affect wide swaths of the global population due to lack of population immunity and delays in vaccine availability as a new vaccine is manufactured	Until a new pandemic strain emerges it is not possible to predict how it will behave in terms of attack rate, virulence and clinical features The World Health Organization and most national governments have published planning guidance based on experience from previous pandemics	Global pandemics of influenza A occurred in 1918, 1957, 1968 and 2009 with high attack rates and significant morbidity and mortality, with effects on health services and other national infrastructure Continuous global surveillance is coordinated by the World Health Organization	Persons with influenza will be urged to stay at home, cough etiquette and enhanced hygiene will be encouraged, affected persons will receive a course of antiviral treatment, business continuity plans will mitigate the effects of absenteeism, nonessential services may be suspended, social distancing measures may be introduced National strategic plans and detailed guidance can be viewed at http://www.cdc.gov/flu/pandemic-resources/index.htm and https://www.gov.uk/pandemic-flu
Hepatitis B and C viruses	Hepatitis B is a subacute viral infection of the liver. The initial illness may be severe and a chronic carrier state may develop, leading after some years to cirrhosis and hepatocellular carcinoma Hepatitis C is also a viral infection of the liver. The initial illness is often asymptomatic but 80% of those infected develop chronic infection that may result in cirrhosis and hepatocellular carcinoma	Human cases and carriers are the source of infection and transmission is by the blood-borne route. Hepatitis B is also transmitted by the sexual route and vertically from mother to infant Healthcare workers and laboratory staff who are exposed to blood and tissues from infected patients are at risk. Other groups of workers such as tattooists and body piercers may also be at risk	Hepatitis B vaccination has decreased the incidence of hepatitis B virus (HBV) in healthcare workers The risk of hepatitis C virus (HCV) after a percutaneous exposure to HCV infected blood is about 2%[19] In the UK there have been 20 cases of hepatitis C seroconversion in healthcare workers following percutaneous exposure (1997–2011)[20]	Standard infection control precautions should be followed (including use of PPE and safe handling of needles and sharp instruments) with all patients Hepatitis B vaccination is recommended for healthcare workers who may have direct contact with patients' blood or body fluids. It is also recommended for workers who are at risk of injury from blood-contaminated sharp instruments, or of being deliberately injured or bitten by patients Guidelines are available for the management of healthcare workers who have had percutaneous exposures Infection may spread from healthcare workers to patients in some high risk situations
Human immunodeficiency virus (HIV)[14]	A chronic retroviral infection which leads to depletion of CD4 lymphocytes and immunosuppression resulting in AIDS	Humans are the source of infection and spread is by the blood-borne, sexual or vertical route Healthcare workers and laboratory staff who are exposed to blood and tissues from infected patients are at risk	In the USA there have been 58 cases of documented HIV seroconversion following occupational exposure in healthcare workers with only one occurring since 1999.[21] In the UK there have been 5 with none occurring since 2004.[22,23]	Standard infection control precautions should be followed (including use of PPE and safe handling of needles and sharp instruments) for all patients Postexposure prophylaxis (PEP) with antivirals is recommended for healthcare workers who are exposed to HIV-infected patients' blood or body fluids. Guidelines are available[24] Spread of infection from an HIV-infected healthcare worker to a patient has been reported rarely

TABLE 72-5 Selected Infections with Occupational Significance (Continued)

Infection	Description of Infection in Humans and Public Health Importance	Risk Factors, Source and Route of Transmission	Surveillance/Ocurrence	Prevention and Control
Tuberculosis (TB)	Infection of lungs and other organs with *Mycobacterium tuberculosis* TB can cluster in healthcare settings, prisons, and other closed communities	Transmission is by inhalation of respiratory droplets from an infectious case Bovine TB (*Mycobacterium bovis* infection) may be contracted by consumption of milk from or contact with an infected animal	Healthcare workers have an elevated expected incidence of TB[25,26]	Infection control procedures should be followed in hospitals including placement of patients with known or suspected TB into airborne isolation (negative pressure ventilation and N95 respirators worn by all staff entering the room) Guidelines are available[27] BCG vaccine is not recommended for US healthcare workers but may be recommended in other countries for those who may have close contact with infectious patients
Leptospirosis	Zoonosis with wide clinical spectrum caused by one of many serovars of *Leptospira*	Many different animal reservoirs Transmission is percutaneous from urine of affected animals Can affect farmers, veterinarians, butchers and sewer workers; also freshwater fishers	Leptospirosis is not reportable in the USA. In the UK, there were 72 laboratory-confirmed cases in 2012. 18 were considered occupational, 25 from recreational activities[28]	Those at risk of exposure to animal urine or contaminated water (i.e. sewers and drains) should use appropriate PPE
Anthrax	Infection in humans affects skin, respiratory and gastrointestinal tract	Spread from infected animals by spores of *Bacillus anthracis* through contact with animals or animal products Not spread person-to-person Spores survive in the environment Spores have been used as agents of bioterrorism	Rare: 2 or fewer naturally occurring cases reported per year in the USA from 1980–2011. In 2001, there were 18 cases related to intentional biologic bioterrorism in Washington DC[29] In 2009, one case was reported in the USA of anthrax acquired at a drumming circle due to spore-contaminated hides used to make two drums[30]	Control anthrax in livestock and disinfect imported animal products Processing of products reduces risk of infection; PPE should be used Postexposure prophylaxis is available
Ovine and avian chlamydiosis (psittacosis)	Zoonosis: Potentially serious respiratory and systemic infection caused by *Chlamydia psittaci*	Spread from psittacine birds (parrots etc.) and other mammals which may be asymptomatic by inhalation of aerosols of bird droppings and other material from infected species Can affect pet shop employees, poultry processing plant workers, and veterinarians Human-to-human spread is very rare	Worldwide distribution Decreasing incidence in the USA, with 2 cases in 2011[29] About 50 cases reported in the UK each year	Affected birds should be quarantined, treated or culled Caution is required when handling birds and cleaning cages
Avian and ovine chlamydiosis	Zoonosis: Respiratory infection; may lead to miscarriage in pregnancy, caused by *Chlamydia abortus*	Spread by inhalation of aerosols from infected and aborting sheep. Cattle and goats may also be affected	Worldwide distribution, particularly in sheep-rearing countries Most common cause of infectious abortion in sheep in the UK but human infection is rare	Pregnant women should not help to lamb or milk ewes; they should avoid contact with aborted or newborn lambs (and placenta) and should not handle clothing that has been in contact with ewes or lambs A live vaccine for use in sheep is available. This should not be handled by pregnant women or women of child-bearing age
Diarrheal disease	There are many causes of infectious intestinal disease. Some are zoonoses, some food-borne, others have only human reservoirs	Transmission is by the direct or indirect fecal–oral route	Refer to surveillance data for specific infections Norovirus infection is highly transmissible and can be an occupational infection amongst healthcare staff	Infection control procedures should be followed, including handwashing and use of PPE.[8] Guidelines are available

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TABLE 72-5 Selected Infections with Occupational Significance (Continued)

Infection	Description of Infection in Humans and Public Health Importance	Risk Factors, Source and Route of Transmission	Surveillance/Ocurrence	Prevention and Control
Methicillin-resistant *Staphylococcus aureus* (MRSA)	A spectrum of infection from minor skin infection to life-threatening bacteremia caused by methicillin-resistant *Staph. aureus*	The reservoir is colonized or infected humans Spread is direct on hands, fomites, equipment or the environment Acquisition of MRSA infection has been described as a result of occupational contact with pigs[31,32]	MRSA is common in hospitals and in other care settings Healthcare staff may become infected or colonized with MRSA either at work or in the community and may act as source of infection for nosocomial transmission	Infection control procedures should be followed, including handwashing and use of PPE[8] Guidelines are available
Hepatitis A	Infection of liver caused by hepatitis A virus Asymptomatic disease is common in children; severity increases with age	Transmitted by the fecal–oral route through person-to-person spread or contaminated food or drink	Routine hepatitis A vaccination of children has resulted in decreasing rates in the USA and the UK Most cases are sporadic although clusters have been reported amongst men who have sex with men, intravenous drug users and hostel dwellers. Travel to endemic areas is also a risk factor	Observing appropriate infection control precautions including hand hygiene and use of PPE will minimize occupational spread of hepatitis A infection Immunization is available. See Table 72-3
Orf	Caused by a poxvirus Presents as a self-limiting subacute papulovesicular cutaneous lesion usually on the hands	Causes 'sore mouth' or contagious ecthyma in animals and can be transmitted to humans by direct or indirect contact Associated with lambs, sheep and goats	Groups affected include farmers, children visiting farms, meat industry workers Cases have been reported after contact with animals who recently received the live virus vaccine[33]	Proper hand hygiene; use of gloves Live virus vaccine for animals available Quarantine of affected animals
Q fever	Caused by highly infectious bacterium *Coxiella burnetii*. Incubation period 2–3 weeks Acute cases present as high fever with malaise, myalgia, sore throat, chills, vomiting, and diarrhea. Some develop pneumonia, liver function abnormalities or hepatitis, and endocarditis 50% of infected humans are asymptomatic. Chronic cases are rare	Transmitted by inhalation of organisms in dried placental material and birth fluids from infected sheep Cattle, sheep and goats are main reservoirs Consumption of raw unpasteurized milk has been a cause of a few cases Individuals with pre-existing heart valve disease are especially vulnerable if they develop chronic Q fever	Notifiable disease in the USA and the UK Occupational groups at risk are farmers, veterinarians and slaughterhouse workers	No licensed vaccine available in USA Preventive measures include proper disposal of products of conception from sheep, and quarantine of imported livestock
Meningococcal infection[34,35]	Meningitis, sepsis and rarely pericarditis or arthritis caused by *Neisseria meningitidis* Serogroups B and C are most common in the UK; B, C and Y in the USA A and W135 occur in other countries	Meningococci colonize the nasopharynx Transmission is by close contact with respiratory droplets from a person carrying the organism, usually requiring prolonged close contact Microbiologists at risk	Incidence decreasing in USA and UK with routine vaccination of adolescents Seasonal epidemics are common in sub-Saharan Africa Epidemics of group A and W135 infection have occurred in association with Hajj pilgrimages to Saudi Arabia Healthcare workers exposed to infected cases are at increased risk but absolute risks are very low	Vaccination recommended for all adolescents in the USA at 11–12 years with booster at age 16 It is also recommended for travelers to high-incidence countries Microbiologists should receive vaccine every five years Infection prevention precautions include droplet isolation (isolation mask for room entry) until 24 hours of effective antibiotics[8] Healthcare workers should minimize exposure by use of PPE Chemoprophylaxis is recommended if the mouth or nose is directly exposed to respiratory secretions from a case

PPE, Personal protective equipment.

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