Biological Hazards

Core Body of Knowledge for the Generalist OHS Professional

Safety Institute of Australia Ltd

Australian OHS Education Accreditation Board

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The OHS Body of Knowledge for Generalist OHS Professionals has been developed under the auspices of the **Health and Safety Professionals Alliance**

The Technical Panel established by the Health and Safety Professionals Alliance (HaSPA) was responsible for developing the conceptual framework of the OHS Body of Knowledge and for selecting contributing authors and peer-reviewers. The Technical Panel comprised representatives from:

The Safety Institute of Australia supported the development of the OHS Body of Knowledge and will be providing ongoing support for the dissemination of the OHS Body of Knowledge and for the maintenance and further development of the Body of Knowledge through the Australian OHS Education Accreditation Board which is auspiced by the Safety Institute of Australia.

Synopsis of the OHS Body of Knowledge

Background

A defined body of knowledge is required as a basis for professional certification and for accreditation of education programs giving entry to a profession. The lack of such a body of knowledge for OHS professionals was identified in reviews of OHS legislation and OHS education in Australia. After a 2009 scoping study, WorkSafe Victoria provided funding to support a national project to develop and implement a core body of knowledge for generalist OHS professionals in Australia.

Development

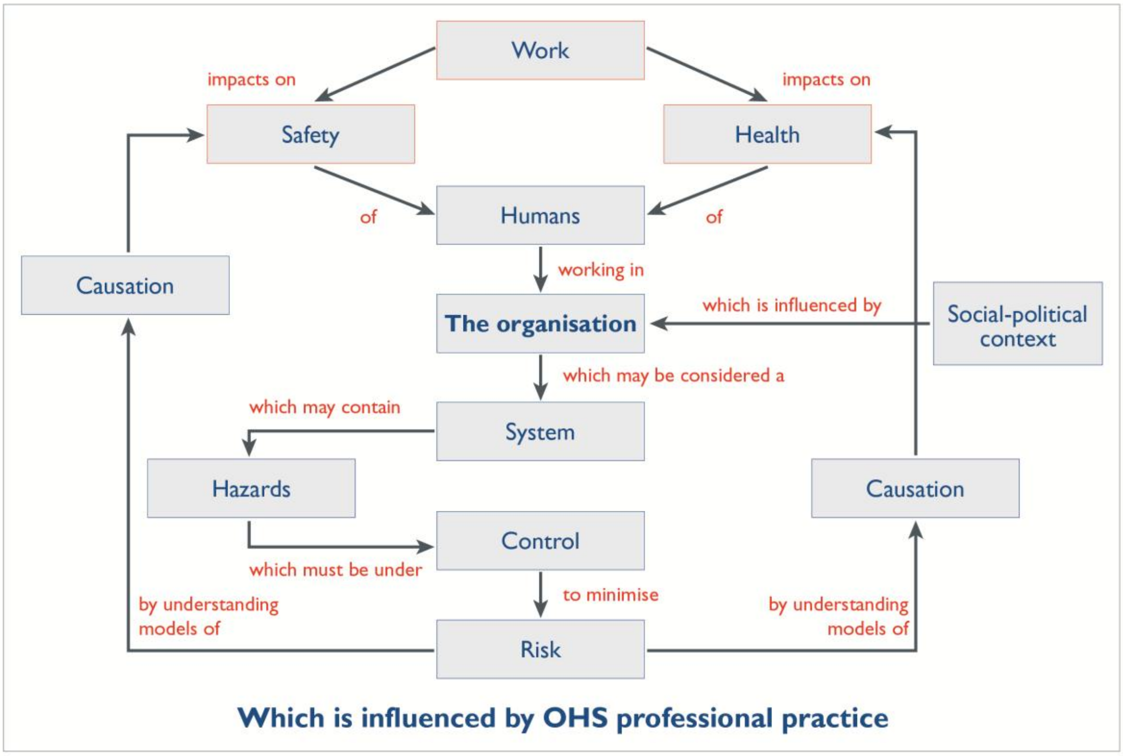
The process of developing and structuring the main content of this document was managed by a Technical Panel with representation from Victorian universities that teach OHS and from the Safety Institute of Australia, which is the main professional body for generalist OHS professionals in Australia. The Panel developed an initial conceptual framework which was then amended in accord with feedback received from OHS tertiary-level educators throughout Australia and the wider OHS profession. Specialist authors were invited to contribute chapters, which were then subjected to peer review and editing. It is anticipated that the resultant OHS Body of Knowledge will in future be regularly amended and updated as people use it and as the evidence base expands.

Conceptual structure

The OHS Body of Knowledge takes a ‘conceptual’ approach. As concepts are abstract, the OHS professional needs to organise the concepts into a framework in order to solve a problem. The overall framework used to structure the OHS Body of Knowledge is that:

> **Work** impacts on the **safety** and **health** of humans who work in **organisations**. Organisations are influenced by the **socio-political context**. Organisations may be considered a **system** which may contain **hazards** which must be under control to minimise **risk**. This can be achieved by understanding **models causation** for safety and for health which will result in improvement in the safety and health of people at work. The OHS professional applies **professional practice** to influence the organisation to being about this improvement.

This can be represented as:



Audience

The OHS Body of Knowledge provides a basis for accreditation of OHS professional education programs and certification of individual OHS professionals. It provides guidance for OHS educators in course development, and for OHS professionals and professional bodies in developing continuing professional development activities. Also, OHS regulators, employers and recruiters may find it useful for benchmarking OHS professional practice.

Application

Importantly, the OHS Body of Knowledge is neither a textbook nor a curriculum; rather it describes the key concepts, core theories and related evidence that should be shared by Australian generalist OHS professionals. This knowledge will be gained through a combination of education and experience.

Accessing and using the OHS Body of Knowledge for generalist OHS professionals

The OHS Body of Knowledge is published electronically. Each chapter can be downloaded separately. However users are advised to read the Introduction, which provides background to the information in individual chapters. They should also note the copyright requirements and the disclaimer before using or acting on the information.

Biological Hazards

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Core Body of Knowledge for the Generalist OHS Professional

Biological Hazards

Abstract

Biological hazards (biohazards) present the Occupational Health and Safety (OHS) professional with complex challenges. Many and varied biohazards may result from workplace exposure to organisms, or substances produced by organisms, that threaten human health. Although workers in health and community care, and agricultural and fishing occupations are at particular risk of exposure to hazardous biological agents, all workplaces harbour the potential for various forms of biohazard exposure, including person-to-person transmission of infectious disease. While prevention and management of biohazards is often the responsibility of occupational or public health personnel, the generalist OHS professional should have an understanding of biohazards and their mechanisms of action, and the importance of vigilance and standard control measures. Armed with this knowledge, the generalist OHS professional can work with occupational health personnel to develop and implement biohazard prevention and mitigation strategies.

Keywords:
biological hazard, biohazard, infection, vector

Contents

1. Introduction

Biological hazards (biohazards) present the Occupational Health and Safety (OHS) professional with complex challenges due to the large number and variety of potential agents and their effects. Many biohazards are capable of coming from, or affecting, the community outside the workplace, due to the potential for infectious disease factors to be transmitted from person to person. Environmental biohazards may be frequently encountered as occupational hazards, especially for outdoor workers. In a review of occupational biohazards, Dutkiewicz, Jabloński and Olenchock (1988, p. 605) observed:

> There are at least 193 important biological agents that show infectious, allergenic, toxic, or carcinogenic activities in the working population. These agents are viruses, bacteria, fungi, plant substances, invertebrate animals (mostly arthropods), and substances derived from vertebrate animals. At least 20 large occupational groups are exposed to these biohazards. The risk is greatest among health care and laboratory workers who are threatened by human pathogens and among agricultural workers who are at risk from dust-borne biological allergens and toxins and by parasitic worms in warm climates. There is growing evidence that biohazards are also important risk factors for many other professions, including woodworkers, workers of textile plants, sewage and compost workers, miners and renovators.

Because the variety of biohazards is so great, and the number of occupations that may be affected by biohazards is very large, it is not intended for this chapter to provide a comprehensive account of all biohazards that may be encountered in the workplace, or for specific occupations. Rather, the intention is to heighten awareness of the need for constant vigilance, and to provide some guidance as to the types of biohazards that can exist in Australian workplaces. Disturbingly, a recent study of biohazard exposure in Australian workplaces revealed a "general lack of information on biological risks" and concluded that "effort should be made to raise the level of knowledge about biological hazards" (de Crespigny, 2011). Consequently, this chapter is an important one for OHS professionals. Definitions for key terms are provided in Appendix 1.

2 Extent of the problem

The recently published *National Hazard Exposure Worker Surveillance* (NHEWS) report (de Crespigny, 2011, p. 1) noted that Australian workers' compensation statistics indicate that each year approximately 1300 workers are compensated for diseases attributed to animal, human or biological factors. However, the report queried the accuracy of this estimate as an indication of the extent of the impact of biohazards as, "amongst other things, many workers in the Agriculture forestry and fishing industry are not covered by workers' compensation schemes" (de Crespigny, 2011, p. 1).

The NHEWS study, undertaken to gain a more accurate picture of the impact of biological hazards, found that:

- 19% of workers surveyed reported they worked in places where there were biological materials. These workers were considered exposed to biological hazards.

- 75% of exposed workers were exposed to human bodily matter.
- 30% of exposed workers were exposed to live animals or animal products.
- Between two and four percent of exposed workers were exposed to laboratory cultures and biohazard waste, sewerage or rubbish
- Workers in the Health and community services and the Agriculture, forestry and fishing industries were most likely to report exposure to biological hazards (de Crespigny, 2011, p. 1).

The main types of biological materials that workers were potentially exposed to in Australian workplaces were:

- human bodily matter (blood, tissues, vomit, urine, faeces, saliva and breast milk etc.) – 75% of exposed workers;
- animal products (meat, offal, skins, bones, blood, milk and eggs) – 18% of exposed workers
- live animals (mammals, birds, fish, invertebrates and their urine or faeces) –12% of exposed workers
- biohazard waste, sewerage and rubbish – 3.4% of exposed workers, and
- laboratory cultures – 2.8% of exposed workers (de Crespigny, 2011, p. 2).

3 Understanding biohazards

3.1 The nature of biohazards

The UK Health and Safety Commission (as cited in Aw & Harrison, 1998) and the US Center for Disease Control and Prevention (CDC, 2009) define biological hazards as "infectious agents or products of such agents that cause human disease," and biological agents as "any microorganism, cell culture, or human endoparasite, including any which have been genetically modified, which may cause any infection, allergy toxicity, or otherwise create a hazard to human health." However, biological agents capable of creating a hazard to human health are not limited to microorganisms, plants, fungi or invertebrate animals as, depending on the nature of the occupation, workers also may be at risk of harm from vertebrates. Additionally, biohazards encompass biological substances including medical waste, or samples of body tissues or fluids from a biological source, which may contain microorganisms, viruses or toxins that can adversely affect human health. Biohazards classified by the United Nations as Dangerous Goods for transportation by UN number include all substances infectious to humans and animals, and medical waste (UNECE, 2001). The available evidence indicates that biological hazards may exist in almost any occupation.

Biohazards may exert an effect on a human, either by direct contact by the causative agent (e.g. a bite from a venomous snake) or transmission of zoonotic agents through contact with animals, animal matter or animal products (e.g. brucellosis). Some diseases can be transmitted directly or indirectly (e.g. toxoplasmosis). Some parasitic diseases are zoonotic (e.g. hydatid disease). However, diseases such as malaria (where the protozoan parasite is transmitted by *Anopheles* spp. mosquito bites), leishmaniasis (where the protozoan parasite is transmitted by the bite of phlebotomine sandflies) [1]and dengue (where the virus is transmitted by *Aedes* spp. mosquitoes) are technically speaking not zoonotic, despite being transmitted by insects or intermediate host vector, as they depend on the human host for part of their lifecycle. *Aedes* spp. prefer to feed from humans rather than other vertebrates, and live in close proximity to humans. Leishmaniasis, dengue and malaria also may be transmitted through infected blood products and through organ donation. Such diseases are referred to as anthroponoses.

Unless generalist OHS professionals work in an industry or geographical area where biohazards are a recognised issue, their involvement in identifying and assessing the associated risk may be limited; however, they still require a basic understanding of biohazards and their mechanisms of action. Thus this section addresses biohazard classification, mode of transmission, and virulence and infectivity.

3.2 Classification by type of agent

Individual biohazards may be classified in several ways. For example, the fungal disease coccidiomycosis may be classified by type of organism (mould/fungus), mode of transmission (inhalation of windborne arthrospores from soil), susceptible occupational grouping, method of environmental contact or location (areas of endemicity). One method of classification – type of agent is considered in this section.

While some definitions of biohazards are limited to infectious agents, as stated in section 1.1, the approach taken in this chapter is to include biological agents that may cause infection, allergy, toxicity or otherwise create a hazard to human health. Thus the types of agents considered are infectious agents, plant and plant products, and animal and animal products.

3.2.1 Infectious agents

As observed by Aw and Harrison (1998), “Infectious agents are capable of causing disease and can be classified according to size, properties, and morphological characteristics (e.g. viruses, rickettsia, bacteria, fungi, protozoa, and helminths. Appendix 2 provides a summary of types of infectious agents, including examples of associated diseases and relevant control measures.

3.2.2 Plant and plant products

Contact with certain plants, plant materials or fungi may cause non-infectious poisoning, stinging, allergic reactions (e.g. anaphylaxis, mushroom workers’ lung, and bagassosis in the

[1] While Australia has been thought to be free of leishmaniasis, there is recent evidence that indicates that this may not be the case (Dougall et al., 2011).

sugar cane industry), and irritant-contact or allergic-contact dermatitis. Fungi may be responsible for a variety of diseases such as ringworm or tinea, which may affect, for example, athletes, military personnel in barracks, and staff of gymnasiums, veterinary practices and laundries. Fungi such as moulds and yeasts can cause allergies that result in hypersensitivity or asthma among farm workers and food process workers. Aspergillus (a fungi) can cause aspergillosis among farm workers, handlers of veterinary waste, and workers in recycling and composting facilities. Absorption of toxic plant components may occur; for example, green tobacco sickness in tobacco plant workers.[2]

3.2.3 Animals and animal products

Zoonoses are infectious diseases that can be vector-borne or transmitted directly from wild or domestic animals (e.g. babesiosis, Lyme disease, plague, tularaemia,[3] West Nile virus[4] and Ross River virus). Other forms of transmission of zoonoses include those due to exposure to bacteria (e.g. leptospirosis, brucellosis and anthrax) or viruses (e.g. bat lyssavirus). Also, a wide range of workers, especially outdoor workers, are potentially at risk of envenomation by venomous terrestrial animals (e.g. snakes, spiders and scorpions) or aquatic animals (e.g. stinging fish, jellyfish, stingrays and sea snakes). Occupational groups that may be affected include farm workers, military personnel, forestry workers, divers, fishers and zoo workers. (For detailed information on venomous animals, see, for example, Adler, 2011; Auerbach & Norris, 2005; Dart, 2004; Newman-Martin, 2007; Warrell & Anderson, 2002; Warrell, Cox & Firth, 2010; White, 2011.)

3.3 Mode of transmission

Knowledge of mode of biohazard transmission – another way of categorising biological hazards in the workplace – is vital to breaking the infection cycle. While some diseases can be transmitted in a variety of ways (e.g. hepatitis A can be transmitted through food, as a result of poor hygiene or by occupational exposure through working in sewers), other diseases have very specific modes of transmission. Transmission of infection may be either:

- Direct, which requires physical contact between an infected person and a susceptible person
- Indirect, where the susceptible person is infected by contact with a contaminated surface, food-borne, droplet/airborne transmission or by vectors.

[2] For more information, see Frohne & Pfänder, 2004.

[3] Although tularaemia has not been reported in Australia, it is widespread in Europe, Asia and North America and is a notifiable disease in this country NAHIS, 2010).

[4] While a subtype of the mosquito-borne West Nile virus (Kunjin virus) occurs in Australia, researchers have speculated about the potential for West Nile virus, particularly the US strain, to spread to Australia (see, for example, MacKenzie, Smith & Hall, 2003).

3.3.1 Direct human-to-human transmission

Workers with a relatively high risk of direct human-to-human infection transmission are those exposed to blood or bodily secretions (e.g. medical and nursing staff, emergency workers, prison workers and sex workers). An example is needle stick injury which may cause percutaneous inoculation of blood-borne pathogens, such as HIV or hepatitis B.

3.3.2 Indirect transmission

Surface contact

Some infectious agents can survive on surfaces for extended periods of time. For example infectious rhinovirus, responsible for about half of all colds has been demonstrated as transmittable from surfaces for as long as 24 hours after surface contamination, highlighting the importance of surface disinfection (Winther, McCue, Ashe, Rubino & Hendley, 2011).

Food-borne/water-borne toxins

Food-borne infections contracted through occupational exposure can affect, for example, food service workers, medical and hospital personnel, prison officers, military personnel and child-care workers. These infections are usually the result of faecal contamination of food through poor food handling, poor hygiene, contaminated water or contamination of the food chain, or by poor food storage allowing the multiplication of bacteria and the production of toxins.

While occupational exposure to water-borne infections may be low the potential for infection from intentional or unintentional ingestion of water should be identified. One example is the infection of swimming pool water with *Cryptosporidium parvum*, a parasite excreted in the faeces of infected humans, cattle, and other mammals causing diarrhoea. The infectious form of the parasite (the 'ocyst') is too small to be seen without a microscope and is resistant to common forms of disinfection (Victorian Government Health Information, 2010).

Droplet/airborne contamination

Droplets or aerosol infection may occur from human or environmental sources. Mucus secretions emitted when a person coughs or sneezes – are generally more contagious than infectious agents spread by direct contact (University of Arizona, 2009). Droplets can travel up to a metre in the air and can enter the respiratory tract. Diseases such as tuberculosis and measles are transmitted in this manner.

Droplet infection from environmental sources such as water or soil sources may cause respiratory diseases such a legionella. Water-based cooling towers as part of air conditioning systems are known to be source of *Legionella* bacteria from which the bacteria can be dispersed through aerosolised drift or may enter the air conditioning systems. (CCOHS, 2006). Occupational gardeners may be exposed to a species of *Legionella, L. longbeachae* which has been found to cause clinical conditions indistinguishable from other *Legionella* species in people who are regular gardeners with a common feature of their gardens being the presence of ferneries with hanging baskets (O'Connor et al., 2007).

Vector-borne diseases

A vector is an organism that carries disease-causing microorganisms from one host to another. As vectors are mobile, they can increase the range of the disease; removing the vector, either by elimination or protecting the person from the vector, prevents infection. Arthropod vectors (e.g. mosquitoes and sandflies) can transmit diseases, including parasitic diseases (e.g. malaria), alphaviruses (e.g. Ross River virus), flaviviruses (e.g. dengue fever) and bunyaviruses (e.g. Rift Valley fever virus). Susceptibility to such diseases depends on a variety of factors, including endemicity, location, specific arthropod species, populations of host species and protective measures. Some animals are capable of causing or transmitting more than one disease. For example, while the bite of an ixodid tick may result in tick paralysis due to the effect of the tick's venom, some ixodid ticks are capable of transmitting vector-borne diseases including rickettsial (e.g. Queensland tick typhus), viral (e.g. Crimean-Congo haemorrhagic fever), bacterial (e.g. Lyme disease) and protozoan (e.g. babesiosis) diseases. (For detailed information, see, for example, Breslow, 2002; Cook & Zumla, 2003.)

3.4 Virulence and infectivity

Risks due to infectious biohazards depend not only on the nature of the agent, but also on its virulence (which encompasses the ability of the organism to survive outside the human body), its infectivity, and the resistance of the body. Greater virulence does not necessarily mean greater infectivity. For example, although Hendra virus is a potentially life-threatening hazard for people who work with horses, the chances of contracting this virus are far less than the chances of contracting a range of other, less-virulent infections within the workplace, such as salmonellosis, cryptosporidiosis and leptospirosis. Some microorganisms, such as tetanus spores, can survive in the soil for long periods, and some viruses can survive outside the human body for hours (e.g. hepatitis B and HIV). Furthermore, while only a small dose of some biohazards (e.g. the highly infectious Marburg virus) can cause infection, a much larger dose of the causative agent of some others (e.g. leprosy) is required to cause infection. (For detailed information on infectious diseases, see, for example, AFOEM, 1999; FDA, 2009.)

4 Occupational factors affecting impact of biohazards

The OHS professional should be aware of biological hazards likely to affect workers in specific workplaces. These will vary according to the type of occupation, the location, the season, the nature of the work, species known to occur in the region and the environment. Research and liaison with specialist advisors may be required to document the type and extent of the biohazards relevant to a workplace, and to prepare a risk assessment and mitigation plan based on that assessment. The impact of occupation type and the environment on the risk of biohazard exposure is discussed below.

4.1 Type of occupation

Occupational contact with biohazards may be:

- *intrinsic to the specific occupation*, e.g. construction and maintenance workers at sewage treatment or wastewater plants are at increased risk of exposure to bacterial infection (see, for example, Garvey, 2005)
- *incidental to work* (i.e. not an integral part of the work process), e.g. upper respiratory infections, infections due to contaminated water, or through food consumed at the workplace (see, for example, OSHA, 2009)
- *contracted during the course of work* especially when living in, or travelling to or from, areas where there is an increased incidence of infectious or other diseases (see Mangili & Gendreau, 2005)
- *not occupationally specific*, e.g. Legionella bacteria, responsible for Legionnaires' disease, is widely distributed in water and soil, and can, therefore, affect workers in a wide variety of occupations, such as water-system maintenance workers and air-conditioned office workers (see, for example, Comcare, 2008).

It has been demonstrated that workers in the Health and Community Services, and Agriculture Forestry and Fishing industries face a relatively high risk of exposure to biological hazards (de Crespigny, 2011). The potential for exposure to some work-intrinsic hazards are briefly considered below. However, generalist OHS professionals in all industries should ensure that knowledge of the nature and source of biohazards informs their hazard identification activities.

4.1.1 Outdoor workers

Outdoor workers, such as wildlife rangers, forestry workers, gardeners, farm workers, construction workers, archaeologists and military personnel, may be exposed to a range of biohazards specific to their occupation and the environment in which they work, including local species of microorganisms, animals, plants and fungi, and the nature of the work. Although there may be some common features (e.g. exposure to venomous snakes and spiders), generally the nature of these biohazard exposures will vary from location to location. Forestry workers may face a variety of environmental/occupational hazards, including stinging plants and insect vectors of disease, which will vary from location to location depending upon the endemic species.

4.1.2 People who work with animals

People who work directly with, or are exposed to, animals or animal products are at risk of a wide range of possible biohazards. These occupations include abattoir workers, animal handlers, animal pound workers, aviary workers, customs officers, meat workers, police officers, farmers, graziers, customs inspectors, laboratory workers, pet shop and quarantine kennel personnel, ranchers, shepherds, stockmen, veterinarians, wildlife rangers, wool sorters and zoo personnel. Biohazards for these occupations include bacterial diseases (e.g. anthrax), viral diseases (e.g. orf), Newcastle disease in poultry workers, rickettsia (e.g. *Coxiella burnetti*, Q fever), diseases transmitted by bites (e.g. lyssavirus), prion diseases (e.g. Creutzfeldt-Jakob, mad cow disease) and ectoparasitic diseases (e.g. scabies). Abattoir workers, veterinarians, stock handlers and farm workers may be at risk of a range of zoonoses, while some farm workers also may be potentially at risk from various animal and insect bites. Some of these infections may be serious or even potentially life-threatening; for example, veterinarians and horse handlers may be at risk of Hendra virus from horses, although the natural host is pteropid fruit bats. These bats are also the natural host of Nipah virus, which can be transmitted by animal-human contact and also human-human contact, and may also cause severe illness in both humans and domestic animals [5](see AWHN, 2011).

4.1.3 Workers exposed to human blood and bodily fluids

Occupational groups that may be at increased exposure to human blood and body fluids include medical and hospital personnel, pathology and other laboratory workers, emergency workers, autopsy and mortuary workers, prison workers, professional sportspersons and sex workers. Sewerage workers and plumbers should also be considered in this category as they may be at risk from a range of pathogenic microorganisms carried in human faeces.[6]

4.1.4 Exposure to biohazards due to particular work environments

There may be an increased incidence of infectious or other diseases that can be contracted by occupational groups working within a specific locality or type of environment. The type of biohazard may be specific to the particular work environment; for example, fishing trawler crew, professional divers, marine biologists and lifeguards might be at risk from physical injury from shark bites, as well as fish or stingray stings, sea snake bites or venomous jellyfish stings, or infection of cuts and grazes by marine pathogens. Roofers, tilers, insulation layers and electricians who work in roof spaces may be indirectly exposed to animals or animal products that may result in infection (e.g. respiratory infections such as psittacosis). Sewer and municipal workers, plumbers, miners and forestry workers are likely to be at risk from infected urine from rodents and other animals.

[5] While not found in Australia Nipah virus is found in Malaysia and Singapore.

[6] For more information refer to Manitoba Health, (2009) http://safemanitoba.com/uploads/bulletins/bltn161july09.pdf

4.2 Location and environment

Location is an obvious predisposing factor for certain vector-borne diseases (e.g. rabies and malaria) that are endemic to particular regions, and for dangerous animals (e.g. crocodiles and venomous snakes). The diversity of biohazard distribution is related to species distribution and the environmental and social characteristics of specific geographic locations. For example, the parasitic disease schistosomiasis, caused by exposure to liver fluke in infested water, is associated with freshwater rice farming and fishing environments. Furthermore, exposure to some types of biohazards may have significantly worse outcomes in some parts of the world than in others. For example, although there is the potential for agricultural workers in Australia to be bitten by a highly venomous elapid snake, the outcome is unlikely to be death or permanent disability (as is often the case for rural workers in developing countries) because of the availability of high-quality specific antivenoms, modern hospitals, highly trained medical personnel, generally well-resourced medical and laboratory facilities, and efficient transport, road systems and communications. Australian medical workers will have a much different hazard profile if they travel to a disaster area in a developing country.

5 Legislation and guidance

The general duty under s 19 of the national model *Work Health and Safety Act* (WHSA) requires a person conducting a business or undertaking (PCBU) to ensure, so far as is reasonably practicable, the health and safety of workers and others who may be put at risk by the conduct of the business or undertaking (Safe Work Australia, 2011).[7] This duty applies to all hazards including biohazards. The model WHS regulations are silent on biohazard control and de Crespigny (2011) has identified a dearth of Australian policy interventions relevant to biological hazards. However the following codes of practice and guidelines are available:

- *National Code of Practice for the Control of Work-related Exposure to Hepatitis and HIV (Blood-borne) Viruses* (NOHSC, 2003)
- AS/NZS 2243.3 *Safety in Laboratories: Microbiological Safety and Containment* (SA/SNZ, 2010)
- Health care industry standards, including AS/NZS 3816:1998 *Management of Clinical and Related Wastes* (SA/SNZ, 1998)
- *Diseases Acquired from Animals* (NOHSC, 1989)
- *Australian Department of Health and Ageing Infection Control Guidelines* (DHA, 2010)
- Jurisdiction-specific guidelines, including Guidelines for Assessing the Risk of Exposure to Biological Contaminants in the Workplace (WorkCover NSW, 2003).

[7] *See BoK* Socio-political Context: OHS Law and Regulation in Australia

In the US, the Centers for Disease Control and Prevention (CDC), and the Department of Health and Human Services periodically publish several national publications on Biosafety, including *Biosafety in Microbiological and Biomedical Laboratories (BMBL)* and its associated appendix, *Primary Containment for Biohazards: Selection, Installation and Use of Biosafety Cabinets* (CDC, 2009). While these documents are US national guidelines they have relevance in promoting the safety and health of workers in biological and medical laboratories in Australia.

6 Control of biological hazards

The NHEWS study found that of five biohazard-control-measure categories – protective clothing; engineering; warnings; waste disposal; and training – Australian workplaces were most likely to provide workers exposed to biohazards with protective clothing and least likely to provide training. Also, “workers exposed to living animals were least likely to be provided with any control measures” (de Crespigny, 2011). Of the two industries with the highest likelihood of exposure to biohazards, Health and Community Services had a higher level of control provision than Agriculture, Forestry and Fishing. Control provisions for biohazards were revealed to be relatively “high for workers exposed to human bodily matter, laboratory cultures and biohazard waste, sewerage and rubbish but relatively low for workers exposed to animals and animal products” (de Crespigny, 2011). The study’s recommendations included relevant policy development and improvement of training in the safe handling of biohazards.

Biohazards should be addressed by an analytical and preventive approach. The complexity of the transmission and mechanism of action of biohazards means that the biohazard needs to be considered in the context of the workplace, the work and the worker. The nature of the controls will depend on the type of agent: its mode of transmission, virulence and infectivity; the nature of the task and the methods of exposure; the number of people potentially exposed and their susceptibility to the biohazard. This can be represented as in Figure 1 which highlights that intervention for control can occur at different points in the triangle,

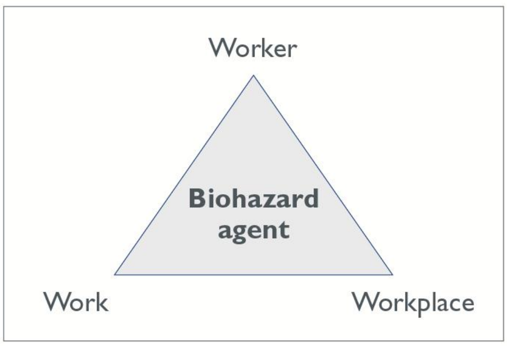

Figure 1: Points for intervention for control of biohazards

As with other hazards the priority for control is elimination of the biohazard. This may be by eliminating the source of the biohazard (e.g. design of air conditioners to eliminate water as a reservoir for *Legionnella*); eliminating the biohazard agent (e.g. use of pesticides to eliminate pest species); eliminating the vector (e.g. elimination of vector species such as birds who act as vector for psittacosis). Where elimination is not possible then the hierarchy of control with engineering, administrative and PPE controls can be applied. Table 1 provides an example of a hierarchy of control for biohazards developed for the health industry.

Table 1: Hierarchy of control as applied to Biohazards (modified from Work Safe Alberta. (2009)

Engineering/Bioengineering controls	• Vaccines • Prophylactic anti-viral medications • Ventilation systems • Engineered safe needle devices • Automated equipment
Administrative controls	• Policies and procedures • Routine practices such 'universal infection control procedures' and other safe work procedures • Immunisation programs • Training • Quarantine and isolation procedures
Personal Protective Equipment (PPE)	• Gloves • Protective clothing • Eye protection • Face protection • Respiratory protection

7 Implications for OHS practice

Recent Australian research has highlighted the general inadequacy of relevant policy, procedures and training, and indicated that "poor understanding of biological hazards leads to poor risk assessments in workplaces" (de Crespigny, 2011, p. 21). While the management of biohazards is often the domain of the occupational health physician, the generalist OHS professional should have a good understanding of biohazards and their control measures, and be cognisant of the necessity for ongoing vigilance.

The generalist OHS professional needs to ensure that the appropriate data gathering and research has been conducted to enable identification of biohazard-exposure risks in their particular workplace. This may require liaison with an occupational hygienist who may undertake assessments to clarify the nature of the biohazard and to identify the presence of any other hazards that may have synergistic or confounding effects.

The resultant information provides a foundation for liaising with the medical practitioner or occupational health physician to conduct hazard identification and characterisation and risk assessments. The development and implementation of appropriate strategies for prevention and harm minimisation may require a team approach with an occupational hygienist providing advice on prevention and monitoring, health advice provided by a medical practitioner, and the generalist OHS professional ensuring the integration of the prevention, mitigation and monitoring strategies into the OHS management system.

8 Summary

Biohazards include infective agents such as viruses, bacteria, protozoa and other microorganisms as well as animals and animal products, and plants and plant products that can cause infections, allergy, toxicity or otherwise create a hazard to human health. While potential risk is highly variable, biohazards should be considered in the hazard profile for workplaces. Outdoor workers, those who work with animals, healthcare workers and others exposed to human body fluids are likely to be at higher risk of exposure to biohazards than workers in other occupations. Control of biohazards requires systematic, analytical application of a hierarchy of control that takes account of the nature of biohazard agent, the workplace, the nature of the work and the workers. The generalist OHS professional has an important role in the management of biohazards by working with healthcare and occupational health personnel to ensure that biohazards are systematically addressed in OHS management processes.

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Appendix 1: Definitions

Anthroponoses: Vector-borne diseases (such as malaria, dengue and some types of filariasis) resulting from a parasite that normally infects only humans and one or more anthropophagic vectors.

Anthropophagic vectors: Vectors which bite (feed from) humans.

Arthrospores: Spore-like thick walled vegetative resting cell from fungi or algae.

Biological hazards, or 'biohazards': Hazards of biological origin, whether from living organisms, or non-living biological material, which may create a hazard to human health.

Host: A species that develops a level of infection with a parasite that can be accessed and transmitted further by a vector.

Infectivity: The ability of a pathogen to spread rapidly from one host to another.

Microorganisms: Microscopic organisms, including bacteria, rickettsia, viruses, prions, protozoa and fungi. Some sources exclude viruses as they are not cellular and are unable to replicate without a host cell, and prions as they are disease-causing aberrant proteins that are not cellular and contain no genetic material.

Parasites: Bacteria, viruses, protozoa, helminths or arthropods which are dependent upon a host for survival.

Pathogen: An agent that causes infection or disease, particularly a microorganism.

Pathogenicity: The capacity of a pathogen to produce disease

Vector: A host species that acquires the parasite from an infected host and transmits it to another host.

Vector-borne disease: A disease caused by a pathogenic agent which is transmitted by arthropods (e.g. mosquitoes, sandflies or ticks).

Venom: A toxic substance, produced by an animal in a specialised venom gland, and applied or injected into another animal by means of a venom apparatus (usually a bite or sting) for defence or acquisition or digestion of prey.

Virulence: Relative pathogenicity, that is, a quantitative measure of the severity of the disease that a group or species of microorganism is capable of causing.

Zoonoses: Diseases (including parasites) which can be passed from animals to humans, transmitted directly or via an intermediate host vector, but where the human host is not an essential part of the lifecycle.

Appendix 2: Summary of infective agents

Agent/Vector	Example	Disease	Effect	Source	Commonly affected worker populations	Controls and prevention
Bacteria	*Bacillus anthracis*	Anthrax	Multisystem disease; high mortality rate	Hoofed animals	Agricultural workers, vets	Avoidance; prophylactic antibiotics after exposure; vaccination of limited efficacy
	Bordetella pertussis	Whooping cough	Cough for 3 months	Infected humans	Close contacts in any environment	Vaccination effective
	Brucella suis	Brucellosis	Post-infectious lethargy for up to 12 months	Pigs	Abattoir workers, pig farmers, feral-pig hunters	PPE, hygiene precautions
	Campylobacter jejuni	Campylobacter-iosis	Acute colitis, diarrhoea, dehydration; mortality in infirm or elderly	Untreated water, dogs and cats	Restaurant workers if hygiene poor; workers in nursing homes, sheltered accommodation, schools	Hygiene precautions
	Coxiella burnetii	Q fever	Flu-like symptoms, endocarditis, hepatitis	Cattle, sheep, goats, dogs, cats	Abattoir and farm workers	Avoidance of abattoirs, birthing animals; vaccination effective; PPE
	Chlamydia psittaci	Psittacosis	Severe pneumonia; 15% mortality if untreated	Birds	Zoo and pet-shop employees; poultry farmers	Preventative husbandry; isolation of infected birds
	Leptospira spp.	Leptospirosis	Flu-like symptoms, nephritis, liver failure; kidney failure	Rat urine	Waste water, treatment plant and sewerage workers	Hygiene precautions; prophylactic antibiotics in areas of high risk
	Salmonella spp.	Salmonellosis	Vomiting, diarrhea, dehydration	Faecal contamination in food or from infected human	Waste water treatment plant, sewerage, and food industry workers	Hygiene precautions; avoid raw met and eggs

Agent/Vector	Example	Disease	Effect	Source	Commonly affected worker populations	Controls and prevention
	Salmonella Typhi	Typhoid fever	Systemic illness; can be severe;	Food or water contaminated by someone with typhoid; food workers	Overseas travellers	Hygiene precautions; avoid risky food (including raw meat) and drink; vaccination
	Vibrio cholerae	Cholera	Severe gastroenteritis, dehydration leading to high mortality	Contaminated water or food	People in third world countries	Hygiene precautions; purified water; vaccine of limited efficacy
	Legionella spp.	Legionnaires' disease	Fever, pneumonia	Cooling towers, hot water systems, air conditioning systems	Office workers; sewage plant workers	Regular maintenance and surveillance of water systems in buildings
Viruses	Hepatitis A	Hepatitis A	Fever, nausea, jaundice; liver damage	Faecal contamination	Waste water treatment plant, sewerage and sex workers; overseas workers; overseas travellers	Good hygiene and sanitation; vaccination effective
	Hepatitis B	Hepatitis B	Inflamed liver; potential for liver failure, liver cancer	Infected blood or body fluids	Hospital, healthcare, laboratory, police, paramedic, sex industry workers	Contact avoidance; vaccination; administrative controls; PPE
	Henipavirus	Hendra virus	Encephalitis; high mortality	Infected fruit bats and horses	Vets, horse workers	Avoidance; PPE
	Human immunodeficiency virus (HIV)	Acquired immunodeficiency syndrome (AIDS)	Failure of immune system	Infected blood or body fluids	Hospital, healthcare, laboratory, police, paramedics, sex industry workers	Contact avoidance; administrative controls; PPE
	Rubella	German measles	Teratogenic for developing foetuses	Person to person via respiratory		Vaccination effective

Agent/Vector	Example	Disease	Effect	Source	Commonly affected worker populations	Controls and prevention
				route		
	Rubulavirus	Mumps	Inflammation of salivary glands; general malaise; potential sterility in males	Person to person via respiratory route		Immunisation effective
	Parapoxvirus	Orf	Skin lesions; potentially erythema multiforme	Direct skin contact from infected sheep or goat	Agricultural workers, abattoir workers, vets	Avoid contact with infected animals; PPE
	Rabies	Rabies	Encephalitis; high mortality rate once symptomatic	Infected animals, most often dogs	Overseas travellers	Avoidance of wild animals; vaccination and gammaglobulin effective
	Ross River virus	Ross River fever	Flu-like symptoms, arthralgia; potential post-viral syndrome	Direct transmission from mosquito carrying the virus	Outdoor workers, particularly close to water in Australian tropics	Avoidance of mosquito bites
Protozoa	*Giardia lamblia/intestinalis*	Giardiasis	Acute gastroenteritis; dehydration	Untreated drinking water; person-to-person transmission	Overseas travelers; childcare workers	Access to purified water; hygiene precautions
Helminths	*Ascaris lumbricoides* (round worm)	Ascariasis	Often minimal; sometimes leads to malnutrition	Soil or food infected by human faeces		Good hygiene and sanitation
Rickettsia	*Rickettsia australis*	Queensland tick typhus (spotted fever)	Flu-like symptoms, rash; potential for relapse	*Ixodes holocyclus* (paralysis tick)	Outdoor workers	Use of repellent in tick-infested areas; examination of body crevices for ticks

Agent/Vector	Example	Disease	Effect	Source	Commonly affected worker populations	Controls and prevention
Prions	Bovine spongiform encephalopathy (BSE) (mad cow disease)	Creutzfeldt-Jakob disease in humans	Incurable degenerative neurological disorder	Infected cattle	Eaters of infected meat; particularly European residents and travellers 1980–1996	
Insects	*Sarcoptes scabiei* (mite)	Scabies	Itchy rash	Person-to-person skin contact	Workers in crowded areas, e.g. schools, nursing homes	Hygiene precautions; avoid sharing towels, linen, etc.; exclude affected children from school