Chemical and Biological Hazards

In the spring of 2015, the Supreme Court of Canada agreed to review a decision made by the Alberta courts in a lawsuit brought forward by Jessica Ernst against Alberta’s energy regulator. Ernst filed a suit against the province and Calgary-based energy company Encana over the contamination of her groundwater by hydraulic fracturing.

Hydraulic fracturing (or ‘fracking’) is a petroleum-extraction process wherein workers drill deep holes and then inject fluid into the ground under high pressure to fracture rock layers and thereby recover otherwise inaccessible petroleum. The occupational and environmental risks associated with fracking are significant and complicated. Each fracking effort can require up to 8 million gallons of water and 400,000 gallons of fracking chemicals. Wells can be fracked up to 20 times. Fracking fluid contains water, sand, and various chemicals. When researchers examined the 632 chemicals known to be used in fracking, they found that 75% of them negatively affect the skin and sensory organs as well as the respiratory and gastrointestinal systems. At least 40% are believed to negatively affect the brain and/or nervous system, immune system, cardiovascular system, and kidneys. And 25% are believed to cause cancer and other mutations.

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Learning Objectives

After reading this chapter, you will be able to:

- Define chemical hazards and explain how they affect workers.
- Interpret toxicity data to prioritize chemical hazards.
- Explain how occupational exposure limits were set and assess the validity of these limits.
- Define biological hazards and explain how they affect workers.
- Assess the positive and negative impact of science on worker safety.
In the spring of 2015, the Supreme Court of Canada agreed to review a decision made by the Alberta courts in a lawsuit brought forward by Jessica Ernst against Alberta’s energy regulator. Ernst filed a suit against the province and Calgary-based energy company Encana over the contamination of her groundwater by hydraulic fracturing.\(^1\) Hydraulic fracturing (or ‘fracking’) is a petroleum-extraction process wherein workers drill deep holes and then inject fluid into the ground under high pressure to fracture rock layers and thereby recover otherwise inaccessible petroleum. The occupational and environmental risks associated with fracking are significant and complicated.

Each fracking effort can require up to 8 million gallons of water and 400,000 gallons of fracking chemicals. Wells can be fracked up to 20 times. Fracking fluid contains water, sand, and various chemicals. When researchers examined the 632 chemicals known to be used in fracking, they found that 75% of them negatively affect the skin and sensory organs as well as the respiratory and gastrointestinal systems. At least 40% are believed to negatively affect the brain and/or nervous system, immune system, cardiovascular system, and kidneys. And 25% are believed to cause cancer and other mutations.\(^2\)

Workers can be exposed to these hazards while fracking. Yet the chemical hazards of fracking don’t just endanger workers. Like most chemical hazards,
they also endanger the general public. For example, fracking chemicals can enter the local water table (which often serves as the source of local drinking water). Leakage can occur along the fissures caused by the fracking, from the well casings (which often pass through local water tables), and from inadequate storage of fracking wastewater. Ernst, for example, alleges that fracking north-east of Calgary has resulted in so much methane entering her well that she can now light her drinking water on fire.

Fracking also causes earthquakes and releases airborne chemical hazards. Drilling the well site alone can release “benzene, toluene, xylene and ethyl benzene (BTEX), particulate matter and dust, ground level ozone, or smog, nitrogen oxides, carbon monoxide, formaldehyde and metals contained in diesel fuel combustion— with exposure to these pollutants known to cause short-term illness, cancer, organ damage, nervous system disorders and birth defects or even death.” Workers on site and individuals passing or living nearby are affected by these chemical hazards.

Fracking is but one example of the growing threat that chemical hazards pose to the health of workers. It also demonstrates that there is no clear division between a workplace hazard and an environmental hazard. There is no comprehensive list of chemical substances that workers may be exposed to in the workplace, but the number is suspected to be at least 80,000. As we will see below, there is toxicological data available for about 1% of these chemicals, and the data that is available is highly suspect. The essentially unregulated nature of chemical exposures in the workplace is an important argument for adopting the precautionary principle in occupational health and safety.

CHEMICAL HAZARDS

Chemicals are everywhere in the modern workplace, from printer toner to engine exhaust to sink cleaners. While most chemical exposures do not cause ill effects, some certainly do. As we saw in Chapter 3, chemical hazards cause harm to human tissue or interfere with normal physiological functioning when they enter our bodies. Some chemicals irritate our tissue while others poison our systems or organs. Chemicals can asphyxiate us or negatively affect the functioning of our central nervous systems. Chemicals can also cause our immune systems to overreact, change our DNA, cause cancer, or damage a fetus.
There are four *routes of entry* by which chemicals can get into a worker’s body, the most common being through respiration (i.e., breathing in contaminated air) and absorption through the skin. Chemicals can also enter our bodies through ingestion (i.e., we can eat them—usually accidentally) and through cuts in our skin. Our bodies excrete some chemicals in our sweat, exhaled breath, urine, or feces, while retaining other substances. Our bodies metabolize some chemicals into other substances, which may be more or less toxic than the original substance.

Chemical hazards have varying levels of *toxicity* (i.e., ability to cause injury). Toxicity can be local or systemic. *Local toxicity* is a reaction at the point of contact. For example, you might experience a burn on the skin of your fingers after handling spicy peppers in a restaurant kitchen. *Systemic toxicity* occurs at a point in the body other than the point of contact. Allergic reactions after prolonged exposure to latex would be an example of systemic toxicity (see Box 5.1). Another example might be organ damage following skin absorption of a pesticide while picking fruit.

**Box 5.1 Contact dermatitis among food service workers**

Many food service workers cope with a chronic rash on their hands. This *dermatitis* is caused by exposures to chemical substances such as cleaners and food products as well as by frequent handwashing—all of which can irritate a worker’s skin. Workers can develop severe itching, burning, flaking, cracking, blistering, and bleeding of their hands. Over time, repeated exposures to chemical substances can also make workers allergic to those chemicals. Allergic reactions mean workers can develop symptoms on other parts of the body. There are over 1000 workers’ compensation claims for dermatitis in Ontario alone each year.\(^4\)

Other factors appear to play a role in food service workers’ propensity to develop dermatitis. Extreme temperatures (such as hot dishwater and serving dishes as well as cold freezers), mechanical trauma (such as friction, pressure, abrasions, and lacerations) and biological agents (such as bacteria on meat and vegetables) are common food service hazards. Each of these hazards can increase the likelihood of workers developing dermatitis.\(^5\)
Some food service workers wear latex gloves as a form of PPE in order to reduce their contact with chemical substances. Latex gloves are also widely used by health care workers. Ironically, latex gloves themselves contain multiple chemicals (called rubber accelerators). These chemicals have allergenic properties and may contribute to the skin damage that gives rise to dermatitis. Workers can also become allergic to the latex gloves themselves, an allergy that can subsequently be triggered by household, recreational, medical, and clothing items. Proper skin care combined with eliminating or reducing exposures to the chemical, physical, and biological hazards of food service is likely to be more effective in reducing the incidence of dermatitis.

Acute toxicity represents the immediate harm caused by exposure to a chemical substance. Chronic toxicity represents a substance’s ability to cause harm over a longer period of time. The time between exposure to a chemical hazard and the development of symptoms from that exposure is called the latency period. Many of the consequences of exposures to chemical hazards (e.g., occupational diseases) have a latency period that is measured in years. As we saw in Chapter 2, this delay can confound the relating of diseases to occupational exposures.

Although only a fraction of all chemical exposures result in a worker’s death, toxicity is often measured in terms of a substance’s lethal dose (LD) as determined from animal experiments. For example, the toxicity of a chemical tested on rats via ingestion might be expressed as Oral LD$_{50}$ (rat): 56mg/kg. What this means is that when rats were fed the substance, half (the ‘50’ after the LD) died shortly after ingestion when given 56 milligrams of the substance per kilogram of animal weight. These LD$_{50}$ values are measures of substances’ acute toxicity and allow us to compare the toxicity of substances. Substances with a lower LD$_{50}$ are more acutely toxic than substances with a higher LD$_{50}$ because lower LD$_{50}$ substances cause half of the animals to die at lower doses. The toxicity of substances may also be measured based upon their lethal concentration (LC) in the air or water.

These toxicity measures show us that the dose (or amount) of a chemical that enters the body affects whether the chemical exposure causes harm and the degree of harm. For example, some chemicals are relatively harmless in low
concentrations, such as the methane gas found in Jessica Ernst’s well water. But, in high concentrations, methane can displace oxygen and cause rapid heart rate, fatigue, nausea, and, eventually, death by asphyxiation. (It is also flammable and potentially explosive.) That said, it is important to note that doses that are too low to cause acute toxicity can still cause chronic toxicity, especially if the dose is repeated over time. Prolonged exposure to silica dust, for example, can give rise to silicosis—a lung disease that impedes respiration—but silicosis may not manifest itself for 10 to 30 years after the exposure.

While toxicity data is helpful in identifying chemical hazards, it is important to be cautious when using it. Lethal dose measures focus on the acute toxicity of a substance and are less useful in assessing a substance’s chronic toxicity or the effect of repeated exposures to low doses. Toxicity experiments also tend to be based upon ingestion of the substance because ingestion-based experiments are less expensive than experiments based upon respiration or contact. This bias may reduce the accuracy of the resulting data because most chemicals enter our bodies through respiration or skin absorption. Toxicity data is also based upon animal experiments, and these results may not be perfectly applicable to humans. Perhaps most concerning is that toxicity experiments typically assess the toxicity of a single substance in isolation. This ignores the reality that most workplaces expose workers to multiple chemicals and these exposures may interact synergistically. That is to say, exposures to multiple chemicals may increase the toxicity of each chemical out of proportion to its toxicity in isolation.

As discussed in Chapter 3, controlling chemical hazards begins by identifying worker tasks and environmental factors associated with the location. Subsequently, we must identify and list each chemical a worker is exposed to and the route(s) of entry for that chemical. The potential hazard posed by each exposure and the risk of exposure should be determined along with control strategies. Control strategies used should follow the hierarchy of controls, beginning with elimination (e.g., using non-chemical processes) and substitution (e.g., using a less hazardous chemical), then progressing to engineering controls (e.g., physically isolating workers from the chemical).6

Less effective control approaches include administrative controls that minimize or standardize exposures and the provision of personal protective equipment (PPE). In addition, some workplaces provide special facilities (e.g., showers, lunch rooms) to minimize workers’ exposure to chemicals. Some organizations will also undertake extensive medical and environmental
monitoring and record keeping. This can include monitoring the level of a hazard in a specific area (area monitoring), the dose experienced by a worker (personal monitoring), or the presence of a chemical or its metabolic residue in a worker’s blood, body fluids, or tissues (medical monitoring). While not hazard controls per se, monitoring and record keeping can provide data that can help to adjust administrative controls, assess the effectiveness of PPE, and identify early signs of health effects.

In practice, controlling exposure to chemical substances can be difficult. Workplaces often use multiple chemicals, which may have poorly documented synergistic effects. Further, the ways in which products are used may change over time, thereby reducing the effectiveness of administrative controls such as exposure and handling protocols. For example, a reduction in the number of cleaning staff in a hotel may mean workers must now work faster because their workloads have increased. Prior to the staffing change, workers may have used one chemical product to clean toilets and, subsequently, another product to clean the bathroom floors. To cope with the reduced time the workers are given to clean the entire bathroom, the workers may begin applying both products at the same time, creating the possibility of hazardous chemical interactions. Such a change in practice may be unknown to the employer. This example demonstrates that health and safety can be profoundly affected by other human resource practices, such as job design, staffing, and scheduling.

OCCUPATIONAL EXPOSURE LIMITS

Toxicity data is used to generate occupational exposure limits (OELs). OELs for chemical hazards represent the maximum acceptable concentration of a hazardous substance in workplace air. In theory, workers exposed to a chemical substance at the OEL for their entire working life will experience no adverse health effects. Each jurisdiction in Canada sets its own OELs. As we saw in Chapter 4, there are also OELs for physical hazards such as noise, radiation, and (more rarely) vibration. There are approximately 800 OELs in Canada.

Provincial and territorial regulations can set three types of OELs, depending on the nature of the substance’s toxicity:

- A time-weighted average exposure value (TWAEV) is the maximum average concentration of a chemical in the air for a normal 8-hour working day or 40-hour working week.
• The **short-term exposure value** (STEV) is the maximum average concentration to which workers can be exposed for a short period (e.g., 15 minutes). The STEV is often higher than the TWAEV.

• The **ceiling exposure value** (CEV) is the concentration that should never be exceeded in a workplace.

OELs for a vapour or gas are often set as parts per million (ppm). Aerosols (e.g., dust, fumes, mist) are normally set as milligrams per cubic meter of air (mg/m$^3$). Fibrous substances (e.g., asbestos) are typically set as fibres per cubic centimeter of air (f/cc or f/cm$^3$). Compliance with OELs is often assessed via air sampling. Periodic air samples do not necessarily capture normal working conditions because the act of testing may temporarily change workplace behaviour. This dynamic is called the **observer effect**.

When establishing OELs, governments often follow threshold limit values (TLVs) published by the ACGIH. The TLVs are the ACGIH’s recommendations for allowable chemical exposure. While it is an arms-length body, concerns about its recommendations have been raised. Nearly one sixth of all the ACGIH’s TLVs have been set based upon unpublished corporate data, which raises concerns about the validity and reliability of the results. Further, the committees that set these standards have included a significant number of industry representatives and consultants—many of whose relationships to industry were hidden while they were members—thereby raising concerns about conflict of interest in the establishment of TLVs.7

Indeed, many scientists dispute the notion that there is any safe level of exposure for carcinogens and reproductive hazards. In this view, so-called safe levels of exposure reflect simply the point below which scientists are (at present) unable to detect ill effects. Box 5.2 takes on the thorny issue of why the ongoing reduction in OELs—while doubtlessly beneficial to workers—is evidence that OELs have not been very effective at protecting them.

**Box 5.2 Why are declining OELs so concerning?**

A concerning trend in OELs is that so-called safe levels of exposure go down over time, often dramatically. The exposure level for benzene, for example, dropped from 100 ppm to 10 ppm between 1945 and 1988, and exposure limits on vinyl chloride dropped from 500 ppm to
5 ppm. This phenomenon is not just a part of the distant past. Alberta reduced its OEL for chrysotile asbestos from 2 f/cc in 1982 to 0.5 f/cc in 1988 to 0.1 f/cc in 2004.

On the surface, this trend toward ever-lower OELs seems to indicate the system works: as new scientific evidence about chemical hazards becomes available, regulators revise their OELs. Yet let us think about this a bit more deeply. The law of probability suggests that, all else being equal, sometimes initial OELs will set be too high and sometimes they will be set too low. So why do OELs always go downward? Shouldn’t they go up at least some of the time?

The constant downward trend in OELs actually demonstrates a systemic underestimation of risk to workers by regulators. That is to say, regulators almost always err on the side of over-exposing workers to chemical hazards. Why is this? There are likely three reasons.

The first is that the science underlying OELs has not been very good. For example, in, 90% of cases where TLVs have been set, there is insufficient data on the long-term effects of exposure from either animal or human studies. This introduces uncertainty into the regulatory process. This uncertainty is exacerbated when employers hide evidence that substances negatively affect workers, sometimes by producing studies of questionable validity. The second reason (explored later in this chapter) is that the threshold of scientific certitude is often set very high and this makes it hard to “prove” substances are hazardous.

The third reason is that regulators operate in a political environment, where workers, employers, and the state all seek to advance their interests. It follows that regulators setting standards must ask what actions will be politically palatable. In this way, setting exposure limits is not a purely scientific process, but also a political one. Among the findings of researchers is that most exposure limits have been set at levels industries were already achieving. That is to say, “safe” OELs appear to be defined in practice as “convenient for employers” rather than “posing no hazard to workers.” Even with processes that involve multiple stakeholders at the table (i.e., labour and employers), the outcomes tend to favour employers due to imbalances in political power and access.
This discussion expands our understanding of how the social construction of hazards affects workplace safety. By labelling levels of exposure as “safe” (even when they are not), the state is able to define some hazards out of existence. This benefits employers because many of these substances are integral to industrial processes or are the least expensive substance available to do the job. The effect of such hazardous substances on workers is ignored. After all, how can a “safe” substance cause harm to a worker?

Compounding concerns about the validity of OELs is their usefulness in today’s labour market. OELs assume a standard employment relationship with a single employer and an 8-hour workday. Many workers have more than one job and may experience chemical exposures at each worksite. These combined exposures may exceed OELs or may entail complicated chemical interactions. Yet OHS regulations do not require employers to consider chemical exposures workers experience from other jobs or in the community. Employers may well not even know that workers have a second job, let alone what chemical exposures they have. In this way, the trend toward increasingly precarious employment can create workplace hazards that are essentially invisible. There is also a gendered dimension to OELs. Most OELs have been set based upon studies of healthy young men, and the resulting standards are applied to both genders. OELs do not take into account individuals’ varying sensitivities to chemicals. The same exposure level may result in no ill effects for one worker, while the next person next might experience health effects.

This critique of OELs raises important questions about the validity of information contained in material safety data sheets (MSDS). An MSDS is supposed to contain information about potential hazards, safe use, storage, and handling practices, and emergency procedures. Manufacturers and suppliers must provide and employers must make available an up-to-date MSDS for any chemicals that are considered controlled products by WHMIS. Often the information in MSDSs is based upon OELs. Inaccurate OELs can undermine the utility of MSDSs, which are the key method by which information about chemical hazards is communicated. Further, analysis of the content of MSDSs has also found them to be incomplete, inaccurate, sometimes out of date, and often incomprehensible to workers. These findings raise profound
questions about the effectiveness of chemical hazard assessment, recognition, and control efforts. More detailed and accurate information is available in databases provided by organizations such as the Canadian Centre for Occupational Health and Safety (e.g., ChemInfo database), but these resources can be expensive to access and difficult for workers to find.

**BIOLOGICAL HAZARDS**

As we saw in Chapter 3, **biological hazards** are organisms or the products of organisms (e.g., tissue, blood, feces) that harm human health. There are three types of organisms that give rise to biological hazards:

- **Bacteria** are microscopic organisms that live in soil, water, organic matter, or the bodies of plants and animals. For example, the E. coli bacterium lives in human and animal digestive tracts and some strains can cause food poisoning, infections, or kidney failure when ingested.

- **Viruses** are a group of pathogens that cause diseases such as influenza (the “flu”) when they enter our bodies.

- **Fungi** are plants that lack chlorophyll, including mushrooms, yeast, and mould. Many fungi contain toxin or produce toxic substances. For example, *stachybotrys chartarum* (black mould) produces toxins called mycotoxins that cause nausea, fatigue, respiratory and skin problems, and organ damage when the toxic spores are inhaled.

Insect stings and bites, poisonous plants and animals, and allergens are also biological hazards. Like chemical hazards, biological hazards can enter our bodies via respiration, skin absorption, ingestion, and skin penetration and can cause both acute and chronic health effects. Our bodies do have mechanisms by which to cope with some biological hazards. For example, our respiratory system has five layers of defence to prevent harmful particles from entering our body, beginning with the hair-like projections (cilia) on the cells that line our airways (which filter out particles) and ending with cells (macrophages) in the air sacs (alveoli) of our lungs that trap and route impurities into the lymphatic system for disposal. Organisms that enter our body are also subject to attack by our immune system. Yet these mechanisms are not effective against every biological hazard or every exposure.

Like all workplace hazards, control strategies for biological hazards should follow the hierarchy of controls. Historically, the provision of adequate
wiping and toilet facilities was an engineering control that significantly reduced worker exposure to many biological hazards. Recent technological improvements, such as automatically flushing toilets and automatic taps, soap dispensers, and towel dispensers, have further limited workers’ contact with bacteria in washrooms.

As noted in Box 5.3, providing workers with vaccinations is an administrative control that can reduce worker susceptibility to viruses. Mandatory vaccinations are, however, controversial. Public health officials in Alberta have been attempting to increase the rate of annual vaccination for influenza among health-care workers (which sits at about 55%) and are considering mandatory vaccinations. In British Columbia, workers who do not receive a flu shot must wear a mask when interacting with patients.\(^{15}\)

While mandatory vaccination for health-care staff is advocated as an important step to protect patients (who may be particularly vulnerable to influenza), opponents note that mandatory vaccination significantly interferes with the rights of health-care workers to control their own health and that the annual “flu shot” is only about 60% effective at preventing influenza.\(^{16}\) Some critics privately assert that employers may be more interested in reducing worker sick-time totals than protecting patient health. This charge should again draw our attention to the potential for financial considerations to affect employer OHS practices.

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**Box 5.3 Communicable diseases, immunization, and child care workers**

Public immunization programs during the latter half of the 20th century—focused specifically on vaccinating school children—have largely eliminated diseases such as polio and smallpox. While primarily aimed at controlling disease in the broader population, vaccination programs have also reduced occupational exposures to biological hazards among health-care and child-care workers.

A since-discredited 1998 study that linked autism to the MMR (mumps, measles, and rubella) vaccine has contributed to declining vaccination rates in Canada and the United States. Fewer immunized children means that child-care workers—95% of whom are female—
are increasingly exposed to biological hazards that can cause diseases, such as hepatitis B and measles.

Indeed, child-care workers face many biological hazards in the course of their daily work. Respiratory infections—spread through the air—are commonplace among children, as are measles, chicken pox, and whooping cough. Intestinal infections can be spread through contact with feces during diapering or through inadequate hand washing. And skin infections (such as ring worm) and infestations (such as lice) can be transmitted through direct contact.

Following a 2014 outbreak of measles in Disneyland linked to unvaccinated children, the State of California made vaccination of school-aged children mandatory. The state has since enacted further legislation requiring child-care workers to be vaccinated against measles, whooping cough, and influenza. Mandatory worker vaccination (which is controversial) helps to control some of the biological hazards faced by child-care workers. Other administrative controls include environmental monitoring and sanitization protocols, such as ensuring that there are adequate facilities for diapering and toileting and physically separating these areas from food preparation and eating areas.

The interaction of public health campaigns (such as immunization) with workplace OHS demonstrates the need for OHS practitioners to be mindful of health issues beyond the workplace. In Chapter 8, we’ll examine the issue of pandemic planning. Pandemics are caused by the widespread outbreak of a new strain of a virus that spreads quickly (due to a lack of immunity) and for which there is no immediately available vaccination. While they are relatively rare, the workplace impact of a pandemic could be severe and many employers have developed plans for coping with such an event.

SCIENCE AS A DOUBLE-EDGED SWORD

Science plays an important role in both injury prevention and compensation. It has identified hazardous chemical and biological agents, determined the mechanism(s) by which these substances cause harm, and suggested ways to control hazards and treat injuries. It is important for OHS practitioners
to understand how scientific conclusions are reached and the limitations of these conclusions.

The scientific method is a process of formulating, testing, and modifying hypotheses. A scientific hypothesis is a proposed explanation of a phenomenon that can be empirically tested to confirm, refine, or refute this explanation. We conduct measurement, observation, and experimentation to gather data that is compared against the hypothesis. If the data agrees with our hypothesis, we may conclude the hypothesis to be true. However, we cannot be certain the results are not the result of chance or a flaw in the method design. In other words we need to ensure the results are both valid and reliable. Validity means the results of the experiment or observation accurately reflect the real world. For example, a scale measuring weight is valid if it correctly reports your actual weight. Reliability is the degree to which the results would be consistent if the measurement or observation were performed again. The scale in our example would be reliable if it produced the same result every time you step on it (assuming your weight has not changed).

The questions of validity and reliability plague scientific researchers, and achieving them is a key element of the scientific method. They are particularly challenging for the kinds of research usually associated with OHS-related matters because most of those issues involve human behaviour and physiology. When dealing with humans acting in the real world, there are limits to the control we can achieve over the measurement. It is unethical, for example, to intentionally expose someone to a toxic substance to measure its effects. Also, we cannot identify and control all the possible variables that may affect our results.

As a result, we can never be absolutely certain our results are accurate. As a result, scientists are concerned with false positives and false negatives. A false positive result occurs when we conclude a difference or relationship exists when it does not. False negatives occur when we conclude no difference or relationship exists when it does. Scientists tend to be particularly concerned with false positives because of their potential consequences. For example, saying a drug is effective at treating a disease when it actually is not can harm patients by subjecting them to an ineffective course of treatment. False negatives can also have real-life consequences as they may lead to inaction on health threats. The potentially harmful consequences of false positives means scientists are prone to being very conservative in their conclusions.
Further complicating matters is that most research conducted on OHS matters can only identify a correlation between two variables (e.g., exposure to asbestos and lung cancer). Demonstrating that asbestos (rather than some other, unmeasured, substance) causes lung cancer requires more complex research. The lack of clarity around cause also contributes to scientists’ conservatism around findings. Unclear causation also is used by employers and government agencies, such as WCBs, to deny the harmfulness of a substance and the injury claims associated with exposure to it. For example, smoking also causes lung cancer and so, if an asbestos-exposed worker also smokes, it can be much more difficult for her to demonstrate that her cancer was the result of the asbestos exposure. This is a common issue for workers who develop long-latency diseases.

The reason that scientific practices matter to OHS practitioners is that health and safety is contested terrain. As we saw in Chapter 1, the interests of employers and workers don’t always align. While scientific analysis has been immensely helpful to workers seeking to identify chemical and biological hazards or receive compensation for injuries caused by such hazards, employers can use the conservative culture of scientific research to slow or block worker efforts in these regards. As Box 5.4 shows, employers will often exploit such doubt in an effort to block regulation of hazardous substances.

**Box 5.4 Avoiding regulation by manufacturing doubt**

Today we know that both vinyl chloride and benzene are dangerous chemicals that affect human health. Vinyl chloride is a polymer used in the production of many plastics, and until the 1970s, it was used in aerosol sprays and other products. Benzene is a component of crude oil that is a powerful industrial solvent and used in production of many products, including nylon. Their dangers were not always widely known.

Debra Davis, a renowned epidemiologist (a scientist studying the patterns and causes of illness and disease in the population), has traced what happened as scientists started to become aware of the health consequences of these chemicals. She found a story of active corporate involvement in the suppression of scientific evidence and discouragement of regulatory controls that she terms “a sophisticated game of scientific hide and seek.”

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These cases draw attention to the strategies employers use to protect their interests in the face of scientific, public, or government pressure for regulation. In both cases, the corporations possessed studies demonstrating the health hazards of the chemicals but refused to allow public access to the results. Insiders trying to get the information into the public’s hand were fired or silenced. Employer strategies in the face of growing public awareness are also illuminating:

To the manufacturing companies, it made sense to fight any effort to restrain production. From the very first reports that vinyl chloride could dissolve the finger bones of workers, cause cancer in animals and deform babies, the industry had a simple response: more research is needed.\(^\text{19}\)

This tactic is aimed at delaying any regulation of the chemical in question. Employers would also sponsor their own research into a substance. In the case of vinyl chloride, employers hired prominent and well-respected scientists such as Sir Richard Doll, considered one of the world’s premiere epidemiologists, whose results downplayed health concerns.

Not until 2000 did it become known that Doll’s efforts on vinyl chloride had not been the independent musings of a disinterested expert. A letter found after his death in 2005 indicated that Doll had served as a consultant to Monsanto [a manufacturer of vinyl chloride] since at least 1979, at a fee of $1,500 a day.\(^\text{20}\)

These efforts are part of a well-documented employer game plan for delaying the recognition of chemical hazards. It starts out with the employer decrying the lack of evidence to substantiate worker concerns about a particular hazard. If the workers have managed to gather evidence to support their claim, employers—sometimes acting through industry associations—will often criticize the methods by which that research was conducted and request additional research, which can cause a multi-year delay in the process.

If the employer has generated research that suggests a substance is hazardous, they may prohibit the researchers they contracted to do the research from publishing the results. They may also misrepresent
the findings to government or hire a more compliant researcher to create evidence that the substance poses no risk. Finally, when it is no longer possible to deny that a substance is hazardous, the employer may seek to blame the workers for their exposure or argue that continued use of the substance is economically necessary.21

Despite the voluminous research into the hazards of benzene and vinyl chloride, neither has been banned or significantly restricted in industrial processes. OELs have been established, and other safety regulations govern their handling, but thousands of workers continue to be exposed to both chemicals.

The standards set by scientific research can make it very difficult at times to establish that a chemical (or other exposure) is hazardous. Employer use of this conservatism can mean that workers can be exposed to hazards with inadequate information about their effects. By contrast, if those regulating chemical and biological hazards adopted the precautionary principle—where the absence of scientific certainty that a substance was hazardous did not preclude regulating potentially hazardous materials or activities associated with it and the burden of proof fell on those advocating its use—it would be much more difficult for employers to resist this regulation. Box 5.5 considers the precautionary principle in more detail.

Box 5.5 Politics and the precautionary principle

The precautionary principle asserts that when a substance is suspected of causing harm to workers, the public, or the environment but there is no scientific consensus on the question, then those seeking to use the substance must prove it is not harmful. In essence, this principle reverses the current evidentiary burden around chemical and biological hazards, which requires critics to prove a substance is harmful before regulation occurs.

The precautionary principle is premised upon the notion that decision makers have a social responsibility to protect workers and the public from harm when there is a plausible case that a substance is
harmful. Europe has moved in the direction of the precautionary principle with its Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations. These regulations place a greater burden on employers and chemical companies to demonstrate that a new chemical is safe, although a number of significant loopholes remain.\footnote{One of the impediments to the adoption of the precautionary principle is that it brings into stark relief and conflict the differing interests of employers and workers around safety. Governments generally prefer to avoid making clear choices between the demands of workers (from whom they derive political legitimacy and electoral support) and the demands of employers (who are economically powerful). Consequently, governments are reluctant to seriously consider the precautionary principle (which most employers oppose). One outcome of this reluctance (albeit an outcome that is difficult to see) is that employers retain the right to continue exposing workers to substances that are possibly (and even probably) hazardous.}

One of the impediments to the adoption of the precautionary principle is that it brings into stark relief and conflict the differing interests of employers and workers around safety. Governments generally prefer to avoid making clear choices between the demands of workers (from whom they derive political legitimacy and electoral support) and the demands of employers (who are economically powerful). Consequently, governments are reluctant to seriously consider the precautionary principle (which most employers oppose). One outcome of this reluctance (albeit an outcome that is difficult to see) is that employers retain the right to continue exposing workers to substances that are possibly (and even probably) hazardous.

\textbf{SUMMARY}

As noted at the beginning of the chapter, the health risks from fracking affect both workers at the well sites and nearby residents. This example demonstrates that when it comes to chemical and biological hazards there is no clear boundary between occupational health and safety and public health or between workplace hazards and environmental hazards. In this way, biological and chemical hazards can be pervasive and difficult to recognize because exposure occurs in multiple settings.

Chemical and biological hazards are also challenging because of the level of complexity involved in their interactions with the human body. It is much harder to ascertain the risk associated with using a cleaning agent than the risk posed by working on a roof or operating an espresso maker. Health effects may only develop from prolonged exposure, or the disease may have a long latency period. Often, pinpointing the cause of a disease can also be difficult due to exposure to multiple hazards, a lack of knowledge about what we are exposed to in the workplace, and the lack of a clear boundary between work-related and environmental exposures.
As a result, this area of OHS relies heavily on science to understand the effects of chemical and biological hazards. Nevertheless, the nature of scientific practices often result in overly conservative conclusions when assessing the risk these hazards pose to workers. Issues with such scientific conventions can be compounded by employers’ long-standing efforts to deny the existence of chemical and biological hazards and avoid taking action to control them. As a result, there is strong evidence suggesting that current protections are inadequate and systematically under-protective of workers. Even if the precautionary principle is not a legal requirement in Canadian workplaces, this dynamic makes a strong argument for adopting the principle for moral reasons when it comes to chemical and biological hazards.

**DISCUSSION QUESTIONS**

› How do chemical hazards harm workers?

› What chemical hazards have you encountered in the workplace? What were the route(s) of entry of those hazards? What acute and chronic effects did they have?

› Why might we be skeptical about the utility of OELs?

› What biological hazards have you encountered in the workplace? What were the route(s) of entry of those hazards? What acute and chronic effects did they have?

› Do you think scientists are too conservative when they assess whether certain substances are hazardous to workers? Why or why not?

**EXERCISES**

⚠️ Go online and find information about black mould. Specifically, try to determine:

1. How can black mould be recognized?

2. What health effects does black mould cause? And what is the route(s) of entry for black mould?
3. What controls are effective for working near black mould? And how can it be eliminated from the workplace?

Go back online and find out what regulations regarding black mould and its remediation operate in your jurisdiction. You will want to consider occupational health and safety rules, as well as environmental regulations and building codes. Now consider the following scenario.

Pretend you are an employer operating a building cleaning company. One of your employees has reported finding black mould in the basement of a building you require the employee to regularly clean.

Using your knowledge of black mould, write a 500-word plan to respond to the employee’s concerns given the rules governing mould in your jurisdiction and the health effects of mould exposure for workers.

If possible, swap plans with another student. If this is not possible, use your own plan. Pretend you are the employee who has received this plan in response to your concerns about black mould in the workplace. What concerns do you have about your employer’s plan? And how would you use your occupational health and safety rights to seek remedy for these concerns?

NOTES


Hygiene/Health-Stories/service-industry-hazards-getting-under-workers-skin.html


19 Ibid., p. 372.
20 Ibid., p. 378.