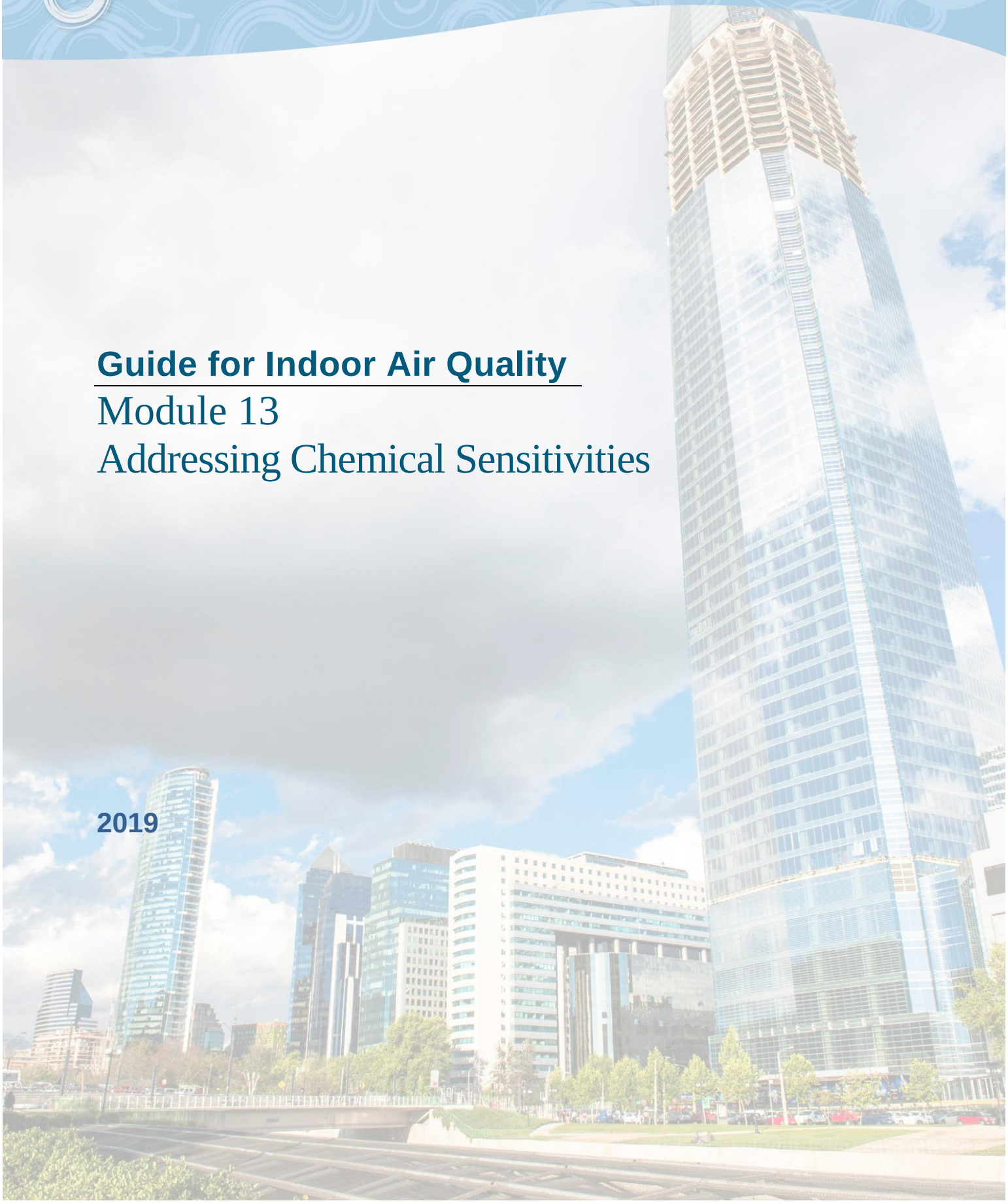
CCIAQB | Canadian Committee on Indoor Air Quality and Buildings



Guide for Indoor Air Quality

Module 13
Addressing Chemical Sensitivities

2019

Canadian Committee on Indoor Air Quality and Buildings (CCIAQB)

Disclaimer

The Guides and other documents produced by the CCIAQB are summary compilations of existing information from many sources. While the CCIAQB makes every effort to verify the accuracy of the information published in its documents, it cannot guarantee complete accuracy.

With the exception of employees of departments and agencies of the Government of Canada, members of the committee are chosen for their individual interests and abilities rather than as representatives of their employer or of particular groups or associations. The views expressed in the documents therefore reflect the collective judgment of the Committee, not those of individual members or their organization. References and links to other sources and organizations are intended as supplementary information. The CCIAQB does not in any way endorse those organizations, the information they disseminate or the products they recommend.

Indoor air quality is a very complex issue and there is currently a significant gap between knowledge of the effects of indoor air quality on the health of occupants and the effectiveness of various air quality technologies and solutions. User discretion is advised.

Preamble

The objective of the CCIAQB is, ultimately, to improve indoor air quality (IAQ) for all Canadians in every type of building. The CCIAQB has decided that its initial focus should be on buildings where many Canadians spend time outside their home, working, learning, shopping, being entertained, etc. For the most part, these buildings have relatively complex heating, ventilating and air conditioning systems that are operated and managed by knowledgeable persons. The table below gives examples of buildings that are covered using the classification found in the *National Building Code of Canada* (NBC). Documents produced by the CCIAQB are primarily intended for the use of building operators and facility managers, but the information contained in the guides can be helpful to anyone seeking a general understanding of indoor air quality issues.

Although the focus to date has been on the types of buildings shown in the table below, the CCIAQB recognizes the importance of homeowners understanding how indoor air quality can affect health and what can be done to create healthier home environments, since people spend the majority of their time indoors at home over their lifetime. Module 13 – Addressing Chemical Sensitivities, is a response to this important need.

The Committee welcomes feedback on the documents as well as ideas for the development of new materials. Contact the CCIAQB Secretary at info@IAQforum.ca or register on the website at www.IAQforum.ca

NBC Classification	Examples
Group A, Division 1	Theatres, movie theatres and other facilities for the performing arts
Group A, Division 2	Art galleries, museums, libraries, educational facilities (schools, colleges and universities), gymnasia, air and rail terminals
Group A, Division 3	Arenas and swimming pools
Group C	Apartments, hotels, college residences
Group D	Offices, including medical and dental offices
Group E	Department stores, supermarkets, shops, retail space

Guide for Indoor Air Quality
Module 13: Addressing Chemical Sensitivities

Table of Contents

1. Purpose of this Module 2
2. Understanding Chemical Sensitivities 2
    2.1 What is Chemical Sensitivities? 3
    2.1.1 How do chemical sensitivities start? 4
    2.1.2 How does the condition progress? 5
    2.1.3 How is the condition identified? 5
    2.2 Initiating Factors and Triggers 6
    2.3 Prevalence of Chemical Sensitivities 7
    2.4 Awareness and Rights Regarding Chemical Sensitivities 8
3. Preventing and Accommodating Chemical Sensitivities 9
    3.1 Minimizing Inhalation Exposures 9
    3.1.1 Source Control 10
    3.1.2. Ventilation 12
    3.1.3 Air Purification/Cleaning and Zone Control 12
    3.2 Accommodation of Chemical Sensitivities 13
4. Communicating With Occupants and Visitors 14
5. References 15
6. Resources 21

1. Purpose of this Module

The purpose of this Module is to inform building operators, managers, occupants and visitors about the complex medical condition known as chemical sensitivities, and potential role(s) that indoor air quality (IAQ) may play. The goal is to prevent the development and subsequent triggering of symptoms in susceptible individuals. The guide includes information and tools to assess, address and prevent potentially problematic indoor air contaminants. Communication is important, to accommodate individuals with chemical sensitivities.

This document is part of a series of modules forming the *CCIAQB Guide for Indoor Air Quality* available at www.IAQForum.ca

2. Understanding Chemical Sensitivities

We all have strengths and frailties, and some people are less able than others to tolerate some of the chemicals in their environment. Vulnerable individuals experience a variety of adverse reactions to environmental exposures, even when those exposures are commonly tolerated by others. Chemical sensitivities is a complex, chronic condition that affects individuals uniquely.

Effects of substances on health have been recognized through the ages. For example, we are familiar with the benefits of nutritious foods, and the disabling nature of toxins including metals (e.g., mercury, lead, arsenic and cadmium) and other harmful chemicals. Modern chemistry introduced humans to tens of thousands of substances in everyday products, that were never encountered during evolution.[2] Many of these novel substances, inhaled as vapours or adhering to dust, are absorbed from the lungs directly into the blood stream. Chemicals can also travel along channels for nerves, from the sinuses directly to the brain.

Unhealthy air quality can affect people with chemical sensitivities in multiple ways. Inhaled chemicals are sensed by many types of cells, with both immediate and longer term effects. For example, in the nervous system cellular receptors can become sensitized to low exposure levels,[3,4] resulting in pain or impairment according to the functions of affected nerves. Small quantities of some common chemicals can also interfere with basic biological processes such as hormone actions.[5,6] Ultimately, we cannot predict definitively the effects of mixtures that we breathe, absorb through our skin and swallow, throughout our lifetime,[7,8,9] and individuals have unique experiences of chemical sensitivities.

We can survive weeks without food, days without water, but mere minutes without air. Air quality may sometimes be beyond one's control, and very sensitive individuals may resort to wearing a mask for personal protection, if the environmental controls are inadequate for them to be otherwise accommodated.

2.1 What is Chemical Sensitivities?

Persons with chemical sensitivities develop symptoms in any body system, in response to multiple diverse chemicals, at exposure levels that most people tolerate, and that the individual themself was previously able to tolerate (see Table 1 below).[10] The nervous system is almost always affected, with headache, "dull" or "foggy" thinking, fatigue, lack of coordination and pain.[11] Skin rashes and flushing, respiratory symptoms of asthma and cough, heart irregularities and changes in blood pressure, digestive problems, urinary urgency, and numerous other symptoms are also common.[10,12]

Persons with chemical sensitivities may have extraordinary exposure histories, or invisible vulnerabilities, such as genes that may make them less able than others to break down and excrete chemicals.[13]Adverse exposure histories may be unrecognized or discounted because others tolerate the environment. People with chemical sensitivities are sometimes likened to "canaries," referring to birds that were taken into mines to signal toxic air, alerting workers to the need for action to protect the health of all.

Certain exposures can cause a normal person to develop chemical sensitivities. Women, particularly in middle age, tend to be affected more commonly than men. Some occupations such as fire-fighting, painting, nursing, manufacturing and other jobs with chemical exposures are more likely to initiate chemical sensitivities.[10,12] That being said, research regarding job categories can be difficult because affected workers are likely to move on, resulting in what scientists call the "healthy worker effect."

Table 1. Symptoms potentially triggered by exposure to environmental chemicals in people with Chemical Sensitivities [1]

Body System	**Symptoms**
Nervous System	Heightened sense of smell Difficulty concentrating Difficulty remembering Variability in mental processing Feeling dull or groggy, or "spacey" Headache Restlessness, hyperactivity, agitation, insomnia Depression Lack of coordination or balance Anxiety Tinnitus (ringing in the ears)
Upper Respiratory System	Stuffy nose, itchy nose (the "allergic salute") Blocked ears Sinus stuffiness, pain, infections

Lower Respiratory System	Cough Wheezing, shortness of breath, heavy chest Asthma Frequent bronchitis or pneumonia
Eyes	Red, watery eyes Dark circles under eyes Pain in eyes Disturbed vision
Gastrointestinal System	Heartburn Nausea Bloating Constipation Diarrhea Abdominal pain
Endocrine System	Fatigue, lethargy Blood sugar fluctuations
Musculoskeletal System	Joint and muscle pain in the extremities and/or back Muscle twitching, spasm or weakness
Cardiovascular System	Rapid or irregular heartbeat Cold extremities High or low blood pressure
Skin (Dermatological System)	Flushing (whole body, or isolated, such as ears, nose or cheeks) Hives Eczema Other rashes Itching
Genitourinary System	Frequency and urgency to urinate Painful bladder spasms

2.1.1 How do chemical sensitivities start?

Chemical sensitivities develop in two stages, starting with initiation or sensitization. This can result from a single exposure "event" (acute exposure) or from multiple exposures over a period of time (chronic exposures).

Examples of acute events include pesticide exposure (e.g., fumigation), a chemical spill (e.g., a disaster such as an oil spill or chemical plant releases),[10] or episodic exposures during conflict (e.g. Gulf War Illness).[14,15] Cancer therapy also commonly heightens chemical sensitivities, with

symptoms such as nausea and headache upon exposure to scents, petrochemicals, some foods and other airborne chemicals.[16,17]

Alternatively, initial sensitization can build gradually over time with chronic, lower-level exposures, such as to chemicals at work (e.g., in maintenance, manufacturing, laboratories or medical care), or hobbies (e.g. solvents, glues and paints), building materials and contents (e.g., renovation materials or new items), microbes that grow on damp materials (mould and bacteria, as well as volatile metabolites, spores and dust), underground toxins permeating the building envelope, or polluted outdoor air being taken indoors via openings from the outdoors, from more polluted spaces such as parking garages and loading docks, or via air intakes.

Buildings are sometimes identified with high proportions of sickened inhabitants, whose time to recovery from exposures becomes extended and who develop broad-spectrum sensitivities, as was the case with lawyers in a Calgary courthouse [18] or medical personnel affected by vapours at Camp Hill Medical Centre in Nova Scotia.[19] Gradual development of chemical sensitivities may be unrecognized until it becomes more severe.[10]

2.1.2 How does the condition progress?

Once an individual is chemically sensitive, low levels of exposure reproducibly trigger symptoms, they abate with removal of/from inciting substance(s), and symptoms return with re-exposure. In severe cases, the individual may become chronically ill.[1,20]

Thus, the initiation of chemical sensitivities may be a fork in the path of an individual's life. If the condition is recognized and accommodated with a clean environment, an individual may go on to lead a relatively healthy, productive life. Without recognition of the condition and steps to ensure safe air, water, food and surroundings, the state of health may worsen, with more diverse and severe symptoms developing in response to a broader range of substances. In other words, if adverse exposures are not recognized and averted, then sensitized people may become more sensitive and symptoms may "spread" to additional exposures, in some cases resulting in intolerances to many environments and foods, with potentially devastating effects on family and social life, and livelihood.[1,21]

2.1.3 How is the condition identified?

People come to the realization that they have chemical sensitivities in a variety of ways. The condition may be self-identified, patterns recognized by family and friends, or diagnosed by a health care practitioner with a detailed clinical and environmental exposure history (see Resources). Some recall a life-changing event such as a fumigation, after which they could no longer tolerate diverse substances. Some may solve the puzzle of feeling better at some times and places – perhaps by Sunday if they cannot tolerate the workplace in a weekday job, or visiting a well maintained residence away from a musty or a newly renovated home. In early stages,

affected individuals may recognize a pattern of symptoms and relief overlying a repeatable pattern of exposures/locations.

Medical diagnosis of a chronically ill individual reporting chemical sensitivities is a complex, multi-pronged strategy including a detailed medical history and physical examination. So far, there are no tests available clinically to 'prove' the diagnosis. An environmental exposure history [12] is a valuable tool for a trained practitioner, to guide advice and counselling to address adverse exposures, plus adaptation and coping.

The diagnosis of chemical sensitivity may be confirmed by a health practitioner who is trained and experienced in environmental medicine. They also address other complex medical conditions, such as myalgic encephalomeylitis/chronic fatigue syndrome and fibromyalgia, which are commonly experienced along with chemical sensitivities.

It is not necessary to fully understand the biochemistry of toxicity to take pragmatic least-toxic approaches. Individuals with lived experience – with repeated reactions to substances and environments – play an important role in identifying the necessary measures to improve IAQ.

2.2 Initiating Factors and Triggers

Exposures that may initiate the condition will also trigger symptoms of chemical sensitivities, although once the condition is initiated sensitivities may "spread" to other agents. Common initiators include volatile or semi-volatile substances such as pesticides; petrochemicals ranging from crude oil, to gases and solvents, to asphalt or tar; engine exhaust; smoke (e.g., tobacco, cannabis, incense, wood); scents of personal care, laundry and cleaning products, air "fresheners;" "new" smells of vehicles, electronics or carpets; newsprint, inks and printed materials; pet dander, insect remains (e.g., cockroaches) or pollen; and construction and renovation materials and related emissions such as paint, glues, flooring, composite wood products or caulking. Intolerances vary among individuals, and may also include some foods and pets.

Investigation of IAQ may indicate compliance with current standards, but the standards are not designed or intended to protect the most sensitive individuals. For example, the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) standard for acceptable indoor air quality is: *air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.*[22] Thus, up to twenty percent of the population may not be protected.

CCIAQB Module 2 – Volatile Organic Compounds (VOC) Sampling Methods and Strategies details examination of IAQ concerns related to VOCs. VOC measurements can potentially be

very helpful to identify otherwise unknown sources of indoor contaminants, but null results must not be used to conclude that there is no IAQ concern. This is discussed further in Section 3.1.1.

Furthermore, the ASHRAE standard 62.1 for ventilation does not specifically consider the semi-volatile organic compounds (SVOCs) found in the indoor environment, such as fire retardants, stain repellents or pesticides. These are mobilized both as vapour and adhering to dust, and are absorbed through the skin and lungs.[23,24] Ingestion of dust, which is of particular concern for children as a result of hand to mouth behaviour, can be an important route of exposure. Ventilation, as well as cleaning practices that do not re-suspend dust (e.g., damp mopping and dusting with a moist cloth), and filtration of vacuum exhaust using a high-efficiency particulate air (HEPA) filter help to reduce SVOCs.[24] Reservoirs such as pesticides in cracks and crevices, and flame retardants in furniture and carpeting are a continuous source of SVOCs, which can only be addressed with ongoing cleaning and careful consideration of replacements when the occasion arises.

Ultimately, once identifiable issues are addressed, a pragmatic approach must be taken to minimize airborne and other routes of exposures, to prevent and to accommodate chemical sensitivities. Individuals with the condition will have specific requirements, so their involvement and communication are essential.

Some sources of chemicals are under the control of the employer, building manager or operator; some are the result of individuals' everyday choices (e.g., use of scented personal care and laundry products); while others are influenced by external industries, agencies, regulators and enforcement agencies. These are discussed in section 3.

2.3 Prevalence of Chemical Sensitivities

Chemical sensitivities manifest along a range of severities, so prevalence of the condition is measured along this range.

The 2014 Canadian Community Health Survey found that 2.7% of Canadians report disabling chemical sensitivities, while 5.5% (1.3 million) report having one or more of three overlapping conditions, including fibromyalgia and myalgic encephalomyelitis (also known as chronic fatigue syndrome).[25] With symptoms in multiple body systems, they may visit numerous health care providers seeking help with their poorly understood condition.[26]

In other studies, a much larger proportion of individuals – up to a third of the population – report symptoms with exposure to scents. A repeated representative U.S. survey in 2016 revealed that 26% reported chemical sensitivities, 13% of whom were medically diagnosed. Among those who were diagnosed, 86% experience health problems such as migraine headaches when exposed to

scents; 71% experience asthma; 70% cannot access places that use scented products such as air fresheners; and 61% lost workdays or a job in the past year due to scents in the workplace. This represents a three-fold increase over a decade, in comparison with identical surveys conducted early in the 2000s.[27] A comparable Australian survey also in 2016 found that 19% reported chemical sensitivities, of whom a third were medically diagnosed. Over 90% reported sensitivities to fragrances, three quarters experienced asthma, and similar numbers could not access public places or workplaces as a result of scents.[28]

Another perspective, given that headache and other neurological symptoms are commonly reported in chemical sensitivities, is that chemical exposures, notably scents and other odours are common triggers of migraine headaches.[29,30]

2.4 Awareness and Rights Regarding Chemical Sensitivities

In *Malingerer or Maligned: A comparative study of multiple chemical sensitivity case law,* US and Canadian law are outlined and contrasted.[31] Discrimination on the basis of disability is prohibited by the Canadian Charter of Rights and Freedoms. This was clarified for environmental sensitivities (including chemical sensitivities) by reviews for the Canadian Human Rights Commission from both medical[32] and legal[33] perspectives, leading to a policy requiring accommodation of this disability under the *Canadian Human Rights Act* to the point of undue hardship (a high bar).[34] Many provinces have recognized chemical sensitivities, such as for example B.C.'s Human Rights Tribunal finding in favour of a pregnant woman who could not tolerate the smell of chemicals for cleaning,[35] Alberta Human Rights Commission's Duty to Accommodate Students,[36] Manitoba's publication of the Canadian Association of Statutory Human Rights Agencies' checklist that includes scent-free policies,[37] and Ontario's Human Rights Commission recognition of environmental sensitivities.[38]

Chemical sensitivities are most frequently publicly recognized in the form of "scent-free" or "fragrance-free" types of policies (for more on scents, see section 3.1.1, and CCIAQB *Module 6 – Scent-Free Buildings*). Scent- or fragrance-free policies are increasingly common in workplaces (hospitals, clinics), government buildings (offices, libraries, community centres), theatres and schools.[39] The thousands of potential ingredients [40] include chemicals known to trigger asthma, neurological symptoms and other conditions, so policies would be responsive to additional concerns not labelled "chemical sensitivities" *per se.*

Chemical sensitivities is a workplace health and safety concern, recognized by unions (see resources). Occupational Health and Safety Committees advocating for healthier workplaces may become engaged in identifying and negotiating accommodations for chemical sensitivities.

Finally, environmental sensitivities, including chemical sensitivities, along with other poorly understood environmentally linked conditions, have been examined repeatedly over the decades. The tragedy has replayed that genuine health impairment, with poor recognition and services, and continuing exposures, may result in affected individuals' health worsening.[25,27,32]

3. Preventing and Accommodating Chemical Sensitivities

In Canada, environmental sensitivities (including chemical sensitivities) is a disability of the individual. Interestingly, in Sweden the attitude is that the environment is inhospitable. Steps to ensure healthy, inclusive environments include minimizing contaminants, and optimizing air handling.

Unlike accommodation of disabilities with built infrastructure such as ramps, prevention and accommodation of chemical sensitivities involves everyone from the owner, managers, operators, maintenance, tenants (businesses and residents) and visitors. Communication is essential to achieve cooperation of occupants, workers and visitors, to optimize indoor air quality in order to prevent initiation and triggering of the condition.

3.1 Minimizing Inhalation Exposures

Best efforts to optimize air handling and maintenance, and to minimize emissions from operations, maintenance, cleaning and renovations are essential to reduce the initiation and triggering of chemical sensitivities.

In commercial buildings (e.g., offices, educational facilities, hotels and retail establishments) responsibility for the facility rests with the building owner and management. Managers for commercial tenants share responsibility for their premises.

Source reduction and elimination is most effective to optimize air quality. Chemicals affecting individuals may result from the building structure (e.g., microbes within the building envelope), contents (e.g., carpets, furniture and appliances), maintenance (cleaning supplies, equipment and practices), or activities within the building (e.g., manufacturing or printing).

Ventilation, filtration and moisture control are essential to remove chemicals generated by occupants and activities, and to maintain a comfortable environment that will not promote microbial growth.

CCIAQB Module 4 – Recognizing and Addressing IAQ Problems and *Module 8 – Creating a Building IAQ Profile* are excellent starting points to identify and to provide a systematic approach to common causes of IAQ issues that would impact individuals with chemical sensitivities.

Microbes can release particles (e.g., mould hyphae and spores) and volatile chemicals that cause inflammation, are toxic to the immune and nervous systems, damage organs and, when eaten, are known to cause cancer.[41,42] When inhaled, these substances are also absorbed to substantial levels within the body,[43] accumulate in sinuses and tissues,[44] cause a broad range of toxic effects, and are recognized to pose health risks globally.[45,43]

Indoors, microbial growth and chemicals emitted by microbes can originate within the building foundations or envelope and air-handling systems, as well as old or once-damp belongings and materials stored in water-damaged or moisture-impacted environments. *CCIAQB Module 5 – Hygienic Operation of Air-Handling Systems* informs building operators and managers how to operate air-handling systems in order to maintain acceptable indoor air quality, while *Module 10 – Management Strategies for Moulds and Microbiologic Agents* provides building owners and managers with information on causes, effects and correction of IAQ issues from moulds and other common microbiological agents. Moisture impacted structures and resulting microbes initiate and trigger a range of chronic conditions, including chemical sensitivities.[21,45,46,47] Of note, anti-microbials such as chlorine bleach may initiate or trigger chemical sensitivities, so oxygen bleach (also known as hydrogen peroxide) should be used when required. Mild soap and water may well suffice on smooth surfaces. Careful rinsing is important, but avoid sprays containing organic chemicals such as essential oils, as these are ineffective, may provoke sensitivities reactions, and could eventually feed more microbes.

3.1.1 Source Control

It is easier and more effective to prevent airborne dispersal of chemicals, rather than to try to clean them up or dilute them with fresh air. Examples of measures to be executed by owners/managers/operators include to:

- Identify, purchase and use VOC-free options for flooring, finishes (e.g., paints and varnishes), furniture, equipment, etc.;
- Identify, purchase and use VOC-free options for cleaning and maintenance;
- Maintain air handling, filtration and moisture control to eliminate microbial growth and to ensure sufficient fresh air without contaminant recirculation;
- Provide a separate enclosed space for equipment, with exhaust and ventilation designed to minimize exposures for users and other occupants. Examples include printing and copying machines, laundry machines, and food preparation areas.
- In workplaces, ensure that all safety equipment is provided, maintained, and that training is provided for correct use. For example, provide dedicated ventilation systems and respiratory protection programs, including supply air respirators where required[48];
- Ensure that air intakes do not entrain contaminants such as engine exhaust or chemical applications in the vicinity;
- Compartmentalize potentially off-gassing items, such as provision of closed closets for outdoor clothing, to minimize exposure to third hand smoke (tobacco by-product residues that

stick to surfaces after cigarettes have been extinguished) and chemicals accumulated during transit; and

- Institute scent-free and smoke-free policies among building occupants and/or as conditions on leases.

It is important to recognize that VOC sampling and analyses as detailed in *CCIAQB Module 2 – Volatile Organic Compounds (VOC) Sampling Methods and Strategies* has limitations. Individual chemicals pose a wide range of toxicities, but total-VOC analyses do not reveal the identity of chemicals detected, so "total VOCs" will under-estimate potential effects of potent chemicals. More detailed and expensive air sampling will identify some but not all substances. Depending upon the circumstances, it is difficult and may not be feasible or relevant to examine all individual chemicals and to estimate potency of a mixture, particularly for individuals with chemical sensitivities.

Scents and smoke. Scents are commonly identified as causing symptoms. While fragrances were once a "special occasion" extravagance, scented volatile chemicals are added to a large and ever-growing number of items including cleaners, laundry products, personal care products, and even items such as garbage bags. Scents also migrate into carpets, furniture, surfaces of walls and ceilings, dust, etc., resulting in ongoing exposure once the original source is removed.

Scents are proprietary mixtures of often dozens of substances, containing hundreds of chemicals among upwards of 4,000 possible ingredients.[40] These mixtures are common in personal care, laundry and cleaning products, playing important roles in marketing as well as masking unpleasant odours of ingredients derived from ingredient sources such as rendered animal remains ("tallow" ingredients). There is no official label for products that are free of scent and masking ingredients.[49] Masking agents also act to deaden the sense of smell, so additional neurological symptoms could also be expected. Scents are commonly formulated along with oily substances called "phthalates" (pronounced "thalates") that slow down evaporation of the scent chemicals, so that the smell lasts longer. When absorbed through the skin, phthalates as well as various scent ingredients interfere with basic biochemistry, mimicking or blocking effects of estrogen, thyroid and other hormones.[50,51] *CCIAQB Module 6 – Scent-Free Buildings* summarizes key definitions and considerations, and provides additional resources and examples to support scent-free policies.

Scent-free policy considerations may also apply to smoking. In Canada, smoking is not permitted in workplaces and many public spaces, nor in vehicles with young children. Smoking is legal in the home, which represents the majority of exposure for affected children. In multi-residential buildings, smoke infiltration into non-smokers' units can affect the health and enjoyment of occupants, and degrade the indoor environment as the smoke-related chemicals linger in materials. Beyond approaches for scents, landlords have rights to restrict smoking, as a condition of a lease.

3.1.2. Ventilation

Chemical sensitivities occurring in "Sick Buildings" emerged in the 1970s as buildings were sealed and ventilation reduced to save heat, in response to the oil crisis. As well, engineering standards for indoor air requiring that IAQ be acceptable to 80 percent of occupants will leave behind those with chemical sensitivities. The situation may re-emerge even with modern systems, as ventilation is decreased further to combat climate change.

Minimal ventilation of commercial buildings when not occupied (e.g., over weekends), can result in problematic air quality at the beginning of the work week. This may be of particular concern in older infrastructure with significant off-gassing of semi-volatile chemicals (e.g., flame retardants, pesticides, perfluorinated stain repellants) or bio-effluents from microbial growth.

Timing of ventilation is important as well. In schools, restarting ventilation prior to heavy traffic periods can reduce intake and levels of related pollutants.[52] As well, with large numbers of people and/or insufficient fresh air supply, indoor carbon dioxide levels can rise to levels that engender fatigue and impair critical thinking and cognition.[53,54]

Air handling may also be disrupted if renovations lead to blocking of vents by new or moved furnishings. *CCIAQB's Module 4 – Recognizing and Addressing IAQ Problems* assists with identification of deficiencies in fresh air supply as well as quality.

CCIAQB's Module 9 – Indoor Air Quality and Energy Efficiency offers recommendations to maintain IAQ in buildings while implementing various methods and systems to reduce energy consumption.

3.1.3 Air Purification/Cleaning and Zone Control

"Zone control" refers to centralizing equipment and materials that may trigger symptoms, such as copy machines, literature or food preparation facilities, within enclosures with enhanced exhaust ventilation.

In addition, an individual with chemical sensitivities in some instances may be accommodated in an enclosed workspace with additional specialized stand-alone air filtration equipment, to remove both particulates plus VOCs (e.g., HEPA plus activated carbon filtration, or a dedicated ducted supply of outdoor air). Electrostatic dust removal equipment should not be used because it is not possible to guarantee that ozone will not be generated.

Enhanced localized air supply or purification may provide some relief, but this should be considered a stop-gap measure, as it is less than ideal. An enclosed office with a stand-alone filter or dedicated air supply singles out the individual with sensitivities; it signifies that other

areas are not accessible, such as washrooms and meeting rooms; and it means that other workers continue to be exposed to a less than optimal environment.

3.2 Accommodation of Chemical Sensitivities

Optimizing IAQ to accommodate individuals with chemical sensitivities engages everyone from the building designers, owners, managers, operators, maintenance staff, tenants (businesses and residents) and visitors.

Individuals with chemical sensitivities have individual requirements, and thus must be involved with management in the identification of choices and making of decisions. In the workplace, occupational health and safety committees and representatives may play a role as intermediaries and advocates.

The building owner/manager/operator can require conditions for leases (e.g., no-smoking and scent-free provisions, and standards for maintenance and pest control), conduct monitoring, and require compliance with policies and least-toxic practices.

Occasions arise when it is not possible to accommodate a worker with chemical sensitivities in a particular location, either temporarily or over the longer term. In this case, relocation, or tele-working from home, should be considered. Workers may also be offered alternative hours, to lessen time and exposures while commuting.

Tenants in multi-residential buildings may be provided with personal in-unit laundry machines, as scented laundry detergents and fabric softeners pose a barrier to use of communal machines, or even entry into such communal laundry rooms. These are but a few examples.

CCIAQB's Module 12 – Healthy Renovations describes material selection and work practices to protect vulnerable occupants, including those with chemical sensitivities. It is prudent to consult affected individuals prior to building and renovation, to ensure that materials will be tolerated, requiring maintenance that is as simple and straightforward as possible, without entailing potentially adverse exposures.

It is necessary to give notice of construction, renovation and less common maintenance (e.g., stripping wax from floors). Even with care to containment, ventilation, work practices and ongoing cleanup during renovations, relocation may be necessary during and for a period following these activities, as off-gassing continues.

Finally, of note, people with chemical sensitivities may also be more sensitive to other factors in their environment such as temperature, noise, and non-ionizing radiation ranging from lighting to radiation from wireless communications and electrical equipment.

4. Communicating With Occupants and Visitors

CCIAQB Module 7 – Communicating With Tenant Organizations and Individual Occupants outlines these roles, as well as procedures and strategies for good communication. A first step is to identify key contacts and to establish clear lines of communication for affected individuals in order for them to obtain timely resolutions. Also important is consultation with potentially affected parties regarding changes to air handling, and in planning activities such as renovations (e.g. materials and scheduling of various stages), and once plans are in place, advance notice regarding IAQ and ventilation (e.g., potential odours, ventilation changes such as containment and negative pressure to ensure contaminants do not become dispersed throughout the building, changes in access and options for entrances/exits and alternative routes). Much of this is also important for safety and emergency preparedness.

The best choices of scent-free and VOC-free products for building maintenance and renovations can be undermined by scents from individuals' personal care and laundry products. Chemicals that become airborne from occupants and visitors' personal care and laundry products, second hand smoke (e.g., tobacco or cannabis) and other chemicals, as well as other tenants' activities in multi-residential buildings (e.g., hobbies), can cause adverse reactions in individuals with chemical sensitivities. *CCIAQB Module 6 – Scent-Free Buildings* summarizes key definitions and considerations, and provides additional resources and examples to support scent-free policies. *CCIAQB Module 7 – Communicating With Tenant Organizations and Individual Occupants* guides managers of facilities such as offices, retail operations, shopping centers, educational and child-care centers, theatres and hotels in communication with tenant organizations and individual occupants, regarding initiatives to improve IAQ.

Awareness is growing of the importance of indoor air quality. Further public acceptance may be gained, with the recognition that improving IAQ in ways that would address chemical sensitivities can improve health and productivity of others in the shared environment,[55] thereby helping to protect the most vulnerable (e.g., the developing foetus and child) [56,57,58] as well as contributing to broader environmental objectives such as reduction of pollution and greenhouse gasses.[59]

5. References

1. Marshall LM, Bested A, Molot J, Kerr KJ, Bray RI. Environmental Sensitivities-Multiple Chemical Sensitivities Status Report. Advances in Knowledge, and Current Service Gaps [Internet]. Office of the High Commissioner. United Nations Human Rights; 2011 Jun. Available from: https://www.ohchr.org/Documents/HRBodies/CRPD/GC/EnvironmentalHealthClinicWomensCollegeArt.9EN.pdf

2. Gross L, Birnbaum LS. Regulating toxic chemicals for public and environmental health. PLOS Biology. 2017 Dec 18;15(12):e2004814.

3. Steinritz D, Stenger B, Dietrich A, Gudermann T, Popp T. TRPs in Tox: Involvement of Transient Receptor Potential-Channels in Chemical-Induced Organ Toxicity—A Structured Review. Cells [Internet]. 2018 Aug 7 [cited 2018 Oct 28];7(8). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6115949/

4. Holst H, Arendt-Nielsen L, Mosbech H, Vesterhauge S, Elberling J. The capsaicin cough reflex in patients with symptoms elicited by odorous chemicals. International Journal of Hygiene and Environmental Health. 2010 Jan 1;213(1):66–71.

5. Bond GG, Dietrich DR. Human cost burden of exposure to endocrine disrupting chemicals. A critical review. Arch Toxicol. 2017 Aug 1;91(8):2745–62.

6. Kortenkamp A, Martin O, Faust M, Evans R, McKinlay R, Orton F, et al. State of the art assessment of endocrine disrupters [Internet]. United Nations Environment Programme. World Health Organization; Available from: http://apps.who.int/iris/bitstream/10665/78101/1/9789241505031_eng.pdf?ua=1

7. Silins I, Högberg J, Silins I, Högberg J. Combined Toxic Exposures and Human Health: Biomarkers of Exposure and Effect. International Journal of Environmental Research and Public Health. 2011 Feb 24;8(3):629–47.

8. World Health Organization. Chemical Mixtures in Source Water and Drinking Water [Internet]. 2017. Available from: http://apps.who.int/iris/bitstream/handle/10665/255543/9789241512374-eng.pdf

9. Kortenkamp A, Faust M. Regulate to reduce chemical mixture risk. Science. 2018 Jul 20;361(6399):224–6.

10. Miller CS. Chemical sensitivity: symptom, syndrome or mechanism for disease? Toxicology. 1996 Jul 17;111(1–3):69–86.

11. Lavergne MR, Cole DC, Kerr K, Marshall LM. Functional impairment in chronic fatigue syndrome, fibromyalgia, and multiple chemical sensitivity. Can Fam Physician. 2010 Feb;56(2):e57–65.

12. Marshall L, Weir E, Abelsohn A, Sanborn MD. Identifying and managing adverse environmental health effects: 1. Taking an exposure history. CMAJ. 2002 Apr 16;166(8):1049–55.

13. McKeown-Eyssen G, Baines C, Cole DE, Riley N, Tyndale RF, Marshall L, et al. Case-control study of genotypes in multiple chemical sensitivity: CYP2D6, NAT1, NAT2, PON1, PON2 and MTHFR. Int J Epidemiol. 2004 Oct 1;33(5):971–8.

14. Medicine I of. Chronic Multisymptom Illness in Gulf War Veterans: Case Definitions Reexamined [Internet]. 2014 [cited 2018 Sep 28]. Available from: https://www.nap.edu/catalog/18623/chronic-multisymptom-illness-in-gulf-war-veterans-case-definitions-reexamined

15. Kerr KJ. Gulf War illness: an overview of events, most prevalent health outcomes, exposures, and clues as to pathogenesis. Reviews on Environmental Health [Internet]. 2015 Jan 1 [cited 2018 Sep 28];30(4). Available from: https://www.degruyter.com/view/j/reveh.2015.30.issue-4/reveh-2015-0032/reveh-2015-0032.xml

16. Bernhardson B-M, Tishelman C, Rutqvist LE. Chemosensory Changes Experienced by Patients Undergoing Cancer Chemotherapy: A Qualitative Interview Study. Journal of Pain and Symptom Management. 2007 Oct;34(4):403–12.

17. Bernhardson B-M, Tishelman C, Rutqvist LE. Olfactory changes among patients receiving chemotherapy. European Journal of Oncology Nursing. 2009 Feb 1;13(1):9–15.

18. Lee TG. Health Symptoms Caused by Molds in a Courthouse. Archives of Environmental Health: An International Journal. 2003 Jul 1;58(7):442–6.

19. Marsh-Knickle L. The Effects of a “Sick Building” on Neuropsychological Functioning [Internet]. [Ottawa]: National Library of Canada = Bibliothèque nationale du Canada; 1994. Available from: http://m.library2.smu.ca/bitstream/handle/01/22669/marsh-kinickle_lauren_r_masters_1994.PDF

20. Molot J. Academic and Clinical Perspectives. Ontario Centre Of Excellence In Environmental Health. Chronic Complex Conditions [Internet]. Toronto, Ont.; 2013 Oct [cited 2018 Oct 17] p. 202. Available from: http://www.meao.ca/files/Academic_Clinical_Perspectives.pdf

21. Genuis SJ. Sensitivity-related illness: The escalating pandemic of allergy, food intolerance and chemical sensitivity. Science of The Total Environment. 2010 Nov;408(24):6047–61.

22. McIvor AE, Hewett MJ, Borges DS, Clements WS, Domanski PA, Evans RA, et al. ANSI/ASHRAE Standard 62-2001. Ventilation for Aeptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (2001):147.

23. Weschler CJ, Nazaroff WW. SVOC partitioning between the gas phase and settled dust indoors. Atmospheric Environment. 2010 Sep 1;44(30):3609–20.

24. Xu Y, Zhang J. Understanding SVOCs. 2011 Dec 1;53.

25. Hu H, Baines C. Recent insights into 3 underrecognized conditions: Myalgic encephalomyelitis–chronic fatigue syndrome, fibromyalgia, and environmental sensitivities–multiple chemical sensitivity. Canadian Family Physician. 2018 Jun 1;64(6):413–5.

26. Gibson PR, Elms AN-M, Ruding LA. Perceived Treatment Efficacy for Conventional and Alternative Therapies Reported by Persons with Multiple Chemical Sensitivity. Environmental Health Perspectives. 2003 Apr 9;111(12):1498–504.

27. Steinemann A. National Prevalence and Effects of Multiple Chemical Sensitivities. Journal of Occupational and Environmental Medicine [Internet]. 2018 Jan 11 [cited 2018 Jan 14];Publish Ahead of Print. Available from: http://journals.lww.com/joem/Abstract/publishahead/National_Prevalence_and_Effects_of_Multiple.98732.aspx

28. Steinemann A. Prevalence and effects of multiple chemical sensitivities in Australia. Preventive Medicine Reports. 2018 Jun 1;10:191–4.

29. Hauge AW, Kirchmann M, Olesen J. Characterization of consistent triggers of migraine with aura. Cephalalgia. 2011 Mar 1;31(4):416–38.

30. Kelman L. The Triggers or Precipitants of the Acute Migraine Attack. Cephalalgia. 2007 May 1;27(5):394–402.

31. Bay OR. Malingerer or Maligned: A Comparative Study of Multiple Chemical Sensitivity Case Law. 36:31.

32. Sears ME. The Medical Perspective on Environmental Sensitivities [Internet]. Ottawa, Canada: Canadian Human Rights Commission (CHRC); 2007 p. 86. Available from: https://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf

33. Wilkie C, Baker D. Accommodation for Environmental Sensitivities: Legal Perspective [Internet]. Ottawa, Canada: Canadian Human Rights Commission (CHRC); 2007 May [cited

2018 Oct 18]. Available from: https://www.chrc-ccdp.gc.ca/eng/content/accommodation-environmental-sensitivities-legal-perspective

34. Canadian Human Rights Commission. Policy on Environmental Sensitivities [Internet]. 2014 [cited 2018 Jun 20]. Available from: https://www.chrc-ccdp.gc.ca/sites/default/files/policy_sensitivity_0.pdf

35. BC Human Rights Tribunal. I was fired. Hill v. Best Western and another, 2016 BCHRT 92 ($2,500) [Internet]. [cited 2018 Nov 5]. Available from: http://www.bchrt.bc.ca/human-rights-duties/remedies/compensation/fired.htm

36. Alberta Human Rights Commission. Duty to Accommodate Students [Internet]. 2010 [cited 2018 Nov 5]. Available from: https://www.albertahumanrights.ab.ca/publications/bulletins_sheets_booklets/bulletins/Pages/duty_to_accommodate_students.aspx

37. Canadian Association of Statutory Human Rights Agencies (CASHRA). CASHRA Accessibility, Inclusion and Accommodation Checklist [Internet]. [cited 2018 Nov 5]. Available from: http://www.manitobahumanrights.ca/v1/news-events/latest-news-pages/cashra-accesibility-check-list.html

38. Ontario Human Rights Commission. Disability [Internet]. [cited 2018 Nov 5]. Available from: http://www.ohrc.on.ca/en/code_grounds/disability

39. School Scent Free Programs [Internet]. Canadians for A Safe Learning Environment. 2015 [cited 2018 Oct 18]. Available from: https://casle.ca/school-scent-free-programs/

40. International Fragrance Association (IFRA). Ingredients and transparency [Internet]. [cited 2018 Jul 17]. Available from: http://www.ifraorg.org/en/ingredients

41. Pizzorno J, Shippy A. Is Mold Toxicity Really a Problem for Our Patients? Part 2—Nonrespiratory Conditions. Integr Med (Encinitas). 2016 Jun;15(3):8–14.

42. Wild CP, Gong YY. Mycotoxins and human disease: a largely ignored global health issue. Carcinogenesis. 2010 Jan;31(1):71–82.

43. Hope J. A Review of the Mechanism of Injury and Treatment Approaches for Illness Resulting from Exposure to Water-Damaged Buildings, Mold, and Mycotoxins. The Scientific World Journal [Internet]. 2013 [cited 2018 Nov 25];2013(ID 767482). Available from: https://www.hindawi.com/journals/tswj/2013/767482/

44. Brewer JH, Thrasher JD, Hooper D. Chronic Illness Associated with Mold and Mycotoxins: Is Naso-Sinus Fungal Biofilm the Culprit? Toxins (Basel). 2013 Dec 24;6(1):66–80.

45. Heseltine E, Rosen J, World Health Organization, editors. WHO guidelines for indoor air quality: dampness and mould. Copenhagen: WHO; 2009. 228 p.

46. Stetzenbach LD, Amman H, Johanning E, King G, Shaughnessy R. Microorganisms, Mold, and Indoor Air Quality [Internet]. American Society for Microbiology; 2004. Available from: https://www.asm.org/ccLibraryFiles/FILENAME/000000001277/Iaq.pdf

47. Lappalainen V, Sohlberg E, Järnström H, Laamanen J, Viitanen H, Pasanen P. IAQ Simulator Tests: VOC Emissions from Hidden Mould Growth. Energy Procedia. 2015 Nov 1;78:1212–7.

48. Canadian Centre for Occupational Health and Safety Government of Canada. Respirators - Respirator Selection : OSH Answers [Internet]. 2018 [cited 2018 Nov 25]. Available from:https://www.ccohs.ca/oshanswers/prevention/ppe/respslct.html

49. Health Canada. Cosmetic advertising, labelling and ingredients [Internet]. Government of Canada. 2011 [cited 2018 Nov 1]. Available from: https://www.canada.ca/en/health-canada/services/cosmetics/cosmetic-advertising-labelling-ingredients.html

50. Ghisari M, Bonefeld-Jorgensen EC. Effects of plasticizers and their mixtures on estrogen receptor and thyroid hormone functions. Toxicology Letters. 2009 Aug 25;189(1):67–77.

51. Patel S. Fragrance compounds: The wolves in sheep's clothings. Medical Hypotheses. 2017 May 1;102:106–11.

52. MacNeill M, Dobbin N, St-Jean M, Wallace L, Marro L, Shin T, et al. Can changing the timing of outdoor air intake reduce indoor concentrations of traffic-related pollutants in schools? Indoor Air. 2016 Oct 1;26(5):687–701.

53. Satish Usha, Mendell Mark J., Shekhar Krishnamurthy, Hotchi Toshifumi, Sullivan Douglas, Streufert Siegfried, et al. Is CO2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO2 Concentrations on Human Decision-Making Performance. Environmental Health Perspectives. 2012 Dec 1;120(12):1671–7.

54. Vehviläinen T, Lindholm H, Rintamäki H, Pääkkönen R, Hirvonen A, Niemi O, et al. High indoor CO2 concentrations in an office environment increases the transcutaneous CO2 level and sleepiness during cognitive work. Journal of Occupational and Environmental Hygiene. 2016 Jan 2;13(1):19–29.

55. Allen JG, MacNaughton P, Satish U, Santanam S, Vallarino J, Spengler JD. Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. Environmental Health Perspectives [Internet]. 2015 [cited 2018 Dec 16]; Available from: https://dash.harvard.edu/handle/1/27662232

56. Pickett AR, Bell ML. Assessment of Indoor Air Pollution in Homes with Infants. Int J Environ Res Public Health. 2011 Dec;8(12):4502–20.

57. Oluwole O, Kirychuk SP, Lawson JA, Karunanayake C, Cockcroft DW, Willson PJ, et al. Indoor mold levels and current asthma among school-aged children in Saskatchewan, Canada. Indoor Air. 2017;27(2):311–9.

58. Liu W, Huang C, Li BZ, Zhao ZH, Yang X, Deng QH, et al. Household Renovation Before and During Pregnancy in Relation to Preterm Birth and Low Birth Weight in China. Indoor Air [Internet]. 2018 Dec 31 [cited 2019 Jan 24]; Available from: http://doi.wiley.com/10.1111/ina.12534

59. McDonald BC, Gouw JA de, Gilman JB, Jathar SH, Akherati A, Cappa CD, et al. Volatile chemical products emerging as largest petrochemical source of urban organic emissions. Science. 2018 Feb 16;359(6377):760–4.

6. Resources

Peer-reviewed environmental exposure / history questionnaires used in medical practice and research:

Taking An Exposure History. Ontario College of Family Physicians https://ocfp.on.ca/docs/default-source/committee-documents/taking-an-exposure-history.pdf
A mneumonic (CH2OPD2) helps to organize the history, and the forms provided can be given to patients to be completed at home and reviewed at a subsequent educational counselling visit:
Community, Home, Hobby, Occupation, Personal habits, Diet, Drugs

QEESI (Quick Environmental Exposure and Sensitivity Inventory). Dr. Claudia Miller.
http://www.chemicalsensitivityfoundation.org/chemical-sensitivity-questionnaire.html
The purpose of this questionnaire is to help identify health problems you may be having and to understand your responses to various exposures. Results support use of these scales individually or collectively for a variety of applications including the selection of chemically sensitive subjects and controls for research, assessment of chemical sensitivity in various study populations, cross-comparison of groups studied by different investigators, pre- and post-assessment of therapeutic interventions, clinical evaluation of complex patients who report intolerances, and teaching medical residents and students how to evaluate patients for chemical sensitivity and MCS.

Chemical Sensitivities at Work

Public Service Alliance of Canada. Multiple chemical sensitivity at work. Guide for PSAC members.
http://psac-ncr.com/guide/multiple-chemical-sensitivity-work-guide-psac-members
Full document (33pp): http://psac-ncr.com/sites/ncr/files/mcsguide2003-e.pdf

United Food and Commercial Workers offers courses in Multiple Chemical Sensitivities, as well as Electromagnetic Fields & Dirty Electricity.
http://ufcw.ca/index.php?option=com_content&view=article&id=30074&Itemid=2020&lang=en

Unifor Issues Fact Sheet includes Multiple Chemical Sensitivity Syndrome.
https://www.unifor.org/sites/default/files/attachments/index_hs_fact_sheets.pdf

Sine, Debra, Leslirae Rotor, Elizabeth Hare, Dr Michel Joffres, Tedd Nathanson P Eng.
"**Accommodating Employees with Environmental Sensitivities**," 2005, 51.
Available at: http://www.healthatworkpeterborough.ca/site/wp-content/uploads/accommodating-employees-with-envl-sensitivities-Nova-Scotia1.pdf Accessed October 18, 2018.

Health Canada Infographic: Maintain and improve indoor air quality

https://www.canada.ca/en/health-canada/services/publications/healthy-living/infographic-improve-indoor-air-quality.html

Citizens' Resources

Environmental Health Association of Quebec (bilingual)
http://www.aseq-ehaq.ca

Environmental Sensitivities Workshop Project (bilingual)
http://hypersensibiliteenvironnementale.com

No Scents Resources

Canadian Coalition for Green Health Care. Fragrance Free Implementation Kit
http://greenhealthcare.ca/safer-chemicals/fragrance-free-implementation-kit/

Canadian Centre for Occupational Health and Safety
Scent-Free Policy for the Workplace
https://www.ccohs.ca/oshanswers/hsprograms/scent_free.html

Scent-Free Zone Poster
https://www.ccohs.ca/products/posters/pdfs/scentfreezone.pdf

Women's College Hospital
https://www.womenscollegehospital.ca/patients-and-visitors/fragrance-free-policy/

Canadian Lung Association
https://www.lung.ca/lung-health/air-quality/indoor-air-quality/scents

Canadians for a Safe Learning Environment
School Scent Free Programs
https://casle.ca/school-scent-free-programs/

Canadian Mental Health Association
Scent Free Policy
https://reddeer.cmha.ca/about-cmha/scent-free-policy/

Canada Safety Council, Perfume in the Workplace
https://canadasafetycouncil.org/perfume-workplace/

Smoking Resources

Health Canada. Smoking, vaping and tobacco
https://www.canada.ca/en/health-canada/services/smoking-tobacco.html

Public Health departments of local municipalities may provide an informative presentation on detrimental effects of smoking and exposure to second hand smoke.

Non-Smokers Rights Association https://nsra-adnf.ca

Wood Smoke

Health Canada https://www.canada.ca/en/health-canada/services/air-quality/indoor-air-contaminants/avoid-wood-smoke.html

National Collaborating Centre for Environmental Health. Residential Use of Wood-Burning Appliances in Canada: Emissions, Health Effects, and Intervention Strategies. 2009. http://www.ncceh.ca/sites/default/files/Wood-burning_Appliances_Dec2009.pdf