Health risks associated with the indoor presence of moulds*

SUMMARY DOCUMENT

information

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INTRODUCTION

Over the years, the indoor presence of moulds has become a matter of concern for health professionals and for the general public. Over the past few years, more and more studies conducted in North America and Europe have revealed a potential link between the indoor presence of moulds and various health problems. Similarly, the number of requests addressed by citizens to Québec government agencies concerning this problem increased sharply in the 90s, giving reason to anticipate a growing problem.

In April 2000, the Ministère de la Santé et des Services sociaux mandated the Institut national de santé publique du Québec (INSPQ) to coordinate the production of a scientific report on the health risks associated with the indoor presence of moulds. To accomplish this mission, a Task Force was created, primarily composed of representatives of the public health network, especially the environmental health and occupational health sectors.

This document is a summary of the scientific report produced by the Task Force, which is based on an up-to-date literature review on the issue and on the opinions of internationally recognized organizations. This document is mainly intended for the stakeholders of organizations interested in management of indoor fungal contamination cases. Readers who wish to obtain more information on the subject should consult the full report, which presents the following sections in greater detail[1].

You should also note that, from March to July 2002, these documents were the object of a broad-based consultation of many Québec and Canadian organizations, primarily in the health and housing fields.

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* These data are excerpted from the scientific report "Health risks associated with the indoor presence of moulds", available on the Web site of the Institut national de santé publique du Québec at http ://www.inspq.qc.ca.

[1] It should be noted that the reader will also find a glossary and all the references consulted in the full version of the report.

Québec

"Fungal contamination" as discussed in this document refers to the uncontrolled growth of moulds on structures, furniture or other materials usually free of humidity, and in ventilation systems. It therefore does not include moulds found in small quantities in regularly damp areas such as bathtub rims or windows. This latter type of fungal growth is not considered problematic and can easily be eliminated by simple housekeeping. Moreover, the "indoor environment", as used in this document, refers to the indoor environment of homes and public buildings, that is, non-industrial and non-agricultural indoor environments.

MOULDS

Moulds consist of ubiquitous microscopic fungi that include thousands of species. These fungi produce spores that are invisible to the naked eye and that, in most species, can readily become airborne. Moulds can also produce chemical substances that may remain inside spores, or be released into the materials they colonize or in the air.

In temperate regions, the concentration and diversity of fungal species mainly vary according to the season and the availability of organic materials found in nature. In the Montréal region, Pineau and Comtois have shown that the greatest number of viable moulds in outdoor air is observed in September. They then range between 2,000 and 2,500 colony-forming units per cubic metre of air (CFU/m³). During the other months of the year, the spore counts barely exceed 500 CFU/m³.

Each mould produces a very large number of spores, the aggregation which, very often appears as a coloured, powdery form on the mould's surface. The diameter of the reproductive structures ranges from 2 to 250 µm, even though, for a large proportion of single spores, it varies between 2 and 20 µm. The spores can withstand extreme conditions; this favours their survival in different environments. They can be transported by air currents or by humans and pets and eventually end up in dwellings and buildings.

To germinate, spores need a sufficient quantity of water, essential nutrients (organic matter, particularly cellulose) and an appropriate temperature (between 10 and 40°C). The latter two conditions are normally encountered in an occupied indoor environment. The main factor contributing to fungal growth therefore remains the presence of available water, which can be due to problems of chronic infiltration, excessive humidity, surface condensation or a broken pipe or a flood. About thirty kinds of moulds are encountered regularly in contaminated indoor environments, the most frequent being *Cladosporium, Aspergillus, Penicillium* and *Alternaria*.

Several kinds of moulds can live off organic matter found in various construction materials. Paper and glue present on the surface of plasterboard, cardboard tiles used in suspended ceilings, glued wallpaper and particleboard are substrates easily broken down by moulds and readily retain water. Cellulose-containing products are increasingly present in recent construction and are excellent substrate for the growth of moulds, as well as are any accumulation of plant matter or organic dust.

There is little data available in Canada on the extent of mould contamination of housing and public buildings. The results of the few studies produced show that the proportion of dwellings faced with mould or excessive humidity problems ranges from 14% to slightly over 30%. As for the studies conducted on the number of species and spores viable in indoor air, most report values between 50 and 1500 CFU/m³. Many studies have been conducted in public buildings and schools where health problems had been reported, without being able to specify the proportion of buildings faced with fungal contamination. Finally, a Québec study on the assessment of mould contamination in mobile classrooms (modular buildings adjoining certain schools) recently showed that more than a third of these units exhibited substantial fungal contamination.

EFFECTS ON HUMAN HEALTH

When the conditions conducive to fungal growth are present indoors and are not controlled, moulds can proliferate, colonize various substrates and eventually end up in the ambient air. The effects of moulds on the occupants' health depend on the mode and extent of exposure, the nature of the agent in question and the susceptibility of the exposed individuals (health status, age, etc.).

In northern regions, such as Québec, where the average annual temperature is relatively low, people spend an average of 90% of their time indoors. Indoor exposure to moulds is therefore different from outdoor exposure firstly by its duration. It also differs by the proximity of fungal components sometimes present in high concentrations, by the possibility of simultaneous presence of sensitizing, allergenic and potentially toxic or infectious species, and by the possibility of differences in species or quantities present. Similarly, nonexistent or poor indoor ventilation contributes, in some cases, in increasing exposure to the different fungal components.

It should be noted that this chapter only discusses the health effects associated with moulds. The reader should consider that other contaminants, whether of biological or chemical origin, may also be present in the indoor environment, and that some of them are likely to result in symptoms similar to those caused by moulds (respiratory symptoms, irritations, allergies). Finally, it must also be noted that exposure to moulds does not necessarily result in symptoms in all exposed individuals.

Fungal components likely to cause harmful effects

Nearly sixty mould species have been listed as allergens by the National Committee for Clinical Laboratory Standards, even though any mould can theoretically contain **allergenic substances**. Studies of antigen extracts have made it possible to identify many substances responsible for allergic reactions, mainly proteins, polysaccharides and lipopolysaccharides. Among the main allergens, those produced by certain species of *Aspergillus, Penicillium, Alternaria* and *Cladosporium* have been isolated.

Glucans, or ß(1-3) glucans, are complex sugars present in the cell membrane of most moulds. In some cases, they may have immunogenic effects and stimulate the function of macrophages and

neutrophils. They could also be involved in the inflammatory process related to pneumonitis by triggering production of specific IgG. Glucans could also be part of the complex mixture related to the occurence of the organic dust toxic syndrome (ODTS[2]).

The metabolism of moulds produces **volatile organic compounds** (VOC), which are responsible for the characteristic odour associated with moulds. In fact, the very low olfactory detection threshold of some of these VOCs makes it possible to detect "mouldy" odours well before any visible signs of mycelial development appear on building materials. Symptoms of eye, nose and throat irritation have often been reported in the presence of strong odours produced by an abundant growth of moulds.

Mycotoxins are secondary metabolites with low volatility, developed by various moulds under certain environmental conditions. The mycotoxins are found in the mycelium and the spores and can diffuse into the substratum. A given mycotoxin (e.g. gliotoxin) is not necessarily specific to a single kind of mould. Similarly, a given mold (e.g. *Stachybotrys sp*) can produce several different toxins. The size of the particles containing them (e.g. spores, mycelia fragments) or on which they are adsorbed (e.g. dust) will determine the depth of penetration of toxic substances into the bronchial tree. Mycotoxins can cause different deleterious effects depending on their mechanism, the nature and extent of exposure and the susceptibility of the exposed subject. In the case of indoor exposure, the mycotoxins especially affect the respiratory system. Experimentally, hepatotoxic, neurotoxic, mutagenic, teratogenic, carcinogenic and immunosuppressive effects have been proved in animals. In agricultural and industrial settings, simultaneous exposure to various toxins has been associated with organic dust toxic syndrome (ODTS), among other health problems.

The cell wall and cytoplasm components of fungal cells, especially **complex substances with high molecular weight**, are immunogenic substances. Thus, as soon as they pass through the natural barriers of the skin and mucous membrane, these substances theoretically can trigger the production of specific IgG antibodies as well as a cellular immune response, following a hypersensitivity mechanism.

Exposure threshold concept

The occurrence of health effects related to fungal components necessitates direct contact with these components. Exposure can occur by inhalation or, to a lesser extent by skin contact or, more rarely, by ingestion. At present, no reliable data exists to establish a threshold below which there is no effect on health. There is also no reference list to evaluate the health risk for a given mould species. In fact, for an allergic person who is already sensitized to moulds, most indoor species can pose a risk of reaction, even in low concentrations. On the other hand, in the case of toxic effects, both allergic and non-allergic persons can be affected. However, it must be noted that repeated exposure or exposure to high concentrations seem to be necessary to induce a reaction. Finally, except for infections, the non-viable structures of a given species can be just as harmful as its viable structures.

[2] ODTS: Organic Dust Toxic Syndrome

Several authors recently proposed guideline values to classify the degree of contamination. Apparently the World Health Organization will soon propose a classification scale based on the proportion of the contaminated surfaces covered by moulds or on the fungal metabolite concentrations in the air, which will allow some grading of the health risk.

Populations at risk

Certain individuals or groups of individuals, because of their underlying health status, are more likely to develop health problems when exposed to fungal contaminants. The populations most often mentioned are atopic individuals, those suffering from certain diseases (e.g. cystic fibrosis), those suffering from respiratory problems such as asthma and chronic obstructive pulmonary diseases, infants and young children, the elderly and immunodepressed individuals, particularly in hospital settings. Since they generally spend more time indoors, the vulnerable people are also those most exposed.

Main health effects associated with moulds

Irritative effects

Symptoms of eye, nose and throat irritation have often been associated with the indoor presence of a fungal growth. However, the causal mechanism of the symptoms sensed or reported has not yet been established with certainty. The generally accepted hypothesis is that of the existence of a mechanical irritation phenomenon due to the fungal particles (e.g. spores, fragments) in the air coming into direct contact with the mucous membranes, combined with a chemical irritation due to the irritating or toxic products (e.g. VOC) contained in the spores.

Immunological reactions

The allergic reactions caused by inhalation of fungal spores are a health problem recognized by clinicians for decades. Allergic rhinitis and asthma are examples of allergic diseases, associated with, among other factors, exposure to moulds. In practice, the reactivity threshold varies from one individual to another. It also varies for any given individual depending on the kind of mould. It has also been proved that the severity of the reaction depends on a great many factors and is therefore not only proportional to the exposure dose. Studies have shown that 5% of school-age children had a positive reaction to mould extract tests. According to some authors, up to 10% of the population would react positively to these tests, while this proportion could be as high as 21% to 27% among asthma sufferers.

Immunological, or hypersensitivity, effects are also possible following exposure to moulds and other bioaerosols. In fact, chronic exposure in an industrial or agricultural environment to organic dust, and especially to moulds, can induce the production of specific antibodies (IgG) and cause a syndrome known as hypersensitivity pneumonitis or extrinsic allergic alveolitis. A recent study suggests that this disease could also arise in workers in offices contaminated with *Aspergillus versicolor*. Moreover, *Aspergillus fumigatus*, which can develop in highly contaminated environments, would also cause an allergic reaction known as allergic aspergillosis.

Infectious effects

Few moulds, among those growing on building materials or in ventilation systems, can be the cause of infections. However, invasive aspergillosis occurring in hospital settings, or nosocamial aspergillosis, is a relatively well-known infection. The mould responsible for aspergillosis is a pathogen, especially for debilitated individuals, which means that it is an opportunistic agent. Aspergillosis can have very serious, even fatal consequences for severely immunodepressed individuals. Moreover, exposure to fungi found in bird or bat droppings (*Cryptococcus neoformans*) and in soil contaminated by droppings (*Histoplasma capsulatum*) can cause an infection with flu-like symptoms, even in healthy people. However, exposure to these pathogens is very infrequent indoors.

Toxic effects

Most of the toxic effects caused by mould inhalation have been associated with exposure in industrial or agricultural environments, that is, in areas where the mould concentration is high and where exposure is repeated or chronic. Apart from the hypersensitivity pneumonitis already discussed, high exposure to organic dust contaminated by moulds could cause organic dust toxic syndrome (ODTS). This disorder can be characterized by a sudden fever, flu-like symptoms and respiratory problems occurring within hours of a single high exposure. More recently, symptoms associated with ODTS have also been noted in occupants of apartments highly contaminated by moulds as well as in workers performing renovation work.

The other toxic effects caused by moulds occur in cases of repeated exposure to environmental contamination, resulting in a high cumulative dose and manifest themselves over the medium and long term. The term "mycotoxicosis", mainly used in cases of poisoning resulting from the ingestion of mould-contaminated food containing mycotoxins, also refers, by extension, to the systemic effects due to environmental exposure to large doses of fungal toxins.

Since 1994, *Stachybotrys chartarum*, recognized to cause various mycotoxicoses, has been associated on some occasions with cases of pulmonary hemorrhage in young children. This is a rare syndrome of unknown origin, associated with bleeding in the lungs. Following these events, the American Academy of Pediatrics had issued a notice calling on physicians to look for exposure to toxic moulds upon discovery of cases of pulmonary hemosiderosis in children and to remove them from environments contaminated by such moulds. The review of the studies on the 1993-1994 outbreak showed that the etiological link was not clearly established. However, reports of similar cases continue to be published and the recent New York City Guidelines recommend that infants suffering from pulmonary hemorrhage who come from a contaminated residence only return home after remedial action.

Some recent articles report neuropsychological effects in people exposed to toxigenic moulds, such as difficulty concentrating, extreme mental fatigue, irritability, headaches, etc. Other systemic symptoms have been identified, such as a change in lymphocytes, fever and painful joints, as well as

gastrointestinal symptoms. However, additional research is necessary to confirm these observations.

Chronic diseases

There is very little data available on chronic diseases resulting from long-term exposure to moulds or their metabolites. The carcinogenic effect of mycotoxins in the concentrations encountered in residential, school or non-industrial settings has not yet been assessed

Epidemiological data and causal link

Many epidemiological studies of various health problems associated with damp conditions, moulds and their metabolites have been published in the past ten years. These studies have primarily focused on the respiratory and irritative effects and, to a lesser extent, on the toxic and systemic effects.

Similarly, in the late 90s, some organizations produced documents presenting the scientific consensus on the health effects of mould exposure. A group of experts assembled by the McMaster Institute of Environment and Health used the Bradford-Hill criteria to evaluate the results of epidemiological studies and determine the probability of a causal association. Almost all the criteria used (strength of the association, constancy, specificity, temporality, experimentation, dose-response relationship, biological plausibility, consistency) were met for non-specific irritative problems and certain respiratory symptoms. The Institute of Medicine (U.S.) expert panel assessed the quality of the epidemiological evidence available regarding different risk factors present in indoor air and the development and exacerbation of asthma. The group concluded that sufficient evidence exists of an association between mould exposure and the exacerbation of asthma and the development of non-specific respiratory symptoms.

Since the work of these two committees, other experimental, clinical and epidemiological studies have been published regarding the pathological mechanisms of various types of moulds and their effects on health. The INSPQ Task Force therefore reviewed these studies to update the weight of evidence. The reviewed studies complement each other, confirm the scientific consensus described in the preceding paragraph and make it possible to state that indoor mould exposure is a health risk varying according to the species encountered, the exposure dose and the subjects' individual susceptibility, and that the symptoms encountered affect several systems, especially the respiratory system. The main problems recognized as being associated with moulds are irritation, asthma exacerbation, and allergic and hypersensitivity reactions. Toxic reactions following a strong or repeated exposure as well as infections in severely immunodepressed subjects are also documented.

INVESTIGATIVE APPROACH FOR FUNGAL CONTAMINATION CASES

Cases of indoor fungal contamination can occur in various environments (single-family homes, rental buildings, housing cooperatives, office buildings, educational institutions, hospitals, etc.). In some cases, these contamination problems can be easily identified and resolved promptly. In other cases,

they will require a much more structured investigative approach.

The approach to follow in cases of fungal contamination will depend on the presence of visible moulds and the reporting of health problems. Depending on the environmental facts reported during gathering of the basic data and the summary description of the occupants' health status, it will be necessary to produce an initial hypothesis suggested by all of the facts gathered and that is compatible with the current state of knowledge in the field. Depending on the types of cases that may be encountered, the different situations that may result in a request on the part of an individual or a group of individuals can be classified in four categories:

1) *Cases of apprehended fungal contamination*[3]*, with no reported symptoms*

These cases usually arise when an individual requests advice, without the presence of specific symptoms or visible moulds. Often this involves a suspected risk due to the presence of a condition conducive to the growth of moulds (e.g. recent water damage, water infiltration, regular condensation, etc.) and/or the presence of vulnerable people on the premises. In these situations, after verifying the reporting data, the requesting party is generally referred to resources who can inform him about the appropriate preventive action.

2) *Cases of presumed fungal contamination*[4]*, with no reported symptoms*

In cases where fungal contamination is apparent (i.e. visible to the naked eye), either on the surface or behind materials[5], or when mould odours are perceptible and when no health problem is reported by the occupants, it is often sufficient to conduct a visual assessment of the extent of the contamination and then proceed with decontamination and correction of the underlying design or structural problems, without pursuing the investigation further. Similarly, given its strong association with mould proliferation, the presence of water infiltration, stagnant water or chronic excessive humidity in an indoor environment requires immediate correction of the underlying problem.

3) *Cases of apprehended fungal contamination in the presence of symptoms compatible with mould exposure*

In cases where health problems are reported by the occupants and where there is an absence of apparent contamination, the stakeholders should, when circumstances favouring fungal growth are present (water damage, chronic infiltration, etc.), consider these situations to be cases of potential fungal exposure. These cases should initially be treated in the same way as presumed fungal contamination and the same investigation strategy should be followed. If the first phase of the investigation does not detect any moulds, the medical and environmental data

[3] Suspected contamination: presence of certain circumstances that may be conducive to fungal contamination, but absence of any visible trace or perceptible odour of moulds.

[4] Presumed contamination: fungal contamination visible to the naked eye or presence of mouldy odours.

[5] Moulds behind materials becomes significant when it can be disseminated in the ambient air of inhabited rooms through cracks, electrical outlets, partition joints, etc.

available will have to be reevaluated to verify whether the initial hypothesis is maintained or whether the investigation must be reoriented to another type of exposure. If the initial hypothesis is maintained, it will be necessary to conduct a more detailed inspection and possibly even microbiological analyses of the environment.

4) Cases of presumed fungal contamination, in the presence of symptoms compatible with mould exposure

In cases where health problems are reported by the occupants and apparent fungal contamination is present, the stakeholders should initially proceed simultaneously with a basic environmental assessment and preliminary health data gathering. For the environmental assessment, it will be necessary to gather data allowing evaluation of the underlying conditions leading to the suspected presence of moulds. Moreover, when the occupants exhibit symptoms compatible with fungal exposure, health data gathering will consist of verifying the number of persons affected and the nature, date of appearance and distribution of the health problems reported. This phase must be carried out promptly to identify the health problems experienced by the occupants clearly. The case definition and the spatiotemporal link may contribute to formulation of the investigation's basic hypothesis. It should be noted that once the first steps of the environmental assessment have made it possible to identify and locate a precise fungal contamination zone, this situation can be corrected, even if the health database is not completed.

Sometimes rigorous inspection is unable to locate fungal growth sites or the contamination identified is insufficient to explain the reported symptoms. In these cases and in some other special situations, such as the persistence of symptoms after the remedial action or an outbreak affecting a large number of individuals, it may be necessary to conduct a detailed environmental investigation and/or a structured epidemiological study.

Environmental assessment

Environmental assessment is used to confirm the existence of fungal contamination, locate the sites where moulds are growing and, if applicable, estimate the extent of this contamination and the associated exposure. In more in-depth investigations, the environmental assessment will make it possible to identify the transmission modes of this contamination and identify the moulds present, as the case may be.

Basic environmental assessment

The basic environmental assessment, an essential phase of the investigation process, has the main objective of providing the basic information necessary to assess the prevailing environmental conditions likely to be related to the health problems reported by the occupants. It consists of gathering data such as the building history, isolated events, and recurring and chronic problems to assess the underlying conditions of fungal proliferation. Parallel to this information gathering, a basic inspection of the premises may be useful to document the extent of contamination or the severity of the underlying problems. This inspection often detects anomalies in materials, making it possible in turn to locate the sources of fungal amplification. In most cases, visual identification of the problem areas will be sufficient to justify the remedial actions required.

Detailed environmental assessment

The detailed environmental assessment (including resorting to microbiological analyses) should only be considered as an option under special conditions, such as when symptoms are observed in occupants but the suspected fungal exposure source could not be located. This assessment level makes it possible to identify the contaminants, if the need arises, and locate their source in order to eliminate and correct the underlying conditions of this contamination. The most important step is still the visual inspection, which should involve a rigorous examination of the premises to detect visible moulds and any signs that would arouse suspicion of its presence. This inspection will also allow identification of the locations where air samples and surface samples will be taken and where destructive tests (involving holes in walls or ceilings) will be performed, if necessary.

For any type of sampling chosen the laboratory analysis results will have to be interpreted by specialists in the field (e.g. microbiologists, hygienists, medical specialists, etc.). It is important to emphasize that there is no quantitative threshold defining indoor fungal contamination, whether for counts of fungal elements in the air or on surfaces, or for measurements of their emanations (e.g. VOC). This is why, for detailed assessments, the level of indoor fungal contamination will have to be estimated as accurately as possible by combining the size of the contaminated surfaces observed during visual inspection with a certain number of factors (types of moulds found, concentrations measured in the air, density of contamination observed on the sampled surfaces).

The presence of indoor fungal proliferation will be estimated by performing a relative, qualitative and quantitative comparison between the indoor and outdoor contamination. Contamination may be suspected when the total number of viable units (CFU/m³) indoors is greater than outdoors or when the relative proportion of the species discovered differs, or if several species found indoors do not exist in the immediate outdoor environment, even if there is little difference in the total counts.

Symptom evaluation

It is important to remember that evaluation of health problems is not always necessary to undertake remediation of an indoor fungal contamination problem. In fact, as already specified, when fungal proliferation is visible or when the basic environmental survey has identified situations conducive to fungal growth, it is recommended to take the necessary remedial action as soon as possible and decontaminate the premises, regardless of whether the occupants exhibit symptoms.

Basic data gathering on health problems

When the occupants of a given location complain of symptoms, it is first necessary to collect the basic data on their health status to verify whether the symptoms experienced are compatible with fungal exposure. It is then important to verify the number of persons affected, the date of appearance and, as the case may be, the distribution of the reported cases. This basic data gathering will make it possible to establish whether the hypothesis of environmental fungal exposure is still plausible while identifying the most severe cases as quickly as possible.

Data gathering during a detailed assessment of health problems

In general, a detailed assessment of health problems will not be considered before a certain amount of evidence has been accumulated in the study location, a basic investigation has been conducted and the compatibility of the symptoms with mould exposure has been established. Thus, it may be necessary to conduct a detailed assessment when the nature or severity of the symptoms indicates a serious health risk for the occupants, when the variability of the reported symptoms indicates a complex situation that must be documented, or when the situation necessitates the establishment of a causal association between the exposure and the health problems experienced by the occupants. This level of assessment should include a survey questionnaire to evaluate, in particular, the prevalence of the symptoms experienced by the occupants and their spatiotemporal variations depending on exposure to the prevailing environmental conditions.

Regardless of whether the situation encountered requires a detailed health survey, it is still recommended that occupants reporting symptoms consult their attending physician who will refer them to specialists as required (e.g. lung specialist, allergist, environmental health clinician, etc.). Diagnosis of a health problem associated with mould exposure remains complex and is explained by the fact that, in most cases, the signs or symptoms are not pathognomonic. In some cases, clinical tests can provide the additional information necessary to arrive at this diagnosis (e.g. X-ray, microbiological culture, respiratory function tests, evaluation of the immune function or inflammation indicator measurements).

Management of a fungal contamination problem

Cases of indoor fungal contamination are reported in various places, both in residential environments and in public buildings. The involvement of various stakeholders from the public sector in the management of fungal contamination cases depends on the type of building affected and the populations present.

Public buildings

When a fungal contamination problem occurs in a public building where workers and other occupants are present simultaneously, such as a school or a hospital, case management should remain under the responsibility of the manager of the institution in question. The investigation and response phases should be organized jointly by the institution, the Direction régionale de santé publique (environmental health and occupational health teams) and the CLSC (occupational health team) concerned. From the start of the investigation, the responsibilities of each partner must be clearly established, for each phase of the response. It is essential that the organizations involved work in close cooperation throughout the investigation and that an effective communication strategy be instituted, so that the people concerned by the problem (occupants, guardians, etc.) are kept informed of the roles and responsibilities of the different stakeholders and the results obtained, at every step of the investigation.

Furthermore, no specific criteria currently exists for the evacuation of a mould-contaminated building. According to the New York City Department of Health, systematic evacuation of a building that has

suffered contamination problems is not indicated except in cases of large-scale contamination, unequivocally linked to health problems considered to be compatible with fungal contamination exposure. The decision to remove people from a contaminated zone is generally made on an individual basis, depending on the clinical evaluation results.

The residential setting

The occupants of a dwelling faced with indoor fungal contamination and/or health problems attributed to the presence of moulds should first contact their local front-line services (e.g. CLSC Info-Santé health line, municipality, Régie du logement, consumer, tenant or property owners' associations) whose role in these situations is described in the *Guide d'intervention intersectorielle sur la qualité de l'air intérieur et la salubrité dans l'habitation québécoise* (Intersectorial response guide on indoor air quality and sanitation in Québec housing)[6]. According to the Ministère de la Santé et des Services sociaux, the Direction de la santé publique can intervene at the request of the front-line stakeholders in cases likely to affect several people and can cooperate with other government agencies, as required. In some cases, the owner, the property manager or sometimes even the tenant confronted with an indoor fungal contamination problem will have to resort to private enterprise (indoor air quality consultants, decontamination firms, renovation companies, etc.) to obtain an assessment or take the necessary remedial action. We should point out that no certification system exists in Québec for this type of business, nor is there any standardized sampling protocol for laboratories. In this context, it is therefore essential to choose a company based on other criteria, several of which are proposed in the above-mentioned guide.

[6] Ministère de la Santé et des Services sociaux (MSSS), 2001. *Guide d'intervention intersectorielle sur la qualité de l'air intérieur et la salubrité dans l'habitation québécoise.*

OVERVIEW OF PREVENTIVE AND REMEDIAL ACTION

Remedial action should be initiated as soon as fungal contamination is located or the extent and nature of water damage is known. Control of the main conditions conducive to development of moulds is the simplest and most effective way to reduce their proliferation and concentration inside a dwelling or a public building. The application of preventive or remedial action is the responsibility of building managers and owners.

Preventive action[7]

In general, problems of high relative humidity or the presence of water inside a building are caused either by isolated incidents (broken pipe, flood, sewer backup, etc.), or by chronic infiltration problems (roof, fenestration, cracked or porous foundations), or by chronic condensation problems due to poor insulation, a deficiency of the vapour barrier or air barrier (exterior walls, roof, attic), or by insufficient ventilation for certain human activities (indoor

[7] The reader should note that much more detailed information on the actions required to prevent situations conducive to the indoor proliferation of moulds can be obtained by consulting the documentation produced by Canada Mortgage and Housing Corporation or other organizations specializing in the housing field.

storage of firewood, cooking in the absence of ventilation, etc.). Efforts should primarily focus on adequate preventive maintenance in order to prevent fungal growth. This should include regular visual inspection of the building structures (foundation, roof and windows) to detect any trace of water infiltration or mould proliferation and to correct any design defects; also should be included cleaning of humidifiers and dehumidifiers, air conditioner and air filtration equipment.

It remains difficult to prevent the development of moulds in places where organic matter and water accumulate repeatedly, such as the bathtub rim, sinks or windows. In this case, regular housekeeping will control the proliferation of surface moulds, preventing its potential penetration into the materials. However, the presence of moulds in places that are usually mould-free (on walls, behind furniture, etc.) or behind structures, can conceal an invisible problem, such as water infiltration or major local condensation. In these cases, it remains essential to identify the cause in order to determine the appropriate remedial action quickly and efficiently.

Remedial action

When rooms are contaminated, the actions to be undertaken involve eliminating the moulds that proliferate on the surface and behind the walls and ceilings, and cleaning the adjacent surfaces. During the work, it is important to make sure that the moulds are not dispersed into the neighbouring rooms. It is also essential to eliminate the causes of fungal proliferation at the source. Otherwise the proliferation can resume when environmental conditions allow it. For all contamination levels, the general approach remains the same: visual inspection, correction at the source, decontamination of rooms and rehabilitation of the premises. However, it must be noted that the decontamination process varies according to the scope of the problem and the nature of the contaminated materials.

Most organizations agree on the cleaning and decontamination process[8]. Some organizations have described decontamination of premises from the perspective, among others, of protecting the occupants and workers assigned to decontamination work[9]. Depending on the visible mould surface, these documents suggest different degrees of containment of the site and protective measures for the workers who will perform the decontamination work. They also emphasize the importance of ensuring that individuals suffering from lung diseases or allergies or who are immunodepressed are not present in the contaminated rooms or in the adjacent rooms during the remedial work.

TASK FORCE FINDINGS

The INSPQ scientific report has been produced to support the establishment of a Québec public health position on the health risks associated with the indoor presence of moulds and to provide a tool to any stakeholder confronted with a case of fungal contamination in a dwelling or a public building. Its

[8] Canada Mortgage and Housing Corporation has produced many documents on the subject, tailored to the general public.

[9] New York City Department of Health, 2000. *Guidelines on assessment and remediation of fungi in indoor environments*; American Conference of Governmental Industrial Hygienists, 1999. *Bioaerosols: assessment and control*.

production, based on abundant scientific literature on the subject, has allowed the following findings:

- the main determining factor in fungal proliferation indoors remains the presence of water, whether in the form of excessive relative humidity, condensation on surfaces, free water inside materials or stagnant water in rooms or premises;
- little data is available on the extent of contamination of dwellings and public buildings by moulds and excessive humidity in Québec, even though the growing number of requests addressed to government agencies give reason to anticipate a growing problem;
- several fungal components are likely to cause harmful effects in an exposed individual, whether these be spores, certain substances produced by moulds (e.g. mycotoxins, volatile organic compounds) or certain cell wall constituents (e.g. glucans); there are therefore potentially multiple health effects;
- the effects of moulds on the occupants' health depend on several factors, including the nature of the agent involved, the extent and type of exposure, and the susceptibility of the exposed individuals (health status, age, etc.);
- some individuals or groups of individuals, because of their health condition, are more susceptible to developing health problems when they are exposed to fungal contaminants (e.g. atopic (allergic) individuals, persons suffering from certain respiratory disorders, infants and very young children, the elderly and severely immunodepressed individuals);
- there is a consensus on the association between exposure to indoor moulds and certain health effects, at least with regard to eye, nose and throat irritation, non-specific respiratory symptoms and exacerbation of asthma;
- even though it is mainly documented in workers heavily exposed in agricultural or industrial settings, organic dust toxic syndrome (ODTS) and hypersensitivity pneumonitis could also occur occasionally in highly contaminated non-industrial environments (e.g. office buildings, apartments);
- the indoor environment may contain non-fungal contaminants likely to trigger the symptoms reported above; this should be considered when health problems related to the indoor environment are investigated.

CONCLUSION

Given the data gathered by this Task Force, it is appropriate, within a public health perspective, to be concerned about problems of indoor proliferation of moulds and the conditions conducive to their growth. Consequently, the INSPQ Task Force on Moulds believes:

- that a mould-contaminated indoor environment is a risk to the health of the occupants who are exposed, particularly in the case of vulnerable individuals;
- that the frequency and severity of the disorders associated with this risk vary depending on the type of health problem:
  - the risk of irritation and non-specific respiratory symptoms, which are generally slightly to moderately severe, is the risk that most often affects the exposed population;
  - the risk of allergic and asthmatic reactions, health problems that may occasionally be

severe, only affects subjects predisposed to atopy (allergies);
  - hypersensitivity reactions, which are often severe, are at the present time, infrequently reported in residential and non-industrial work settings;
- that the health risk is increased in hospital settings, given the presence of a population at high risk of opportunistic infection. These are rare but often fatal infections. In these circumstances, the emergency of the response depends on the type of patients, the care sectors and the existence of risky procedures
- that any "fungal contamination"[10] on the surface of building materials or behind them in an indoor environment, as well as any condition conducive to it (e.g. water infiltration, stagnant water, condensation on the building structures) are unacceptable situations from a public health standpoint and must therefore be corrected.

[10] The meaning of "fungal contamination" as used in this document has been defined in the introduction.

HEALTH RISKS ASSOCIATED WITH THE INDOOR PRESENCE OF MOULDS
Summary Document

Taken from: Health Risks Associated with the Indoor Presence of Moulds

Authors: **Marie-Alix d'Halewyn, Jean-Marc Leclerc, Norman King, Marcel Bélanger, Michel Legris, Yves Frenette**

Coordinated by: **Maurice Poulin**

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