Understanding Mold Toxins and Infections

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The allergenic and asthmatic effects of mold spores are well established. It is also well known that the susceptibility to mold varies widely among individuals. Allergic affects are expected to comprise the large majority of effects on healthy individuals. People with compromised immune systems or other severe health problems are more susceptible to the other health impacts from mold, which we will consider in this article. Certain drugs such as steroids have immunosuppressive effects, such as may be prescribed for back problems, so we shouldn't limit our concern of mold infection or other diseases to visibly frail or sickly people.

We have come a long way in understanding "toxic black mold," as was hastily attributed the cause of the death in the well-publicized occurrence in Cleveland Ohio in 1994 that resulted in a rash of infant deaths. The understanding of the cause of death has since been refuted as not including the other factors involved including heavy exposures to tobacco smoke and possible exposures to bacterial endotoxins or other pathogenic substances. [1] The specific black mold implicated (*Stachybotrys spp.*) is not considered infectious in humans although culturable spores have been recovered from lungs. The health risk appears to be associated with the accumulation and degradation of the spores in the lungs. The potential toxic or other health effects that could result from mycotoxins or other mold-related substances are still not well understood.

What are Mycotoxins?

Mycotoxins ("Mold toxins") are small and light weight molecules produced by molds as part of their metabolism. Some of the toxins have the secondary effect of being toxic to other molds, which enables them to better compete for food, moisture and surface area. Mycotoxins interfere with RNA synthesis and may cause DNA damage. Mycotoxins, even in minute quantities, are fat-soluble and readily absorbed through the intestinal lining, airways, and skin. [2]

One of the most toxic substances known to man, Aflatoxin, occurs associated with fungi that grow on nuts, seeds and grains. Aflatoxin is suspected to be the main culprit in the rise in peanut allergies, although the scientific explanation remains elusive.

Many mycotoxins are proven carcinogens in laboratory animals or from epidemiological studies. The cancers generally affect the digestive organs (e.g. liver or gall bladder) or kidneys. Foods commonly associated with molds (e.g. nuts and cheeses) are required by the FDA to be routinely tested for the most harmful and common toxins from food molds. Organic foods such as spices and herbs have been found to contain higher levels of mycotoxins (but within FDA health standards) due to the absence of the use of any fungicide. [3]

Mycotoxins are also suspected to have endocrine disruptive effects, particularly targeting estrogen, androgen and thyroid hormones either by mimicking the hormone or by binding to and thereby blocking the function of certain hormones. [4] Strictly speaking, endocrine disruption is a "non-toxic" effect.

The most common mycotoxins are Aflatoxin, Trichothecenes, Ochratoxin, and Gliotoxin. Some mycotoxins may be generated from the normal and healthy conditions in the body. For example, *Candida spp.*, which is commonly found in the body can produce Gliotoxin. [8]

A majority of mycotoxins do not appreciably bioaccumulate and are believed to have a short-half life in the body and begin to be excreted as quickly as 24 hours after exposure. Trichothecenes (linked predominantly with *Stachybotrys spp.*) have a short half-life of a few hours in the body. One exception is Ochratoxin, which has an estimate half-life of 35 days in the body due in part to its unusual ability to bind to plasma proteins.[5] Because of the short residency time in the body of a majority of the mycotoxins, the clay and charcoal binders and other health supplements sold for "mold detoxification" are unnecessary and generally considered to be one of many naturopathic scams.

It has been reported that approximately 25% of people have a gene (HLA-DR) that predisposes a person to the effects of mycotoxins. This gene reputedly causes a misprocessing of antigens, which inhibits the immune system from reacting correctly to infections and toxins.[6]

Molds do not always produce spores or mycotoxins. In the ideal environment, they can grow "fat and happy." However, in my experience in a majority of cases of mold in buildings there is sufficient competition between molds and bacteria for food and sufficient environmental disturbance to cause mold spore production, which is a probable indicator of mycotoxin production. It is rare to find a mold problem without evidence of mold spore impact to air. One study estimated that as *Stachybotrys* dries, the mycotoxin production increases up to 40,000 times.[7]

Mycotoxin production can vary within a species depending on a combination of poorly understood environmental factors including the substrate, type of food source, amount of light, temperature as well as the maturity of the colony.[12]

Mycotoxins production can vary within a species or even

within a strain of species, particularly as observed for *Stachybotrys spp.*, further complicating our understanding and studies of mycotoxins. [9]

Additional substances released by degrading mold include enzymes and glucans, both of which can be irritating and evoke an immune system response. [1] At this time, these substances would appear to be secondary to or part of the exposure response to mycotoxins.

Mycotoxins should not be confused with mold VOCs (Volatile Organic Compounds), which are also produced by mold. It is generally well established that humans, pets and even building products emit some of these compounds. There is no evidence that they cause health concerns as they are present in water damaged and moldy buildings at levels well below toxic levels.[2] Human odor detection of certain mold VOCs and mycotoxins such as observed with the so-called "musty odor" rivals or even exceeds some analytical detection methods![12] Mycotoxins explain the hallucinogenic properties of certain mushrooms associated with recreational drug use.

Infectious Health Impacts

One of most common infectious health impacts from mold is Chronic Rhinosinusitis (CRS), more commonly called "sinusitis." It was estimated from a study in 2006 that approximately 14% of the US population suffers from chronic sinus problems. This can include various respiratory symptoms including constant cold-like symptoms, pain and tenderness of the face, fatigue and ear pain. Infections can result in growths within the sinuses. [10] One study indicated culturable fungi recovered in 64% of cases but due to the ubiquitousness of viable mold spores, it was estimated fungi alone was only identified as the primary cause in 5-10% of sinus infection cases. [13]

Fungal respiratory infections are far more likely to occur in asthmatics or persons with lung disease such as cystic fibrosis. It is estimated that 0.25-0.8% of asthmatic children suffer from Aspergillosis, one of the most prevalent of these diseases. [1]

Infectious health impacts from mold remain far more significant in occupational settings, where exposures are typically higher than in residential settings.

Non-Infectious or Sub-Clinical Infection Health Impacts

Hypersensitivity pneumonitis is a respiratory disease in which the repeated inhalation of certain antigens provokes a hypersensitivity reaction. Most commonly the causative agents include animal proteins and certain chemicals (e.g. diisocyanates). A majority of disease occurrences are occupational (e.g. food workers). One study of 86 child patients attributed 17% to mold. Genetics plays an important role in determining susceptibility to the development of hypersensitivity pneumonitis, because only a small proportion of exposed persons are affected. Studies have linked susceptibility to a certain gene. The most common fungal agents associated with hypersensitivity pneumonitis in children include *Cladosporium*, *Epicoccum*, *Penicillium*, and *Stachybotrys spp*. [12]

Mold exposure has also been linked by some with Chronic Fatigue Syndrome, fibromyalgia, hypothyroidism and various other hormonal disorders, neurological disorders (tremors, vertigo, extreme sound and light sensitivity etc.) and even dementia and Alzheimer's Disease. One study showed that 92% of a group of 112 patients with fibromyalgia and chronic fatigue syndrome that resisted conventional treatment tested positive in a urine test for mycotoxins.[11] These assertions remain controversial and many of the doctors involved in these studies have been linked to "alternative medicines" and publish studies in lesser known publications that do not require stringent peer review. Some authorities claim that mycotoxin exposures may mimic the symptoms of other diseases or accelerate but not cause these largely unexplained medical conditions.[14]

Ingestion and Inhalation of Mycotoxins

The toxic effects from ingestion are well understood (e.g. eating moldy peanuts) due to numerous case studies and controlled studies of animals ingesting mold-impacted foods as well as case of studies of human poisonings. Research suggests that mycotoxins may play a role in people who suffer dietary problems from gluten. The hypothesis is that the wheat and other grain products associated with gluten contains various mycotoxins. [15,16]

Toxic effects from mycotoxins from inhalation due to building exposures remain more difficult to quantify. One of the leading and fully independent experts in the field, Dr. Harriet Burge of Eurofins EMLab, claims that there is no scientific evidence proving health impacts from mold metabolites (excluding unusual agricultural and occupational circumstances that don't apply to people in moldy homes). However, it is understood that as with other various air quality contaminants, mold toxins in air could be additive or even synergistic. More research of this is needed!

Mycotoxin Biofilms

In some respiratory infections, a "symbiotic" fungal-bacterial biofilm develops. This film helps protects the infecting fungal cells from the host's immune system response. This helps possibly explain the chronic persistence of fungal infection well after the mold problem has been corrected and the mold exposure eliminated. This embedded fungal colony serves as a source for the production of mycotoxins.

How to Test for Mycotoxins

Testing of mycotoxins in blood serum, nasal fluid and urine can be performed by a doctor. The cost is about $400-

700, depending on the specific test utilized. You can also order a urine test kit online. The methodology for testing of mycotoxins in body fluids is controversial. According to Quackwatch.org, the prevailing medical opinion is that it is of unproven diagnostic utility and that health standards for mold toxins in urine have not been developed. There is no assurance that mycotoxins are being efficiently excreted in a sick individual. Furthermore, these tests have not been approved by the Center for Disease Control (CDC) or the Food and Drug Administration (FDA). While the tests have not been scientifically proven based on the rigorous and legally-defensible validation requirements of the medical field, a test could provide anecdotal and useful information in some circumstances, particularly if a very low or high result is obtained or if a carefully controlled methodology is utilized and applicable excretion rates are accounted for. If someone has persisted for years with undiagnosable or untreatable symptoms by conventional medicine, it is understandable if people look to unproven medicine for answers.

Mycotoxin testing of blood has proven problematic. In a study of the blood levels of trichothecene in 33 patients, the results did not show any significant difference between mold symptomatic individuals compared to the 17 non-symptomatic persons used as controls, possibly explained by the rapid removal from the blood. [18]

One published article demonstrated an anecdotal connection between the tissue cultures of surgically removed nasal polyps with mycotoxins in urine samples. The cultured mold type *Aspergillus Niger* is a producer of Ochratoxin, which was found elevated in the patient's urine sample. [10]

A study of people suffering from CRS determined that viable mold was recovered from their sinuses, including *Aspergillus (flavus, niger, fumigatus, versicolor), Chaetomium, Fusarium, Penicillium and Trichoderma spp*. In addition, other trapped mold particulate was recovered including hypha, conidia and spores. However, positive swab cultures from nasal mucous were found in 91% of patients and 91% of healthy individuals used as controls, indicating their mere presence is not diagnostic of a problem. However, a study of nasal washings showed that mycotoxins could be detected in the infected individuals but was not present in the healthy control group. This suggests the nasal washing method may be the most useful of all the proposed medical mycotoxin tests.[17]

The testing for antibodies to mold (immunoglobulin E) is less expensive. However, these tests are not helpful except in the case of very unusual circumstances that cause unusual molds to grow since nearly everyone has been exposed to and therefore carries antibodies to all the major types of mold. Blood tests for specific antigens or antibodies have been shown to be useful in the diagnosis of some fungal infections, but these are the exception not the rule. [19] One laboratory advertises for blood serum testing for identification of 12 common antibodies to mycotoxins for a cost of $380. This laboratory operates offshore and does not include any official certifications. These tests are problematic because there are a number of interferences and a lack of discrete specificity among most antibodies (e.g. many antibodies cannot be conveniently linked to specific mold types, *Histoplasma spp.* being a notable exception).[19]

Unfortunately, current laboratory detection methods do not allow for reliable detection of mycotoxins in an air sample. For environmental testing, the principal means of testing these trace substances is with a sterile gauze wipe of a dense accumulation of dust. A target sample of at least 3 grams of dust is needed to achieve the recommended detection limit, which can be difficult to obtain in clean homes. This method of dust testing in a home remains relatively expensive, generally starting at about $400 per sample. Fortunately, it has been reported that composite samples from multiple locations of the home are appropriate and reliable predictors of exposure. Therefore, typically only one dust sample is needed unless there are distinctly different mold problems within a large home. The identification of specific species of mold in dust can be diagnostic for fingerprinting purposes. However, like mold spore air tests, there are no health standards and little published data on normal background levels. Therefore, unless a sample results are very low or very high, the test results are rather subjective in nature and can be difficult to interpret.

Mycotoxins as an Indicator for Nanotoxins

Mycotoxins are not only linked to spores, conidia and hyphae. Recent research interest has increased in fine mold fragment cell debris, enzymes and other metabolic residues (crudely known as mold "nanotoxins"). The black mold *Stachybotrys chartarum* as well as other molds and bacteria produce large quantities of very fine nanometer range fragments (0.03 - 0.3 microns in diameter) when compared to airborne spore counts. These nanotoxins are too small to be seen in an air test. However, the number of nano-sized mold fragments present are estimated to be least 300 times greater than the spore counts. The respiratory deposition of these fine fungal fragments has been measured at 230 times that of spores. [20]

Due to the difficulty in measuring nanotoxin fragments, additional research is needed to understand how much health impact is associated with these nearly invisible mold particles. Bulk mycotoxin dust samples include the mycotoxin contributions from these tiny particles in addition to the larger mold spores, hyphae and conidia. In certain situations where a mold source has been eliminated,

the larger cellular mold particulate may be degraded but a substantial amount of smaller mold nanotoxins may remain from the initial stage of the decomposition process.

A Case Study on Mycotoxin Testing

A recent mold remediation industry webinar featured a case study involving mycotoxins. A house was known to have persistent water-damage problems from mold for a number of years, causing chronic illness of a resident. After the problem was corrected and all mold cleaned up, the resident's symptoms did not clear up. Mold spore testing indicated the house was fine with no evident mold problems. Follow up dust testing discovered elevated levels of mycotoxins. A subsequent thorough inspection of the home found that a custom-built wood enclosure was built over a sump pump in the basement. The malfunction of the sump had caused saturation of the interior cabinet of the wood, causing suspect mold and bacteria growth. Unfortunately, testing of the wood was not performed. The resident was also not medically examined for fungal infection. After the cabinet was removed and the house cleaned, a re-test of the dust was performed, resulting in non-detectable levels of mycotoxins. [21]Due to the insufficient control of the variables in this case study including testing for bacterial endotoxins, it was inconclusive whether the mycotoxins could be linked to past problems, the moldy wooden cabinet or the resident's health problems. A valuable opportunity to better understand mycotoxins was lost!

Conclusions

Mold spore testing of air samples will remain the dominant measure of assessing mold impact in the near future. Dust testing has some practical uses but will remain cost-prohibitive for most typical mold assessment and remediation options. There is a need for the development of new test methods involving mold degradation products including nanotoxins. Medical test methods involving mycotoxins remain costly and largely experimental. Those of us in the industry can look forward to and hope for new and more affordable test methods to be developed with an increase in sensitivity as well as a better understanding that the role that mycotoxic particulate may play in health effects.

An improved understanding of how mold affects the body demonstrates that correcting a mold problem will not necessarily result in a reduction of chronic health symptoms. People who live in a mold remediated home should be evaluated by a doctor. Clinical or subclinical respiratory infections could persist, particularly if a resilient biofilm is present in their sinus. Antifungals may be prescribed to eliminate any low level infections but sometimes surgical polyp removal or other invasive procedures may be required. One study of mycotoxin exposed individuals showed that 90% had a dramatic improvement in health after medical treatment.[22]

There are many diseases and disorders that have not been adequately explained to date. We should keep an open mind to mycotoxins or other mold-related health impacts being linked to their cause.

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