Molds and Mycotoxins in Autopsy Specimens in a Death Related to Fungal Pneumonia and Pancytopenia, Marijuana Usage and a Water-Damaged Home: A Case Report

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Abstract: A 31 year old male was exposed to high levels of mold spores (up to 29,000 spores/m³) in a newly constructed home in October, 2000. Upon moving in he began to have multiple health complaints, developed pancytopenia and died from respiratory failure and cardiac arrest 4½ years later. He used marijuana for 15 years prior to his death. No other personal or health issues were present. Realtime PCR DNA tests on tissue samples obtained at autopsy identified *Aspergillus flavus* and *niger* in the liver, *Penicillium fellutanum* and *A. niger* in the lungs, and *A. niger* in the brain. Other mold DNA detected in lesser concentrations included *Penicillium chrysogenum*, *A. versicolor*, *sydowii* and *Eurotium (formerly Aspergillus) amstelodami*. Trichothecenes (2.5-3.25 ppb) and aflatoxins (6.0 ppb) were detected in the lungs and liver, while the brain was positive for trichothecenes (2.05 ppb), aflatoxins (5.5 ppb) and ochratoxins (170 ppb). The data and observations are discussed with respect to marijuana use and exposure to mold in damp indoor spaces. Because the man was well before moving into the home, then became very ill and eventually expired it is concluded that the home exposure was most likely the principle cause of illness and death. However, it is also recognized and discussed that chronic use of marijuana may have contributed to the situation.

Keywords: PCR DNA, Aspergillus, Penicillium, aflatoxins, ochratoxin, trichothecenes, lungs, liver, brain, pancytopenia, mycoses, mycotoxicosis, construction defects.

INTRODUCTION

Water damage to homes and buildings (WDB) leads to growth of molds and bacteria [1-8]. By-products of the microbial growth include: 1-3-β-D-glucans [9-13], endotoxins [13, 14], particulates less than one micron), a variety of mycotoxins [15-21], exodigestive enzymes, and actinobacteria and secondary metabolites [21 -25], and Microbial VOCs [26, 27].

Occupants of these environments develop multiple health conditions that include: Neurological manifestations [28-33]; upper and lower respiratory infections [34], asthma, hypersensitivity pneumonitis, aspergillosis and respiratory morbidity [35-39]; fungal sinusitis [22, 40-43]; chronic fatigue [44], sarcoidosis [45, 46], and immunotoxicity [47] and neuroendocrine dysregulation, leading to endocrine system disruption [42].

We present here an immune competent young man, who used marijuana for 15 years prior to exposure to mold in his new water-damaged home from October 2000 through May 2001. In March, 2001 coincident with developing a septic knee, he developed neutropenia, and thrombocytopenia that developed into pancytopenia. By July, 2001 he acquired bi-basilar fungal (*Aspergillus*) pneumonia. His condition and health improved after 10 months of anti-fungal therapy. He was re-exposed to mold in a second water-damaged home in June 2004, and on January 23, 2005 developed respiratory failure and died from cardiac arrest. RT-PCR detected fungal DNA in autopsy specimens along with mycotoxins identified by an ELISA method. It is proposed that mycotoxins suppressed his bone marrow creating the window of opportunity for pulmonary aspergillosis from which he recovered in July, 2001, only to succumb to the systemic fungal infection in January, 2005, as a result of the continuing effects of his untreated aspergillosis and confirmed mycotoxicosis. The potential role of marijuana in his death is also discussed.

The Patient

The family moved into a newly constructed home in October 2000. The husband, age 31, an immune competent individual, immediately began experiencing health problems as outlined below. The wife was unaffected. His health history prior to the move in was as follows: childhood immunizations (small pox, measles, mumps, and vaccinations for polio and DPT and, tetanus); no allergies and negative TB tests. He smoked marijuana weekly for 15 years. He had two accidents: (1) fell while skate boarding (June, 1999) causing multiple abrasions of elbow, wrist, face, chin
laceration and cerebral concussion; (2) In April 2000 he fell on the left hand sustaining fractures of intraarticular surface of the left radius and left scaphoid. He recovered from both injuries. He used over the counter Ranitidine beginning March, 2001 for epigastric pain secondary to a *Helicobacter pylori* (*H pylori*) infection. This was discontinued after his first hospital stay.

The patient worked full time as a retail salesman and as the owner/manager of a ski/snowboard shop in Breckenridge, Colorado prior to his illness. He used workplace solvents, degreasers, cleaning fluids and epoxy glues associated with snowboard repair. The chemicals were used under fume hood, but resulted in some exposure. He stated that no adverse effects occurred from these exposures. He did not develop allergies to the epoxy glues.

**Fungal Exposure and Re-exposure**

The family (patient and wife) moved into a new home in October, 2000. The patient began experiencing multiple symptoms that eventually required hospital stays (Tables 2-5 for history of Hospitalizations and treatments). In May, 2001 they noted water staining and inspection of the attic by the patient revealed mold growth (Figure 1). The indoor counts for nonviable mold spores exceeded outdoor counts by several fold. The greatest concentration of spores (29,097/m³) was detected in the attic (Table 1). An industrial hygienist confirmed the presence of *Aspergillus fumigatus* and *versicolor*, along with *Myrothecium* and several species of *Penicillium* using bulk samples and malt extract cultures. After recovering from the pneumonia post amphotericin antifungal therapy was begun (see below). Re-exposure to a fungal contaminated home occurred on May, 2004. The patient's wife was away on a business trip and the patient spent 6-7 hours per day for 2 weeks visiting the friends' home, watching TV and eating meals. The home had water intrusion as indicated by water staining of dry wall and presence of visible fungal growth. Though recommended by the patient's treating physician, mold testing was not performed on this home because the plaintiff's attorneys advised the

**Figure 1**: These photos show the extent of fungal growth in the attic. Total nonviable spore counts were >29,000/m³.
family against it claiming that the findings would compromise their legal case.

**History of Illness** (See Table 2): On 10/18/00 he was diagnosed with non-bacterial conjunctivitis and

### Table 1: This Table Summarizes the Results of the Identification of Non-Viable Airborne Mold Spores

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Outside Air</th>
<th>Crawl-Space</th>
<th>First Floor</th>
<th>Second Floor</th>
<th>Attic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria</td>
<td>ND</td>
<td>ND</td>
<td>22</td>
<td>22</td>
<td>178</td>
</tr>
<tr>
<td>Ascosporides</td>
<td>53</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>178</td>
</tr>
<tr>
<td>Aureobasidium</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>6,222</td>
</tr>
<tr>
<td>Basidiosporides</td>
<td>320</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>889</td>
</tr>
<tr>
<td>Cladosporum</td>
<td>187</td>
<td>178</td>
<td>533</td>
<td>1,067</td>
<td>20,089</td>
</tr>
<tr>
<td>Epicoccum</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>220</td>
</tr>
<tr>
<td>Myrothecium</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>22</td>
<td>ND</td>
</tr>
<tr>
<td>Pen/Asp Type</td>
<td>107</td>
<td>4,622</td>
<td>178</td>
<td>356</td>
<td>1,422</td>
</tr>
<tr>
<td>Smuts, Periconia, Myxomycetes</td>
<td>80</td>
<td>ND</td>
<td>ND</td>
<td>44</td>
<td>88</td>
</tr>
<tr>
<td>Torula</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>747</td>
<td>4,800</td>
<td>777</td>
<td>1,556</td>
<td>29,097</td>
</tr>
</tbody>
</table>

### Table 2: This Table Summarizes the Medical and Hospital Records Beginning in October 2001 through January 2005

<table>
<thead>
<tr>
<th>Dates</th>
<th>Facility</th>
<th>Health Noted in Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/09/00-03/03/01</td>
<td>High Country Health Care</td>
<td>Conjunctivitis, nasal congestion, H. Pylori, weak, diarrhea, increased ALT and Alk Phos</td>
</tr>
<tr>
<td>03/20/01</td>
<td>Vail Valley Medical Center</td>
<td>Rt. septic knee, Bloody fluid and cocci isolated, fever, cachexia, tired, leukopenia, HepC+, HIV-, decreased Neutrophils, lymphocytes, RBC, HCT. Diagnosis of Neutropenia, Vancomycin and Neupogen therapy.</td>
</tr>
<tr>
<td>03/29/01</td>
<td>Presbyterian Lukes Medical Center</td>
<td>Neutropenia, weight loss, Fever. Became thrombocytopenic while in hospital, treatment with G-CSF, suspect spleen sequestering.</td>
</tr>
<tr>
<td>06/26/01</td>
<td>Presbyterian Lukes Medical Center</td>
<td>Re-admission. Diagnosis of pancytopenia, bone marrow biopsies (4) showed 20 % blast, adequate precursors of platelets, RBC and polyclonal proliferating cells, IVIG plasmaphoresis did not produce adequate improvement of platelet counts, performed splenectomy, discharged to home 06/27/01</td>
</tr>
<tr>
<td>07/18/01-07/24/01</td>
<td>Presbyterian Lukes Medical Center</td>
<td>Re-admission. Generalized aches, nausea, vomiting, diarrhea, pancytopenia, Gums bleeding, nose bleeds, platelet infusion, severe thrombocytopenia and neutropenia, bone marrow with megakaryocytic and granulocytic hyperplasia. Cyto genetics negative for gain or loss of chromosomes 5, 6 and 20, DNA sequence negative for AMI/E1O rearrangement (See Table 3).</td>
</tr>
<tr>
<td>07/24/01</td>
<td>Presbyterian Lukes Medical Center</td>
<td>Chest X-rays – infiltrates of anterior segment of upper rt. lobe and left segment of left lower lobe, BAL positive for rare yeast and with branching hypal forms. Follow up for Aspergillus infiltrates. Discharge Diagnoses: Fungal pneumonia, herpes stomatitis, pancytopenia, H. pylori, hematuria, splenectomy. GERD. Began antifungal therapy (see Table 4)</td>
</tr>
<tr>
<td>05/29/01</td>
<td>Stanford Hospital and Clinics</td>
<td>Consultation for Cytogenetic Studies (see above) and review of Medical Records. The cytogenetic studies ruled out myelodysplastic changes, firm diagnosis could not be given.</td>
</tr>
<tr>
<td>09/04/01</td>
<td>National Institutes of Health – Hematology Services</td>
<td>Consultation: Peripheral Blood Smears, Bone Marrow Biopsies, Bone Marrow Metaphases. Analysis of 20 bone marrow metaphases showed not chromosome abnormalities. Peripheral blood smear showed marked neutropenia and mild thrombocytosis. Bone marrow biopsy revealed M:E ratio of 1:5, increased megakaryocytes, reticulin fibrosis and negative histochemical stains for CD3, CD4, CD8 &amp; CD20. Diagnosis: Pancytopenia and fungal pneumonia. Exposure to fungus can cause Pancytopenia.</td>
</tr>
<tr>
<td>08/15/02</td>
<td>National Jewish Hospital</td>
<td>Consultation for Pancytopenia. Diagnosis resulted in agreement that the patient had pancytopenia and fungal pneumonia. The fungal pneumonia probably resulted from the neutropenia</td>
</tr>
<tr>
<td>11/19-21/2002</td>
<td>Progressive Health Care</td>
<td>Assessment: Toxic encephalopathy, Small airway disease; post plasmaphoresis, H. pylori, pancytopenia, fungal pneumonia; amphotericin B and itraconazole therapy; Autoimmunity (positive autoantibodies to CNS and PNS myelin, and ANA. Placed on additional antifungal therapy (See Table 4)</td>
</tr>
<tr>
<td>05/04/2004</td>
<td>High Country Health Care</td>
<td>Re-exposure. Developed petechia, nose bleeds, purpura, SOB. Thrombocytopenia (count - 3,000) with normal WBC and RBC counts. Treated with IVIG for 5 weeks with minimal response.</td>
</tr>
<tr>
<td>01/23/05</td>
<td>Summit County Coroner</td>
<td>Vomiting off and off since January 18, became semiconscious, EMS called, placed in ambulance and went into cardiac arrest: DOA from respiratory failure and cardiac arrest.</td>
</tr>
</tbody>
</table>
nasal congestion. During the next several months he began experiencing a variety of symptoms including stomach pain (GERD), hematuria, diarrhea, and poor appetite. On 03/20/2001 he entered the hospital because of a septic knee joint. Laboratory analysis showed decreased neutrophils, bilirubin, elevated liver AST, and alkaline phosphatase. He was positive for Helicobacter pylori, and urinalysis was positive for nitrites, protein, ketones, hemoglobin. Cultures for other bacteria were negative. His next hospital stay began experiencing a variety of symptoms including stomach pain (GERD), hematuria, diarrhea, and poor appetite. On 03/20/2001 he entered the hospital because of a septic knee joint. Laboratory analysis showed decreased neutrophils, bilirubin, elevated liver AST, and alkaline phosphatase. He was positive for Helicobacter pylori, and urinalysis was positive for nitrites, protein, ketones, hemoglobin. Cultures for other bacteria were negative. His next hospital stay starting on 03/29/2001 (Table 2) involved a septic knee with the diagnosis of neutropenia (mean = 2.36 x 10^3 WBC) thrombocytopenia (mean = 87 X10^3), decreased RBC (mean = 3.85 x 10^3) and hematocrit (mean = 35.8). He was treated with Vancomycin, Neupogen and G-CSF (filgrastim). The peripheral blood condition returned to neutropenia and was then treated with IVIG, plasmaphoresis, and splenectomy. Though the septic knee resolved, none of therapeutic treatments resulted in improved WBCs and Platelets within 3 days. Bone marrow biopsies showed adequate blast precursors for WBC, RBC and platelets. Cytogenetic studies (Table 3) did not reveal chromosome deletions and the DNA sequence was consistent with evolving acute myelogenous leukemia. Additional confirmation of the cytogenetic studies was obtained from the Stanford Medical School, National Institutes of Health and National Jewish Hospital. In July, 2001 Chest X-rays revealed infiltrates of anterior segment of upper right lobe and lateral segment of left lower lobe. Broncho alveolar lavage was positive for rare yeast and branching hyphal forms. IV amphotericin was initiated resulting in improved WBCs and Platelets within 3 days. Follow up for Aspergillus infiltrates was prescribed. Discharge Diagnoses was fungal pneumonia, herpetic stomatitis, pancytopenia, H. pylori, hematuria, splenectomy, Antifungal therapy was continued (see Table 4). His blood picture continued to improve with a report of a WBC of 10,700 and platelet count 328,000 in August 2000. When seen at Progressive Health Care in November 2002 his CBC was normal (See Table 5 for history of CBCs).

Table 4: Antifungal Therapy

<table>
<thead>
<tr>
<th>Month</th>
<th>Therapy</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2001</td>
<td>Amphotericin 2 months</td>
<td>I.V.</td>
</tr>
<tr>
<td>August 2001</td>
<td>Amphotericin B plus Itraconazole for 10 months</td>
<td>Oral Normalization of Blood Picture</td>
</tr>
<tr>
<td>November 2002</td>
<td>Ketoconazole</td>
<td>Nasal Spray (5%) and Rhinocort</td>
</tr>
</tbody>
</table>

Following the re-exposure to mold in June, 2004 he developed nose bleeds, petechia, purpura, shortness of breath and thrombocytopenia (platelet count = 3,000) with normal WBC and RBC. He was treated with IVIG for approximately 6 weeks without significant improvement of his complaints. In January 2005 he had uncontrolled episodes of vomiting, respiratory distress and became somnolent on January 23, 2005. EMS responded to a call in the early A.M., hours. He was placed in ambulance and went into cardiac arrest. An autopsy was performed at Summit County, Office of the Coroner (see results of autopsy). At Dr. Gray’s request, and under the direction of Dr. Hooper, samples of multiple tissues and body fluids were taken for mold and mycotoxin testing.

RESULTS OF THE AUTOPSY

Briefly, microscopic organ pathology was summarized as follows: (a) Liver had multi foci of necrosis associated with mononuclear inflammatory cells and few polymorphonuclear inflammatory cells; (b) Heart had interstitial edema, mild mononuclear inflammatory cell infiltrate suggesting an interstitial myocarditis; (c) Bronchus had generalized sloughing of mucosa mild diffuse submucosal mononuclear inflammatory cell infiltrate; (d) Lungs had congestion, intra-alveolar edema and thickening of alveolar septa with mononuclear inflammatory cell infiltrates.; (e) Adrenal gland had decreased cortical lipid with decrease in normal medul-
DNA by RT-PCR as previously reported [48, 49]. The lungs grew out Staphylococcus aureus, yeasts, Lactobacillus, Alpha Streptococcus (not Pneumococcus or Enterococcus).

Toxicology was positive for cannabis and negative for acid and basic drugs. Cause of death (prior to the receipt of the testing from Realtime Laboratory) was listed as respiratory failure with cardiac arrest.

**RealTime-Polymerase Chain Reaction (RT-PCR) for Mold DNA and Results**

Autopsy specimens from the lung, liver and brain were processed and tested for the presence of fungal DNA by RT-PCR as previously reported [48, 49]. The DNA probes consisted of 11 species of *Aspergillus*, 10 species of *Penicillium*, and *Stachybotrys chartarum*. These probes were developed and patented by RealTime Laboratories. A positive result was defined as any amplification observed crossing a baseline fluorescence of >20 between cycles 1 and 39 of the real-time RT-PCR run. An equivocal result was defined as amplification present over 40 cycles of the RT-PCR and is not a true negative. A negative result is defined as no amplification crossing the baseline during the PCR run. The results are summarized in Table 6. Positive detection of fungal DNA was as follows: lungs (*P. fellutanum*, *A. niger*; liver (*A. flavus*, *A. niger*; and brain (*A. niger*). Equivocal detection of other species in the three organs is also listed.

**Mycotoxin Testing and Results**

Tissues and fluids were extracted and tested for the presence of mycotoxins determination as described previously [22, 44, 50]. Competitive direct enzyme linked ImmunoSorbant assays (ELISA) were conducted for aflatoxins (AT), ochratoxin A (OTA) and macrocyclic trichothecenes (MT). The concentration in ppb for each mycotoxin was recorded and compared to limit of detection reported in previous publications as follows: AT (≥ 1 ppb), OTA (≥2.0 ppb) and MT (≥0.2 ppb) [22, 44, 50].

Samples of lung, liver and brain that were fixed in 10 % formalin at the time of autopsy were processed as previously published [22, 44, 50]. Concentrations of AT, OTA and MT in the tissue samples are summarized in Table 7. Mycotoxins detected in the lungs and liver were as follows: (a) MT (2.05 to 3.25

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### Table 5: This Table Summarizes the Peripheral Blood Absolute Cell Counts that were Done in the year 2001 in an attempt to define the cause of the pancytopenia.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>1.41±0.024</td>
<td>2.36±0.5</td>
<td>1.73±0.58</td>
<td>1.84±0.28</td>
<td>11.8</td>
<td>4.8-10.8 X 10^3</td>
</tr>
<tr>
<td>RBC</td>
<td>4.34±0.03</td>
<td>3.85±0.03</td>
<td>3.82±0.66</td>
<td>2.94±0.054</td>
<td>5.11</td>
<td>4.7-6.1 X 10^3</td>
</tr>
<tr>
<td>HGB</td>
<td>14.3±0.7</td>
<td>12.6±0.07</td>
<td>11.9±0.20</td>
<td>9.09±0.19</td>
<td>17.9</td>
<td>14-18 g/dl</td>
</tr>
<tr>
<td>HCT</td>
<td>42±2.6</td>
<td>35.8±0</td>
<td>34.02±6.2</td>
<td>26.3±0.63</td>
<td>50.2</td>
<td>42-52 %</td>
</tr>
<tr>
<td>PLT</td>
<td>180±12.1</td>
<td>87±4.2</td>
<td>42±3.2</td>
<td>125±151</td>
<td>107</td>
<td>130-400 x 10^3</td>
</tr>
</tbody>
</table>

a = on 8/1/01 his platelet count was 15,000, up from 4,000 on 7/30/01. On 8/02/01 he was given IVIG and his platelet count rose dramatically to 375,000 on 9/07/01. During his hospital stays he was treated with various combinations of prednisone, Neupogen and then GM-CSF with GCS-f and then with GM-CSF alone and IVIG plasmaphoresis alone without a significant effect on the pancytopenia. In addition, splenectomy did not resolve the condition. The cause of the pancytopenia was not determined, though tricothecene toxicities remains the front runner for causation, given its global inhibition of protein synthesis, and it being categorized as a radiation mimicker.

b = Blood counts at the end of November 2002 showed normalization after having received 10 months of anti-fungal therapy. The platelet count appeared low, however microscopy revealed platelet clumping with numbers appearing adequate on the slide.

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### Table 6: This Table Summarizes the Mold Species Detected in the Lung, Liver and Brain by Real Time Polymerase Chain Reaction (RT-PCR).

<table>
<thead>
<tr>
<th>Organ</th>
<th>Positive</th>
<th>Equivocal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>P. fellutanum, A. niger</td>
<td>A. versicolor, P. chrysogenum</td>
</tr>
<tr>
<td>Liver</td>
<td>A. flavus, A. niger</td>
<td>A. versicolor, A. amstelodami, P. chrysogenum, A. sydowii, P. fellutanum</td>
</tr>
<tr>
<td>Brain</td>
<td>A. niger</td>
<td>P. chrysogenum, P. fellutanum, A. sydowii, A. flavus</td>
</tr>
</tbody>
</table>

Positive = defined as any amplification crossing a baseline fluorescence >20 between cycles 1 and 39 of the real time PCR run.

Equivocal = defined as an amplification present over 40 cycles of the real time PCR run and is not a true negative.

Negative = defined as no amplification observed crossing baseline fluorescence between 39 cycles of the real time PCR run.

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### Table 7: This Table Summarizes the Mycotoxin Determination as Described in previous publications [22, 44, 50].

<table>
<thead>
<tr>
<th>AT</th>
<th>MT</th>
<th>OTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.05 to 3.25</td>
<td>2.05 to 3.25</td>
<td>2.05 to 3.25</td>
</tr>
</tbody>
</table>
concentrations of AT (5.5 ppb) and (b) AT (5.5 to 6.0 ppb). With respect to the brain, OTA was present at 170 ppb along with lesser concentrations of AT (5.5 ppb) and MT (2.05 ppb).

Table 7: This Table Summarizes the Concentration in ppb of Macroyclic Trichothecenes, Aflatoxins and Ochratoxin A Detected in the Lung, Brain and Liver Autopsy Specimens

<table>
<thead>
<tr>
<th>Organ</th>
<th>Trichothecenes (ppb)</th>
<th>Aflatoxins (ppb)</th>
<th>Ochratoxins (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>2.15</td>
<td>6.0</td>
<td>N.D.</td>
</tr>
<tr>
<td>Liver</td>
<td>3.25</td>
<td>6.0</td>
<td>N.D.</td>
</tr>
<tr>
<td>Brain</td>
<td>2.05</td>
<td>5.5</td>
<td>170</td>
</tr>
</tbody>
</table>

Limit of Detection: Trichothecenes (0.2 ppb); Aflatoxins (2 ppb); Ochratoxins (2 ppb)

Discussion

The deceased in this case was a weekly user of marijuana. The plant is known to be contaminated with several species of Aspergillus (fumigatus, niger, flavus), Mucor, Penicillium spp, and Thermoactinomyces spp. Precipitins to Aspergillus species are identified in 52 % of marijuana users [51]. Invasive fungal infections resulting from marijuana usage have been related to various conditions in immune compromised patients: Corticosteroids and lung disease [52, 53]; colorectal cancer [54] renal transplant recipient [58], and Leukemia [59]. Thus, in this case the possible role of marijuana usage should be considered as contributory to the onset of the health conditions of the deceased. However, other factors must also be considered with regards to this case.

Both the viable (data not shown) and non-viable airborne mold spores in his residence from 10/2000 through 05/2001 were significantly elevated over outdoor concentrations (Table 1). Spore counts do not include the fine particles <1 micron shed by mold colonies. The fine particulate count exceeds the mold spores by up to or greater than 500 fold [2, 11,15, 16, 57-59]. In addition, the fine particulates are deposited at a rate 250 times greater in lungs of adults than are the spores [5]. Thus, the estimated exposure incurred by this patient to fine particles plus mold spores would have ranged from 233,100 (first floor) to 8,729,400 (attic) particle/m³. Because the patient’s business office was in the bedroom on the second floor in which a door in the ceiling offered access to the attic, his exposure would have frequently approached the upper estimate. It is becoming increasingly apparent that non-viable spore counts greatly under estimate the exposures to toxins, allergens, and other by-products produced by microbial growth in WDB [2, 11, 15, 16, 58, 59]. This is further emphasized by the following: (1) MT, AT, OTA and gliotoxin have been observed in the sera and other tissues of mold exposed and/or mold infected humans [20, 40, 44, 50, 60, 61]; (2) Antibodies against albumin-conjugates of stachylysin and trichothecenes are present in mold exposed humans [61-64]; and 3) Mycotoxins are airborne and present in dust from water damaged buildings [15, 16, 17, 18-22]. Thus, it is a reasonable medical and scientific certainty that inhalation exposure to particle/dust borne mycotoxins occurs during occupation of water-damaged homes and buildings.

The patient had abnormal peripheral blood counts during each of his four hospital stays (Table 2). During the initial stay in March, 2001 he had a neutropenia followed by pancytopenia (decreased WBC, RBC, HGB, HCT and platelets) beginning in June though August 2001. The combination of treatments with Neupogen, Prednisone, GM-CSF (sargramostin) with and without Granulocyte Colony Stimulating factor, plasmaphoresis and splenectomy did not resolve the pancytopenia. Bone marrow biopsies (Table 3) revealed normal cellular elements. Cytogenetics reported: No loss of DNA involving chromosomes 5, 6, & 20 DNA probes ruling out AML. The patient was eventually discharged without resolution of a cause for the pancytopenia.

Clues as to the cause of the pancytopenia can be derived from the following: antifungal treatments, re-exposure to molds and results from the autopsy. The patient was put on antifungals, amphotericin in July 2001 and itraconazole, beginning in December 2001 for eight months. His peripheral blood began to improve within three days of the initiation if IV amphotericin and his cell counts returned to normal by October, 2002. When seen at this clinic in October 2003 his CBC was still normal. In May 2004 he was re-exposed to a WDB and his platelet count fell to 3,000 shortly thereafter. His health declined and he expired on January 23, 2005 from respiratory failure. These facts suggest that mold and mycotoxins were causative mechanisms in the pancytopenia. The hematotoxicity of MT, AT and OTA includes neutropenia, lymphopenia, thrombocytopenia and erythroptenia in animals and humans [68-73]. Although most of the research regarding hematotoxicity of mycotoxins centers on acute effects on bone marrow, peripheral cell counts may be reduced as a result of accelerated apoptosis of mature cell lineages [74-77].
The patient died suddenly after an acute illness. The findings at autopsy listed the cause as respiratory failure with microscopic evidence of interstitial pneumonitis, laryngitis, bronchitis, interstitial myocarditis, multifocal liver necrosis and jaundice. These findings are consistent with the pulmonary cytotoxicity of secondary metabolites of Stachybotrys chartarum as well as other mycotoxins (atranone, C. brevianamide, cladosporin, mycophenolic acid, neochinulin A & B, sterigmatocystin and TMC-120A) and mycotoxin containing spores of several mold genera [78-80]. The detection of multiple Aspergillus spp. and Penicillium fellutanum and chrysogenum, along with MT, AT and OTA in autopsy specimens (Table 5) confirms the role of the exposure to molds and their associated multiple mycotoxins in the patient’s WDB, the possible interaction with marijuana use after the patient had been immunosuppressed by his residential exposures, and subsequent development of pancytopenia, pulmonary failure and death in this patient. Finally, knowledge that mycotoxins are produced and found in tissues of individuals and insects with invasive aspergillosis [19, 34, 35, 39, 44, 53, 54, 81-84], and in the tissues and fluids of individuals with exposure to respirable particulates associated with water damaged buildings, allowed the final cause of death to be determined as mixed mold mycoses and mixed mold mycotoxicosis in this 36 year old man, who had been healthy prior to his residence in a home with a construction defect: the failure to provide for ventilation in the attic, which in turn resulted in condensation and mold growth on the underside of the roof decking during the cold evenings in Colorado.

CONFLICT OF INTEREST

Dr. Gray was a treating physician in this case and was an expert witness during settlement procedures.

Dr. Hooper performed the PCR DNA and mycotoxin testing. Dr. Hooper has testified as expert in defense and plaintiff litigation. He is the owner and operator of RealTime Laboratories, a CLIA and CAP certified diagnostic laboratory.

Dr. Thrasher reviewed all of medical documents in this case. He was not an expert in the litigation. Dr. Thrasher has testified as an expert in defense and plaintiff litigation.

REFERENCES


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Fungal Pneumonia Cardiac Arrest, Marijuana and Moldy Home International Journal of Clinical Toxicology, 2 014, Vol. 2, No. 1