Potential for Misuse of Fungal Exposure Thresholds Used for Risk Assessment in Building Biology

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Introduction

Despite the recent release of an update to the ANSI/IICRC S520 Standard and the IICRC R520 Reference Guide for mould remediation[1-3], we report on the potential for manipulation of published thresholds[4-5] for the assessment of airborne and surface mould (viable and non-viable). We explore how this can result in buildings/areas being "passed" after remediation, despite mould levels remaining relatively high. We review the existing Australian Mould Guideline, AMG (2010)[6] with the aim to tighten both the thresholds contained therein compared against other metrics, and the practical definitions for when to use what test, and how, and then interpret results to develop practical recommendations for cleanup/scope of works as required. We show using Industry reports, how tables of sample mould and indoor air quality results on a per building or area basis can be manipulated to semi-plausibly gain a "pass result" which one can hypothesize could be used to gain a financial advantage favoring the remediator, assessor or the insurer. We highlight how the unscrupulous use of different thresholds can present a misleading picture to the responsible authority (e.g. insurer) with regard to having satisfied the post-remediation clearance objective, whilst potentially failing on a fundamental health and safety basis for the occupants. We also show with examples how failing to provide adequate reference controls and under-sampling or misuse of equipment or media can lead to false positive clearance results or conversely how generating mixed and matched thresholds taken from diverse sources can lead to false conclusions (a "fail result") lacking in evidence or rigor. We highlight improvements to the AMG that should minimize under-sampling or manipulation of air or surface microbiology counts and/or taxonomic identification efforts used widely in aerobiology. Case studies are presented that highlight aspects of these problems and recommendations are given to improve the existing Australian Mould Guideline to better meet the needs of key stakeholders.

Context

The aim of risk assessment of water damaged buildings is to provide practical guidance for remediation of the built structure (real estate) as well as remediation of property (contents) to for example protect persons from harm through unreasonable exposure to fungi[7]. In many cases, real estate damage is covered partially or in full under Insurance. Claims assessment and those steps involved in moving from the initial water damage event towards a conclusion (end point) is fraught with potential problems. Exactly what is and is not part of a claim depends on the insurer and the response to objective facts made by different parties to each claim. Despite there being available literature[8] detailing how to inspect and interpret results from potential mould contamination data, we are of the opinion that inappropriate risk assessment based on often poorly collected datasets of water damage impacting on the built environment is a major cause of financial loss to both claimants and the insurer. In turn, there are serious discrepancies between different published works regarding benchmarking what is considered suspect, normal, elevated or high risk microbial contamination. To this end, this paper articulates a way forward within an Australian context to minimize time and financial loss by defining a minimum set of recommendations for evidence gathering.

The practical problem is that many different persons can potentially make a determination of the hygiene state of a particular property. This is fundamental to the task of risk assessment. There are major long term ramifications of incorrect risk assessment and can result in contaminated properties being classed as normal and vice versa. The financial, time impacts and emotional distress caused to the different parties is a serious consequence of such errors. Table 1 shows how three different labs compare their data to determine risk.

Where things can go wrong

Building biology deals with the microbiology of the indoor living environment. When water damage occurs, the microbiological impact can affect the built structure, air quality, and personal property. The ANSII/IICRC S500:2015, pp. 35 defines only three categories of water damage: category 1: begins as sanitary water; category 2: significant contamination, potential to cause discomfort or sickness or category 3: grossly contaminated, pathogenic, toxigenic or harmful to persons

The aim of the pre-restoration report(s) and subsequent remediation efforts are to return the building and contents to Category 1 at post remediation verification (PRV). The problem is that this fundamental classification can be easily manipulated to favor either the claimant, the insurer or the remediator. This unfortunate triangle of opportunity develops when the evidence for decision making is flawed or obscured or manipulated to present a water damage event scenario and its repair methodology that is not based on fact or reason. We refer to such opportunity as 'fraud points' and will articulate a broad set of behaviours that may occur more or less frequently on the way towards a repair outcome.

Why things go wrong

Water damage assessment is a branch of environmental science and occupational health and safety principles follow from the factual evidence. The problem is that junk science, laboratory fraud, deceptive practice and human errors can all contribute and impact on the presentation of factual evidence.

High Order Examples:

- Fabricating data,
- Misrepresenting control samples,
- Calibrating equipment using non-standard methods,
- Sample modification to alter characteristics,
- Manipulation of analytical results,
- Substitution or omission of samples, files or data,
- Falsification of records of analytical equipment readings

Factors that can contribute to such fraud points include:

- Ineffective oversight of lab and field data collection, interpretation and analytical methods or policies and procedures that don't reflect published literature
- Commercial intent over quality assurance/lack of ethics/integrity allowing for scientific misconduct
- Rigid analytical approach to complex environmental data
- Flawed analytical methodologies

Fine-Grained Examples:

- Non-existent or insufficient number of control samples; e.g. spore traps submitted without outdoor controls
- Biased target sampling; e.g. tape lifts only from visibly mould contaminated areas
- Under-sampling; e.g. only taking samples from easy to remediate areas/surfaces as part of PRV
- Threshold bias; e.g. some labs state that 1000 spores/m^3 is normal while other literature exists showing that much lower levels are required for a normal classification (i.e. <500 spores/m^3)
- Taxonomic error; e.g. mis-classification ID of sample Genus or Species due to a lack of experience/reference matter (slides, cultures, reference works) or not in accord with D7391-09
- Measurement error; e.g. Incorrect counting procedures for spore trap evaluation
- Data acquisition mistakes; e.g. incorrect air sampling time
- Stratified sampling; e.g. using several methods (spore traps, petri plates and tape lifts) but under-sampling all areas
- Over-reporting; e.g. tape lift ID to Species where not possible
- Data reduction approach; e.g. use of ERMI to collect one sample from a target property and make a decision about the whole property based on only one sample.

Areas for improvement

The AMG (2010) provides a way to classify microbial contamination using: spore traps, tape lifts, and viable cultures of the air or of surfaces. One of us (lab #1[1]) has extensively used the AMG (2010) and tested it's efficacy against many thousands of rooms. The other two labs (lab #2 and lab#3) do not properly follow the AMG (2010) and Table 1 shows how easy it is to make wildly different conclusions regarding indoor air quality and mould risk to persons depending on the thresholds used. As well, it is important to sample from all or most rooms in a property to minimize the risk of report bias as well as make comment/readings on the subfloor and roof void.

Revisions to the AMG (2016)

The IICRC Standards are fundamentally qualitative practical cleaning methods and should be clearly defined in limitation against other more precise metrics used for the assessment and practical resolution of environments that present as quantified infection control risks. The revised AMG is premised on extending the hygiene classification of countable colonies from 55mm press plates to also apply for air sample collection of countable colonies onto 90mm petri plates. As well, we include in whole D7338-14 regarding how to assess fungal growth in buildings. Importantly, we tighten the thresholds about which conclusions about mould and/or spore contamination are made with regard to reporting on opinions of scientific and technical experts (E620-11 and E678-07) and which may be used or relied on (E1020-13) as part of criminal or civil litigation. In the event that field data, lab reports and subsequent expert reports have been used based on false thresholds or other metrics unsupported by the current literature or the principles of the relevant ASTM Standards[9-19], we can envisage obvious litigation recovery efforts based on opinions made and actions taken from false, pseudo-scientific or misleading information.

Comparison of 3 Australian Labs

SPORE TRAPS	AMG (2010) - mechanically ventilated	AMG (2010) - naturally ventilated	Lab #2	Lab #1 - mechanically ventilated	Lab #1 - naturally ventilated	Lab #3
LOW	<100	<=1/2 OA	<100	<100	<=1/2 OA	<100
NORMAL	< 1/2 OA or <500	<=OA	<1000	< 1/2 OA or <500	<=OA	<1000
ELEVATED	500-1000	<=1000	1000-4225	500-1000	<=1000	<2500
HIGH	1000-2500	<=2500	4225-10,000	1000-2500	<=2500	<4200
VERY HIGH	2500 to >5000	>5000	>10,000	2500 to >5000	>5000	>=4200
TAPE LIFTS	**AMG (2010)**	**Lab #1**	**Lab #2**	**Lab #3**		
LOW	<50	<50	<50	<100		
NORMAL	50-500	50-500	<500	<1000		
ELEVATED	500-1000	500-1000	500-1000	<2500		
HIGH	>1000	>1000	1000-5000	<4200		
VERY HIGH	>5000	>5000	>5000	>=4200		
VIABLE PETRI PLATES	**AMG (2010) - Hygiene**	**AMG (2010) - Risk - mechanically ventilated**	**Lab #2**	**AMG (2010) - Risk - Naturally ventilated**	**Lab #1 - Hygiene**	**Lab #1 - Risk**	**Lab #3**
LOW	<12 CFU/Plate	NA	Not given	NA	<= 12 CFU/Plate	NA	Low = /+
NORMAL	12-25 CFU/Plate	<1/2 OA	Not given	<=OA	>=13-25 CFU/Plate	≤ Outdoor Air (OA)	Normal = +
ELEVATED	25-60 CFU/Plate	>1/2 OA to <=OA	Not given	>OA to <=2 x OA	>=26-60 CFU/Plate + prevailing species	> OA to ≤ 2 x OA	Elevated = ++
AT RISK/CONTAMINATED	>60 CFU/Plate + dominant species	>OA to <= 2 x OA	Not given	>2 x OA	>= 61-299 CFU/Plate + dominant species	>2 x OA	High = +++
HAZARDOUS/EXTREME CONTAMINATION	>300 CFU/Plate + dominant species + confluent growth	>2 x OA + speciation	Not given	>2 x OA + speciation	> 300 CFU/Plate + dominant species + confluent growth	>2 x OA + speciation	Very High = ++++
SEVERE/EXTREME CONTAMINATION		>2 x OA + speciation + mycotoxins	Not given	>2 x OA + speciation + mycotoxins		> 2 x OA + speciation + known mycotoxins	

Table 1. Different thresholds in use at different Australian labs can lead to different conclusions regarding *normal* versus *suspect*, *at risk* and *unhealthy* environments. For example, Lab #2 will consistently under-report contamination since they classify NORMAL levels up to 1000 spores/m^3, ELEVATED as 1000-4225 spores/m^3 and HIGH as 4225-10,000 spores/m^3 versus the AMG that will classify these same categories far more stringently. This provides an obvious commercial incentive for remediators to use Lab #2 for PRV since it will be much easier to PASS a building. Another example for Lab #3 shows that this Lab does not ID fungi using a quantitative scale, hence any conclusions are at best qualitative.

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