Dry surface biofilms: what you need to know

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Abstract

Environmental dry surface biofilms (DSB) are a new type of biofilm found on dry surfaces. To date investigation related to the presence of DSB have only be conducted in healthcare settings. Findings show that DSB are widespread on surfaces and contain multispecies including multidrug resistant organisms (MDRO). Single species DSB can be made artificially *in vitro* and using *in vitro* DSB, studies have shown the resilience of DSB to cleaning and disinfection and the propensity of bacteria within DSB to be transferred post-intervention. Environmental DSB are not visible by eyes and cannot be detected by wet or dry swabbing of dry surfaces. Since DSB harbour MDRO, are resistant to cleaning and disinfection and cannot be detected by swabbing, it is likely that they may play an important their role in the persistence of pathogen in the healthcare environment.

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Introduction

Hospital environment harbours potentially pathogenic organisms to personnel and patients and visitors. Appropriate infection control measures which include routine cleaning, are crucial in lowering the risk of healthcare associated infections. Worryingly, studies shows that cleaning efforts in hospitals are not always effective, with pathogens surviving on surfaces despite regular environmental cleaning or more advanced terminal cleaning. These pathogens can be further transmitted to vulnerable patients directly from high-touch surfaces or indirectly through healthcare worker's hands.

It is now recognised that patients are at a higher risk of acquiring an infection with a multidrug-resistant organism (MDRO) from a previous room occupant, even when deep cleaning protocol are applied, and environmental surface swab tests are negative. Such observations pertain to our ability to detect microorganisms by wet swabbing, a well-accepted routine method used not only in healthcare settings but also in other environments. Swabbing is known for low sensitivity, yet still trusted to deem the surface safe.

Another pertinent observation is the efficacy of disinfectant products in practice. Such products are essential for effective infection control, and label claim report product efficacy tested against planktonic bacteria dried on surfaces or not, yet still in a free-living state. Planktonic state is not a common mode of growth for microorganisms present on hospital surfaces; sessile bacteria on surfaces is, in biofilm. Biofilms are known to be much tougher to eradicate!

Biofilms living in a challenging environment

First discovered on 93% of disinfected intensive care surfaces "dry surface biofilms" (DSB) are a relatively recent concern in healthcare settings. The term was coined with the introduction of a new dry surface biofilm model in 2015.[1,2] The widespread presence and abundance of DSB on environmental hospital surfaces has now been well documented.[3]

But what is a dry surface biofilm? There is not yet an official definition of dry surface biofilms, but they consist of multispecies bacterial communities embedded in

extracellular polymeric substances, present and growing on environmental surfaces subjected to low water availability; in a dry state. DSBs are not planktonic cells simply dried on the surface.

Under the microscope, we can observe DSB as scattered cellular aggregates of complex structures within thick EPS (figure 1). DSB tend to be thinner and more randomly scattered on surfaces than wet biofilms, but due to harsh conditions they live in, low moisture and nutrients levels, their survival depends on high resistance to desiccation. We do not yet know how DSB form on surfaces and it is unclear whether DSBs follow a standard biofilm lifecycle with attachment, accumulation, maturation, and dispersion steps or not.

A dormant danger?

Dry surface biofilms are resistant to chemical disinfection and less susceptible to physical processes than their wet biofilm equivalents.[4,5] Although the direct link between infection outbreak and pathogenic bacteria from dry surface biofilm is yet to be made, connecting the dots from various studies paints a worrying picture.

We know that DSB are widespread on a various range of surfaces across hospitals, from patient folders through to nurse station keyboards to high-touch areas in close proximity to patients.[3,6,7] These include surfaces that were routinely decontaminated, so in theory should be safe.

We also know that DSB are composed of various environmental bacteria including *Staphylococcus* spp. and *Bacillus* spp., and multi-drug resistant microorganisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE) or multi-drug-resistant (MDR) *Acinetobacter* spp.[6,7]

Finally, we know that bacteria from artificial DSB studies can be transferred directly and indirectly via gloves[7,8] and when disturbed following cleaning or disinfection for example, although when dry, transfer is unlikely, explaining the failure of wet swabbing to detect DSB on environmental surfaces. Therefore, there is a possibility that gloved hands of a hospital staff member can act as a bacterial carrier.

Should we be worried?

On one hand, DSBs mostly consist of environmental microbes that we face in our everyday life,[3] effectively do not multiply rapidly, and do not seem to be transferable

when dry. They could just be a harmless inhabitants of environmental hospital surfaces.

But on the other hand, DSB could be ticking time bomb. DSB are difficult to detect, difficult to eradicate, harbour pathogens[3,6,7] and transferable when disturbed.[7,8] We have hypothesised that transmission of MDRO to naïve patients from a previous room occupant despite the use of appropriate infection control regimen could have resulted from the persistence of DSB on environmental surfaces.

Conclusions

The role dry surface biofilms play in healthcare associated infections is at present unclear. Additional studies need to be conducted to establish a link between pathogenic microorganism residing on hospital surfaces in DSB and infection outbreaks.

Nevertheless, it is important for infection control professionals to be aware of the presence DSBs and the potential threat they pose. DSBs cannot be overlooked in the efforts to create a safe hospital environment, with introduction of cleaning and disinfection protocols effective against DSBs.

To date, DSBs have only been studied in Helathcare settings, but are highly likely to be present in other environments such as food manufacturing.

Summary (5-8 key points)

- Dry surface biofilms are widespread on dry environmental surfaces in healthcare settings (As high as 95% of surfaces)
- Dry surface biofilms can harbour bacterial pathogens including multidrug resistant organisms
- Dry surface biofilms cannot be detected by routine wet swabbing
- Dry surface biofilms are less susceptible to disinfection
- Bacterial pathogens in dry surface biofilms are transferable by direct and indirect contact (gloves) following cleaning and disinfection.

Conflict of interest

None to report

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Figure 1 Scanning electron microscopy image (magnification 10,000) of an environmental dry surface biofilm recovered from a atient folder. (The biofilm is artificially coloured).