How do we tackle contaminated hospital surfaces?

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The role of contaminated environmental surfaces in the transmission of nosocomial pathogens has been debated for many years. Studies published in the 1970s and 1980s indicated that contaminated surfaces contributed negligibly to nosocomial transmission. However, more recent data show that bacterial endospores, vegetative bacteria and some viruses are shed into the hospital environment, can survive on dry surfaces for extended periods, usually measured in months, and can be transferred to the hands of healthcare personnel from surfaces. The most convincing evidence that contaminated environmental surfaces are important in the transmission of nosocomial pathogens comes from the finding that admission to a room previously occupied by a patient with methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), Clostridium difficile and certain Gram-negative rods such as Acinetobacter baumannii increased the chances of acquiring these pathogens by a factor of two or more. These data indicate that inadequate terminal disinfection is responsible for residual contamination with pathogens that increases the chances of the incoming patient acquiring a nosocomial pathogen. Thus, more needs to be done to disinfect rooms when patients are discharged (‘terminal disinfection’) in order to mitigate this increased risk.

These are fever studies evaluating daily cleaning and/or disinfection during the stay of a patient. The contribution of contaminated surfaces aside from residual contamination surviving from a prior room occupant is more difficult to quantify. It seems likely that pathogens shed during the stay of a patient infected or colonised with a nosocomial pathogen will have infection control implications some of the time, for example, when acquired on the hands of healthcare personnel during patient care. Therefore, there is strong rationale for improving cleaning and disinfection both during the stay of patients and when they are discharged.

A current controversy surrounds whether to improve conventional disinfection methods or to turn to ‘no-touch’ automated room disinfection (NTD) systems for terminal disinfection. The use of fluorescent markers or ATP assays to evaluate the cleaning process itself, the adoption of newer, more effective disinfectants or equipment (such as microfibre materials) can all help to improve the effectiveness of conventional methods. There is evidence that improving the efficacy of conventional cleaning and disinfection can be effective in reducing the microbial burden and transmission of nosocomial pathogens. However, there may be occasions when even optimised conventional methods do not reliably eliminate pathogens. On these occasions, an NTD system may be useful. Commonly used NTD systems include hydrogen peroxide vapour (HPV), aerosolised hydrogen peroxide (aHP) and systems based on ultraviolet C or pulsed-xenon UV. There are important differences between these systems and the choice of system will likely depend on the application. The most studied NTD system is HPV, which has been shown to be superior to conventional methods for the elimination of pathogens from surfaces, and can help to bring outbreaks under control and can reduce the spread of pathogens in endemic settings. A recently published study from the US showed that HPV successfully mitigated the increased risk from the prior room occupant, with patients admitted to rooms disinfected using HPV being 64% less likely to acquire a multi-drug resistant organism (MDRO), particularly VRE, when the prior room occupant was infected or colonised with an MDRO.

NTD systems are only useful for terminal disinfection, whereas improved conventional methods can be applied both during the stay of patients and when they are discharged. Thus, the most comprehensive environmental strategy would be a program of systematic improvement of conventional methods coupled with NTD disinfection of selected patient rooms. Whilst this approach would likely result in the greatest impact in terms of reduced transmissions, it would not be possible to determine the relative benefit of improved conventional methods and NTD disinfection. The ‘ultimate’ study would be a large, cluster-randomised, controlled trial to evaluate the impact of improved conventional methods and NTD disinfection individually and combined on the transmission of nosocomial pathogens. Studies of this type are likely to be performed in the future, but in the meantime, hospitals need to decide when their current methods are sufficient, when to implement improved conventional methods and when to turn to NTD systems. I would advocate a scenario-based approach, where the strategy chosen is dictated by the local challenges...
and aims. For example, the terminal disinfection strategy for a patient infected with multidrug-resistant *A. baumannii* on an ICU may well be different than for a patient colonised with MRSA on a general ward.

Other approaches to tackling environmental contamination in hospitals warrant consideration. There are several ways to reduce the amount of pathogens that are deposited onto environmental surfaces. For example, converting multi-occupancy bays into a series of individual rooms will likely improve the containment of pathogens.24 Similarly, daily bathing of patients using chlorhexidine for ‘source control’ reduces shedding and has been shown to reduce transmission.25 The introduction of surfaces composed of or impregnated with antimicrobial materials can reduce the microbial burden on surfaces.26 For example, several studies show that copper surfaces reduce the microbial burden.27 Several recent studies suggest that contaminated air may be an important factor in the spread of nosocomial pathogens.28,29 Thus, interventions aimed at reducing the microbial burden in air may help to reduce the burden of pathogens on hospital surfaces.30 Finally, improved hand hygiene would help to prevent the transmission of pathogens acquired on the hands of healthcare personnel from surfaces. However, a blinkered focus on hand hygiene without paying attention to contaminated surfaces is not the way forward since some transmission will occur directly or indirectly from contaminated surfaces. Equally, improving surface disinfection at the expense of hand hygiene compliance will have a limited impact on transmission since some transmission will occur independently of contaminated surfaces. Thus, a bundled approach considering all possible transmission routes will be most effective for reducing the transmission of nosocomial pathogens.3

Further research is required to determine the best ways to tackle contaminated hospital surfaces. Key questions include:

- How far can conventional methods go in reducing microbial contamination on surfaces?
- When are NTDs systems warranted, and which NTD system is suitable for the intended application?
- Is contaminated air key in transmission, and under which circumstances?
- Should ‘source control’ be implemented universally across the hospital?
- Are antimicrobial surfaces going to be useful in preventing transmission, and, if so, which is the most effective?
- Can the introduction of single rooms in multi-occupancy bays contain pathogens more effectively?

Further research into these and other important questions will give us more guidance as to how to tackle contaminated hospital surfaces. However, controversies will continue and large, randomised controlled trails are likely to remain rare. The problems due to nosocomial pathogens are likely to increase, in particular relating to multidrug-resistant Gram-negative bacteria. As these multidrug-resistant pathogens continue to be transmitted in healthcare facilities worldwide, and treatment options become more limited, the emphasis will move from control to prevention. Thus, the assessment and adoption of cost effective interventions to deliver a clean, safe environment should be high on the agenda of healthcare facilities.

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**References**

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