The science of safe surfaces

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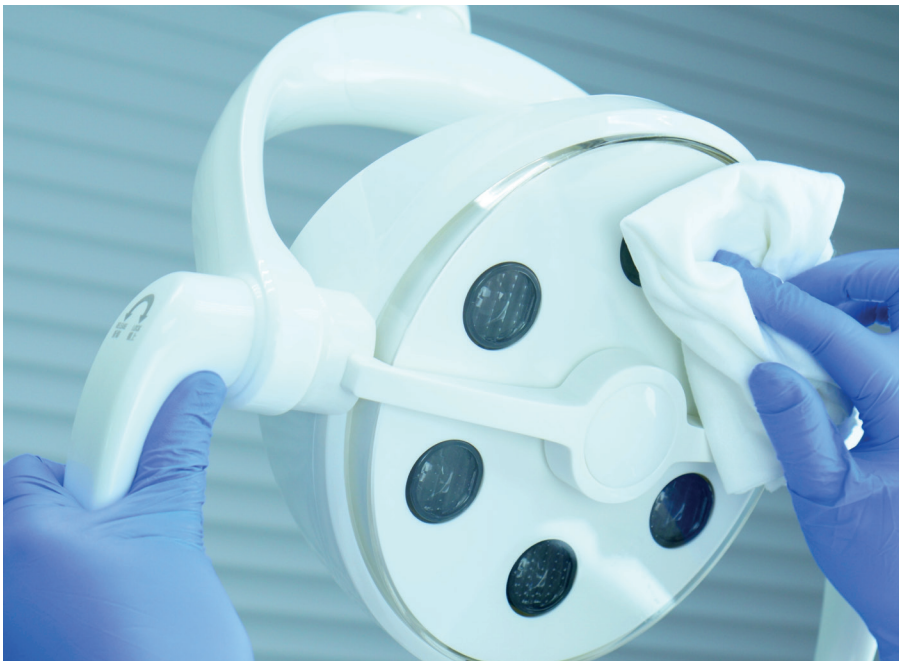
provides an insight into effective disinfection protocols, aimed at reducing the risk of transmission of healthcare-associated infections.



Effective disinfection protocols are essential to support infection prevention strategies in hospitals. Environmental surfaces contaminated with pathogens have the potential to become sources of infection. Cleaning and disinfection are key interventions to reduce contamination levels on surfaces. However, the efficacy of these interventions is determined not only by the methods used but also by the type of surface being cleaned and where it is situated.[1] Therefore a risk stratified approach should be considered when determining protocols, based on a number of factors which are examined in this article.

Viruses and bacteria are the most common causes of infectious diseases acquired in hospitals and cause a considerable negative impact on the health of patients. Healthcare associated infections (HCAIs) also known as "nosocomial" infections are defined as infections that occur in patients during the process of care in a hospital or other healthcare facility, which was not present or incubating at the time of admission. Such infections increase morbidity and mortality, as well as presenting significant extra costs.[2] The most recent UK data[3] estimates a prevalence in hospitals in England of 6.4%. Although a recent study estimated that 5%-15% of hospitalised patients in high-income countries acquire an HCAI.[4]

In hospitals, the direct transmission of pathogens generally occurs from person to person, but indirect transmission through contaminated surfaces is also recognised.[1] Surfaces can become contaminated by hands, objects, and the settling of virus containing aerosols or contaminated fluids.[5] Therefore, these surfaces can play an important role for transmission of pathogens in healthcare settings.[5] Transmission of pathogens by a person touching a contaminated surface has been demonstrated to be possible.[6]

Microorganisms including gram-positive and gram-negative bacteria can persist on inanimate surfaces for prolonged periods of time.[7] Viruses may remain on surfaces for between a few hours and a few months; generally non-enveloped viruses are more stable on environmental surfaces than enveloped ones.[7] A recent report on the persistence of various coronaviruses on different surfaces showed viral survival from 2 hours to 9 days.[8] A study specifically examining SARS-CoV-2 found the virus, which causes COVID-19, is stable on plastic and stainless steel for up to 72 hours, on copper for up to 4 hours, and cardboard up to 24 hours under laboratory conditions.[9]

Noroviruses are found on different types of surfaces including floors, tables, doorknobs, handles, bed rails, carpets, and curtains in healthcare facilities. Along with many other enteric viruses like poliovirus ▶

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and rotavirus, and respiratory viruses such as influenza virus, noroviruses may remain infectious for up to several weeks. Both noroviruses and other enteric viruses may be transmitted through contaminated surfaces, which is an important factor to consider in environmental transmission.[1]

Bacteria also demonstrate significant survival times on hospital surfaces. Methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE) have been shown to survive for days and even weeks on environmental surfaces in healthcare facilities.[10]

The risk of infection resulting from transmission through contaminated surfaces depends on a number of factors, including the level of shedding of infective particles, their stability on surfaces, resistance to decontamination procedures, and the amount of pathogens required to cause infection.[1] Temperature, environmental humidity and types of surfaces are additional factors affecting risk.[1]

Pathogen transfer in hospitals can be interrupted by the appropriate cleaning and disinfection of surfaces; with disinfectant wipes having a key role to play.[11] Decontamination of surfaces takes place by combining the microbiocidal action of the disinfectant with the physical (mechanical) action of wiping.[11]

Although wipes may look similar, their composition and subsequent ability to clean and disinfect critical surfaces shows considerable variation. The size, thickness, material composition, layering, formulation, and degree of absorbency of the wipe will determine the quantity of disinfectant retained in and released from it. The physical structure of the wipe also influences the degree of contact it makes with the surface as well as its cleaning of the surface and the capacity it has to pick up and hold soils, microbes, and particles as the surface is wiped.[11]

In practice, wiping with a weak or slow-acting disinfectant may not only be ineffective but also possibly spread localised contamination over a wider area.[11] The greater the surface area cleaned with a single wipe, the more soil is acquired and the weaker the disinfectant becomes.[11] Nosocomial pathogens vary widely in their susceptibility to surface disinfectants depending on their biology, growth phase, environmental conditions such as relative humidity and air temperature, nature of the surface, and type and level of the associated soil. Therefore, for routine wiping to be effective, it must be designed and executed to cover as wide a variety of commonly encountered pathogens as possible.[11]

The wipe needs to be capable of both containing and transferring the optimum amount of disinfectant onto the surface to achieve the antimicrobial effect. The EN16615 test is the highest level of testing for antimicrobial wipes under the recognition of the European Standards committee. The test examines the efficacy of the wipe as a whole i.e. the wipe plus the disinfectant component. It is therefore an excellent starting point for wipe selection.

A combination of how the surface has been used, its location in the clinical setting, accessibility and contamination of the surface will determine the efficiency of wiping and also the level of contact between the target pathogens and the disinfectant. The surface to be wiped must not only permit direct contact between the pathogens and disinfectant but also allow for an optimum contact time to achieve the desired level of decontamination.[11]

In general, the ease of decontamination by wiping is directly related to the degree of smoothness of the surface.[11] Difficult to reach or very uneven surfaces may need to be sprayed directly with a disinfectant, rather than wiped. Spraying requires a number of safety measures to be undertaken to protect the person carrying out the decontamination.

It is also worth remembering that surface contamination is rarely uniform and is likely to be concentrated in certain “spots.” Wiping a contaminated surface inevitably dislodges wet or dried microbial contamination and may spread it over a wider area during the decontamination if not killed or inactivated effectively at the point of contact.[11]

Therefore, it is imperative that the combined action of disinfection and wiping is efficient enough to reduce the pathogen load to as low a level as possible to avoid spreading pathogens over a wider area.[11]

An additional factor affecting the efficacy of surface cleaning is the way in which the wipe is used in practice. The type and frequency of wiping action as well as the pressure exerted during wiping can profoundly influence the outcome of decontamination.[11] These wiping variables are difficult to control, therefore it is essential that all staff responsible for cleaning and decontamination receive thorough training.

There is discussion in terms of whether in practice, a single wipe across a contaminated surface is sufficient to deactivate potentially transmissible pathogens. Evidence suggests that two wipes of a surface is more beneficial than a single wipe on a contaminated area. Research has demonstrated that when a single wipe is followed by a second wipe, an extra 1- to 3-log^{10} reduction in pathogens (viruses and bacteria) is achieved on stainless steel surfaces.[1] ‘Precleaning before disinfection of the contaminated surfaces is recommended’ by the researchers.[1]

Likewise, the Centre for Disease Control and Prevention (CDC) states that cleaning is the necessary first step of any disinfection process. If a surface is not cleaned first, the disinfection process is compromised.[12] Cleaning is a form of decontamination that renders the environmental surface safe to handle by removing organic matter, salts, and visible soils, all of which may interfere with microbial inactivation.[12]

The efficacy of cleaning and disinfection is determined not only by the intrinsic effectiveness of the method applied but also by the appropriateness of the surfaces treated.[1] There have been recommendations that the choice of cleaning materials and the methods employed should focus on the type of surface (including surface sensitivity to detergents) and also its actual location. Reducing the infective load on critical spots such as doorknobs, handles, light switches, and other frequently touched surfaces is more likely to have a profound impact on transmission than disinfecting rarely touched surfaces.[1]

The CDC recommends taking certain

factors into consideration before selecting the optimum product and procedure for healthcare environmental surfaces. These include the type of surface, the amount of soil present and the likely contamination by microorganisms.[12] The CDC divides environmental surfaces into two categories: medical equipment surfaces (knobs or handles on haemodialysis machines, x-ray machines, instrument carts) and housekeeping surfaces (e.g. floors, walls, and tabletops).

The Robert Koch Institute (RKI) classifies hospital surfaces according to risk. The likelihood of direct contact and possible contamination with pathogens on near-patient surfaces or surfaces with frequent skin/hand contact is higher than surfaces significantly further away from patients.

Areas with 'low infection risk' are classified as those furthest away from patients and include stair cases, offices and corridors. Areas posing a 'greater infection risk' include general wards, maternity and outpatient areas. 'Highest infection risk' areas include operating theatres and intensive care units.[13]

Routine bedside disinfection is recommended for near-patient surfaces to restrict the spread of pathogens during care and treatment. It should include surfaces which are likely to have been contaminated with pathogen-containing material, even if this is not visible.[13] Cleaning without routine disinfection can be employed for surfaces without frequent hand or skin contact by staff or patients. Such surfaces include floors and walls. Cleaning with disinfection should be focused on the most critical areas which are the surfaces mainly involved in pathogen transmission.[13]

With increasing recognition of high-touch environmental surfaces as vehicles for nosocomial pathogens, there is renewed emphasis on routine surface disinfection for infection control in hospitals. Although the survival of pathogens on surfaces depends on a number of environmental factors, the underlying 'risk' of exposure presented to healthcare staff and patients should not be underestimated. Effective cleaning and disinfection protocols are therefore imperative to minimise the risk of cross infection. CSJ

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Dr Kayleigh Cox-Nowak received her M.Chem in biological chemistry and Ph.D. in chemistry from the University of Sheffield. She subsequently spent 8 years working in chemical manufacturing, starting as a research and development chemist and progressing to technical manager. In 2020 she joined Schülke & Mayr UK Ltd as technical support manager.