Are hand hygiene and cleaning enough?

Carole Hallam argues that the use of air decontamination systems to improve indoor air quality should be considered as part of Trusts' infection prevention and control strategies. She warns that hand hygiene and surface cleaning are not enough.

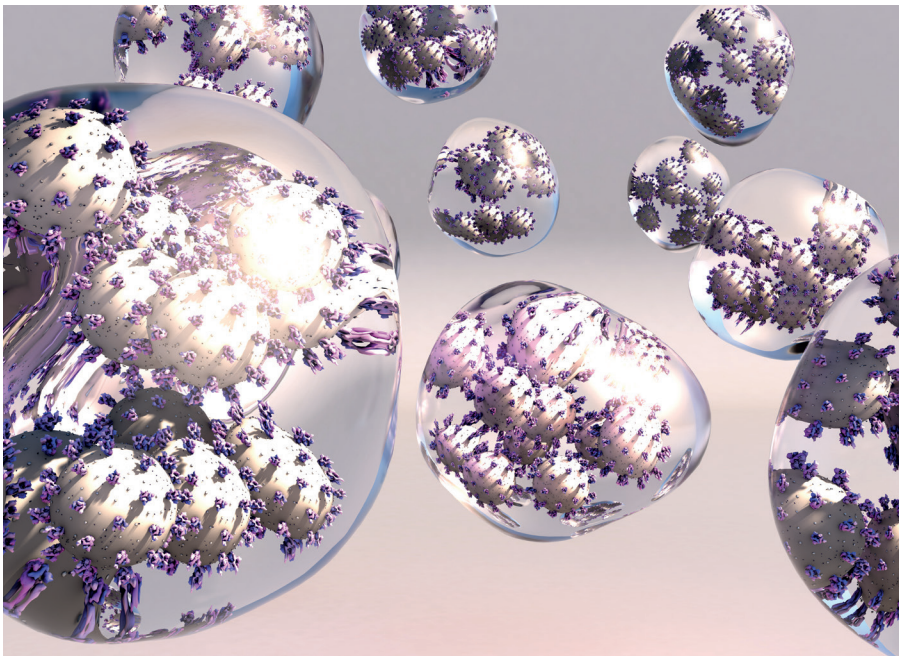
The burden of healthcare associated infections (HCAI) is a major concern across the world with an estimated 8.8 million patients affected across Europe in both acute and long-term care facilities with more than half being preventable.[1] Not only does HCAI result in poor outcomes for patients in terms of morbidity and mortality and but it also has a huge cost to healthcare providers. Modelled annual costs to the NHS are in the region of £2.7 billlion[2] and an estimated extended length of hospital stay of up to 25 days[3] – what else could that money be usefully spent on and how else could the hospital beds be better utilised?

In addition to the costs and extended length of stay for patients with an HCAI, there is an even bigger concern around the growing incidence of antimicrobial resistance (AMR). One in three microorganisms causing HCAI are resistant to at least one antibiotic making these infections harder to treat.[1] With an estimated 4.95 million deaths globally[4] associated with bacterial AMR in 2019 there has never been a more important time to prevent HCAIs.

Therefore, the principles of infection prevention and control are an essential strategy for preventing infections and the cornerstone in combating the spread of AMR. The SARS-CoV-2 pandemic has seen an increase in HCAI and an overuse of antibiotics increasing the risk of AMR, so they could not be a better time review infection prevention and control practices and to act.

Principles of infection prevention and control

Earlier this year, NHS England published the *National infection prevention and control manual for England*[5] (NIPCM) based on the Scottish National infection prevention and control manual. Standards for infection prevention and control are outlined within the NIPCM and include the standard precautions and transmission-based precautions with an aim to "ensure a consistent UK wide approach to infection prevention and control".



The standard precautions include the preventative processes to reduce the transmission of infectious agents from patients with identified infection, as well as those with unidentified sources of infection. These standard precautions should be used "by all staff, in all care settings, at all times, for all patients, whether infection is known to be present or not, to ensure the safety of those being cared for, staff and visitors in the care environment".

Hand hygiene, personal protective equipment (PPE) and cleaning of patient equipment and the environmental surfaces are outlined within the NIPCM but, if over half the HCAIs are preventable, do we need to relook at how we manage infection prevention and control and consider what are the gaps?

Transmission based precautions are categorised into 'contact precautions', 'droplet precautions' and 'airborne precautions' and provide the additional precautions to be taken dependent on how an identified infectious agent is transmitted. Confusion has arisen with SARS-CoV-2 and whether it should be classed as 'droplet' or 'airborne'. These traditional transmission-based categories are now beginning to be questioned by experts across the globe and has generated some very interesting discussions with Martin Kiernan and Brett Mitchell in their *Infection Control Matters* Podcasts (definitely worth a listen).

Droplet v. Airborne

Airborne and droplet transmission are usually defined by the size of the expelled aerosols or droplets, with airborne aerosol ▶

size of £5μm and droplet aerosol size of >5μm. The terms aerosols and droplets are used but in fact they are both the same and are a result of particles expelled on exhalation suspended in the moisture from the breath of an individual. The size of the droplet is thought to determine how far the droplet will travel, with the larger droplets travelling the furthest before falling, compared to smaller droplets that start to evaporate quickly but can stay suspended within a cloud for a longer period.[6] Following exhalation, the cloud of droplets will start to disperse with the available airflow until the droplets eventually fall.

Some have argued the distance that different droplet sizes travel is based on outdated evidence and fails to consider the physics of respiratory emissions.[6] Droplets exist in a variety of sizes and are held and moved with the hot turbulent gas cloud and moisture of the exhaled breath which enables the cloud to be carried over a distance in a few seconds. Singing, shouting, coughing and sneezing can move droplets further and potentially spread beyond 6-7 metres.

Several papers have evidenced the spread of SARS-CoV-2 by airborne transmission. An interesting article describes an investigation, using whole-genome sequencing, of the transmission of SARS-CoV-2 on two wards leading back to the Emergency Department (ED). Although the ED had good ventilation and single rooms, patients still acquired COVID-19 infection in the ED, leading the authors to conclude that airborne transmission had occurred on more than one occasion.[7]

The relationship between hands and surfaces

Hand hygiene has always been promoted by infection preventionists as the single most important procedure to reduce the risk of infection and not many would argue against this. However, hands can become contaminated easily as the healthcare workers have continual contact with the environment such as door handles, privacy curtains,

patient's bed rails and patient equipment. Hands can even become contaminated after seemingly 'clean' procedures.

Missed opportunities for hand hygiene contributes to the spread of microorganisms onto surfaces and the vicious cycle occurs with unclean hands contaminating surfaces and surfaces contaminating hands. A recent study at Great Ormond Street Hospital, using a non-pathogenic organism, showed how micro-organisms can transfer from an isolation room to almost half the frequent contact points outside the isolation room within 10 hours.[8] The overuse and misuse of gloves is common and results in missed opportunities for hand hygiene with gloves often put on too early and not removed promptly after a procedure is completed.

Failures of surface cleaning

Micro-organisms have a great ability to survive for lengthy periods on hospital surfaces, for example, *Clostridioides difficile* can survive for many months on surfaces. As patient equipment becomes more complex and patient flow through the hospital increases, so does the challenge to keep surfaces clean. It is suggested that up to 50% of surfaces are missed in manual cleaning following terminal cleaning, increasing the risk of infection to the next occupant.

We have known about wet biofilms creating a challenge to cleaning and disinfection for many years; these wet biofilms are associated with equipment where moisture is present. Perhaps more worrying is the little understanding and attention paid to the dry biofilms. Dry biofilms have been shown to be present on many hospital surfaces, despite cleaning, and harbour mainly gram-positive bacteria such as staphylococcus but also Acinetobacter species.[9]

Although dry biofilms are harbouring pathogens, further research is needed to understand their role in transmission. Moreover, poor cleaning and disinfection may further exacerbate the harbouring of pathogens.

What is the role of indoor air quality?

During the SARS-CoV-2 pandemic we have learnt about the importance of indoor air quality (IAQ) in the hospital environment. Bed spacing, patient isolation and cough etiquette can only minimise airborne spread of micro-organisms. Many hospital wards have poor ventilation requiring additional technology to improve the IAQ.

Florence Nightingale, in her 1859 book, '*Notes on Hospitals*', described her vision for a hospital ward as: "a large pavilion with soaring ceilings and plentiful windows, where patients would be separated, and clean air would circulate". She advised hospital architects to avoid "closed corners, lest infectious air to stagnate".

The last 20 years has seen a shift from the old-fashioned Nightingale wards to small bays of 4-6 beds and single rooms, predominantly to provide privacy for patients and reduce the spread of infection. The refurbishment of these old wards has affected the airflow of fresh air through the ward areas creating poorer air quality. Even many of the newly built hospitals have been poorly designed in terms of providing adequately ventilated wards with some hospital rooms and staff rest rooms with no access to an external wall with an opening window.

Hierarchy of controls

During the pandemic there was an emphasis on the hierarchy of controls, particularly when it was realised that much weight had been placed on PPE, which in fact is suggested to have the lowest effect at controlling infection. The hierarchy of controls is a way of determining which actions will best control exposures, in this case, control the risk of infection.

The hierarchy of controls has five levels of actions to reduce or remove the hazard with the preferred order of action based on

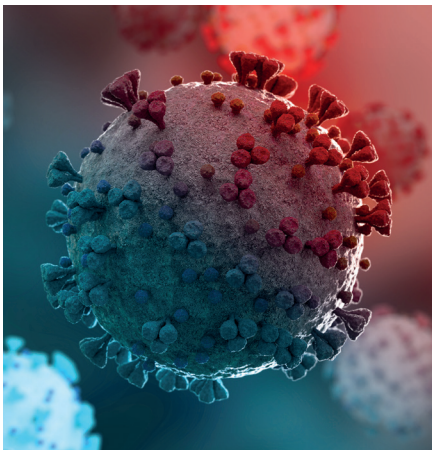
general effectiveness with level one being the most effect and level 5 being the least effective.

1) Elimination
2) Substitution
3) Engineering controls
4) Administrative controls
5) Personal protective equipment (PPE)

These hierarchy of controls have enabled the discussions about the adequate ventilation and general quality of the air circulating within the healthcare environment. Certainly level 3 'engineering controls' has opened up the discussion about the use of technology to mitigate the risk of infection.

Can technology reduce surface contamination?

Automated room disinfection (ARD) units have become a popular and effective over the last 20 years and provide an effective method for surface disinfection. Their greatest use is for the terminal decontamination of a vacated single room or bay following the discharge of a patient(s) with an infection and thus reducing the risk of infection for the next patient. Although ARD units are extremely efficient, they can only be used in an empty room and the process can take several hours before the room is ready for further use.



There has been an increased use in stand-alone air decontamination units mainly to mitigate the transmission of COVID-19. Interestingly, air decontamination units have been shown to reduce not only contaminants in the air but also surface contamination in the hospital environment because the aerosols found in the air will eventually fall and add to the bioburden of surfaces.

Reduced surface contamination will make surface cleaning easier and therefore reduce the risk of hand contamination from surfaces. Different terminology seems to be interchangeably used with air decontamination, air purification and air cleaning units. Most of these will have some form of filtration with some having additional benefits of UVC or plasma-based technology that will actually inactivate the micro-organism rather than just filtering these out of the air.

A recently published study carried out in Turkey found surface contamination was reduced when air purification units were installed in the critical care unit and they also saw a reduction in HCAI.[10] This study looked at the indoor air microbial loads in the immediate surroundings of intensive care unit (ICU) patients in two similarly designed ICUs, and to evaluate the effectiveness of air purifiers installed for filtering microbial loads and preventing healthcare associated infections. There was a significant positive correlation between the number of colonies detected in the air and surfaces and the rate of hospital-acquired infections in the intervention ICU.

Is air decontamination the missing link?

There is growing evidence to support the view that air decontamination may be the missing link in the relationship between surface and hand contamination. The use of air purifiers in addition to heating, ventilation and air conditioning systems in hospitals may be an effective way to reduce the microbial load in the air and on surfaces, ▶

and thus hospital-acquired infections.

Infection prevention strategies have never been so important with the increase in antimicrobial resistance and the need to reduce the risk of infection to provide a safer environment for our patients. Current hospital design generally does not prioritise clean air, and infection control policies emphasise hand hygiene and surface disinfection. Improving the air quality in healthcare environments seems to be the missing link in infection prevention and control cycle of infection transmission. The use of air decontamination systems to improve indoor air quality should be considered part of the infection prevention and control toolbox particularly where the risk of infection is high and ventilation is poor. CSJ

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Disclosure

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About the author

Carole Hallam is an independent infection prevention and control nurse consultant. During her long career in the NHS, with over 25 years specialising in infection prevention and control, she worked in 3 different acute trusts and worked for the Department of Health as an advisor. She is an active member of the Infection Prevention Society and spent 6 years as an IPS Board member and is currently on the steering committee of the Indoor Air Quality Society.