Containment of Antibiotic-resistant Superbugs Through More Robust Cleaning of the Hospital Environment – the Case for Emerging Technologies and Innovations

Dr. Dorminic NC TSANG
MBBS, FRCPath, FHKCPath, FHKAM(Pathology)
Chief Infection Control Office, Hospital Authority

Background

In an age when previously sensitive micro-organisms have gradually acquired resistance to multiple antibiotics, hence leading to the emergence of multi-drug resistant organisms (MDRO), nicknamed as “superbugs” by the public media, there have been concerns as to whether affected patients are able to inadvertently spread these MDROs to their non-infected counterparts through the hospital environment, during their stay in the hospital. Thus, there is a recent renewed focus on maintaining an acceptable state of hygiene in the healthcare setting.

Environmental Transmission of MDROs

Thorough cleaning of the hospital environment had never been regarded as crucial in the control of MDROs in the hospital. However, recent studies increasingly showed that contaminated surfaces in hospitals may be a source of transmission of pathogens. In these studies, patients who were either colonised or infected with nosocomial pathogens, such as methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), Clostridium difficile spores, Acinetobacter species, and Norovirus shed these organisms onto their immediate environment. Furthermore, the strains of these drug-resistant micro-organisms in the environment were found to be genotypically identical to those obtained from the very same patients colonised or infected with these organisms. Of particular concern is that these pathogens were observed to survive for days, weeks and even up to months (and years for C. difficile spores) on various inanimate surfaces, despite requiring no additional growth support.

It is hardly surprising that these organisms are likewise found on a myriad of tactile items in the clinical setting. For example, all members of the Staphylococcal genus show an avid ability to survive in the environment and on various non-critical items despite wide variations in temperature and humidity, to the extreme even after exposure to sunlight. Furthermore, intermingled with hospital dust, MRSA is still revivable for more than 1 year after inoculation. Following through this line of thought, when healthcare workers touch the contaminated surfaces of MDRO-affected patients’ immediate environment without performing adequate hand hygiene afterwards, they will likely transmit this organism to the next patient they care for, even though the healthcare worker had no direct contact with the affected patient in the first place. This shows that there is an indisputable dynamic relation between MDRO carriers, healthcare workers and their environments regarding pathogen transmission, and it is only natural that this transmission occurs reciprocally.

The Importance of Environmental Decontamination

In view of multiple studies indicating the environment to be an important source of bacterial transmission, more stringent routine environmental decontamination practices in healthcare facilities with regular monitoring is necessary in the MDRO containment bundle. In fact, Hayden et al. showed that reducing environmental contamination through improved cleaning practices of contaminated surfaces significantly reduced VRE acquisition by patients, especially after compliance to a detailed newly introduced cleaning protocol. Likewise, Gould et al. reported on how environmental cleansing with bleach, environmental samplings, the ready availability and use of hand gel, and admission screening simultaneously implemented in response to an MRSA surge, resulted in a decrease in the number of routine isolations of MRSA. Compellingly, to support the importance of thorough environmental cleansing, the removal of the bleach cleaning process from the containment bundle immediately precipitated a rebound in positive MRSA specimens.

Staff Training

The core elements to successful staff training should include both technical training and education on infection control awareness. Proper staff training on the technical cleansing procedure (Figure 1), with the aid of training videos and standardised cleaning protocols, together with regular monitoring and auditing, and in providing real-time feedbacks on their technical competence to individual staff is essential to help maintain the effectiveness of environmental decontamination. By taking references from the National Health Service (NHS) and Australian standards, implementation of a standardised colour coding scheme to ensure that soiled items should not be used in different areas, enhancing staff compliance to help mitigate the risk of cross-transmission of MDROs.
The Way Forward

In conjunction with routine environmental deep cleaning methods, in 2009 the National Health NHS has proposed a slew of new technologies that show promises in helping minimise the chance of pathogen-specific recontamination of the environment post-cleaning. These include the use of adenosine triphosphate (ATP) cleaning monitors (Figure 2) to give instantaneous feedback to the cleaning team staff on how effective the cleaning procedure had been carried out, in terms of Relative Light Units (RLU), which is proportional to ATP production and in turn the organic materials or microbial number present. Although it is not a direct assay of MDROs, the measurement of ATP, nonetheless, could serve as a surrogate marker to reflect upon the efficacy of the cleaning procedure on a real-time basis which could not be provided by the conventional bacterial culture method.

Recently, a public hospital in Hong Kong has been experimenting with the use of a novel polymer encapsulated chlorine dioxide coupled with zinc chloride disinfectant coating designed by the Hong Kong University of Science and Technology. Once this light chemical is sprayed onto frequently-touched areas of the environment, such as on computer keyboards and mice, it is able to be released and activated immediately upon direct finger contact of the sprayed surface by healthcare workers accessing these equipments, and hence is able to carry out its action in reducing the microbial load of the immediate environment.

A 10-month intervention trial that used microcondensation hydrogen peroxide vapour fumigation to decontaminate rooms after they were vacated by patients who suffered from Clostridium difficile associated diarrhoea demonstrated that this cleaning technique significantly reduced the incidence of hospital-associated C difficile diarrhoea and the MDRO acquisition in patients who were subsequently admitted to the same room. However, despite hydrogen peroxide being effective in destroying micro-organisms and spores, the gas is toxic and frontline staff must take care to completely vacate and seal off all rooms before carrying out the fumigation process, hence this method would best be used after considerable ward movement planning by both the ward and decontamination team in advance, or in the outbreak setting where the MDRO burden would be relatively high, rather than as a routine ward cleaning measure.

A recent study by Nerandzic et al. demonstrated that an automated mobile UV-C light unit, particularly in the 254-nm range was able to reduce bacterial contamination of hospitalised patients’ rooms and laboratory bench-top surfaces of C. difficile, VRE and MRSA by 2-3 log CFU/cm², 3-4 logs and 2-3 logs respectively. Since this method of decontamination is mobile and relatively easy to manipulate, perhaps it will have a future role to play in a larger-scale environmental decontamination in the hospital setting, particularly in the hope to reduce rates of colonisation or infections with MDROs.

Precisely because it has proven to be difficult for housekeepers to clean and disinfect environmental surfaces consistently despite adhering to hospital guidelines, these new room decontamination technologies come at a very timely fashion and certainly warrant further investigation and on-site trials to determine their cost-effectiveness and their applicability in routine cleaning as well as terminal room disinfection. Thorough cleaning and disinfection of the environment would remain one of the topmost effective preventive measures intended to provide reassurance that patients
as well as staff are not put at unnecessary risks during their stay in the hospital setting and scientific research in this direction would undoubtedly contribute substantially and be awaited with anticipation.

Acknowledgement

The author would like to express his sincerest thanks to Dr Vivien WM Chuang, Ms Doris KW Wong and Dr Naomi HY Cheng for their assistance.

References