INTERNATIONAL SOCIETY FOR INFECTIOUS DISEASES

# GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING

# New Technologies in Infection Prevention


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## Topic Outline




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## KEY ISSUE

New technologies for the prevention of healthcare associated infections are increasingly developed and marketed to healthcare centers worldwide. This explosion of products has somewhat outpaced the outcome data to support efficacy. While there is substantial promise in simulated test environments, decreasing infections in the clinical setting has not been well established. Nevertheless, these technologies are appealing adjuncts to infection prevention programs because they are not dependent on human behaviors.

## KNOWN FACTS

- Cross transmission in the hospital environment has been linked to contamination of hospital surfaces, contaminated medical devices and other fomites, and contamination of healthcare worker hands and clothing. There is considerable debate as to which of these mechanisms are most important in cross-transmission events. However, there is clear evidence that both cleaning and handwashing are suboptimal.
- A patient admitted to a hospital room in which the previous occupant had methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile,* or certain multidrug resistant gram negative rods, has a significantly increased risk of acquiring each of these pathogens.
- Furthermore, it has been estimated that 30-40% of hospital acquired infections are related to contamination of healthcare worker hands.
- Improvement in environmental cleaning practices as well as hand washing have traditionally relied on direct observation and feedback interventions. Feedback of observations includes an education component that ideally results in a change in human behavior. These programs are effective, though time consuming. An ongoing

commitment to the monitoring and feedback program is essential; decreasing benefits are well documented when these activities end.
- The following sections are a brief discussion of the alternative or adjunctive technologies designed to decrease the bioburden in the hospital environment.

## Technologies to Improve Cleaning Monitoring

- Adenosine triphosphate (ATP) levels and fluorescent markers have been used as surrogates of contamination to assist in monitoring of cleaning. Fluorescent markers have also been used to teach and test adequacy of hand hygiene. ATP levels represent the organic load, or general cleanliness of a surface. Fluorescent markers are placed on surfaces prior to cleaning, then reassessed with black light for their persistence after cleaning efforts; manual cleaning should remove these markers.
- There is controversy regarding which objective monitoring method, ATP versus fluorescent markers, is superior or better representative of microbial contamination.
- Visual inspection offers a more comprehensive assessment of surfaces, as it is not limited to specific spots like ATP and fluorescent marker monitoring. However, the perceived subjectivity of visual observation may diminish the impact of data feedback using this method.

## "Touchless" Technologies: Room Cleaning Robots

- Bypassing the variability in human practices, disinfection devices are now increasingly deployed after manual cleaning to further reduce bioburden in patient rooms.
- Devices include hydrogen peroxide (HP) or UV-light emitting machines. Manual cleaning remains an important precursor step, as gross organic

soil must be removed from surfaces to allow penetration of germicidal vapor/aerosol or radiation.

- The HP or UV light is toxic to humans. Thus, these devices are used only in empty patient rooms – for example, after a patient discharge.
- Both devices are able to decrease microbial bioburden on surfaces.
- Data to support reductions in healthcare associated infections comes mostly from before-and-after studies at single institutions. Modest reductions in HAI rates over time have been reported, but in the context of inability to control for concurrent interventions and expected improvements over time.
- There has been a single large, multi-center, controlled study to assess HAI reduction using a UV device. This study found a significant reduction in HAI acquisition when the UV device was added to quaternary ammonium cleaning. Clostridium difficile acquisitions were not significantly impacted.
- UV and HP devices are costly, and cost-effectiveness has not been well established. They also require human resources to deploy.

## Antimicrobial Surfaces

- Several antimicrobial coatings are under pre-clinical study for their potential application to surfaces in healthcare centers.
- Of these coatings, copper has been studied most extensively. It has been shown to decrease bioburden on surfaces, primarily in short term studies.
- Copper has also been used in clinical environments, though with conflicting results in terms of ability to prevent hospital acquired infections.
- Copper coating of hospital surfaces carries a substantial financial investment.

- Long term development of bacterial resistance to copper is a theoretical concern. A 24 week study of bacteria exposed to copper did not find evidence of resistance.

## Antimicrobial Textiles

- Textiles with antimicrobial properties show promise in the laboratory setting. Some materials have a documented ability to kill bacteria after a few hours of contact time.
- In the clinical environment, antimicrobial scrub garments and patient room curtains have been evaluated with mixed results. Some studies have shown reduction in the burden of important hospital microbes from silver curtains (Vancomycin resistant Enterococcus) and quaternary ammonium impregnated provider scrubs (MRSA). However, other studies have reported no difference in contamination rates, particularly from scrubs near the end of a healthcare worker's shift, or after several weeks of antimicrobial curtain use in an ICU.

## Hand Hygiene Monitoring Technologies

- Hand hygiene is a core infection prevention strategy that is simple to perform, yet healthcare worker compliance is often low. Studies have estimated a wide range of compliance, with an average of roughly 40% according to World Health Organization (WHO) analysis.
- Monitoring and feedback is essential to improve compliance. Traditional monitoring has been direct observation, but this strategy is limited by high resource requirements, low number of observations, and the Hawthorne Effect.
- Technologies have been developed with a broad range of capabilities, from monitoring product usage as an estimate of hand hygiene events,

to fully automated systems that track healthcare worker movements and product dispensation events.

- Fully automated monitoring systems are capable of detecting hand hygiene events as healthcare workers enter and exit patient areas, and in some cases, may monitor all 5 of the WHO's Moments of Hand Hygiene. Data can be collected for individuals and systems may have the capability to transmit feedback data in real time. Real time feedback can function as a reminder to perform hand hygiene when indicated.
- A systematic review of efficacy of fully automated systems in improving hand hygiene compliance concluded that most studies were of low quality and at risk of bias. Improving quality of the study was associated with more modest increases in compliance.
- Most fully automated systems have been implemented in single units as pilot programs. Results from sustained, large scale implementations are lacking.

## Limitations to Current Knowledge

- Much of the published data is of low quality with potential for industry bias.
- It is not known to what extent surfaces must be clean to prevent cross-transmission; acceptable residual bioburden levels have not been established. This makes evaluation of cleaning technologies difficult to standardize.

## SUGGESTED PRACTICE

- New technologies may have a place in infection prevention programs as part of a multimodal approach, assuming that sufficient resources exist

to ensure the basic components of the improvement strategy are in place.

- The available data and experience with these new technologies supports their use as an adjunct to existing, evidence based, infection prevention practices. They should not be used to replace traditional cleaning processes or hand hygiene monitoring strategies.
- Any healthcare center embarking on the acquisition and implementation of new technologies must consider the cost, human resource requirements for deployment and tracking, safety of use in the context of potential chemical or toxin exposures to patients and staff, and effects on through-put and other existing center functions.
- Caution should be exercised in extrapolating HAI reduction benefits from in vitro or pre-clinical data; antimicrobial effects may not translate into clinically relevant outcomes.

## SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

- Virtually all studies on new technologies for infection prevention have been reported from high resource countries. The feasibility, safety, and impact of these products in other settings is unknown.

## SUMMARY

New technologies to prevent cross-transmission of pathogens in healthcare centers are increasingly available to healthcare centers, though often at significant financial cost and with unique implementation considerations. There may be an adjunctive role for such technologies in existing infection prevention programs, as part of a multifaceted approach.

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