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Review Article

Hospital infections related with hospital microbial environment

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Abstract. This review discusses the important role of contaminated environmental surfaces in contributing to transmission of healthcare-associated pathogens, including the ability of pathogens on dry environmental surfaces, touched by patients and healthcare workers, and so transmission to patients.

Contamination of hospital equipment, medicines and water supplies with hospital pathogens is common source of outbreaks of infection.

This study reviews several important pathogens including *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin- resistant *enterococci* (VRE), *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *norovirus* that have the ability to survive in the dry-surface environment, which may then become a source for transmission.

The role of contaminated environmental surfaces in transmission of healthcare-associated pathogens is also supported by the fact that cleaning and/or disinfection of the environment can reduce the incidence of healthcare-associated colonization or infection.

Key words: Hospital infection, environment

1. Introduction

Environmental surface contamination was suggested to play an insignificant role in the endemic transmission of healthcare-associated infections (1). However, inanimate hospital environment becomes contaminated with nosocomial pathogens, the most important are *Clostridium difficile,* vancomycin-resistant enterococci, methicillin-resistant *Staphylococcus aureus, Acinetobacter baumannii*, *Pseudomonas aeruginosa* and probable pathogens are norovirus, influenza virus, severe acute respiratory syndrome–associated coronavirus, and *Candida* species (1, 2).

The role of the environment in harboring and transmitting multidrug-resistant organisms link environmental contamination with increased risk of hospital-associated infections. The incidence of antimicrobial resistance is also increasing (3).

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Health care-associated infections (HAI) remain a major cause of patient morbidity and mortality. An estimated 20% to 40% of HAI have been attributed to cross infection via the hands of health care personnel. This contamination has been via direct contact with the patient or indirectly by touching contaminated environmental surfaces. Prolonged periods in the hospital stay terms of hospital infection have been associated with frequent surface contamination in hospital rooms and health care workers' hands. In some cases, the extent of patient-to-patient transmission has been found to be directly proportional to the level of environmental contamination (4).

In this review, some of the most important hospital pathogens are compiled to give brief information about their prevention.

2. Some hospital pathogens related with hospital environment

Clostridium difficile

Clostridium difficile is a Gram-positive and anaerobic spore former. This pathogen is an important nosocomial and community-acquired pathogenic bacterium. C. *difficile* infections (CDI) are a leading cause of infections with elevated rates of morbidity. C. *difficile* spores play an essential role in episodes of CDI recurrence and horizontal transmission (5).

During the last decade, *C. difficile* has emerged as a major cause of healthcare-associated diarrhea and death. Transmission of this spore-forming bacterium is thought to occur via the hands of healthcare providers or via the contaminated environment (6).

Asymptomatic colonization by C. *difficile* is ranging from 21% to 48% in the neonatal period, early infancy and in childhood. Asymptomatic C. *difficile* carriers are associated with significant skin and environmental contamination, similar to those with difficile-associated diarrhea (CDAD) (7).

3. Vancomycin-resistant enterococci

Prior room contamination was highly predictive of VRE acquisition (8). Contaminated surfaces make an important contribution to the epidemic and endemic transmission vancomycin-resistant enterococci. Efforts to improve environmental hygiene should include enhancing the efficacy of cleaning and disinfection and reducing the spread of pathogens (1).

Health Care Workers (HCW) have contaminated their hands or gloves after touching the environment in a room occupied by a patient colonized. Gloves were highly protective in the hand contamination (9).

VRE are associated with significant morbidity in immunosuppressed patients. Stool culture is considered the gold standard for VRE screening. Groin swabs were used to detect VRE. But, in direct comparison, stool culture has better sensitivity according to groin swabs (10).

3.1. Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major cause of nosocomial infection. MRSA on ward and individual patient levels in a hospital where transmission was common (11). Hospital staff could act as a link and transmit MRSA acquired from the community to patients nursing students are responsible from this contamination in one study. According to this study, A total of 36 (30.3%) students were found to be carriers of *S. aureus* in the group exposed to hospital environment, and 34 (34%) in the group whis was not exposed. The MRSA carrier rate of the exposed group was not significantly greater than that of the non-exposed group. According to researchers; this could be explained by contact of the nursing students with patients and others in the community, overcrowding, poor hygiene, and widespread over the counter use of antibiotics among the general population. These findings show us; the group exposed to hospital environment carried MRSA strains similar to those carried by the non-exposed group. Therefore suggests that healthcare workers could act as a link and transmit MRSA acquired from the community to patients under their care (12). This study we think of as some hospital-acquired bacteria, in fact in terms of showing that moved from community to the hospital is a very good example.

In another study, researchers observed a direct relation between hand and stethoscope contamination, with higher levels of hand contamination associated with the increased levels of stethoscope contamination. This observation suggests that the patient's skin and immediate surroundings are the common denominators and determinants of both physician's hands and stethoscope contamination (13). In one study; 106 stethoscopes sampled, Gram-positive organisms were the most (60%) frequently isolated. Among them, *S. aureus* accounted for 15.8% of the flora of which 21% were resistant to methicillin. The rate of isolation of *S. aureus* and methicillin resistant *S. aureus* (MRSA) was higher in critical care units. According to this article; disinfection was found to reduce the bacterial count significantly (14). In another interesting study; Stethoscopes are commonly and frequently used in the assessment of patients in the emergency department (ED). In this article; prevalence of *S. aureus* contaminated stethoscopes was found as 1 % and no MRSA was isolated. The majority of ED health care providers reported cleaning their stethoscope at least on a weekly basis; most used alcohol-based wipes. This pilot study identified one *S. aureus* isolate that was not methicillin resistant. These results are likely influenced by the fact that the study was conducted at a time of increased awareness for infection control, which may have led ED health care providers to clean their stethoscopes more frequently, thereby reducing the typical, overall contamination rates and rates of *S. aureus* and MRSA (15).

3.2. Acinetobacter baumannii

Acinetobacter baumannii is one of the most commonly encountered microorganisms in nosocomial infections. It is thought that strains found in the environment can be a source for contamination of patients by *Acinetobacter* strains that are resistant to environmental conditions (16).

In one study; researchers investigated major biologic characteristics of *A. baumannii* isolates from hospital environment and respiratory tract samples of patients admitted to adult intensive care units (ICUs). They found; *A. baumannii*

isolates from the patients' respiratory tract and hospital environment carried much similar multidrug resistance patterns and biologic characteristics. This study shows that all MDR *A. baumannii* strains survived well in the hospital environment, especially in water and moist environment and produced biofilm, which might be responsible for high colonization in the respiratory tract of patients in ICU (17).

In addition; *Pseudomonas aeruginosa* and *Acinetobacter baumannii* have been reported to cause outbreaks of ventilator-associated pneumonia (VAP) in several studies. The ICU environment was observed to be the potential reservoir for VAP pathogens; therefore, strict adherence to environmental infection control measures is essential to prevent health-care-associated infections (18).

Of the *A. baumannii* in various publications that have information transmitted in different ways, as an interesting example; *A. baumannii* has emerged globally as a significant pathogen in hospitals. It is also present in soil and water. *A. baumannii* and soil, (especially in regards to its bioremediation), as well as to determine its importance in nosocomial infections and outbreaks in the ICU (19).

3.3. Pseudomonas aeruginosa

In one study, researchers found that wheelchairs are contaminated with several pathogenic bacteria, among them antibiotic-resistant strains such as MRSA, *P. aeruginosa*, *A. baumanni* etc. (20).

As a general rule drinking water in hospitals does not represent a risk for the normal patient. However, for high-risk patients with compromised immune defense systems drinking water in hospitals may become a source of nosocomial infections (*Pseudomonas aeruginosa*, *Acinetobacter* spp. and *Legionella* bacteria) (21).

Wound infection is a major cause of morbidity and mortality in burn cases. In one study it was found that *Pseudomonas aeruginosa* and *Proteus mirabilis* were the most common infective organisms occurring in 53.6 and 10.7 percentages respectively (22).

4. Group B Streptococci

Group B streptococcus (GBS), also known as *Streptococcus agalactiae*, causes severe disease in the neonatal period associated with significant morbidity and mortality as a reservoir for pathogens involved in outbreaks. Patient monitors and other high touch surfaces have been implicated as the source, indirect transfer of GBS from patient to patient via contaminated hands of health care workers with involvement of a contaminated environmental (4).

According to one study; In a maternity clinic, the circulation of group B streptococci among the newborns; Group B streptococci were detected at different biotypes of newborns (the pharynx, the imbilical stump, external suditory meatus, nasal and oral mucosa, eyes and feces), their mothers (the vagina, the perianal area, breast milk, the pharynx, urine, the umbilical cord, amniotic fluid) and in the pharynx of the personnel. According to this study; these results confirmed earlier data concerning two possible ways of transferring infection to newborn infants: vertical (from the mother to the child during parturition), and nosocomial (from contaminated newborns or members of the personnel) (23).

In addition; nosocomial infections result in considerable morbidity and mortality among neonates in high-risk nurseries (HRNs). Bloodstream infections, the most frequent nosocomial infections in all birth weight groups, should be a major focus of surveillance and prevention efforts in HRNs. For bloodstream infections, stratification of surveillance data by maternal acquisition will help focus on prevention efforts for group B streptococci outside the HRN. Within the nursery, bloodstream infection surveillance should focus on umbilical or central intravenous catheter use, a major risk factor for infection (24).

5. Norovirus

Norovirus (NoV) are RNA viruses highly contagious, stable in the environment, genetically variable, and the most common cause of viral sporadic acute gastroenteritis worldwide. The presence of NoV was higher than RV in children with diarrhea. NoV infection showed defined characteristics regarding age, gender, seasonal occurrence and nosocomial transmission that are important epidemiological features (25, 26). In one study; Researchers found that symptomatic patients and health care workers (HCWs) were more often involved in transmission events than asymptomatic shedders. Asymptomatic HCWs rarely contributed to transmission, despite high levels of fecal virus shedding (27). The healthcare environment presents serious challenges for control, both because of the physical structure of the built space and the high levels of contact among patient populations who may have compromised hygiene. Increased vulnerability among the populations in healthcare institutions is likely to be multifactorial and may include the following: nutritional status,

immunodeficiency or senescence, chronic inflammation, and microbiome alterations. Current control measures are based on general infection control principles, and treatment is mainly supportive and nonspecific. Vaccines and antiviral agents are being developed with promising results, but none are currently available (28).

6. Rotavirus

In most studies, RV was found to be the major etiologic agent of pediatric nosocomial diarrhea (31-87%). In one of them; Nosocomial RV (NRV) infections are mainly associated with infants 0-5 months of age, whereas community-acquired RV disease is more prevalent in children 6-23 months of age. Prevention of RV infection by mass vaccination could have a positive impact on the incidence of NRV by reducing the number of children hospitalized for gastroenteritis, therefore reducing the number of hospital cross-infections and associated costs (29). According to another study; Due to susceptibility, hospital infections occur mainly in children within their first two years of life and prolong their stay in a hospital. The number of hospital rotaviral diarrhea episodes should be reduced with universal immunizations, prevention of rotavirus transmission and use of probiotics (30).

Interestingly; The airborne spreading of enteric viruses can occur through the aerosol and droplets produced by toilet flushing. These can contaminate the surrounding environment, but few data exist to estimate the risk of exposure and infection. One study confirms that toilets are an important source of viral contamination, mainly in health care settings, where disinfection can have a crucial role in preventing virus spread (31).

7. Prevention

Hospital surfaces are frequently contaminated with important healthcare-associated pathogens. Contact with the contaminated environment by healthcare personnel is equally as likely as direct contact with a patient to lead to contamination of the healthcare provider's hands or gloves that may result in patient-to-patient transmission of nosocomial pathogens. Admission to a room previously occupied by a patient with MRSA, VRE, *Acinetobacter*, or *C. difficile* increases the risk for the subsequent patient admitted to the room to acquire the pathogen Pathogens may also be transferred directly from contaminated surfaces to susceptible patients. There is an increasing body of evidence that cleaning or disinfection of the environment can reduce transmission of healthcare-associated pathogens. Because routine cleaning of equipment items and other high-touch surfaces does not always remove pathogens from contaminated surfaces, improved methods of disinfecting the hospital environment are needed (32, 33).

Increasing numbers of hospital-acquired infections have generated much attention over the last decade. The public has linked the so-called 'superbugs' with their experience of dirty hospitals but the precise role of environmental cleaning in the control of these organisms remains unknown. Removal with or without, disinfectants, appears to be associated with reduced infection rates for patients (34).

In the environmental decontamination of rooms of patients with *C. difficile* infection (CDI) hypochlorite (diluted 1/10) or a sporicidal product can be used. Novel 'no-touch' methods for room disinfection have recently been introduced. Ultraviolet (UV) light or hydrogen peroxide systems are most widely used (6). Importantly, norovirus and *C. difficile* are relatively resistant to the most common surface disinfectants and waterless alcohol-based antiseptics. Current hand hygiene guidelines and recommendations for surface cleaning/disinfection should be followed in managing outbreaks because of these emerging pathogens (35).

8. Conclusion

Hospital infections can be prevented, but unfortunately cannot be reset. For this, the prevention of patients hospitalized for various reasons from hospital infections is very important. Therefore; the staff must be well trained and know how to implement prevention of nosocomial infections. Furthermore, each hospital must establish its own surveillance and bacterial resistance rates. Thereafter, in the accompanying guidebook should take their own precautions.

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