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Improving Hospital Hygiene through Environmental Design

A growing body of evidence shows that hospital design directly impacts the cleanliness of the hospital environment and therefore contributes significantly to the reduction of hospital-associated infections. This paper focuses on some of the key environmental measures that improve the hygiene of the hospital environment (air and inanimate surfaces) and personnel.

Air Hygiene

Aerial dissemination of dust, droplets, and skin scales is a frequent transmission route for many pathogens, e.g. TB, MRSA, *Acinetobacter*, and *C. difficile* spores. Ventilation, filtration, and disinfection are major environmental approaches to reduce pathogen concentration in air and to reduce the chance of airborne transmission. Ventilation, the movement of air in and out of healthcare spaces, is important not only for operating rooms and special care areas for high risk patients but also for regular care units. The effectiveness of ventilation depends on careful design of the whole heating, ventilation and air conditioning (HVAC) system, including the location of air duct openings and the air flow pattern in addition to ventilation rates. For example, supplying and extracting air through ceiling may be more efficient in reducing bioaerosol concentration than putting ventilation openings on walls, as was found in a computational fluid dynamics (CFD) simulation study by Beggs et al. (2008).

High-efficiency particulate air (HEPA) filters, either portable or integrated into the HVAC system, effectively remove airborne pathogens as small as 3 µm in diameters. If integrated in the HVAC system, HEPA filters should be located close to the air supply diffusers because air coming out of HEPA filters located centrally in the main air duct may be re-contaminated in the ducts before entering patient care spaces and this recontamination may lead to high pathogen (e.g. bacteria and aspergillar) concentration in patient care spaces.

Ultraviolet germicidal irradiation (UVGI) is a technology able to inactivate a wide range of airborne pathogens e.g. influenza, measles, and TB. UVGI devices installed on the upper part of hospital rooms can significantly reduce the airborne concentration of pathogens in lower part of the rooms therefore interrupting the transmission of certain airborne diseases. However, some environmental factors, such as humidity, may influence the effectiveness of upper-room UVGI.

Environmental Surface Hygiene

The inanimate environmental surfaces in hospitals (e.g. floors, walls, furniture, medical equipment, paper towel dispensers, sink faucets) are often contaminated and become reservoirs for pathogens such as MRSA, VRE, and *Acinetobacter calcoaceticus*. Environmental measures to control the level of surface contamination include cleaning, disinfection, and the use of antimicrobial materials and coatings.

Cleaning is the removal of visible dirt. Disinfection is the process of killing or inactivating pathogens. There are various cleaning and disinfecting methods suitable for different surface materials but these methods are not always able to remove or kill germs, especially the tenacious, such as VRE. Hydrogen peroxide vapor (HPV) is a relatively new disinfection technology used in healthcare settings. It involves filling a sealed room with hydrogen peroxide vapor gas to kill germs and converting the gas into water and oxygen after decontamination. Research shows that HPV is more effective than terminal cleaning in disinfecting patients' rooms contaminated with MRSA and VRE even though recontamination may occur several days after decontamination. Putting patients in single rooms instead of multibed rooms may facilitate the use of HPV because using HPV in single rooms after patient discharge eliminates the need of temporarily moving patients out of rooms which is often the case for multi-bed rooms.

Antimicrobial materials or surface coatings (e.g. silver-zeolite) contain anti-bacterial ingredients (e.g. silver) that inhibit the growth of and kill pathogens. Antimicrobial materials and coatings have successfully prevented surface contamination in experimental settings. However, environmental factors such as humidity may significantly affect the effectiveness of antibacterial materials. It is not clear how durable and useful these materials and coatings will be in real healthcare conditions.

Hand Hygiene

The hands of healthcare workers can be easily contaminated when touching patients or environmental surfaces around patients. Proper hand hygiene of healthcare workers has been identified as the single most important measure to prevent contact transmission between patients because patient to patient direct transmission is relatively rare. The problem of low hand hygiene compliance is a complex human behaviour issue. Environmental features that significantly influence hand hygiene behaviors include the type, number, location of hand hygiene facilities and the environmental cues serving as reminders.

Compared with soap-and-water, sink alcohol-based hand rub is more efficient—costing less and requiring less time for hand disinfection. It is small and therefore is easy to carry around or install at locations accessible to healthcare workers. However, it is not suitable when hands are visibly dirty and contaminated with organic matter, such as blood. Automated sinks and dispensers that are simple to use, e.g. touch-free alcohol-based hand rub dispenser, have been found to increase frequency of hand hygiene. The number and location of hand hygiene facilities determine the accessibility of these facilities and the convenience of hand hygiene. In one study, hand hygiene compliance by nurses after their direct contact with patients and medical equipment was higher in the intensive care unit with a higher sink-to-bed ratio. Similar positive correlation between sink-to-bed ratio and hand hygiene compliance was also found in other settings.

Several environmental features are able to promptly remind healthcare workers of hand hygiene and increase the compliance rate. One example of such environmental reminders is an electronic device monitoring room entry / exit and producing voice-prompts when hand hygiene is not performed properly. Hand hygiene compliance increases significantly due to the installation of this type of electronic alerting device.

Based on the above discussion, some environmental design recommendations to enhance hospital hygiene are as follows:

Design HVAC system to effectively reduce air contamination by properly placing air duct openings and incorporating HEPA filters and other disinfecting devices;

Select materials that are easy to clean and disinfect; follow proper disinfection procedures for particular materials;

Design single rooms to facilitate certain disinfection procedures (e.g. HPV);

Provide enough alcohol based hand rub dispensers in addition to an ample number of sinks; and carefully consider the locations of the hand hygiene sinks and dispensers in early design phase;

Employ environmental cues (e.g. lighting and electronic alerting device) as reminders of hand hygiene.

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Infection Control Initiatives Design Bugs Out

Design Bugs Out is a competition launched by the UK Design Council in association with the NHS and the UK Department of Health in October 2008. As the name suggests the aim was to encourage designers to use their talent and vision to reduce the number of HCAs in the hospital environment.

The challenge was to design and prototype new furniture, equipment and services for hospitals to improve infection control and prevention. There were five categories to choose from:

Hand hygiene;

Beside environment;

Commode;

Patient transport, and

An open brief to design a piece of equipment, furniture or system which will reduce HCAs.

Thirty-seven designer/manufacturer teams applied and the submissions were judged by a panel of judges made up of experts in design, microbiology, nursing and patient care. The winning design teams have been chosen and include top designers and manufacturers responsible for some very well known designs including Parker Pens and Herman Miller chairs. Projects include re-designs of porter's chairs, patient lockers and commodes and new designs for everyday items used by patients, nurses and other staff.

Many of the prototypes are re-designs of essential everyday items in the hospital environment. The focus is on making these items, which regularly come into contact with both patients and staff and therefore pose a significant threat to hygiene, easy to clean. Items such as blood pressure cuffs have been re-designed using waterproof and easily cleanable materials instead of fabric and Velcro and pieces of furniture traditionally hard to clean have been simplified to ensure their thorough cleaning.

The designs will be showcased at 7 NHS hospitals across the UK.

For more information, please visit: www.designcouncil.org.uk

Don't be the One to Pass it on

University College London Hospital has launched a hard-hitting, interactive infection control campaign. Funded by the UK Department of Health, this is no ordinary campaign; it includes holograms, stickers, posters, a youtube video and even a specially commissioned song! The message: "don't be the one to pass it on".

The campaign is about motivating people to improve hand hygiene and to change their attitudes and behaviour. Both staff and patients agreed that a bold, eye-catching campaign would be a successful way of promoting hand hygiene and contributing to reducing the number of hospital acquired infections.

By disseminating a range of serious and light-hearted messages through both traditional and new media the campaign aims to reach a wide range of audiences staff, patients and visitors, young and old.

Slogans on posters and badges include:

"Don't be the one to pass it on. Every two minutes someone gets infected"

"Give bugs hell- use the gel"

"Soapy not dopey"

"Don't bug me and Gel baby yeh!"

To watch the video, please visit: [www.youtube.com/ UCLHinfectioncontrol](http://www.youtube.com/UCLHinfectioncontrol)

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