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Infection control in special areas

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Introduction

In the previous two issues of this series, I had detailed the basic practices in Hospital Infection Control (HIC) that included hand hygiene, environmental disinfection, device associated infections and surveillance. In this third and final issue, infection control aspects in special clinical areas such as Operation Theatre, Haemodialysis Unit and Bone Marrow Transplant Unit are discussed. Owing to the procedures carried out as well as the patient type treated in these units, they need special considerations and all these additional and allied aspects are discussed.

Infection Control in Operation Theatres and Operation Rooms

The aim of infection control efforts in Operation Theatres (OTs) and Operation Rooms (ORs) is to prevent surgical site infections (SSI). In most contaminated surgeries, micro-organisms causing SSI arise from endogenous or colonizing flora at the surgical site. On the other hand, in case of infections in clean and prosthetic implant surgeries, micro organisms come from the OR itself– the source being dust, lint, skin squames and respiratory droplets. As few as 10 organisms are sufficient to cause deep infection in prosthetic replacement arthroplasty [1].

In the OR, the level of microbial load is directly proportional to the number of people inside the OR and their thoroughfare. This microbial load or 'bio-load' in the OR air can be minimized by efficient air ventilation and filtration system. This is achieved by plenum (positive pressure) ventilation and filtration through appropriately designed Air Handling Units (AHU). It is recommended that these AHUs are controlled in such a way that the pressure gradient from sterile zone to clean zone to disposal area is maintained at 25 Pa, 14 Pa and 0 to -5 Pa, respectively [2], while ensuring that recommended 20 air changes take place per hour

The filtration of air in AHUs is carried in two or three stages. Primary or pre filters remove larger dust particles, while secondary filters filter out bacteria carrying particles down to 3 µm in size. For ORs used for implantations, prosthetic valve replacements and transplant surgeries, it is recommended that they have provision to deliver ultra clean air through laminar flow systems. This is achieved by introducing an additional third stage of High Efficiency Particulate Arrestor (HEPA) filtration, which is a 0.3 µm filter, fitted to the diffuser of size 2.8 m by 2.8 m and positioned directly above the operative field. In addition, use of total body-exhaust suits further reduces the chances of infections in orthopaedic prosthetic implant surgeries. Maintaining the temperature of the OR between 15°C and 25°C and relative humidity between 40% and 60% is also important for control of infection.

Microbiological monitoring of the OR air quality is carried out regularly with the help of High Volume Air Sampler. At least 10,000 litres of air is sampled at a time and bio-load is determined in terms of colony forming units (cfu)/m^3 air [3]. It is recommended that for routine plenum ventilated OR, air bio-load should not exceed 35 cfu/m^3 in an empty theatre or 180 cfu/m^3 during the surgical procedure. The upper limits for the same for an ultra clean theatre are 1cfu/m^3 and 10cfu/m^3, respectively [3].

Another equally important aspect of HIC in OTs is to ensure that perfect sterilization is achieved for the surgical instruments and implants, and is the responsibility of the Central Sterile Supplies Department. Therefore, individual process steps such as washing of instruments, packing and sterilization with autoclaving or low temperature methods need validation and monitoring by using various types of chemical and biological indicators as well as process challenge devices. The documentation of these results for every sterilization cycle is important and needs to be carried out systematically.

Infection Control in Haemodialysis Units (HU)

Patients who have an end stage renal disease are treated by maintenance haemodialysis. A typical haemodialysis system consists of water supply, a system for mixing water and concentrated dialysis fluid and a machine to pump the dialysis fluid through the artificial kidney (hemodialyzer). The dialyzer is connected to the patient's circulatory system and blood is pumped through it to accomplish dialysis by means of a membrane to remove waste products from the patient's blood. Microorganisms, especially gram negative bacteria, which persist and actively multiply in water, can reach levels of 10^8-10^9 bacteria/ml and can cause septicaemia or endotoxemia in these patients.

Haemodialysis patients typically undergo a 4-hour dialysis session, thrice in a week and hence, are exposed to approximately 360 litres of water per week [4]. Therefore, water used for preparation of dialysis fluid must be appropriately treated to remove microbial and chemical contaminants to ensure that the specified microbial and chemical quality is maintained. A typical water treatment system used in HUs consists of three components [4] –

1. Pre-treatment consisting of sediment and sand filters to remove large particles, softener to remove hardness and activated carbon filters and micro-filters to remove chlorine and fine particles.
2. Primary treatment involving reverse osmosis and deionizer.
3. Post-treatment of dialysis water and dialysis fluid with sub-micronic filters, UV treatment and ultra filtration.

The source of water to the haemodialysis unit must be regularly screened for the presence of bacteria and endotoxins. Measurement of aerobic bacterial counts in terms of cfu/ml is determined by the membrane filtration method [4]. Limulus Amoebocyte Lysate (LAL) assay is the recommended test for detection of endotoxins, which are expressed as Endotoxin Units (EUs) [4]. The American National Standards published by the Association for the Advancement of Medical Instrumentations (AAMI), prescribe an upper limit for viable bacterial count as 200 cfu/ml [5]. The European standards are more stringent with the allowable limit for bacterial count set to ≤100 cfu/ml and endotoxin at ≤ 0.25 EU/ml [6]. To prevent transmission of blood-borne pathogens such as HIV, Hepatitis B and C viruses, the patients on haemodialysis should be screened regularly for HIV, Hepatitis B and C infections, the haemodialyzers should have a dedicated patient use and should undergo high level of disinfection with hydrogen peroxide or per acetic acid before every reuse.

Infection control in Bone Marrow Transplant Units

Bone Marrow transplantation is a life saving therapy for many malignancies and genetic or acquired haematologic syndromes. It involves intravenous infusion of hematopoietic stem cells to reconstitute the function of the bone marrow and can be allogenic or autologous transplantation. The most overwhelming complication of Bone Marrow Transplant (BMT) is profound immunosuppression. Therefore, infectious complications are most common cause of morbidity and mortality in these patients. Infections in early post transplant period are due to host's own commensal or colonizing flora or can be acquired from the environment [7]. Heating and air conditioning systems can spread fungi such as Aspergillus. Hospital water can also be a source of specific bacteria such as *P. aeruginosa, Non-Tuberculous Mycobacteria* and *Legionella spp*. Surfaces can be contaminated with *C. difficile* spores and can act as a reservoir for nosocomial outbreaks of pseudo-membranous colitis.

Owing to the liberal use of broad-spectrum antibiotics in BMT units, multi-drug resistant bacteria such as *Vancomycin Resistant Enterococcus (VRE), Methicillin-resistant Staphylococcus. aureus (MRSA), P. aeruginosa* and *S. maltophila* can emerge and colonize the environmental surfaces in these units and hence, this 'environmental control' is a major aspect of HIC in BMT units. A set of prevention measures termed as "Protective Environment" has been recommended by Centre for Disease Control, USA, to prevent HAIs in hematopoetic stem cell transplant patients [8]. These guidelines consist of engineering and design interventions to decrease the risk of exposure to environmental fungi. BMT patient(s) should be placed in private rooms where the incoming air is filtered using HEPA filters capable of removing 99.97% of particles with ≥0.3 µm diameter. Positive air pressure in the room relative to the corridor with a pressure differential of ≥ 12.5 Pa is to be maintained and the air flow should be directed entering on one side, moving across the patient and exhausted on the opposite side. Rooms should be well sealed and have at least 12 air changes per hour. Rooms should have non porous surfaces and carpeting should be avoided. Respiratory protection with N95 masks should be provided when BMT patients are required to leave the Protective Environment. In spite of the Protective Environment, standard precautions are of utmost importance for all patient interactions in the BMT unit.

In summary, HAI presents as a significant risk to all patients admitted to the hospital. It can also be a risk to the hospital staff. Evidence based procedures and protocols need to be strictly implemented to ensure that these infections remain under control and not contribute to increased levels of morbidity and in extreme case mortality. This requires effective team work with multidisciplinary approach wherein the clinical, paramedical, administrative and engineering staff work in close collaboration to achieve the best results.

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