Review Articles
Role of Theatre Design in The Prevention of Wound Infection


Abstract
Operation theatre has to be properly designed to function efficiently in order to avoid discomfort for surgeons, anaesthetists, sisters, and also to prevent the micro bacterial contaminations. Wound infection can be defined as a type of secondary infection which occurs when an unhealed wound is exposed to infectious agents which may be the surrounding air, unsterilized wound dressing, etc. Post operative infections add to the risk to patient’s life, recovery and increases length of stay and reduce the man-hours which the individual can contribute to the nation thus bringing down the overall productivity of the country. The theatre suite should be in a right position, made with right materials, correctly lit, ventilated, sterilized properly (clothes of staff, patients). Controversy exists over the extent and frequency of micro biological surveillance of operation theatres, causing post-operative wound infections. The sources of infection may be either endogenous (from the patient himself) or exogenous (from the theatre environment). Prevention of post-operative wound infection is dependent on several factors including effective sterilization and disinfection procedures, good surgical techniques, theatre design, bacterial contamination of theatre air, discipline which includes restricting the movement of staff near the operating table, appropriate use of antibiotics (for patients with septic wounds). Modern design of theatre should be able to meet all the requirements of surgeons and be flexible to adapt any changes in future.

Introduction
Wound infections are known to be one of the major causes of any discrepancies creeping in the surgical procedure performed on the patient. So the prevention of theatre infection is the first and foremost factor to be kept in mind during the design of the operation room. We carried out the detailed study and analysis of the operation theatre at the KJ Hospital and PG Research Centre and made certain unique observations which form the centrepiece of this article.

This theatre was designed by one of the authors around four decades back and is still very much relevant in the present surgical scenario. The main aim when planning the surgical centre is to create proper working conditions for the medical staff and to contribute towards avoiding wound infection. Planning measures for the prevention of infection should be based on knowledge of all sources and mechanisms of the infection as one component in a wider pattern of defenses against hospital infection.
Wound Infection

A clean, undrained closed wound does not become infected unless there is a greater number of a micro-organism (especially staphylococci). The source of contamination which lead to the development of a post-operative infection may be endogenous or exogenous. Types of micro-organism capable of harming the surgical patient are staphylococci, Pseudomonas aeruginosa, streptococci, the enteric bacilli and the clostridia.

Causes of wound infection: Increase of people present during the operation gives an increase in the incidence of wound infection.

1. **Patient himself**: The endogenous sources of contamination may not be from the patient blood and lymph vessels, upper or lower respiratory tract, gastrointestinal tract and genito-urinary tract but even from body surfaces, particularly the following areas: under the nasopharyngeal cavity, groin and the armpits.

2. **Staff**: Doctors' rooms are generally the most contaminated. Staff particularly the unscrubbed personnel is considered to be the most exogenous source of contamination. Any part of the body is considered to be a genuine site of skin carriage.

Increase in the number of operation leads to increase in the sepsis rate.

3. **Environment**: There are more reports of pathogenic bacteria having been isolated from various parts of anaesthesia apparatus such as corrugated tubing, reservoirs bag, Y-pieces, breathing bags, masks and from metallic inhaling and exhaling tubes of a closed-circuit absorber and also from physical environment which includes the door, walls, lights, ceilings, floors and air is the transmission medium of organisms which cause infection.

Role of Theatre Design in Prevention of Wound Infection

1. **Location**

Theatre in the hospital, its location is an important factor to be considered which mainly depends on two parameters:

a) Its relationship to the central sterile supply department (CSSD), it is the department which contains gas sterilizers (ethylene oxide), autoclaves, ultrasonic washers and standby electrical generators to sterile all the surgical equipments, cloths, gloves, etc.

Theatre and CSSD must be interconnected. Theatre location must be such a way that it's isolated and self-contained unit.

b) Its relationship to the surgical wards. Lengthy journey from ward to theatre is avoided. The theatre and CSSD must be located in the ground floor away from all thoroughfare.

2. **The Theatre**

The Design of the operation theatre itself is very important in achieving zero per cent theatre infection. Including the dimensions of the room, walls, floor, colour, light, temperature, humidity, staffs, etc. everything plays an important role in obtaining zero per cent theatre infection.

a) All rooms in operation site are built with hard non-porous washable surface which can be cleaned at regular intervals.

b) A special gurney system should be present which makes sure that stretchers from the various unsterile
wards need not enter the sterile theatre area, thus avoiding any infection being transported in via the wheels or other parts of the stretcher. This is done by using a special stretcher which is used only inside the sterile area. This stretcher latches on to the stretcher carrying the patient, aiding the transfer of the patient onto this special gurney. This avoids the unnecessary entry of the infected stretcher into the operating room.

c) Slide doors were incepted in the theatre design in order to block the entry of outside air inside the operating room. Ordinary doors have the property of sucking in the outside air into the theatre which can be avoided by using slide door. These
doors can be either automatic or manual.

d) In order to avoid the accidental electrocution of the patient, surrounding staff, etc. due to the biomedical equipment being used during the surgical procedure, conducting strips are embedded in the flooring of the room in order to remove the ground any stray, leakage current.

e) Special OT shoes lined with metal again aids in the process of removal of leakage current which may cause potential damage to the individuals in contact with the electronic equipment.

f) Special sterile footwear and gowns are to be used by the medical personnel in order to avoid being the carrier of infection from outside to inside the OT.

3. **Lighting**

There must be adequate and a shadow less light for the surgeon, anaesthetists, nursing staff and in case of a teaching theatre, the students. For the surgeon, the lighting must illuminate a cavity of 12 inch deep. Anaesthetists must be able to see the patient’s natural colour. Another important property of the theatre light is, it must produce less heat. Ultraviolet tube lights are present in the theatre which is switched on when there are no procedures taking place in the operation room in order to sterilize the static air.

4. **Heating and Air Conditioning**

The heating and air conditioning installation is one of the most potent
factor by which the architect can combat bacterial infection, and at the same time create those environmental comforts. Clean atmosphere reduces the risk of airborne infection and danger of anaesthetic explosion. The adjustable range of temperature builds a positive pressure inside the theatre. Normal temperature is said to be 65-75°F. Ventilation system must cause little noise. Carbon dioxide absorbers and oxygen boosts to revitalize the air preventing aerial contamination. Micron filters are used in order to remove various bacteria, spores, fungi, etc.

The appropriate amount of air displacement was found to be 6 times per min (the OT air is displaced six times over in a time span of 1 min) using laminar flow of gas under positive pressure. This takes care of the removal of any residue suspended in the air due to the procedure, etc.

5. **Staff environmental conditions**

Sterile gowns, caps for completely covering the hair and even the beard, masks and gloves should be donned in the scrub-up room. A surgeon should wear a sterilized plastic apron. Sterile towels are used for drying. The assistance of a second person is needed in donning the gowns. An area of 3-4 metre square is required for donning the gown. The scrub room should be adjacent to the theatre but physically separated from the theatre to prevent infections. The scrub room should be planned so that washing and gowning activities proceed simultaneously without detriment to either activity.

**Conclusion**

This design was found to be quite efficient in the prevention of post-operative wound infection and its efficiency was ensured and maintained by enforcing all the measures meticulously and by undertaking bacteriological sample monitoring.

**Future Development**

The surgeon in future will depend more on electrical and mechanical apparatus to extend their techniques. Further advances in extra-corporeal blood pumps and oxygenation. Security of the hospital records can be maintained using face recognition, thumb impression and retina recognition for identification purpose. Ultra Clean Ventilation-ceilings can be employed in hospitals where the air temperature, humidity, and velocity can be individually regulated. Simplicity and standardization are the key factors on which the whole conceptual design depends on.

**Acknowledgements**

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**References**

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Epistaxis

Most anterior nosebleeds are self-limited and do not require medical treatment. They can be controlled by pinching the anterior aspect of the nose for 15 minutes, which provides tamponade for the anterior septal vessels. The patient should relax, if possible. The head position can be either forward or backward, whichever is more comfortable, but it is important for the patient to avoid swallowing or aspirating any blood that may be draining posteriorly into the pharynx. A common mistake is for the patient to attempt to compress the area along the nasal bones.

Epistaxis that is refractory to pressure and topical vasoconstrictors may require cautery.

Anterior nasal packing is used for epistaxis that originates in Kiesselbach’s area and is refractory to the above treatments. These packs are left in place for 1 to 3 days before removal. In randomized, controlled trials, their use stopped bleeding in approximately 60 to 80% of cases refractory to vasoconstrictors and pressure.

Posterior nasal packing may be required for bleeding attributable to the sphenopalatine artery.

When nasal packs are in place, topical antibiotic ointments that coat the nasal packing or oral antibiotics are often used because of concern about the toxic shock syndrome.

When conservative measures fail to stop the bleeding, embolization or surgical ligation of the offending vessels is needed. The risk of a major complication, such as stroke, facial paralysis, blindness, or nephropathy associated with the administration of contrast material, is approximately 4%.

According to several case-series reports and literature reviews, success rates for surgical ligation of the sphenopalatine artery are equivalent to or better than success rates for embolization.