

Infection control in the surgical environment

Bevan Scott surveys the many infection control factors that go into the design and use of an operating department

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Abstract

A well-designed operating department includes features that support the prevention and control of infection. The incorporation of ventilation systems, safe waste management and environmental regulation contributes to an operating department, which promotes a safe environment for both patients and healthcare workers (Rothrock, 2003). This article considers aspects of theatre design and construction, and their impact on infection control in an operating department. Staff attitudes and discipline are also considered, in regard to the impact that they have on the effectiveness of the design in controlling infection. The author made the observations in practice during clinical placements and work experience opportunities in operating departments. These occurred in three NHS trusts in the south-east of England. Supported by evidence where possible, solutions are put forward where it is thought that improvements could be made to increase the control of infection in the practice setting, include suggestions regarding hospital policies, staff conformity and education.

Key words

Infection control, design, operating department, ventilation, lighting

Reference

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Introduction

Infection control is every healthcare worker's business, but for surgical staff it is especially important. This article provides an overview of how the physical environment of an operating department is designed and maintained with infection control in mind.

Environment

When considering infection control, the construction and planning of an operating department are important because the layout and relation of rooms determine the traffic flow and the possible route of any infection, via a carrier, through the department. The hospital's infection control team should be involved in all phases of the construction project and liaise with architects, engineers, contractors and medical staff, to ensure that the infection control needs of the department have been planned for, and met (Gruendemann & Mangum, 2001). After construction, it is not always possible to correct design faults as a result of inadequate planning, because renovation can prove costly and pose unnecessary health risks to patients and staff in a partly functioning department. It is therefore vital for the infection control team to review the layout of rooms, at the design/planning stage of the project to ensure that the location and relation of rooms within the department, and the resulting traffic flow, support suitable infection control practice (National Health Service Estates, 2002).

For infection control purposes, the layout of the department is divided into zones. An unrestricted zone allows access for visitors and personnel in

street clothes and serves as a transition zone between the operating department and main hospital (Phillips, 2004). The semi-restricted zone is limited to authorised personnel in surgical attire, and is often referred to as the 'clean' corridor, which provides access to the theatres (Phillips, 2004). The remaining restricted area is the operating theatre itself, where surgical attire is enforced, as well as strict aseptic techniques. Some departments do not recognise these particular zones; instead, the department is divided into two areas, clean and dirty. With the exception of the cleaners' room and dirty corridor, the entire department maybe considered a clean area. The dirty corridor surrounds the perimeter of some theatre suites, or may run in parallel to the clean corridor in others. It is used for removing used surgical instruments, dirty theatre clothing and clinical waste, and should not receive traffic from a clean area, such as the semi-restricted and restricted zones (Riley and Manias, 2002). Non-sterile equipment and supplies are kept in the dirty corridor of some departments, and staff regularly access, what is considered a dirty area, from a clean area. Despite the necessity of a dirty corridor from a purely logistical perspective, studies have shown very little difference in bacterial counts between clean and dirty areas, and with their use, no effect in reducing surgical site infections (Wilmore et al, 2003). This would suggest that the activities of staff in this regard, utilising dirty corridors as a store, may not be decreasing infection control within the departments.

Some departments built in the mid-

1970s have recently seen their workload exceed their design target. The result of increased demands on departments with outdated designs has meant that storage space for rising levels of equipment and supplies is inadequate. Some theatre doors, designed to afford an easy exit out of the theatre post surgery, have become blocked with machines and instruments, so that the post-surgery exit route for the patient is via the anaesthetic room. The anaesthetic room and clean corridor are considered clean areas, and transferring a patient from a dirty theatre, through a clean area to recovery, does not support good infection control practice. The solution is a purpose-built equipment room, adjacent to the department, to help alleviate congestion.

Ventilation

The operating department requires specialised ventilation systems in order to control the movement of air, and thus the transport of airborne contaminants, through the department (Scott, 2004). Before air is introduced into the department, it is conditioned through a series of filters, as well as having the temperature and humidity set to within their optimum range (Mason, 2006).

One of two types of ventilation systems are usually employed in modern operating departments: a conventional ventilation system utilising positive air pressure, and an ultra-clean ventilation system making use of laminar air flow (LAF) technology. In theory, both are designed and incorporated into operating departments, to reduce surgical site infections (Humphreys, 2002). Positive Pressure (PP) systems are designed to manage airflow throughout the department, whereas LAF systems are utilised within the operating theatre itself.

PP systems should be designed to provide 25 filtered air changes per hour throughout the department (Davey and Ince, 2004). Ensuring that the introduc-

tion rate of air into the theatre is higher than its evacuation rate creates positive pressure. As a result, the flow of air caused by the pressure differential, ensures that airborne contaminants are transported away from the surgical site, and towards adjacent rooms and corridors (Mason, 2006). This is achieved via purposefully-designed exhaust ducts positioned towards the lower part of the theatre walls. The adjacent preparation and scrub rooms should have an air pressure equal to, or slightly lower than, the pressure in the theatre. The lowest pressures are found in the corridors, offices and changing rooms (Phillips, 2004). A drawback with



PP systems is that in the interests of good communication, team members are not always vigilant in ensuring doors between the anaesthetic room and theatre are closed. However, it is important that all theatre staff are aware of how their actions may disturb the positive pressure air system operating throughout the department. A further drawback with PP ventilation is that despite its extensive use, there is little scientific evidence to support its inclusion in operating departments, particularly in theatres involving minimally invasive procedures (Stacey et al, 2002).

LAF systems are frequently utilised in orthopaedic theatres. They are unidirectional

flow systems that are more commonly vertically directed, as opposed to horizontally directed. Although the former suffers from minor air turbulence generated by heat from surgical lamps, the latter often suffers from major flow disturbance due to staff movement and is therefore used less frequently. For orthopaedic surgery, LAF systems are used with high-efficiency particulate air (HEPA) filters, capable of removing airborne particles of $0.3\mu\text{m}$ in size, with an efficiency of 99.97% (Dharan & Pittet, 2002). This ultra-clean air descends over the patient in a unidirectional flow, creating an ultra-clean zone by removing contamination from within the zone and supplying freshly filtered air. As a result, the effects of LAF remove the need for PP systems in these particular theatres (Hoffman, 2002).

Temperature

When designing an air system, consideration needs to be given to the characteristics of the air circulating within the operating department. Temperature needs to be viewed from several perspectives. Its effect on microbial growth, the patient's age and condition, and staff comfort all need to be taken into account when selecting a suitable temperature for the operating theatre. Davey & Ince (2004) suggest that mesophile

pathogens (disease-causing microorganisms) are able to reproduce within a temperature range of $20\text{--}45^\circ\text{C}$. Maintaining as low an ambient temperature as possible reduces the growth rate of the mesophiles, and thus reduces possible infection spread (Tortora et al, 2006). However, setting an ambient temperature of 20°C in an operating theatre may not be ideal from the perspective of the patient. Due to the increased body surface/body weight ratio in neonates and infants, temperatures below 23°C can rapidly bring about hypothermia. (Tander et al, 2005). Burn patients are also susceptible to developing hypothermia (Langley & Sim, 2002). A room temperature of



26°C has been found to be effective in preventing hypothermia (Tander et al, 2005), but may not be a comfortable temperature for staff to work in. A temperature range of between 20-24°C is most suitable for reducing bacterial growth, maintaining the patient's core body temperature and ensuring the comfort of theatre staff.

Individual theatre controls are necessary to provide optimum conditions for each patient (Gruendemann and Mangum, 2001). Some departments' temperature controls in the theatres have little or no effect over the theatres' temperature, partly due to an insufficient air conditioning system, which may struggle to reduce temperatures on hot summer days. This further reduces the control over infection. A state of equilibrium needs to be achieved, which provides a high enough temperature to avoid patient hypothermia and low enough to maintain staff comfort and reduce bacterial growth rates.

Humidity

The relative humidity in the department also has an effect on the bacterial growth rate. The internal humidity of an operating theatre should be maintained below 60%, but kept above 50%, to minimise bacterial growth potential (Modern Building Services, n.d). The monitoring of the humidity within the department should be managed by the hospitals engineering department, and checked regularly (Scott, 2004).

Lighting

There are two main types of lighting found in operating theatres, and both pose a risk of infection. Microorganisms settle on horizontal surfaces, such as equipment and lighting, and once disturbed by activity within the theatre, may potentially infect the surgical site. (Phillips, 2004). The luminaire lighting used to light the operating theatre and auxiliary rooms should be recessed, in order to prevent the collection of dust (National Health Service Estates, 2002). The surgical lights should be cleaned regularly to reduce the risk of infection. Possibly due to the surgical lights being

positioned above head height, they are not frequently cleaned in departments. One solution is to install anti-microbial theatre lighting, which use technology such as 'Polygiene' casing impregnation. Polygiene destroys microorganisms within hours of contact, removing the need for frequent dusting (Health Estates Journal, 2005).

Surfaces

The quality of finish on flooring, walls, doors and ceilings should be of a high standard to ensure ease of cleaning. Theatre floors should be of a hard impervious nature. This is to allow for ease of cleaning and to prevent wear from regular exposure to detergents and disinfectant chemicals, such as hypochlorite solutions (National Health

2003) when cleaning the theatre. The mops and cloths used for this purpose can be a source of infection and should either be sterilised frequently, or disposed of. The final cleaning of the day is often contracted out to a separate cleaning company (Line, 2003). The contracted cleaners in some departments are not responsible for cleaning any blood or body fluids, and it is necessary for the theatre team to ensure that the theatre is free of all blood and body fluids at the end of the days' list.

Waste

Another possible source of infection in the department is clinical and infectious waste. Where reasonably practicable, the authors' practice placement is required to ensure the health and safety of its employees, and persons not in their employ, for example students (HSE, 1974). To meet this requirement necessitates good waste disposal. Different types of

waste should be segregated and disposed of in the appropriate manner (DH, 2006b). Colour coding of waste is not mandatory, but is considered best practice (DH, 2006a). Yellow clinical waste bags are provided for waste that may pose a risk of infection, or prove hazardous. All waste known, or considered, to cause disease in humans or other living organisms, is considered infectious waste (DH, 2006a). Infectious waste is subject to Hazardous Waste Regulations and is segregated from all other wastes (House of Commons, 2005). This is achieved by containment in orange leak-proof rigid containers and orange waste bags. All waste bags should not be more than three quarters full (Davey & Ince, 2004) to ensure their secure closure – a responsibility of the theatre staff.

This is not always achieved in practice. Black domestic waste bags are not provided in some theatres, and as a result a large volume of instrument tray wrapping paper is placed in the yellow clinical waste bags. Should the department choose to use both black and yellow waste bags in theatre, the

Staff do not always conform to policies and guidelines already in place, and it is important to understand why.

Service Estates, 2002). The join between the floor and walls in the theatre should be of a continuous nature, to prevent the build up of bacteria and to allow for ease of cleaning (Gruendemann & Mangum, 2001). Both hard impervious flooring and a curved joining of floor and walls have been employed in departments in the south of England, as well as a restriction on painting theatre walls pink. This is to make the identification of body fluids easier when cleaning.

Cleaning

High standards of cleanliness are required in order to reduce reservoirs of infection (DH, 2003). Theatres should be cleaned several times during the day. The theatre must be damp-dusted prior to the first case of the day, after which it is necessary to clean and disinfect all contaminated areas of the theatre at the end of each case (Gruendemann & Mangum, 2001). Care should be taken by staff to avoid contamination from blood and body fluids by employing appropriate personal protective equipment (NICE,

potential for clinical waste to be placed in black bags, which are not incinerated, exists. Using only yellow clinical waste bags ensures that all theatre waste is incinerated, meeting the requirements of The Control of Substances Hazardous to Health Regulation (COSHH) (House of Commons, 2002).

Discussion

A number of issues have been highlighted above, regarding staff behaviour and attitudes while working in the operating department. Cardwell (2003) defines conformity as a form of social influence where people adopt the behaviours, attitudes and values of other members of a reference group. Staff do not always conform to policies and guidelines already in place, and it is important to understand why. Are the policies and guidelines out of date for current practice, and thus impractical, or does the design of the operating department promote non-conformity towards policies and guidelines? In the example mentioned above, where staff move between dirty and clean areas to access stock, this non-conformance can

be considered 'forced', because the decision to locate this stock in a dirty area has forced non-conformance towards the policy. This is due solely to the location of stock. A recent national survey regarding surgical scrub antiseptic practice has shown varied conformity to recommended guidelines by practitioners (Tanner et al, 2007), and suggests that this may be due to either unclear national guidelines or unawareness of them. Staff may be unaware of the guidelines and policies concerning air movement in the department. As a result doors between the anaesthetic room and theatre are being left open by staff.

How then, can best practice and acceptable levels of infection control be maintained if staff are unaware of guidelines and policies? ODPs are required to maintain their standards of proficiency and knowledge as technology and techniques advance (HPC, 2004), and should always be aware, and utilise, current best practice. At the same time, it is necessary for policies to be updated regularly to reflect these changes. A well designed operating department, utilising the most recent

infection control measures, will be less effective in controlling infection if policies and guidelines are not updated when necessary and followed.

Conclusion

There are many areas that need to be considered in the fight against infection in the operating department. Some need more regular attention than others. Construction techniques and design are crucial to the success of the department in controlling infection. Ventilation systems need to be maintained on a regular basis and temperature and humidity parameters need constant monitoring. Lighting and other fixtures, especially in the theatre, need appropriate daily cleaning. Most important of all – and most challenging – is the continuous education of staff to ensure conformity to regularly updated policies. **CODP**

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