



Original article

The passage of bacteria through surgical drapes

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The passage of bacteria through surgical drapes is a potential cause of wound infection. Previous studies have shown that liquids and human albumin penetrate certain types of drapes. We studied the passage of bacteria through seven different types of surgical drape and an operating tray. Bacteria easily penetrated all the woven re-usable fabrics within 30 min. The disposable non-woven drapes proved to be impermeable, as did the operating tray. We recommend the use of non-woven disposable drapes or woven drapes with an impermeable operating tray in all surgical cases.

Key words: Bacteria – Drapes – Contamination

Infection has always been a complication of surgery, although the incidence has fallen dramatically over the past 150 years. From 1864 to 1866, Joseph Lister performed 35 amputations: 16 (46%) of these patients died of sepsis.¹ After introducing routine disinfection of hands and sutures, Lister's mortality rate dropped to 6 (15%) out of 40 amputations performed between 1867 and 1869.^{2,3} In 1969, Charnley and Eftekhar reported a deep infection rate in total hip arthroplasty of 9%. They suggested the introduction of laminar air flow and routine prophylactic antibiotics.⁴ In the 1980s, Lidwell published three papers showing infection rates of 3.4% without the use of laminar air flow and prophylactic antibiotics and 0.3% with the use of laminar air flow and prophylactic antibiotics.^{5–7} Schutzer and Harris reported infection rates

of 0.38% in 659 procedures on 575 patients.⁸ They used peri-operative antibiotics, laminar air flow operating theatres and body exhaust suites in all cases.

Infection remains a problem despite modern aseptic surgical techniques and the routine use of antibiotics. There is also growing concern over the infection of healthcare workers by patients, particularly those with the hepatitis and human immunodeficiency viruses (HIV). It has been postulated that acquired immunodeficiency syndrome (AIDS) can be acquired by skin contact with HIV-infected blood. Braathen *et al.* suggested that HIV has an affinity for the Langerhans' cells of the skin⁹ and, in 1987, the Centers for Disease Control reported three cases of non-percutaneous transmission of HIV in healthcare workers.¹⁰

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Table 1 Results of experiment one

| Drape type | Bacterial growth of <i>Staph.</i> and <i>Strep.</i> at: | | |
|--|---|--------|--------|
| | 30 min | 60 min | 90 min |
| Non-woven, single use materials | | | |
| Baxter Isobac Optima | None | None | None |
| Baxter Optima | Scanty | Heavy | Heavy |
| Johnson & Johnson absorbant barrier | None | None | None |
| Johnson & Johnson adhesive operating towel | None | None | None |
| Woven re-usable materials | | | |
| 100% Continuous filament polyester with fluorocarbon | Heavy | Heavy | Heavy |
| Dense woven 50% polyester/50% cotton | Heavy | Heavy | Heavy |
| Ordinary weave 50% polyester/50% cotton | Heavy | Heavy | Heavy |
| Infla-tec® operating tray | None | None | None |

Table 2 Results of experiment two

| Drape type | Bacterial growth of <i>Staph.</i> and <i>Strep.</i> at: | | |
|--|---|--------|----------|
| | 30 min | 60 min | 90 min |
| Non-woven, single use materials | | | |
| Baxter Isobac Optima | None | None | None |
| Baxter Optima | None | None | Moderate |
| Johnson & Johnson absorbant barrier | None | None | None |
| Johnson & Johnson adhesive operating towel | None | None | None |
| Woven re-usable materials | | | |
| 100% Continuous filament polyester with fluorocarbon | Moderate | Heavy | Heavy |
| Dense woven 50% polyester/50% cotton | Heavy | Heavy | Heavy |
| Ordinary weave 50% polyester/50% cotton | Heavy | Heavy | Heavy |
| Infla-tec® operating tray | None | None | None |

In the operating theatre, infective organisms can be spread either directly by means of instruments, hands and penetration of drapes and gowns, or indirectly through air contamination.

Whyte *et al.*¹¹ and Hubble *et al.*¹² have shown that air contamination, caused by shedding of bacteria by theatre personnel, is a significant cause of wound contamination. They suggested special clothing with occlusive cuffs to prevent shedding.

Surgical gloves are routinely worn to prevent direct contamination of wounds. Hand scrubbing does not eradicate bacteria. Latex gloves provide an impermeable barrier to bacteria, even if they sustain minor perforations.¹³ Blom *et al.* found that instrument contamination is unlikely to be a significant source of infection in laminar flow theatres.¹³

The passage of bacteria through surgical drapes poses a major concern. Mackintosh and Lidwell performed experiments to determine the resistance to penetration by aqueous fluids of certain materials commonly used to make surgical drapes. Untreated woven fabrics are rapidly penetrated; non-woven synthetic materials resisted longer and tightly woven cotton fabrics resisted the longest. Of the fabrics tested, only the Johnson and Johnson Dexter fabric proved to be impermeable to tap water.¹⁴ Ha'eri and Wiley used human albumin microspheres labelled with ⁹⁹Tc as tracer particles to determine

the permeability of drapes. The particles penetrated woven drapes, but not non-woven drapes.¹⁵ This study does not take into account the physical and biological differences between albumin and bacteria. These differences may affect rates of penetration.

Using a new method to assess the permeability of fabrics,¹⁶ we performed an experiment to determine the passage of *Streptococcus viridans* and coagulase-negative *Staphylococci* spp. (common skin commensals) through various wet surgical drapes.

Materials and Methods

We tested seven types of surgical drapes that are in common use in operating theatres in the Bristol hospitals, as well as a PVC operating tray. Twenty-four round agar plates, with a diameter of 90 mm, were prepared by filling them to the brim with Columbia agar (Becton Dickenson, Oxford, UK) containing 8% whole horse blood (TCS Microbiology). The plates were inoculated with 10⁷ colony forming units of *Strep. viridans* and coagulase-negative *Staphylococcus* and incubated in air at 37°C for 18 h. The plates were divided into eight sets of three plates. A set of agar plates was assigned to each type of drape to be tested. A sterile section of drape was placed over each agar plate. Each drape was

then wet with 15 ml sterile normal saline placed with a sterile pipette over the centre of each agar plate.

Twenty-four square agar plates, 100 mm x 100 mm in size, were filled to the brim with blood agar. Each of these plates was inverted and placed over a round agar plate. After 30, 60 and 90 min, a square agar plate was removed from each set and incubated for 48 h. All the square plates were inspected for growth of *Strep. viridans* and coagulase-negative *Staphylococci* spp. The experiment was then repeated a second time to check for reproducibility.

Results

Scanty growth was defined as less than 10^2 colony-forming units. Moderate growth was defined as 10^2 – 10^5 colony-forming units. Heavy growth was defined as $>10^5$ colony-forming units. All of the reusable woven drapes allowed penetration by bacteria within 30 min. Drapes made of non-woven synthetic materials were impermeable apart from one (Tables 1 & 2).

Discussion

Wet non-disposable polyester and cotton fabrics are easily penetrated by common skin commensals. These materials are commonly used as surgical drapes in hospitals in the UK in the mistaken belief that they provide protection against bacterial contamination. We have demonstrated that they do not.

The Baxter Optima drape proved more resistant than the non-disposable drapes, but a significant contaminant of bacteria penetrated this type of drape. Some manufacturers believe that drapes that are impervious to water are, by definition, impervious to bacteria. The 3M web site states: 'new 3M Biocade Fabric meets these recommendations. Incorporated into many of our labor and delivery drapes and accessories, this new fabric is 100% impervious to liquid strike-through and, therefore, the passage of bacteria'.¹⁷

We have demonstrated that drapes that appear impervious to water, may still allow the passage of bacteria. The Baxter Isobac Optima and both types of Johnson and Johnson drapes proved to be impermeable to *Strep. viridans* and coagulase-negative *Staphylococci* spp. Therefore, the authors recommend the use of these or similar non-woven single use drapes.

The Infla-tec® operating tray (Intavent-Orthofix Ltd, Maidenhead, Berks, UK) was impermeable to both

types of bacteria. The surgical tray has been designed to contain the spread of hazardous fluids in the operating field. Fluids are contained by the tray and then drained by a suction mechanism. We recommend its use in contaminated surgical cases, where lavage is anticipated or where blood spillage occurs, especially when woven reusable drapes are used.

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