

A Review of Prevention of Surgical Site Infections: General Principles and Relation to Facial Wounds



By Kenneth Dolynchuk

Although facial surgery has historically had a low incidence of surgical site infections (SSIs) when compared with other surgery, certain clinical situations can arise in which infection occurs. Sepsis has been on the rise over the past two decades, and, while the death rate is decreasing in the general population and facial infection carries a low mortality risk, the morbidity is significant.¹ *Staphylococcus aureus* and *Streptococcus pyogenes* are the most common isolates from facial wound infections and in septicemia.² *Pseudomonas* infection is common in the ear, and anaerobic bacterial infection is common in the intra-oral locations.^{3,4} The following review will present our current understanding of the pathogenesis of infection with emphasis on recommendations for prevention of infection in the facial surgical site.

History

Experience with prevention of facial infection dates back to the 16th century and Brancha and his son who used fresh urine in an attempt to disinfect amputated noses on the dueling field.⁵ In an attempt to perform delayed facial reconstruction in field hospitals, mafenide acetate was placed in facial wounds as prophylaxis by the Germans in the Second World War. The British used analine dyes to achieve control of infected maxillary wounds during the same period.⁶ In the modern era, systemic antibiotics provided the ability to perform complex head and neck reconstructions without concern of fulminant sepsis from prolonged exposure of the aerodigestive tract in the

wound during surgery. In spite of these advances, death and debility continue to be a problem in cases where host immune function is decreased or pathogenic virulence is allowed to go unheeded by physicians.⁷ The principled surgeon should be able to recognize the major factors contributing to infection and reduce the preventable factors in the patient at risk. Let us examine these factors.

Contamination

The risk of infection rises with the amount of contamination in the wound.⁸ The size of the inoculum required to cause infection in incisional wounds has been studied and used to determine a classification on which to base treatment of wounds. Generally, the *clean*, *clean-contaminated*, *contaminated* classification has been used in facial wounds as well as wounds elsewhere to assess the risk of infection.⁹ In facial wounds the time used in predicting a clean-contaminated wound is extended from six to 24 hours due to the rich blood supply in the face.

The incidence of surgical site infection has been significantly reduced clinically by preparation of the skin pre-op using chlorhexidine skin cleanser the night before and the day of surgery by the patient.¹⁰ It has been shown previously by Burke that control of bioburden is important in permitting normal wound healing.¹¹ Resident bacteria in the wound are effectively removed by topical antibiotics during delayed primary wound closure. The presence of local wound infection will prevent skin graft take. Furthermore, systemic antibiotics have little role in preventing local infection prophylactically

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once bacteria quantitatively reside in the wound.¹²⁻¹⁵ This provides the impetus to find better strategies to reduce bacterial numbers in the wound prior to closure, since we know that *de novo* invasion does not occur after an hour of the wound being closed.

Patient Assessment

The need for proper pre-operative patient assessment is vital in the fight against SSIs. Malone et al. studied 5,031 patients who underwent non-cardiac surgery at Veteran Affairs Hospital over a six-year period ending in 1990. The overall incidence of SSIs was 3.2 per cent, and independent risk factors for the development of infection included ascites, diabetes mellitus, post-operative anemia, tobacco use, or corticosteroid use.¹⁶ As stated above, host immunity carries with it the balance between colonization and infection. The need for strict adherence to surgical principles and prophylactic antibiotics in the presence of depressed host immunity (such as HIV) is paramount. Where possible, steroid medication and antimitotic drugs must be stopped in advance of the surgery to enable patient immune systems to recover. In addition, radiation injury provides an ischemic environment with depletion of reserves in the wound to control infection, whether clinically evident or not.

Other important causes of altered host immunity include diabetes, and tight control of blood glucose is an important determinant in preventing surgical site infections.^{17,18} The presence of complicating skin lesions needs to be addressed pre-operatively. Secondary infection due to the presence of such conditions as poison ivy, psoriasis, eczema, atopic dermatitis, acne and scabies has led to the contamination of wounds with known pathogens.¹⁹

Inadequate blood flow into a region of injury has been documented to affect many factors in healing wounds. The most important is inhibition of host defences. Adrenalin ischemia has been studied in the presence of known amounts of bacteria, and it was found that infection is increased with ischemic insult during the first few hours post injury.²⁰ Insight into host immune mechanisms has provided some explanation for this finding.

Leukocyte influx into areas of inflammation is stimu-

lated by chemokines and complement. The latter is both chemotactic and opsonic in its function but is less microbiocidal than the leukocytes that are attracted. Polymorphonuclear leukocyte defence is dependent on the presence of oxygen. Bacteria, which are common wound pathogens such as *Staphylococcus*, *Streptococcus*, *Escherichia coli* and *Klebsiella*, are sensitive to this mechanism of defence.²¹ They are the most likely to flourish in hypoxic conditions as well. Where nutrient flow is diminished, so is the influx of antibiotics into the tissues. Tissue ischemia must be prevented as much as possible in the care of acute wounds in order to prevent surgical site infection.

The patient's temperature has profound effects on tissue perfusion, and even mild hypothermia can increase the likelihood of infection. Mild pre-operative warming of the patient reduces these risks significantly.²²

Surgical Technique

Proper preparation of the surgeon before the operation, including scrubbing up and double gloving, has been shown to be key, and adherence to standard operating theatre protocol has been shown to reduce patient risk.²³

Studies by Haury et al. have shown that devitalized tissue can serve as a nidus for infection.²⁴ Bacterial killing is hampered by trauma to the nutrient inflow, which provides ingress of leukocytes. Since then, Miles demonstrated that a critical period of three hours post-injury is the most important in terms of being able to mount an effective inflammatory response.²⁵ This is also vital in timing of peak levels of prophylactic antibiotics in the wound tissue.

Clinically, Hohn has determined another important factor in mastectomy scars. He demonstrated that devitalized tissue is phagocytically removed by macrophages, which are then relatively incapable of microbiocidal activity.²¹ This all leads to the importance of adequate wound debridement prior to any form of closure.

There is considerable evidence that induced foreign bodies have a number of detrimental effects on inflammation and repair. The type of suture material used can influence the rate of infection. Edgerton's group found that monofilament nylon or polypropylene had less infection-promoting effects than polyfilament silk or cotton.²⁷ Stainless steel or Dacron was intermediate

in its effects. Furthermore, in standard infected wound models the critical concentration of bacteria (>10⁵ organisms/gram of tissue) was related to the closure material.²⁸ Tape was shown to be superior in skin closure of elective abdominal surgery in which bowel was entered. Subcutaneous suture placement resulted in a 62 per cent infection rate in animals, whereas no attempt to close dead space resulted in no infection. Suture closure of adipose tissue was advisably discouraged, even in the obese patient.

Debridement is the most important first step in these wounds. It is not only important in removing devitalized tissue, which will impair the host response, but it controls resident bacteria in the wound. Ultimately, inflammation is kept to the lowest level of activity possible in order to prevent excessive scar formation, which is an important consideration in the facial area. Primary closure of facial wounds has been controversial even though little debate exists in abdominal wounds. The ability to debride the edges in limited fashion and irrigate the edges with pulsed lavage has been instrumental in permitting primary closure in facial wounds for aesthetic reasons. Meanwhile, preservation of tissue for aesthetic reasons needs to put limits on the degree of debridement as well. The use of an antimicrobial impregnated suture would be beneficial in this regard. The innovation of a triclosan impregnated suture has advanced our technology further by preventing resident bacteria present in the wound at the time of closure from persisting to create a nidus for wound infection.²⁹ This has an advantage over topical antimicrobials in that the activity is at the very location where bacteria preferentially colonize wounds, at the site of the suture itself. Furthermore, neither triclosan-resistant organisms nor skin sensitivity problems have yet to emerge.³⁰

The development of an antibacterial suture and skin adhesives promises an even greater diversity in the tools available to the surgeon. Skin adhesives are designed for use on small incisions but can be very useful for children and adults where the desired cosmetic effect during healing precludes the use of bandages.³¹

Summary

As with all surgery, the optimal clinical outcome is restoring patient health and preventing serious infection. However, with facial surgery, cosmesis has to be taken

into account and may indeed be the principle reason for the surgery. Proper assessment and preparation of the patient before surgery and adherence to standard operating theatre protocol during surgical procedure has been shown to significantly reduce patient risk.

Topical antibacterial creams are efficacious and first-line in infection management, whereas systemic antibiotic use can be considered for patients at particular risk or in operations where risk of SSI is particularly high. New devices such as skin adhesives and the triclosan antibacterial suture are yet other tools for the surgeon to use and may become commonplace in facial surgeries as the shift in emphasis moves toward prophylaxis rather than treatment. ☺

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