Chemoprophylaxis in surgery

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Summary

The literature on the prophylactic use in surgery of disinfectants, antibiotics and the chemotherapeutic agents is reviewed. It is concluded that there is little place for the routine use of antibiotics or chemotherapeutic agents except in a very few conditions. Disinfectants do have a part to play in skin sterilization and in the reduction of postoperative wound infection. However, none of the compounds yet replaces careful technique and standard surgical procedure.

Introduction

Prophylaxis is described as 'the preventive treatment of disease' in the Shorter Oxford English Dictionary and so the place of antiseptics, antibiotics and other chemotherapeutic agents in the prevention of complications of surgery will be discussed in this paper.

A review of the value of chemoprophylaxis in surgery is necessary because postoperative wound infections are reported to be costing the National Health Service about £22.3 million a year in additional bed occupancy (Gilmore and Sanderson, 1975a). This fact alone would justify attempts at reducing infection, but in addition and perhaps of greater importance is the fact that these complications add to the discomfort and inconvenience of patients undergoing surgery. However, wound infections are not the only complications of surgery attributable to bacteria, and prophylaxis for chest infections, endocarditis and bacteraemia will be mentioned in this review.

History

Probably the first description of the use of prophylactic techniques against infection following surgery was by Hippocrates, who irrigated wounds with wine. Since then, mercuric chloride was used by Arabian physicians in the Middle Ages, followed by various other compounds until carbolic was introduced by Lister in 1867. The real advent of the use of chemoprophylaxis as we know it today was in the early 1940s with the commercial development of

penicillin. Now there are in excess of 2000 antibiotic compounds available, together with a variety of other chemotherapeutic and disinfectant agents.

When the dramatic effects of penicillin and its early successors were observed in the treatment of infection it seemed logical to believe that if these compounds were used early enough they would also prevent infection. Physicians thought Ehrlich's 'magic bullet' had been found. Although this was theoretically logical, in practice the infecting organisms rapidly developed a resistance to the antibiotics used (Barber and Rozwadowska-Dowzenko, 1948). In addition, it seemed that the destruction of some relatively innocuous bacteria allowed the growth of other resistant and far more virulent organisms. Price and Sleigh (1970) report an increased mortality in a neurosurgical unit when prophylactic ampicillin was used and the death rate did not fall until the drug was stopped. Another serious problem now commonly observed is that antibiotics induce sensitivity reactions in some patients, the effects of which can be disastrous. So it is necessary to review very critically any attempts to reduce the excessive incidence of infection following surgery.

Skin preparation

Since the skin is colonized by a variety of organisms, some of which if introduced into the tissue may become pathogenic, it is obvious that attempts to reduce the numbers of organisms, both on the patient's skin before cutting the surface and on the surgeon's hands before gloving, are necessary. Techniques for this have varied from scrubbing with soap and water to anointing the skin with various compounds. Although total sterilization is impossible, preparations such as 3% hexachlorophane in detergent (Phisohex), povidone-iodine detergent (Disadine) and 4% chlorhexidine detergent (Hibiscrub) seem effective (Smylie, Logie and Smith, 1973). Scrubbing with soap and water alone has been known for many years to be counter-productive, probably because quiescent organisms in the deeper parts of the hair follicles are brought to the surface, thus increasing the number of organisms on the surface and facilitating their invasion into traumatized tissues.

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Prophylaxis of wound infections

There has been a wealth of literature in recent years reporting surveys which have been carried out to investigate the effects of antibiotics and other chemotherapeutic agents in preventing operative wound infection. Observations have included studies on patients who have been treated with these compounds systematically, while others have described their use locally in the wounds. However, all these papers are difficult to analyse because controls are unsatisfactory and there is confusion between clean, clean-contaminated and contaminated cases. A clean case is defined as one in which surgery is carried out under aseptic conditions without opening any infected structure, a clean-contaminated case as one in which there is no overt infection but during the operation an infected structure, for example the large bowel, is opened; and a contaminated case as one in which surgery is carried out for or in the presence of overt infection such as peritonitis or trauma. In the latter group, and probably the clean-contaminated group too, any antibiotic treatment must really be regarded as being therapeutic rather than prophylactic. When these reports are reviewed there is some evidence to suggest that initially a new antibiotic used either systemically or locally will reduce the incidence of wound infection in the clean cases (Gilmore and Sanderson, 1975b; Stoker and Ellis, 1972; Evans, Pollock and Rosenberg, 1974). However, resistant strains develop very rapidly and so it has been suggested that the continued use of such treatment as a general procedure is contra-indicated (Lowbury and Ayliffe, 1974).

It seems pertinent to discuss in more detail prophylaxis in surgery on the large bowel. This is one field in which various chemotherapeutic agents are being used pre-operatively for prophylaxis. The literature is most confused and is well reviewed by Forgan-Smith (1975). The idea of sterilizing the large bowel has been found to be impossible; only the composition of the flora changes and antibiotic-resistant strains rapidly appear (Altemeier, Hummel and Hill, 1966). The danger is that the patient treated with neomycin or phthalylsulphathiazole before surgery is regarded by the surgeon as having 'been prepared' and 'had his gut sterilized'. The psychological effect of this is to lull the surgeon into a false sense of security. This may lead to a disastrous situation, since the gut organisms at this stage are more likely to be antibiotic-resistant strains which may produce wound infections or peritonitis difficult to treat. The postoperative incidence of wound and other infectious complications has been shown to be similar in the 'prepared' and 'unprepared' groups. One report has shown that the use of phthalylsulphathiazole was of value in large bowel preparation only when it was accompanied by purga-

tion, bisacodyl suppositories and repeated enemas for 5 days before surgery (Rosenberg *et al.*, 1971). A very recent publication (Goldring *et al.*, 1975) has shown a significant reduction of both aerobic and anaerobic colonic microflora and subsequently postoperative wound infection when patients were treated with oral metronidazole in combination with kanamycin before gut surgery. One hopes this regime will be of value, but in view of previous optimistic reports subsequently being disproved, one should remain sceptical until other workers have verified these observations.

Patients having surgery for peritonitis have a very high incidence of wound infection which needs reducing. Various combinations of treatments have been used including peritoneal lavage with saline solutions and noxytiolin or wound irrigation with noxytiolin (Frazer-Moodie, 1974), or antibiotics. Despite Altemeier, Culbertson and Hummel's (1968) claim that prophylactic antibiotics increased wound infection, most reports suggest a slight reduction in infection rate. However, resistant strains and antibiotic sensitivity develop, each producing its own problems.

When disinfectant compounds such as noxytiolin were used in rats, treated animals had a higher mortality rate than untreated controls. In the clinical situation, no difference in wound infection rate was observed between treated patients and untreated cases (King *et al.*, 1975). This suggests there is a specific contra-indication to the use of such compounds.

Following wound irrigation or spray with antibiotics, resistant organisms in other patients in the ward have been observed (Hughes, 1970). However, the local use of povidone-iodine does seem to have a valuable effect, in reducing the infection rate (Gilmore and Sanderson, 1975a). Probably the best technique for reducing wound sepsis in these patients is still adequate drainage or delayed primary skin closure techniques.

Chest infections

Chest surgery in the mid-1960s was always 'covered' by routine antibiotics. However, this was good for the surgeon's peace of mind but did not stand up to critical examination when tested with controlled trials. There is only a little evidence in the literature that there is any value in this technique (Laszlo *et al.*, 1973). The chest infections that developed in patients who received antibiotics were, if anything, worse than in the control groups. Pre- and postoperative physiotherapy and, where necessary, tracheal toilet and bronchoscopy are far more effective. Even neonates requiring postoperative ventilation in whom pneumonia is a common

complication should not receive antibiotics without a very good reason (Davies, 1975).

Foreign materials

The insertion of foreign materials into the body such as prosthetic heart valves, prosthetic joints or internal fixation of bones presents special problems. Initially these operations were all 'covered' by various broad-spectrum antibiotics. The place of antibiotic cover in these cases has not yet been adequately defined. The nature of the materials and the surgical techniques employed probably contribute more to the reduction in infection rate than any drugs. Antibiotics may be instilled locally (Scales, Towers and Roantree, 1972), although the complications of this have not been investigated and may still outweigh the advantages. Such treatment at present is no substitute for meticulous attention to asepsis during the operation.

Valuable chemoprophylaxis

Gas gangrene infections complicate leg amputations and extensive necrotic tissue damage following major trauma, especially in the presence of arterial insufficiency. Since the causative organisms are sensitive to penicillin, all patients having a limb amputation should be treated prophylactically with penicillin or an alternative antibiotic if the patient is sensitive to this. Consideration should be given to similar therapy in surgery for major trauma and burns. However, in the case of burns, owing to the rapid development of resistant strains of bacteria (Lowbury, 1972), care should be exercised in their use and perhaps local disinfectants such as silver nitrate or silver sulphadiazine are preferable to antibiotics, reserving these for the treatment of systemic bacteraemia.

Surgery, in patients with proved rheumatic heart disease or septal defects, even if it is of a minor nature such as dental treatment, may be complicated by endocarditis. However, if the patient is pre-treated with antibiotics appropriate to the potentially infecting organisms, the risk can be reduced.

Another group of patients at risk from infection are those with sickle-cell disease. Since any systemic infection may precipitate a crisis, the use of prophylactic antibiotics has been suggested for these patients. However, the literature on the subject is sparse and we must await the results of controlled trials before formulating definitive policies in this field.

Quiescent pulmonary tuberculosis can be activated by major abdominal surgery. The National Tuberculosis Advisory Council of Australia (1972) recommended the use of prophylactic treatment in such cases.

Another group of patients in whom prophylactic

antibiotics need to be considered is that in which are those who are therapeutically immunosuppressed or who have depressed defences for other reasons (Davidson, Smith and Smylie, 1971). In these cases the theoretical advantages of prophylaxis need to be weighed against the disadvantages, and treatment should only be started with care and after consideration of the potentially infecting organisms.

Surgery in the obstructed biliary and urinary tracts readily predisposes to bacteraemia, especially if the insult is invasive without immediate relief of obstruction. An example of this is percutaneous transhepatic cholangiography in the investigation of large duct obstructive cholestatic jaundice. Ideally, once obstruction has been proved, then immediate drainage is essential. Occasionally, this is impossible and systemic antibiotics appropriate to the potentially infective organism have been used. The literature on this is very poor at present and this is a field in which careful study is indicated to allow a rational approach. It is unlikely that chemotherapy will replace adequate drainage.

Conclusions

It would seem that the initial prospects that chemotherapeutic agents would act prophylactically to reduce the incidence of infection in surgery have not been sustained. Apart from a few isolated occasions, chemoprophylaxis with antibiotics is not only valueless but may increase the morbidity and mortality of the treated patient. It may be said that there is greater scope for antibiotic abuse in prophylaxis than treatment (Gilmore and Sanderson, 1975b). Chemoprophylaxis does not replace careful surgery and meticulous postoperative care.

In 1920 Lord Moynihan said 'every operation in surgery is an experiment in bacteriology'. Have we advanced beyond that today? In one way I believe we have. Today the science of microbiology has developed greatly; surgeons now have professional microbiological colleagues with whom they can collaborate to discuss problems of infection. By this means I believe we are approaching the time when our operations will cease to be experiments in bacteriology and will become safe, controlled, therapeutic procedures which are free from infection.

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