Cephalosporins in Surgery
Prophylaxis and Therapy

David W. McEniry and Sherwood L. Gorbach
Nutrition/Infectious Unit, Department of Community Health, Tufts University School of Medicine, Boston

Summary

Prophylactic antibiotics in surgery are intended to prevent morbidity and mortality, as well as to reduce the duration and cost of hospitalisation. The indications for prophylaxis, and its effectiveness, should be evaluated with these criteria in mind. The basis for antibiotic prophylaxis in surgery is either provision of an effective concentration of antibiotic in the tissue site at the time of potential contamination, or (primarily in the case of colorectal surgery) to reduce the inoculum of potentially contaminating bacteria.

Cephalosporins are the antibiotics most widely used for prophylaxis in surgery, and have clearly been shown to reduce postoperative morbidity in vaginal hysterectomy, resection of head and neck cancers, vascular grafting, total joint replacement, repair of hip fractures, and high risk gastroduodenal surgery. They are probably also useful in cardiac surgery, abdominal hysterectomy, caesarean section, and colorectal surgery.

For orthopaedic, cardiac, gynaecological, and gastroduodenal procedures it is important to select an antibiotic with proven clinical activity against Gram-positive organisms. For head and neck surgery, the spectrum of activity should also include oral anaerobes and Enterobacteriaceae. For biliary surgery an antibiotic effective against both Gram-positive and Gram-negative organisms may offer at least theoretical advantages, while for appendectomy a cephaparomycin represents the most appropriate choice. In colorectal procedures, activity against B. fragilis is the major consideration in selecting an antibiotic for systemic prophylaxis.

When intra-abdominal sepsis occurs following surgery, a potentially wide range of bacteria may be implicated, but in practice such infections are due to a small number of species, with B. fragilis most commonly implicated. The most useful cephalosporins in this setting are those active against both aerobic Gram-negative bacteria and anaerobes, especially B. fragilis. In practice, an aminoglycoside is often administered concomitantly. Importantly, prompt surgical treatment is the cornerstone of management of abdominal sepsis, and empirical antibiotic therapy should be adjusted as needed when culture and sensitivity tests become available.

1. Prophylaxis

One of the most common uses of antimicrobial drugs is for prophylaxis, particularly in surgery. This applies especially to the cephalosporins (Shapiro et al., 1979), which have been studied in this setting for more than 15 years (Evans and Pollock, 1973; Evans et al., 1974; Polk and Lopez-Mayor, 1969). When used in situations in which it has proven value, antibiotic prophylaxis can prevent much of
the morbidity and cost of postoperative infectious complications. When used indiscriminately it can increase hospital costs and contribute to overall morbidity.

1.1 Goals and Indications

The primary goal of the use of prophylactic antibiotics in surgery is the prevention of morbidity and mortality. Of almost equal importance is the reduction in duration and cost of hospitalisation. These goals are most likely to be met in circumstances in which the potential risk of infection is high. This category includes primarily contaminated and clean-contaminated surgery. In certain ‘clean’ procedures involving the implantation of prosthetic material, prophylaxis is indicated despite the low incidence of infectious complications, because of the catastrophic nature of those complications. When infection is presumed to be present, as in contaminated or ‘dirty’ surgical procedures, antibiotics are given with therapeutic intent.

Mortality is uncommon in most postsurgical infections and this infrequency makes it difficult to demonstrate a statistically significant effect of prophylaxis. Prevention of mortality, however, is an important goal when postoperative infection carries a high risk of mortality, as in endocarditis following prosthetic valve implantation.

Infectious morbidity following surgery is much more common and, hence, easier to study, but benefit is more difficult to define. Prevention of minor, self-limiting infections, especially those managed easily without increasing the duration or cost of hospitalisation, is a less important goal than the prevention of serious infections causing great discomfort and risk to the patient and requiring long, costly inpatient therapy.

1.2 Risks versus Benefits

It is necessary to consider the morbidity caused by the prophylaxis itself in the determination of overall benefit. Antibiotic toxicity is determined by the inherent toxicity of an antibiotic, its dosage, the duration of administration, and the idiosyncratic susceptibility of the patient. When safe drugs are used for a very brief period, such as a single preoperative dose, drug toxicity is negligible. In practice, however, prophylaxis is often given for a prolonged period (Shapiro et al., 1979), during which adverse drug effects are more likely to cause morbidity.

Even more difficult to assess in the equation of risk versus benefit is the effect of antibiotics on the flora of the patient and the hospital. Since antibiotic usage contributes to the development of antibiotic resistance in the indigenous hospital flora, a paradoxically adverse effect may occur. Many infections in patients undergoing cardiac surgery are now caused by Staphylococcus aureus or S. epidermidis resistant to β-lactam antibiotics, the antibiotics these patients most commonly receive for prophylaxis. Therapy of these infections usually requires prolonged treatment with vancomycin, a more toxic drug.

1.3 Guidelines

The characteristics of an ideal surgical prophylactic regimen are that it should: (1) prevent serious morbidity or mortality; (2) reduce the length and cost of hospital care; (3) have no untoward effects on patients; and (4) produce no adverse impact on the microbial flora of the patient or hospital. To achieve these characteristics a drug should: (1) be active against the pathogens most likely to contaminate the wound; (2) be given in appropriate doses, at a time that will ensure adequate concentrations at the incision site during the time of potential contamination; (3) be safe; and (4) be given for the shortest effective period in order to minimise cost and spare adverse drug effects.

Before employing a specific prophylactic regimen, it should have been demonstrated to be beneficial in controlled clinical trials, although such studies must be interpreted in the setting of local conditions. The risk of postoperative wound infection depends on many factors that vary between hospitals or surgeons, including the volume of surgery at a particular institution (Farber et al., 1981).