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Preventing Postoperative Infections

Current Treatment Recommendations

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Contents

Abstract

Surgical site infections (SSI) remain a major source of postoperative morbidity. The preventive effect of antimicrobial drugs on postoperative infections is without debate. The common basis of accepted indications for prophylaxis is available evidence of effect. Valid reasons to administer antimicrobial prophylaxis include a significant reduction of SSI or reducing the risk of SSI in procedures where the consequences of infection are serious or even disastrous. The antimicrobial drug must be effective against pathogens associated with infection after a given procedure. The first generation cephalosporin, cefazolin, has been considered one of the prophylactic drugs of choice in many authoritative guidelines.

The optimal timing of intravenous antimicrobial prophylaxis in surgery is considered to be about 30 minutes before incision, i.e. at induction of anaesthesia. A single dose of antimicrobial drugs before the operation is sufficient prophylaxis for most surgical procedures. The development of bacterial resistance is associated with antimicrobial use, and therefore prophylactic antibiotics should be used

as little as possible; in addition, the spectrum of activity of drugs used should be as narrow as possible. Although the principles of antimicrobial prophylaxis in surgery have been clearly established, many reports continue to describe inappropriate drug use. Overconsumption in terms of invalid indications or use of drugs with too broad a spectrum of activity should be eliminated by adhering to accepted guidelines.

Practical suggestions are given to optimise timing, such as simple reminders on the daily operating programme, the display of prophylaxis regimens according to type of surgery in table format in the operating room and having the anaesthetist note the complete drug regimen on the patient's anaesthesia record. Such measures will help to optimise antibiotic prophylaxis and restrict if to the operating room where it belongs

Surgical wound infections are the most common nosocomial infections in patients undergoing surgery; they remain a major source of postoperative morbidity.[1] Many environmental factors can be manipulated to reduce the risk of postoperative infection (table I). Sound judgment and proper operative technique, as well as the general health and stage of disease of the patient, are considered the most critical factors in the prevention of postoperative wound infection by surgeons.[2] However, as these authors point out, fastidious surgical technique, although easily recognised, is difficult to measure, and host risk factors are difficult to optimise. These are major reasons why the considerable reduction in postoperative wound infection in the last quarter century has been mainly attributed to rational antimicrobial prophylaxis.

In this paper, only recommendations on the preventive effect of antimicrobial drugs will be given. Prophylaxis of endocarditis and prophylaxis of infection following diagnostic procedures (endoscopy) are purposely excluded. Identification of procedures at high risk of infection, choice of appropriate antimicrobial drugs and principles of administration will be discussed. Although only a small number of relevant original articles in the English literature up to 1997 have been cited here, authoritative guidelines or state-of-the art articles published in the past 5 years (rather than the original references) have been frequently referred to. The recommendations, based on an internationally accepted consensus of scientific societies, do not include detailed dosing regimens for specific procedures. Instead, they aim to provide the knowledge for developing local hospital-based programmes for prophylaxis with antimicrobial drugs, and, most importantly, for implementing these programmes and monitoring compliance with them.

Table I. Measures commonly used to reduce the risk of surgical site infection

Preoperative showers, bathing with disinfectant soap
Skin disinfection
Theatre environment (e.g. clean air, laminar air flow)
Gloving techniques, hand-washing
Elimination of nasal carriage of *Staphylococcus aureus*
Topical antimicrobial drugs in the operative field
Preoperative oral antimicrobial drugs
Perioperative systemic antimicrobial drugs
Wound infection surveillance feedback

1. Principles and Evidence Derived from Well-Designed Studies

1.1 Definitions

The US Centers for Disease Control (CDC) have redefined the problem of postoperative infections, and proposed the term surgical site infections (SSI).[3] SSI are divided into incisional (superficial and deep) and organ/space infections, with the latter being used to describe the part of anatomy opened or manipulated during the operative procedure other than the incision. This revised classification clearly illustrates the variable clinical severity of these SSI. Some patients experience only a

minor superficial suppuration of the skin incision which is managed by removal of sutures and which resolves after a few days. At the other end of the spectrum, a patient with an infected hip prosthesis can experience lifelong incapacitation. This wide range in severity of SSI has an important impact on prophylaxis strategies in different surgical procedures.

1.2 Purpose of Prophylaxis with Antimicrobial Drugs

Early studies led to the recognition that reducing the amount of bacteria in the wound lowers the infection rate. Prophylaxis is aimed at a reduction of SSI by preventing local growth of potential pathogens in the tissues. Prophylaxis is mainly shown to be effective in reducing incisional SSI. Nosocomial infections in surgical patients at other sites than the operative site (e.g. respiratory, urinary) have been inconsistently reported to be influenced by the administration of preoperative antimicrobial drugs. However, most studies of surgical prophylaxis have not been designed to detect this effect. A significant lowering of the incidence of SSI results in several advantages:

- decrease of postoperative stay
- decrease in therapeutic use of antimicrobial drugs
- cost containment benefits.

1.3 Risk Factors of Surgical Site Infection

A classification of surgical procedures according to the chance of the incision being contaminated and, by inference, to the size of the bacterial inoculum, was created with the following 4 categories: clean, clean-contaminated, contaminated and dirty. It was assumed that clean operations had a low risk for postoperative infection (less than 5% in patients not receiving prophylactic antibiotics), and that contaminated operations had a higher risk.[4] Surveillance studies using this classification showed large variations in postoperative infection rates between centres for the same type of procedure.[5] This led to identification of intrinsic risk factors. Intrinsic factors associated with increased risk of surgical infection and their amenability via interventions are listed in table II. Because patients with these risk factors have a higher risk of infection, SSI rates must be stratified by risk factors. A consensus paper was published in which the CDC National Nosocomial Infection Surveillance (NNIS)-derived index[6] was chosen to stratify surgical wound infection data.[7] The NNIS-index stratifies by American Society of Anaesthetists score (a numeric quantification of disease severity), surgical wound class and duration of procedure.

Table II. Environmental, surgeon-related and patient-related risk factors associated with a higher rate of infection

Factors known to increase risk, and which are easily amenable to intervention
Long preoperative stay
Preoperative antimicrobial therapy
Preoperative shaving 1 day before operation
Length of operation
Drains in wounds
Tissue damage
Blood loss/blood transfusion
Factors known to increase risk, and which are more difficult/impossible to reduce
Old age
Malnutrition
Obesity
Immunosuppression
Diabetes mellitus
Corticosteroid use

1.4 Indications for Antibiotic Prophylaxis

The Infectious Diseases Society of America,[1] the American Society of Hospital Pharmacists,[8] the Canadian Infectious Diseases Society,[9] the French Society of Anaesthesia and Intensive Care[10] and the Surgical Infection Society,[11] all agree on a number of indications for antimicrobial prophylaxis which are listed in table III.

The common basis of these guidelines is available evidence of effect. There is agreement about most procedures with a risk of SSI higher than 10%. Patient studies have led to the classification of gastroduodenal, biliary and gynaecological

surgery into a category with low wound infection rates, therefore not necessitating prophylaxis. Exceptions are some specific operations or high risk procedures which are listed in table III. Prophylaxis should be restricted to these procedures. Cardiothoracic surgery consists mainly of coronary artery bypass grafts. Wound infection rates in these patients not receiving antimicrobial drugs have ranged from 9 to 54%. Nasal carriage of *Staphylococcal aureus* is a major risk factor.[21] Cephalosporins have lowered the wound infection rate to below 7%.[8] In ocular lens surgery, the devastating consequences of endophthalmitis justify topical prophylaxis.

Table III. Operative procedures for which antimicrobial prophylaxis is generally recommended

Clean-contaminated and contaminated operations, risk of infection >5-30%
Colorectal[12]
Appendectomy[a][13]
Oesophageal
Gastroduodenal high risk[b]
Small intestinal
Biliary high risk[c]
Gynaecological
hysterectomy[14]
high risk caesarean section[d]
second trimester and first trimester high risk abortion[15]
Head and neck
incisions through oropharynx[16]
Clean operations; risk of infection may be low but consequences are serious
Cardiac procedures with median sternotomy[8]
Noncardiac thoracic
pulmonary[11]
Neurosurgery
craniotomy[17]
Vascular
abdominal aorta
groin incision[11]
Ophthalmic
cataract surgery
Vascular prostheses
Joint prostheses,[18] osteosyntheses[19]

a Perforated appendicitis represents infection that has to be treated.

b Situations in which gastric acidity and gastrointestinal motility is impaired, percutaneous gastrostomy, or when the patient is morbidly obese.

c Patients at high risk were defined by age > 70 years, with acute cholecystitis, common bile duct stones, or obstructive jaundice.[20]

d Premature rupture of the membranes, long duration of labour and nonelective surgery.[15]

There is controversy, and thus disagreement, about antimicrobial prophylaxis in clean operations not belonging to the previously cited categories. The reason is a low risk of infection and poor evidence from randomised, controlled trials.[1,22] In fact, the list of procedures which do not require prophylaxis is long. Recent updates of guidelines now clearly state procedures for which prophylaxis is not warranted.[23] Examples are peripheral vascular carotid and vein surgery, surgery of the spine without prosthesis, most plastic surgery and urological procedures with sterile urine. A study by Platt et al.[24] reported a significant reduction in the numbers of infections after breast surgery and herniorrhaphy and suggested antimicrobial prophylaxis to yield a short term cost savings benefit. However, the routine use of antimicrobial prophylaxis in these clean surgical procedures is still considered controversial by members of the Surgical Infection Society of North America.[25] In some procedures such as cerebrospinal fluid shunt surgery, studies of antimicrobials against placebo have contributed to the insight that the benefits are probably minimal and that it is better to refrain from prophylaxis.[26]

Until recently, controlled trials of antibiotic prophylaxis in minimally invasive procedures (laparoscopic approach) were lacking.[27] Authors of prospective randomised clinical trials of antimicrobial prophylaxis in low risk laparoscopic cholecystectomy[28] and arthroscopic surgery[29] concluded that in these clean procedures, routine prophylaxis was not indicated. In contaminated laparoscopic procedures, such as high-risk cholecystectomy and bowel surgery, it is probably safest to apply the standards for similar open procedures in the absence of well conducted studies.[1] Although some host risk factors for development of postoperative wound infection are now acknowledged to a variable degree,[6] there is no standardisation of recommendations in the surgical literature for antibac-

terial prophylaxis in clean procedures regarding populations with impaired host defences.

1.5 Choice of Antimicrobial Drugs for Prophylaxis

Criteria describing the ideal antimicrobial agent for prophylaxis are listed in table IV. The drug must be effective against pathogens associated with infection after a given procedure. It is not necessary to cover the entire spectrum of contaminants of the wound. Table V lists both major pathogens causing SSI in procedures where prophylaxis is without debate and antimicrobial drugs of choice in these settings. Ideally, data on the sensitivities of bacteria from human commensal flora in the same geographical area should be used. If available, data from hospital infection-surveillance programmes should be used to monitor resistance patterns of pathogens causing SSI. Because incisional surgical infections are predominantly caused by *S. aureus*, activity against *S. aureus* is needed for all procedures that have at least 1 incision through the skin. First generation cephalosporins, such as cefazolin, have been considered the prophylactic drug of choice.[1,8-11,22]

Table IV. Characteristics of the ideal prophylactic antimicrobial drug

Has the necessary spectrum of activity and is active against the pathogens causing postoperative surgical site infections in patients
Reaches adequate concentrations in the tissues of the operative site
Has a half-life which permits single dose injections
Can be given by bolus injection at induction of anesthesia
Has no adverse effects associated with short term administration
Is not allergenic
Does not interact with drugs given perioperatively
Does not select for resistant micro-organisms in the patient
Is not an essential drug of the therapeutic arsenal
Is not expensive

Cefazolin has most of the characteristics of the ideal drug listed in table IV. Its effectiveness has been shown in many clinical trials. In prosthetic implant surgery, coverage against methicillin-resistant *S. epidermidis* can be of concern, since in the UK methicillin-resistant *S. epidermidis* have been detected on the skin of healthy adults who had not received any antimicrobial treatment for more than a year.[30] A recent review of 4 patient studies in prosthetic joint surgery showed equal effects of the glycopeptide teicoplanin (effective against

Table V. Major pathogens causing surgical site infections and antimicrobial drugs of choice for prophylaxis

Pathogens	Procedures	Drug/preoperative dose
Staphylococcus aureus and *Staphylococcus epidermidis*	Clean procedures (skin incision, no opening of viscus) for which prophylaxis is accepted[a]	Cefazolin 1-2g, (flu)cloxacillin 1g, clindamycin[b] 600mg, vancomycin 1g[c]
S. aureus Streptococci and oral anaerobes	Contaminated head and neck surgery Oesophageal	Cefazolin 1-2g, amoxicillin-clavulanic acid 1g, clindamycin 600mg
Enterobacteriaceae and streptococci and Gram-positive cocci	Gastroduodenal high risk Biliary high risk	Cefazolin 1-2g
Enterobacteriaceae and all anaerobes and *S. aureus*	Appendectomy Colorectal[d]/distal ileum Abdominal hysterectomy Caesarean section high risk[e]	Cefazolin 1-2g and metronidazole 500mg, amoxicillin-clavulanic acid 1g, cefotetan 1g, cefoxitin 2g
Enterobacteriaceae all anaerobes	Vaginal hysterectomy	Cefazolin 1-2g and metronidazole 500mg, amoxicillin-clavulanic acid 1g, cefotetan 1g, cefoxitin 2g

a Includes thoracic and open heart surgery, craniotomy, insertion of vascular and articular prostheses.

b In patients with β-lactam allergy.

c When methicillin-resistant staphylococcal aureaus (MRSA) cause surgical site infections.

d Colorectal: Oral neomycin and erythromycin base combined with bowel cleansing, starting 18 hours before the procedure.

e After clamping of the umbilical cord.

MRSA and MRSE), and of cephalosporins.[31] Since the glycopeptides vancomycin and teicoplanin are the last resource in the treatment of methicillin-resistant infections it is prudent to limit the use of glycopeptides to surgical prophylaxis in patients who are MRSA or MRSE carriers.[32] In colorectal surgery, activity against aerobe Gram-negative gut bacteria (Enterobacteriaceae, predominantly *Escherichia coli*) and Gram-positive and Gram-negative anaerobes (*Bacteroides* spp.) is required. A recent study comparing cefotetan with cefazolin in gynaecological surgery has provided convincing results regarding the need for antimicrobials with anaerobic activity.[14] A greater number of infections (11.6%) developed in the patients undergoing elective total abdominal hysterectomy who were given cefazolin 1g compared with those who received cefotetan 1g (6.3%). It is anticipated that a single dose of metronidazole 500mg in addition to cefazolin could provide the same efficacy against anaerobes (table V).

If the oropharyngeal anaerobic flora is still susceptible to penicillin and cefazolin, there is no need for β-lactamase inhibitors, or specific drugs with anaerobic activity, as prophylaxis in contaminated head and neck surgery. A recent study has supported the need for activity against Gram-negative aerobes in these patients.[33] Second generation cephalosporins (cefamandole, cefuroxime) have no advantages over cefazolin in surgical prophylaxis: they have a slightly broader spectrum against Enterobacteriaceae, which is not needed in elective surgery, and they are more expensive.

For all procedures for which drugs with anaerobic activity are needed, metronidazole can be combined with the cephalosporin. However, a disadvantage of metronidazole is the need for a slow infusion. Although metronidazole is a cornerstone of antimicrobial therapy in Europe, no increase in antimicrobial resistance to it has been reported to date. Second generation cephalosporins with activity against anaerobes such as cefotetan or cefoxitin are extensively used in the US and constitute an alternative for the combination cefazolin plus metronidazole. Although their anaerobic activity is less potent than that of metronidazole, it is probably sufficient for prophylaxis.

Cefotetan has a longer serum half-life (3 to 4.6 hours) than cefazolin (1.4 to 1.8 hours) and cefoxitin (45 minutes), and does not require repeat injections during surgery. Amoxicillin-clavulanic acid inhibits β-lactamase producing methicillin-sensitive *S. aureus* and *S. epidermidis*. Methicillin-resistant strains are resistant to this combination. In clean surgery, the broad spectrum of action of amoxicillin-clavulanic acid against Gram-negative aerobes and anaerobes is not needed, and in addition, there is concern that its use encourages the development of resistance.[34] Most prophylaxis studies with amoxicillin-clavulanic acid have been small and unblinded, although a meta-analysis is available.[35] Ampicillin-sulbactam has a spectrum of activity comparable to amoxicillin-clavulanic acid. Alternative drugs effective against staphylococci are clindamycin and vancomycin. Clindamycin is derived from a macrolide compound, and is effective against over 90% of methicillin-susceptible *S. aureus* and most anaerobes. It can be used for patients allergic to β-lactams.

For drugs with equal efficacy, the drug with the least potential for causing adverse effects should be chosen. The cost of antimicrobial prophylaxis is only a minor issue when the cost of perioperative regimens are compared. Replacement of expensive drugs saves money but the gain is modest.[36]

Parenteral [intravenous (IV)] administration of antimicrobial drug prophylaxis is used for most procedures (table V). Oral prophylaxis has been successfully used only in bowel surgery; neomycin plus erythromycin base is still an accepted standard in the US.[23] The benefit of combinations of oral and IV prophylaxis has never been established.[13] Topical mupirocin as a nasal ointment has reduced SSI in cardiothoracic surgery.[21] The antimicrobial effect of clindamycin mouthwashes has recently been studied in contaminated head and neck surgery.[37] Prophylaxis with topical antibiotics was more efffective than with parenteral administration at reducing the number of bacteria in the neck viscera, a theoretical advantage in this type of surgery.

The effect of antibiotic-containing cement in combination with IV administered drugs in total hip arthroplasty led to less revision surgery for infection of the prosthesis than either prophylactic measure alone.[38] In ocular lens surgery, antibiotic-supplemented irrigating solutions are being used.

1.6 Timing and Duration of Antimicrobial Prophylaxis

Protection against infection is maximal when the antibiotic is present in the tissues before microbial inoculation of the wound occurs. The rationale is to be found in the experimental work of Burke[39] and the clinical trials of Stone et al.[40] The half-life of the antimicrobial drug should be long enough such that a single injection can guarantee adequate concentrations in the tissues until the end of the procedure, or an additional intraoperative dose will need to be given. The same applies when blood loss amounts to more than 2 litres. Studies in patients have confirmed the importance of the timing of antimicrobial administration, as administration more than 1 hour preoperatively has resulted in a higher rate of infective complications.[41] In addition, the rates of wound infections increased further when the drug was given either more than 2 hours preoperatively or at any time postoperatively.[42]

The timing of IV antimicrobial prophylaxis in surgery has been considered to be optimal about 30 minutes before incision, i.e. at induction of anaesthesia.[23] A single dose of antimicrobial drugs before the operation is sufficient prophylaxis for most surgical procedures;[43] single doses have been effective in hysterectomy,[44] caesarean section, gastric, biliary and colorectal surgery including appendicitis, head and neck surgery,[16] arthroplasties,[45] and recently, cardiac surgery.[46] The interpretation of the results of clinical trials concerning the optimal number of antimicrobial doses has been hampered by a frequently encountered study design which compares a single dose of a new, broad spectrum drug) sometimes with a long half life) with multiple doses of a an older, narrow spectrum drug. Although explained by the need to obtain funding, this approach has left many questions on choice of antibiotic and optimal dose and duration unanswered. In colorectal surgery, a recent meta-analysis of 147 trials could identify only seventeen trials that compared a single-dose regimen with a multiple-dose (2 or more doses) regimen using the same antibiotic or combinations of antibiotics. There were no significant differences in surgical wound infection rates, even when the results were pooled.[47] A consensus on postoperative administration of antimicrobial drugs has been recently published.[48]

2. Adverse Effects of Antimicrobial Prophylaxis

2.1 Drug Reactions

Any drug used for prophylaxis should not produce major adverse events and should not interact with anaesthetic drugs. Also, a careful history of allergies should be taken from the patient before drug administration. Allergic reactions and anaphylaxis are well known for penicillins, e.g. (flu)cloxacillin, amoxicillin-clavulanic acid or ampicillin/sulbactam. Due to lower risk of allergy, cephalosporins are preferred to penicillins. The cross-reactivity of cephalosporins in persons with a penicillin allergy is less than 10%.[49] If an immediate hypersensitivity reaction to a β-lactam antibiotic is reported, an alternative drug from another class, such as clindamycin, should be given. Vancomycin is another alternative; however, rapid infusion of the drug can cause flushing of the upper body, pain and muscle spasm. Thus, the drug should be infused over a 60 minute period. Colitis due to *Clostridium difficile* toxins has been reported after perioperative prophylaxis with cephalosporins.[50]

2.2 Development of Resistance

Because the development of resistance is associated with antimicrobial use, prophylactic antibiotics should be used as little as possible, with drugs with as narrow a spectrum as possible. Preferentially, drugs should be selected that will not be used in therapy. Third generation cephalosporins

such as cefotaxime and ceftriaxone, ceftazidime and ceftizoxime offer no advantage over the first generation cephalosporins in surgical prophylaxis because they are less active against staphylococci. Their unnecessary broad spectrum of activity can select for resistant micro-organisms. With the exception of ceftriaxone, of which due to its long half-life 1 dose can be considered as 24 hour prophylaxis, third generation cephalosporins are more expensive than their first generation cousins. The same conditions apply to broad spectrum penicillins, fluoroquinolones and carbapenems. Since glycopeptides are an important part of the therapeutic arsenal, their use in prophylaxis should be avoided.[51] Cautious use of topical mupirocin is also warranted as in many countries nasal mupirocin plays a major role in containing outbreaks of MRSA.[52]

3. Pitfalls in Antimicrobial Prophylaxis

The Achilles heel of surgical prophylaxis is logistics. Although the principles of antimicrobial prophylaxis in surgery have been clearly established, many reports continue to describe inappropriate use. The adoption of agreed upon guidelines is the basis, but not a guarantee, for success of a programme.

3.1 Surveys

A few surveys using questionnaires have been conducted to provide information on the availability of guidelines for surgical prophylaxis in hospitals. In Britain, half of the respondent microbiologists stated that guidelines were available or in preparation, although response rates to the survey were only 41%.[53] Surveys of surgeons before the introduction of guidelines,[26,54] or anaesthetists,[55] yielded response rates between 81 and 91%.

3.2 Audits

Although some information on the availability of guidelines has been provided by surveys, compliance with these guidelines can be extremely deficient in daily practice. Overall compliance with older guidelines was as low as 32%.[36] Correct timing of prophylaxis seems to be a worldwide problem. In their review of the timeliness of antimicrobial prophylaxis in 44 US hospitals, Silver et al.[56] found that up to 54% of patients did not receive the drugs within 2 hours preoperatively. Gyssens et al.[57] found suboptimal timing in 53% of operations in a university hospital in The Netherlands. In Israel, inappropriate antibacterial prophylaxis timing was recorded in 46% of operations.[58]

4. Recommendations

The strategy outlined in table VI has been successful in an intervention study optimising the quality of surgical prophylaxis, including timing of the prophylaxis.[36,58]

Table VI. Strategy for the successful implementation of surgical antimicrobial prophylaxis by a multidisciplinary team[a]

1. Review current practices. Consult and discuss the most recent authoritative guidelines of scientific societies of all disciplines
2. Adapt into local guidelines with the surgeons, but do not impose guidelines upon them. Identify procedures which need and do not need antimicrobial prophylaxis
3. Use a minimal number of different drugs and different dosing regimens for all procedures and within one discipline
4. Select the drugs for prophylaxis which are not needed for subsequent therapy
5. Allow a local surgical opinion leader to introduce and implement these guidelines in his/her own division
6. Transform these guidelines into clear instructions in table format[b] for each division, and display them for staff and nurses in the wards
7. Introduce a prophylaxis +/- column to be filled in on the daily operating room programme
8. Involve all anaesthetists and have the complete drug regimen noted on the patient's anaesthesia record, including the exact time of administration checked off on a time scale
9. Display the clear instructions in table format in the operating room
10. As a general rule, keep prophylaxis simple and unambiguous

a A multidisciplinary team would comprise infectious disease specialists, medical microbiologists, clinical pharmacists, surgeons and anesthesiologists.

b The table would contain drug name, dosage(s), route, with alternatives for patients with β-lactam allergies.

4.1 Development of Local Guidelines

A forum for discussion can be started by a multidisciplinary team with a review or a survey of current practices and how these differ from a quality standard for prophylaxis. The strongest argument against invalid prophylaxis is that the incidence of infections will only slightly be lowered and that the benefits of prophylaxis do not counterbalance the disadvantages (toxicity, induction of resistance, costs). If there is no standard or consensus, it is better to refrain from prophylaxis. The selection of a drug for prophylaxis, and limiting its use to prophylaxis alone, avoids any confusion between prophylaxis and therapy and facilitates detection of prolonged prophylaxis practices. Standardised regimens will also improve drug quality-of-use.

4.2 Implementation of Guidelines

Compliance with any guidelines depends on their acceptance by each individual surgeon. Such acceptance can be enhanced by the introduction of the guidelines by a surgical staff member. All practical measures described in table VI can be adapted to the local setting.

4.3 Continued Monitoring of Practice

Criteria for inappropriate prophylaxis should be defined by local hospital staff after review of published guidelines.[59] Established criteria are available for consultation.[60] Compliance with the local guidelines can be reviewed and summarised by type of procedure, surgeon (anonymously) and service, and reported to department chiefs.[1] Antibiotic order forms can assist with timely discontinuation of drug prophylaxis, as can computer-assisted support.[61]

5. Conclusions

The purpose of these recommendations is to ensure the prophylactic use of antibacterials in surgical procedures in which they have been demonstrated to be effective. The outcome is a reduction in SSI rates and a limitation on the amount of antimicrobial agents used in settings where they are controversial. The motto should be: if there is no standard or consensus, better refrain from prophylaxis. The strongest argument against prophylaxis in these procedures is the fact that the incidence of infections will not be lowered and the benefits of prophylaxis do not outweigh the disadvantages (toxicity, induction of resistance, costs).

The balance between benefit and toxicity should be seen on a long term basis. If very large studies are needed to prove a minimal benefit, it means that many patients will have to be exposed to prophylaxis to avoid a few, minor infections. The choice of antimicrobial drug is very important: drugs which are typically reserved for resistant organisms are usually not advisable for prophylaxis. In view of increasing microbial resistance to antibiotics worldwide, it is time to concentrate efforts on the development of implementation and surveillance strategies, rather than setting up studies to compare nearly equivalent drugs for procedures in which the risk of infection is low.

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