Antimicrobial prophylaxis can decrease the incidence of infection, particularly surgical site infection, after certain procedures. Recommendations for prevention of surgical site infection are listed in the table that begins on page 84.

CHOICE OF A PROPHYLACTIC AGENT

An effective prophylactic regimen should be directed against the most likely infecting organisms, but need not eradicate every potential pathogen. For most procedures, the first-generation cephalosporin, cefazolin (Ancef, and others), which is active against many staphylococci and streptococci, has been effective.

Some Exceptions – For procedures that might involve exposure to bowel anaerobes, including Bacteroides fragilis, the second-generation cephalosporin cefoxitin (Mefoxin, and others), has been recommended because it is more active than cefazolin against these organisms. Cefoxitin availability has been limited, however, due to high demand and cefotetan (Cefotan), once an alternative, is no longer being manufactured.1 Cefazolin plus metronidazole (Flagyl, and others), or ampicillin/sulbactam (Unasyn, and others) alone, are other reasonable alternatives.2

Cefuroxime (Zinacef, and others) is a second-generation cephalosporin with little activity against B. fragilis, but it can be used instead of cefazolin in cardiac, non-cardiac thoracic and orthopedic operations.

Ertapenem (Invanz) has been approved by the FDA for prophylaxis of elective colorectal procedures, but most Medical Letter consultants would not recommend routine use of such a broad-spectrum drug.

Not Recommended – Third-generation cephalosporins, such as cefotaxime (Claforan), ceftriaxone (Rocephin), cefoperazone (Cefobid), ceftazidime (Fortaz, and others), or ceftizoxime (Cefizox), and fourth-generation cephalosporins such as cefepime (Maxipime) should not be used for routine surgical prophylaxis because they are expensive, some are less active than cefazolin against staphylococci, and their spectrum of activity includes organisms rarely encountered in elective surgery.

Penicillin Allergy – Cefazolin can often be used for prophylaxis in patients with penicillin allergy, but some may rarely have allergic reactions to cephalosporins.3 When allergy prevents use of a cephalosporin, vancomycin (Vancocin, and others) or clindamycin ( Cleocin, and others) can be used, but neither is effective against gram-negative bacteria; many Medical Letter consultants would add gentamicin (Garamycin, and others), ciprofloxacin (Cipro, and others), levofloxacin (Levaquin) or aztreonam (Azactam, and others).
## Antimicrobial Prophylaxis for Surgery

<table>
<thead>
<tr>
<th>Nature of operation</th>
<th>Common pathogens</th>
<th>Recommended Antimicrobials</th>
<th>Adult dosage before surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>Staphylococcus aureus, S. epidermidis</td>
<td>cefazolin or cefuroxime</td>
<td>1-2 g IV², 1.5 g IV², 1 g IV³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR vancomycin³</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esophageal, gastroduodenal</td>
<td>Enteric gram-negative bacilli, gram-positive cocci</td>
<td>High risk⁴ only: cefazolin⁷</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td>Biliary tract</td>
<td>Enteric gram-negative bacilli, enterococci, clostridia</td>
<td>High risk⁵ only: cefazolin⁷</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td>Colorectal</td>
<td>Enteric gram-negative bacilli, anaerobes, enterococci</td>
<td>Oral: neomycin + erythromycin base⁶</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR: metronidazole⁶</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parenteral:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>cefoxitin⁷</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR cefazolin</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ metronidazole⁷</td>
<td>0.5 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR ampicillin/sulbactam</td>
<td>3 g IV</td>
</tr>
<tr>
<td>Appendectomy, non-perforated⁶</td>
<td>Enteric gram-negative bacilli, anaerobes, enterococci</td>
<td>1-2 g IV</td>
<td></td>
</tr>
<tr>
<td>Genitourinary</td>
<td>Enteric gram-negative bacilli, enterococci</td>
<td>High risk⁸ only: ciprofloxacin</td>
<td>500 mg PO or 400 mg IV</td>
</tr>
<tr>
<td>Gynecologic and Obstetric</td>
<td>Enteric gram-negative bacilli, anaerobes, Gp B strep, enterococci</td>
<td>cefoxitin⁷ or cefazolin⁷</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR ampicillin/sulbactam</td>
<td>3 g IV</td>
</tr>
<tr>
<td>Cesarean section</td>
<td>same as for hysterectomy</td>
<td>cefazolin⁷</td>
<td>1-2 g IV after cord clamping</td>
</tr>
<tr>
<td>Abortion</td>
<td>same as for hysterectomy</td>
<td>First trimester, high risk¹⁰: aqueous penicillin G</td>
<td>2 mill units IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR doxycycline</td>
<td>300 mg PO¹¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second trimester:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>cefazolin⁷</td>
<td>1-2 g IV</td>
</tr>
</tbody>
</table>

### Notes:

1. Parenteral prophylactic antimicrobials can be given as a single IV dose begun 60 minutes or less before the operation. For prolonged operations (>4 hours), or those with major blood loss, additional intraoperative doses should be given at intervals 1-2 times the half-life of the drug for the duration of the procedure in patients with normal renal function. If vancomycin or a fluoroquinolone is used, the infusion should be started 60-120 minutes before the initial incision in order to minimize the possibility of an infusion reaction close to the time of induction of anesthesia and to have adequate tissue levels at the time of incision.

2. Some consultants recommend an additional dose when patients are removed from bypass during open-heart surgery.

3. Vancomycin is used in hospitals in which methicillin-resistant S. aureus and S. epidermidis are a frequent cause of postoperative wound infection, for patients previously colonized with MRSA, or for those who are allergic to penicillins or cephalosporins. Rapid IV administration may cause hypotension, which could be especially dangerous during induction of anesthesia. Even when the drug is given over 60 minutes, hypotension may occur; treatment with diphenhydramine (Benadryl, and others) and further slowing of the infusion rate may be helpful. Some experts would give 15 mg/kg of vancomycin to patients weighing more than 75 kg, up to a maximum of 1.5 g, with a slower infusion rate (90 minutes for 1.5 g). To provide coverage against gram-negative bacteria, most Medical Letter consultants would also include cefazolin or cefuroxime in the prophylaxis regimen for patients not allergic to cephalosporins; ciprofloxacin, levofloxacin, gentamicin, or aztreonam, each one in combination with vancomycin, can be used in patients who cannot tolerate a cephalosporin.

4. Morbid obesity, esophageal obstruction, decreased gastric acidity or gastrointestinal motility.

5. Age >70 years, acute cholecystitis, non-functioning gall bladder, obstructive jaundice or common duct stones.

6. After appropriate diet and catharsis, 1 g of neomycin plus 1 g of erythromycin at 1 PM, 2 PM and 11 PM or 2 g of neomycin plus 2 g of metronidazole at 7 PM and 11 PM the day before an 8 AM operation.

7. For patients allergic to penicillins and cephalosporins, clindamycin with either gentamicin, ciprofloxacin, levofloxacin, gentamicin, or aztreonam, each one in combination with vancomycin, can be used in patients who cannot tolerate a cephalosporin.

8. For a ruptured viscus, therapy is often continued for about five days. Ruptured viscus in postoperative setting (dehiscence) requires antibacterials to include coverage of nosocomial pathogens.

9. Urine culture positive or unavailable, prooperative catheter, transrectal prostatic biopsy, placement of prosthetic material.

10. Patients with previous pelvic inflammatory disease, previous gonorrhea or multiple sex partners.

11. Divided into 100 mg one hour before the abortion and 200 mg one half hour after.

12. If a tourniquet is to be used in the procedure, the entire dose of antibiotic must be infused prior to its inflation.
Antimicrobial Prophylaxis for Surgery

<table>
<thead>
<tr>
<th>Nature of operation</th>
<th>Common pathogens</th>
<th>Recommended drugs</th>
<th>Adult dosage before surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Head and Neck Surgery</strong></td>
<td>Incisions through oral or pharyngeal mucosa</td>
<td>Anaerobes, enteric gram-negative bacilli, <em>S. aureus</em></td>
<td>600-900 mg IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>clindamycin + gentamicin OR cefazolin</td>
<td>1.5 mg/kg IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1-2 g IV</td>
</tr>
<tr>
<td><strong>Neurosurgery</strong></td>
<td><em>S. aureus, S. epidermidis</em></td>
<td>cefazolin OR vancomycin³</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 g IV</td>
</tr>
<tr>
<td><strong>Ophthalmic</strong></td>
<td>*S. epidermidis, S. aureus, streptococci, enteric gram-negative bacilli, <em>Pseudomonas spp.</em></td>
<td>gentamicin, tobramycin, ciprofloxacin, gatifloxacin levofloxacin, moxifloxacin, ofloxacin or neomycin-gramicidin-polymyxin B cefazolin</td>
<td>multiple drops topically over 2 to 24 hours</td>
</tr>
<tr>
<td><strong>Orthopedic</strong></td>
<td><em>S. aureus, S. epidermidis</em></td>
<td>cefazolin¹² or cefuroxime¹² OR vancomycin³¹²</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 g IV</td>
</tr>
<tr>
<td><strong>Thoracic (Non-Cardiac)</strong></td>
<td><em>S. aureus, S. epidermidis, streptococci, enteric gram-negative bacilli</em></td>
<td>cefazolin or cefuroxime OR vancomycin³</td>
<td>1-2 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5 g IV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 g IV</td>
</tr>
<tr>
<td><strong>Vascular</strong></td>
<td>Arterial surgery involving a prosthesis, the abdominal aorta, or a groin incision</td>
<td><em>S. aureus, S. epidermidis, enteric gram-negative bacilli</em></td>
<td>1-2 g IV</td>
</tr>
<tr>
<td>Lower extremity amputation for ischemia</td>
<td><em>S. aureus, S. epidermidis, enteric gram-negative bacilli, clostridia</em></td>
<td>cefazolin OR vancomycin³</td>
<td>1-2 g IV</td>
</tr>
</tbody>
</table>

Resistant Organisms – Long preoperative hospitalizations are associated with increased risk of infection with an antibiotic-resistant organism; local resistance patterns should be taken into account. In institutions where surgical site infections are frequently due to methicillin-resistant *Staphylococcus aureus* (MRSA) or methicillin-resistant coagulase-negative staphylococci, vancomycin can be used for prophylaxis, but routine use should be discouraged because vancomycin does not appear to be any more effective than cefazolin in these settings.⁴⁻⁵ Preoperative administration of intranasal mupirocin (Bactroban, and others) may decrease the rate of post-operative infections with MRSA in some patients undergoing cardiac surgery who are known to be colonized with the organism preoperatively⁶; use of this approach is increasing, but it is controversial and the need for preoperative evaluation of colonization also makes it difficult.

**TIMING AND NUMBER OF DOSES**

It has been common practice to give antibiotics at the time of anesthesia induction, which results in adequate serum and tissue levels; there is no consensus on whether the infusion must be completed by the time of incision. For procedures lasting less than 4 hours, Medical Letter consultants recommend a single intravenous dose of an antimicrobial started within 60 minutes before the initial skin incision, which should provide adequate tissue concentrations throughout the procedure. If vancomycin or a fluoroquinolone is used, the infusion should begin 60-120 minutes before the incision is made in order to minimize the risk of antibiotic-associated reactions around the time of anesthesia induction and ensure adequate tissue levels of the drug at the time of the initial incision.

Additional Doses – If the procedure is prolonged (>4 hours) or major blood loss occurs, redosing every 1-2 half-lives of the drug (in patients with normal renal function) should provide adequate antimicrobial concentrations during the procedure (ampicillin/subbactam q2-4 hours, cefazolin q2-5 hours, cefuroxime q3-4 hours, cefoxitin q2-3 hours, clindamycin q3-6 hours, vancomycin q6-12 hours, and metronidazole q6-8 hours).⁷ Published studies of antimicrobial prophylaxis often use one or two doses postoperatively in addition to one dose just before surgery. Most Medical Letter consultants believe, however, that postoperative doses are unnecessary after wound closure and can increase the risk of antimicrobial resistance.
Antimicrobial Prophylaxis for Surgery

INDICATIONS

Cardiac Surgery – Prophylactic antibiotics can decrease the incidence of infection after cardiac surgery, and intraoperative redosing has been associated with a decreased risk of postoperative infection in procedures lasting >400 minutes.7 Antimicrobial prophylaxis for prevention of device-related infections has not been rigorously studied, but is generally used before placement of electrophysiologic devices, ventricular assist devices, ventriculoperitoneal shunts and arterial patches.9 Studies of antimicrobial prophylaxis for implantation of permanent pacemakers have shown a significant reduction in the incidence of wound infection, inflammation and skin erosion.10

Gastrointestinal Surgery – Antimicrobial prophylaxis is recommended for esophageal surgery in the presence of obstruction, which increases the risk of infection. After gastroduodenal surgery the risk of infection is high when gastric acidity and gastrointestinal motility are diminished by obstruction, hemorrhage, gastric ulcer or malignancy, or by therapy with an H2-blocker or proton pump inhibitor, and is also high in patients with morbid obesity.11 A dose of cefazolin before surgery can decrease the incidence of postoperative infection in these circumstances. Prophylaxis is not indicated for routine gastrointestinal endoscopy, but most clinicians use it before placement of a percutaneous gastrostomy.12,13

Antimicrobial prophylaxis is recommended before biliary tract surgery for patients with a high risk of infection, such as those more than 70 years old and those with acute cholecystitis, a non-functioning gallbladder, obstructive jaundice or common duct stones. Many clinicians follow similar guidelines for antibiotic prophylaxis of endoscopic retrograde cholangiopancreatography (ERCP).14 Prophylactic antibiotics are generally not necessary for low-risk patients undergoing elective laparoscopic cholecystectomy.15,16

Preoperative antibiotics can decrease the incidence of infection after colorectal surgery; for elective operations, an oral regimen of neomycin (not available in Canada) plus either erythromycin or metronidazole appears to be as effective as parenteral drugs. Many surgeons in the US use a combination of oral and parenteral agents. Whether such combinations are more effective than just one or the other is controversial.17

Preoperative antimicrobials can decrease the incidence of infection after surgery for acute appendicitis.18 If perforation has occurred, antibiotics are often used therapeutically rather than prophylactically and are continued for 5-7 days. In studies of penetrating abdominal and intestinal injuries, however, a short course (12-24 hours) was as effective as 5 days of therapy.19-21

Genitourinary Surgery – Medical Letter consultants do not recommend antimicrobial prophylaxis before most urological surgical procedures in patients with sterile urine. When the urine culture is positive or unavailable, or the patient has a preoperative urinary catheter, patients should be treated to sterilize the urine before surgery or receive a single preoperative dose of an agent active against the likely microorganisms.

Antimicrobial prophylaxis decreases the incidence of postoperative bacteriuria and septicemia in patients with sterile preoperative urine undergoing transurethral prostatectomy.22 Prophylaxis is recommended before transrectal prostatic biopsies because urosepsis can occur.23 Surgical prophylaxis is generally used if a urologic prosthesis (penile implant, artificial sphincter, synthetic pubovaginal sling, bone anchors for pelvic floor reconstruction) will be placed.24

Gynecology and Obstetrics – Antimicrobial prophylaxis decreases the incidence of infection after vaginal and abdominal hysterectomy.25 Prophylaxis is also used for laparoscopic hysterectomies. Antimicrobials, usually given after cord clamping, can prevent infection after elective and non-elective cesarean sections.26-28 Antimicrobial prophylaxis can also prevent infection after elective abortion.29

Head and Neck Surgery – Prophylaxis with antimicrobials has decreased the incidence of surgical site infection after head and neck operations that involve an incision through the oral or pharyngeal mucosa.

Neurosurgery – An antistaphylococcal antibiotic can decrease the incidence of infection after craniotomy. In spinal surgery, the infection rate after conventional lumbar discectomy is low, but the serious consequences of a surgical site infection have led many surgeons to use perioperative antibiotics. One meta-analysis concluded that antibiotic prophylaxis prevents infection even in low-risk spinal surgery.30 Infection rates are higher after prolonged spinal surgery or spinal procedures involving fusion or insertion of foreign material, and prophylactic antibiotics are usually used.31 Studies of antimicrobial prophylaxis for implantation of permanent cerebrospinal fluid shunts have produced conflicting results.

Ophthalmology – Data are limited on the effectiveness of antimicrobial prophylaxis for ophthalmic surgery, but postoperative endophthalmitis can be devastating. Most ophthalmologists use antimicrobial eye drops for prophylaxis, and some also give a subconjunctival injection or add antimicrobial drops to the

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intraocular irrigation solution. There is no consensus supporting a particular choice, route or duration of antimicrobial prophylaxis. Preoperative povidone-iodine applied to the skin and conjunctiva has been associated with a lower incidence of culture-proven endophthalmitis. There is no evidence that prophylactic antibiotics are needed for procedures that do not invade the globe.

Orthopedic Surgery – Prophylactic antistaphylococcal drugs administered preoperatively can decrease the incidence of both early and late infection following joint replacement. One large randomized trial found a single dose of a cephalosporin more effective than placebo in preventing wound infection after surgical repair of closed fractures. They also decrease the rate of infection when hip and other closed fractures are treated with internal fixation by nails, plates, screws or wires, and in compound or open fractures. In such cases antibiotics may be used therapeutically and continued for a number of days; the optimal duration is unknown. If a proximal tourniquet is used for the procedure, the antibiotic infusion must be completed prior to its inflation. A prospective randomized study in patients undergoing diagnostic and operative arthroscopic surgery concluded that antibiotic prophylaxis is not indicated.

Thoracic (Non-Cardiac) Surgery – Antibiotic prophylaxis is given routinely in thoracic surgery, but supporting data are sparse. In one study, a single preoperative dose of cefazolin before pulmonary resection led to a decrease in the incidence of surgical site infection, but not of pneumonia or empyema. Other trials have found that multiple doses of a cephalosporin can prevent infection after closed-tube thoracostomy for chest trauma with hemo- or pneumothorax. Insertion of chest tubes for other indications, such as spontaneous pneumothorax, does not require antimicrobial prophylaxis.

Vascular Surgery – Preoperative administration of a cephalosporin decreases the incidence of postoperative surgical site infection after arterial reconstructive surgery on the abdominal aorta, vascular operations on the leg that include a groin incision, and amputation of the lower extremity for ischemia. Many experts also recommend prophylaxis for implantation of any vascular prosthetic material, such as grafts for vascular access in hemodialysis. Prophylaxis is not indicated for carotid endarterectomy or brachial artery repair without prosthetic material.

Other Procedures – Antimicrobial prophylaxis is generally not indicated for cardiac catheterization, varicose vein surgery, most dermatologic and plastic surgery, arterial puncture, thoracentesis, paracentesis, repair of simple lacerations, outpatient treatment of burns, dental extractions or root canal therapy because the incidence of surgical site infections is low. A study in patients undergoing cosmetic procedures who did not receive prophylactic antibiotics found that infection was more common after longer operations; the authors concluded that a single dose of cefazolin might be helpful before operations that will last more than 3 hours. The need for prophylaxis in breast surgery, herniorraphy and other "clean" surgical procedures has been controversial. Medical Letter consultants generally do not recommend surgical prophylaxis for these procedures because of the low rate of infection, the low morbidity of these infections and the potential adverse effects with use of prophylaxis in such a large number of patients; some recommend prophylaxis for procedures involving placement of prosthetic material (synthetic mesh, saline implants, tissue expanders).

1. www.ashp.org/shortage
17. RT Lewis. Oral versus systemic antibiotic prophylaxis in elective...
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