MAJOR ARTICLE

Antimicrobial Prophylaxis for Surgery: An Advisory Statement from the National Surgical Infection Prevention Project

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In January 2003, leadership of the Medicare National Surgical Infection Prevention Project hosted the Surgical Infection Prevention Guideline Writers Workgroup (SIPGWW) meeting. The objectives were to review areas of agreement among the most-recently published guidelines for surgical antimicrobial prophylaxis, to address inconsistencies, and to discuss issues not currently addressed. The participants included authors from most of the groups that have published North American guidelines for antimicrobial prophylaxis, as well as authors from several specialty colleges. Nominal group process was used to draft a consensus paper that was widely circulated for comment. The consensus positions of SIPGWW include that infusion of the first antimicrobial dose should begin within 60 min before surgical incision and that prophylactic antimicrobials should be discontinued within 24 h after the end of surgery. This advisory statement provides an overview of other issues related to antimicrobial prophylaxis, including specific suggestions regarding antimicrobial selection.

Surgical site infections (SSIs) are the second most common cause of nosocomial infections [1, 2]. Up to 2%–5% of patients undergoing clean extraabdominal operations and up to 20% undergoing intraabdominal operations will develop an SSI [3]. The US Centers for Disease Control and Prevention (CDC) estimates that ~500,000 SSIs occur annually in the United States [4]. Patients who develop SSIs are up to 60% more likely to spend time in an intensive care unit, 5 times more likely to be readmitted to the hospital, and 2 times more likely to die than are patients without an SSI [5]. Health care costs are substantially increased for patients who develop SSIs [1, 5–8].

In August 2002, the Centers for Medicare and Medicaid Services and the CDC implemented the national Surgical Infection Prevention (SIP) project [9]. The goal of the SIP project is to decrease the morbidity and mortality associated with postoperative SSIs by promoting appropriate selection and timing of administration of prophylactic antimicrobials. A panel of experts in surgical infection prevention, hospital infection control, and epidemiology developed 3 performance measures for national surveillance and quality improvement [9]. These measures are (1) the proportion of patients who have parenteral antimicrobial prophylaxis initiated within 1 h before the surgical incision, (2) the proportion of patients who are provided a prophylactic antimicrobial agent that is consistent with currently published guidelines, and (3) the proportion of patients whose prophylactic antimicrobial therapy is discontinued within 24 h after the end of surgery. For the purposes of national surveillance, the SIP project focuses on operations commonly performed on Medicare patients and for which there is no controversy over the need for antimicrobial prophylaxis. These operations include coronary artery bypass grafting; other open-chest cardiac surgery, excluding transplant surgery;

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vascular surgery, including aneurysm repair, thromboendarterectomy, and vein bypass; general abdominal colorectal surgery; hip and knee arthroplasty (excluding revisions); and abdominal and vaginal hysterectomy [9].

Several guidelines for antimicrobial prophylaxis in surgery have been published [10–16]. Although there is considerable agreement in recommendations for antimicrobial selection and timing (table 1), inconsistencies exist, and several important issues are not addressed. In January 2003, leadership of the national SIP project hosted a meeting of the Surgical Infection Prevention Guideline Writers Workgroup. Authors from most of the groups that have published North American guidelines and representatives of several additional specialty societies interested in surgical infection prevention attended the meeting. The objectives of the meeting were to review areas of agreement, to address issues of inconsistency, and to discuss issues not currently addressed in published guidelines.

This advisory statement summarizes the workgroup meeting and subsequent discussions, provides an overview of current guidelines on antimicrobial prophylaxis, and provides expert consensus on issues that are inconsistent or not addressed in the guidelines. Specific recommendations regarding the national performance measures and antimicrobial prophylaxis for operations targeted in the national SIP project are discussed. This article is not meant to be an exhaustive review of the literature of antimicrobial prophylaxis for surgery, because published guidelines provide such reviews and because the workgroup discussions were generally limited to operations being evaluated in the national project.

GENERAL RECOMMENDATIONS

Timing of the first dose of antimicrobial therapy. The goal of antimicrobial prophylaxis is to achieve serum and tissue drug levels that exceed, for the duration of the operation, the MICs for the organisms likely to be encountered during the operation. As early as 1961, Burke [18] demonstrated that, when antimicrobials were administered before incision, experimental incisions contaminated with *Staphylococcus aureus* could not be distinguished from incisions that had not been contaminated. He found that antimicrobials were effective in reducing lesion size if administered no later than 3 h after bacterial contamination

Table 1. Summary of previously published guidelines on antimicrobial prophylaxis for operations targeted for national surveillance.

Operation	Recommended antibiotic prophylaxis[a]	Comments
Cardiothoracic surgery	Cefazolin [10–13, 16],[b] cefuroxime [12, 14, 16], or cefamandole [12]; if the patient has a β-lactam allergy: vancomycin [10–12, 14, 16] or clindamycin [13][b]	Most of the guidelines agree that prophylaxis for cardiac surgery should be administered for >24 h after surgery. The ASHP suggests continuation of prophylaxis for cardiothoracic surgery for up to 72 h; however, its authors suggest that prophylaxis for ≤24 h may be appropriate [12].[c] Cefamandole is not available in the United States.
Vascular surgery	Cefazolin [10–12, 14, 16] or cefuroxime [16]; if the patient has a β-lactam allergy: vancomycin [10–14, 16], vancomycin with or without gentamicin [12], or clindamycin [13][b]	…
Colon surgery	Oral: neomycin plus erythromycin base [10–12, 14, 16] or neomycin plus metronidazole [16]; parenteral: cefoxitin or cefotetan [10–12, 14, 16] or cefazolin plus metronidazole [14, 16]	Currently, none of the guidelines address antimicrobial prophylaxis for those patients with documented β-lactam allergy. Cefmetazole is not available in the United States [10, 12]. Although a recent study indicates that the combination of oral prophylaxis with parenteral antimicrobial prophylaxis may result in lower wound infection rates, this is not specified in any of the published guidelines [17].
Hip or knee arthroplasty	Cefazolin [10–12, 14, 16] or cefuroxime [16]; if the patients has a β-lactam allergy: vancomycin [10–12, 14, 16] or clindamycin [13]	Although not addressed in any of the published guidelines, the workgroup recommends that the prophylactic antimicrobial be completely infused before the inflation of a tourniquet. Cefuroxime is recommended as a choice for patients undergoing total hip arthroplasty.
Vaginal or abdominal hysterectomy	Cefazolin [10–12, 14–16], cefotetan [12, 14–16], cefoxitin [12, 14–16], or cefuroxime [16]	Metronidazole monotherapy is recommended in the ACOG Practice Bulletin as an alternative to cephalosporin prophylaxis for patients undergoing hysterectomy [15]. Trovafloxacin, although still available in the United States, is recommended only for serious infections [16].

NOTE. Data are from [9], unless otherwise indicated. ACOG, American College of Obstetricians and Gynecologists; ASHP, American Society of Health-System Pharmacists.

[a] These antibiotics are on the list used in the National Surgical Infection Prevention Project to assess quality of care on the national performance measure on the proportion of patients who receive prophylactic antimicrobials consistent with current recommendations.

[b] The Hospital Infection Control Practices Advisory Committee recommends either clindamycin or vancomycin as alternatives for gram-positive bacterial coverage if a patient is unable to receive a cephalosporin because of β-lactam allergy [13].

[c] The ASHP recommendation for duration of prophylaxis for cardiothoracic surgery was based on expert opinion, and its authors suggest that prophylaxis for ≤24 h may be appropriate [12].

was introduced. In 1969, Polk and Lopez-Mayor [19] reported a randomized trial of antimicrobial prophylaxis administered to patients undergoing elective gastrointestinal tract surgery that demonstrated a significant reduction in the incidence of wound and intraabdominal sepsis among treated individuals. In 1976, Stone et al. [20] demonstrated the lowest SSI rates among patients undergoing gastrointestinal, biliary, and colon operations when antimicrobials were administered within 1 h before incision. Administration of the first antimicrobial dose postoperatively resulted in SSI rates almost identical to those among patients who did not receive prophylaxis [20]. Ideally, the antimicrobial should be administered as near to the incision time as possible to achieve low SSI rates [18–26].

On the basis of published evidence, the workgroup endorsed the national performance measure that infusion of the first antimicrobial dose should begin within 60 min before incision. However, when a fluoroquinolone or vancomycin is indicated, the infusion should begin within 120 min before incision to prevent antibiotic-associated reactions. Although research has demonstrated that administration of the antimicrobial at the time of anesthesia induction is safe and results in adequate serum and tissue drug levels at the time of incision, there was no consensus that the infusion must be completed before incision. When a proximal tourniquet is required, however, the entire antimicrobial dose should be administered before the tourniquet is inflated.

Duration of antimicrobial prophylaxis. The majority of published evidence demonstrates that antimicrobial prophylaxis after wound closure is unnecessary, and most studies comparing single-dose prophylaxis with multiple-dose prophylaxis have not shown benefit of additional doses [3, 10–14, 27–29]. Prolonged use of prophylactic antimicrobials is associated with emergence of resistant bacterial strains [30–32]. For the majority of operations being evaluated in the SIP project, the guidelines cited in this article recommend that prophylaxis end within 24 h after the operation. The single guideline exception is the preferred regimen of antimicrobial prophylaxis for cardiothoracic surgery recommended by the American Society of Health-System Pharmacists (ASHP), which recommends continuing prophylaxis for up to 72 h after the operation [12]. This ASHP recommendation was based on expert opinion, and its authors suggest that prophylaxis for $\leqslant$24 h may be appropriate [12]. On the basis of published evidence, the workgroup endorsed the national performance measure that prophylactic antimicrobials should be discontinued within 24 h after the end of surgery.

Screening for β-lactam allergy. Although many patients have drug allergies documented in their medical records, the symptoms or circumstances associated with the allergies are rarely documented. Several studies have demonstrated that the incidence of true drug "allergy" is lower than that recorded in medical records [33–35]. Because β-lactam antimicrobials often represent agents of choice for prophylaxis, the medical history should be adequate to determine if the patient likely had a true allergy (e.g., urticaria, pruritus, angioedema, bronchospasm, hypotension, or arrhythmia) or a serious adverse drug reaction (e.g., drug-induced hypersensitivity syndrome, drug fever, or toxic epidermal necrolysis) [36].

In operations for which cephalosporins represent appropriate prophylaxis, alternative antimicrobials should be provided to those with a high likelihood of serious adverse reaction or allergy on the basis of patient history or diagnostic tests such as skin testing. However, the incidence of adverse reactions to cephalosporins among patients with reported penicillin allergy is rare, and penicillin skin tests do not predict the likelihood of allergic reactions to cephalosporins in patients reporting penicillin allergy. Practical approaches to patients with a history of antibiotic allergy have been previously published [36–38].

Antimicrobial choice for β-lactam allergy. Recommendations for patients with confirmed β-lactam allergy are provided in the discussion of specific operations that follow. In operations where prophylaxis is directed primarily at gram-positive cocci, such as orthopedic operations with joint replacement, cardiothoracic operations, or general, vascular, and neurosurgical operations with implants, alternatives to cephalosporins for patients with β-lactam allergy are vancomycin and clindamycin [13]. The decision to use vancomycin or clindamycin should involve examination of local antimicrobial resistance patterns and institutional incidence of infections caused by organisms such as *Clostridium difficile* and *Staphylococcus epidermidis* [39]. On the basis of antimicrobial spectrum data, vancomycin and clindamycin are appropriate alternatives to β-lactams, although there are few data supporting the use of either for routine prophylaxis.

Methicillin-resistant* Staphylococcus aureus *(MRSA). The Hospital Infection Control Practices Advisory Committee guideline suggests that a "high" frequency of MRSA infection in an institution should influence the use of vancomycin for prophylaxis [13]. However, there is no consensus about what constitutes a "high" prevalence of methicillin resistance. In addition, there is no evidence that routine use of vancomycin for prophylaxis in institutions with perceived high rates of MRSA infection will result in fewer SSIs than do agents such as cefazolin. In a study of cardiac surgery in an institution with a perceived high rate of MRSA infection, Finkelstein et al. [40] randomized 885 patients to prophylaxis with cefazolin or vancomycin. There was no difference in SSI rates between the 2 groups (SSIs were observed in 9.0% and 9.5% of patients who received cefazolin and vancomycin, respectively; $P = .8$). However, patients who received cefazolin and later developed an SSI were more likely to be infected with MRSA. Patients who developed an SSI after vancomycin prophylaxis were more

likely to be infected with methicillin-susceptible *S. aureus*. The choice of antimicrobial changed the flora of infections that occurred but did not alter infection rates. Similarly, Manian et al. [41] recently demonstrated that 2 postoperative factors (receipt of postoperative antibiotic treatment for >1 day and discharge to a long-term care facility) were associated with development of MRSA SSIs. Lack of vancomycin prophylaxis was not associated with risk of MRSA SSI [41].

For patients with known MRSA colonization, vancomycin should be considered as the appropriate antimicrobial agent for prophylaxis. The Society for Healthcare Epidemiology of America recently recommended routine surveillance cultures at the time of admission to the hospital for patients at high-risk for carriage of MRSA [42]. Rates of MRSA colonization may be higher among patients who have previously spent >5 days in an institutional setting, including long-term or acute-care centers [42–45].

Limitation of additional agents. The goal of antimicrobial prophylaxis is to prevent infection of the wound due to organisms most likely to be encountered for that type of operation. For most operations, a single antimicrobial is sufficient to prevent SSIs. However, there may be cases where an unlikely contaminant is present or suspected (e.g., in cases of coexisting infection) and for which additional coverage is necessary. For clean procedures, it is recommended to treat or remove other sources of infection before an elective operation [13]. If it is not possible to postpone the operation, antimicrobial prophylaxis specific for the suspected bacteria and appropriate for the surgical site is recommended.

Intranasal mupirocin has been studied in a variety of operations to evaluate its impact on SSIs. Although the use of intranasal mupirocin has been effective at reducing nasal carriage of *S. aureus,* the majority of studies do not demonstrate a reduction in SSI rates [46–48].

Antimicrobial dosing. There are limited published data on appropriate antimicrobial dosing for prophylaxis. The drug should be provided in an adequate dose on the basis of patient body weight, adjusted dosing weight, or body mass index, and administration should be repeated intraoperatively if the operation is still in progress 2 half-lives after the first dose to ensure adequate antimicrobial levels until wound closure. In a study of obese patients undergoing gastroplasty, blood and tissue levels of cefazolin were consistently below the MICs for prophylaxis against gram-positive and gram-negative organisms in patients who received a 1-g dose preoperatively [49]. Those patients receiving 2 g of cefazolin had an incidence of SSI that was lower than that among those receiving a 1-g dose [49]. Studies of patients undergoing gastrointestinal, biliary, and cardiac operations have demonstrated that successive dosing with antimicrobials with short half-lives is associated with lower SSI rates [50–52]. Suggested initial dose, infusion time, and time to redosing for commonly recommended prophylactic antimicrobials are summarized in table 2.

Nonantimicrobial methods of preventing infection. Recent data suggest that attention to intraoperative temperature control and supplemental oxygen administration along with aggressive fluid resuscitation may reduce infection rates [56–59]. Additional research is required before definitive recommendations can be made [60]. There is considerable evidence that aggressive perioperative control of blood sugar with intravenous insulin for patients undergoing cardiac operations reduces SSI rates [61–63]. The risk of SSI appears to be related to the presence of hyperglycemia rather than to a diagnosis of diabetes mellitus.

SPECIFIC ANTIMICROBIAL RECOMMENDATIONS

There is published evidence to support the use of many prophylactic antimicrobial regimens besides those included in this advisory statement or in existing guidelines. However, factors such as cost, half-life, safety, and antimicrobial resistance favor the use of older agents with a relatively narrow spectrum. The use of newer, broad-spectrum drugs that are front-line therapeutic agents should be avoided in surgical prophylaxis to reduce emergence of bacterial strains that are resistant to these antimicrobials.

Gynecologic and obstetrical surgery. For abdominal or vaginal hysterectomy, cefotetan is preferred, but reasonable alternatives are cefazolin and cefoxitin [10–12, 14–16, 64]. Metronidazole monotherapy is included in the American College of Obstetricians and Gynecologist's Practice Bulletin as an alternative for patients undergoing hysterectomy, although it may be less effective as a single agent for prophylaxis [15]. In cases of β-lactam allergy, the workgroup recommends the use of one of the following regimens: clindamycin combined with gentamicin, aztreonam, or ciprofloxacin; metronidazole combined with gentamicin or ciprofloxacin; or clindamycin monotherapy. A single 750-mg dose of levofloxacin can be substituted for ciprofloxacin.

Patients undergoing cesarean section can be divided into low- and high-risk groups for postoperative infection [65]. High-risk patients include those undergoing cesarean deliveries after rupture of the membranes and/or onset of labor, as well as with emergency operations for which preoperative cleansing may have been inadequate. Although antimicrobial prophylaxis is recommended for both risk groups, the benefits are greatest for high-risk patients. A narrow-spectrum antimicrobial regimen similar to that recommended for hysterectomy provides adequate prophylaxis [66, 67]. In the United States, the antimicrobial is usually not administered until the umbilical cord is clamped. Although there is no evidence to support the delay

Table 2. Suggested initial dose and time to redosing for antimicrobial drugs commonly utilized for surgical prophylaxis.

Antimicrobial	Renal half-life, h		Recommended infusion duration	Standard dose	Weight-based dose recommendation[a]	Recommended redosing interval,[b] h
	Patients with normal renal function	Patients with end-stage renal disease				
Aztreonam	1.5–2	6	3–5 min,[c] 20–60 min[d]	1–2 g iv	2-g maximum (adults)	3–5
Ciprofloxacin	3.5–5	5–9	60 min	400 mg iv	400 mg	4–10
Cefazolin	1.2–2.5	40–70	3–5 min,[c] 15–60 min[d]	1–2 g iv	20–30 mg/kg (if <80 kg, use 1 g; if >80 kg, use 2 g)	2–5
Cefuroxime	1–2	15–22	3–5 min,[c] 15–60 min[d]	1.5 g iv	50 mg/kg	3–4
Cefamandole	0.5–2.1	12.3–18[e]	3–5 min,[c] 15–60 min[d]	1 g iv		3–4
Cefoxitin	0.5–1.1	6.5–23	3–5 min,[c] 15–60 min[d]	1–2 g iv	20–40 mg/kg	2–3
Cefotetan	2.8–4.6	13–25	3–5 min,[c] 20–60 min[d]	1–2 g iv	20–40 mg/kg	3–6
Clindamycin	2–5.1	3.5–5.0[f]	10–60 min (do not exceed 30 mg/min)	600–900 mg iv	If <10 kg, use at least 37.5 mg; if >10 kg, use 3–6 mg/kg	3–6
Erythromycin base	0.8–3	5–6	NA	1 g po 19, 18, and 9 h before surgery	9–13 mg/kg	NA
Gentamicin	2–3	50–70	30–60 min	1.5 mg/kg iv[g]	…[g]	3–6
Neomycin	2–3 (3% absorbed under normal gastrointestinal conditions)	12–24 or longer	NA	1 g po 19, 18, and 9 h before surgery	20 mg/kg	NA
Metronidazole	6–14	7–21; no change	30–60 min	0.5–1 g iv	15 mg/kg initial dose (adult); 7.5 mg/kg on subsequent doses	6–8
Vancomycin	4–6	44.1–406.4 (CCR <10 mL/min)	1 g over 60 min (use longer infusion time if dose >1 g)	1 g iv	10–15 mg/kg (adult)	6–12

NOTE. Data are from [53–55]. CCR, creatinine clearance rate.

[a] Data are primarily from published pediatric recommendations.

[b] For procedures of long duration, antimicrobials should be readministered at intervals of 1–2 times the half-life of the drug. The intervals in the table were calculated for patients with normal renal function.

[c] Dose injected directly into vein or via running intravenous fluids.

[d] Intermittent intravenous infusion.

[e] In patients with a serum creatinine level of 5–9 mg/dL.

[f] The half-life of clindamycin is the same or slightly increased in patients with end-stage renal disease, compared with patients with normal renal function.

[g] If the patient's body weight is >30% higher than their ideal body weight (IBW), the dosing weight (DW) can be determined as follows: DW = IBW + [0.4 × (total body weight − IBW)].

in administration, it is standard practice and is preferred by neonatologists because of concern of masking septic manifestations in the neonate [68].

Orthopedic total joint (hip and knee) arthroplasty. The preferred antimicrobials for prophylaxis in patients undergoing hip or knee arthroplasty are cefazolin and cefuroxime [10–12, 14, 16]. Vancomycin or clindamycin may be used in patients with serious allergy or adverse reactions to β-lactams. Several studies comparing short- with longer-duration antimicrobial prophylaxis for total joint arthroplasty have shown no advantage to prolonged prophylaxis [3, 69–74]. The workgroup recommends that antimicrobial prophylaxis be discontinued within 24 h after the end of the operation [3, 10–12, 14, 16, 69–74]. If a proximal tourniquet is used, the antimicrobial should be completely infused before inflation.

There is no evidence that continuing antimicrobials until all catheters and drains are removed will lower infection rates. However, use of drains has been associated with numerous complications, including infection, drain retention, and soft-tissue problems [75–77]. The necessity of drains for total joint arthroplasty is controversial [76–84]. Over time, there is increased bacterial colonization of the drain tip and migration of skin organisms into the wound [85–87].

Despite the potential benefits of antibiotic-impregnated bone cement for joint arthroplasty, controversies remain regarding its use. There are no established guidelines for use of these agents as prophylaxis. Commercially available preblended antibiotic bone cements are indicated only for use in the second stage of a 2-stage revision for total joint arthroplasty after elimination of active infection. These products are not currently approved for prophylaxis.

Cardiothoracic and vascular surgery. The recommended antimicrobials for cardiothoracic and vascular operations include cefazolin or cefuroxime [10–12, 14, 16]. For patients with serious allergy or adverse reaction to β-lactams, vancomycin is appropriate, and clindamycin may be an acceptable alternative [13]. The workgroup acknowledged the concern of some cardiovascular surgeons over discontinuing the antimicrobial before all invasive lines and drains are removed. Although a number of studies have found no advantage of longer-duration prophylaxis over short-duration prophylaxis for patients undergoing cardiothoracic surgery, the consequences of deep sternal infections or infected prostheses are devastating. Longer-duration prophylaxis has been associated with higher rates of resistant organisms when SSI occurs [30]. The consensus of the workgroup is that administration of prophylaxis for $\leqslant$24 h is acceptable and that there is no evidence that providing antimicrobials for longer periods will reduce SSI rates (table 3). Pending a systematic review of the literature by its Committee on Evidence-Based Medicine, the Society of Thoracic Surgeons currently recommends that antimicrobial prophylaxis be continued for 24–48 h.

Colorectal surgery. Antimicrobial prophylaxis for colorectal operations can consist of an orally administered antimicrobial bowel preparation, a preoperative parenteral antimicrobial, or the combination of both. Recommended oral prophylaxis consists of neomycin plus erythromycin or neomycin plus metronidazole, initiated no more than 18–24 h before the operation, along with administration of a mechanical bowel preparation. Cefotetan or cefoxitin are recommended for parenteral prophylaxis [10–12, 14, 16], and the combination of parenteral cefazolin and metronidazole is also recommended as a cost-effective alternative [88, 89]. Although a recent study suggests that the combination of oral prophylaxis with parenteral antimicrobial prophylaxis may result in lower SSI rates, this is not specified in any published guideline [17]. A survey of colorectal surgeons found that combination oral and parenteral prophylaxis is common practice in the United States [90]. For patients with confirmed allergy or adverse reaction to β-lactams, use of one of the following regimens is recommended: clindamycin combined with gentamicin, aztreonam, or ciprofloxacin; or metronidazole combined with gentamicin or ciprofloxacin. A single 750-mg dose of levofloxacin can be substituted for ciprofloxacin.

CONCLUSION

Optimal prophylaxis ensures that adequate concentrations of an appropriate antimicrobial are present in the serum, tissue, and wound during the entire time that the incision is open and at risk for bacterial contamination. The antimicrobial should be active against bacteria that are likely to be encountered during the particular type of operation being performed and should be safe for the patient and economical for the hospital. The selection and duration of antimicrobial prophylaxis should have the smallest impact possible on the normal bacterial flora of the patient and the microbiologic ecology of the hospital.

In this advisory statement, members of the Surgical Infection Prevention Guideline Writers Workgroup attempted, as they did with guidelines of organizations to which they are affiliated, to address the need for effective, safe, economical prophylaxis that does not promote antimicrobial-resistant bacteria. The advice included in this report will be appropriate for most patients at the majority of facilities. However, sound clinical judgment must be exercised to recognize those unusual cases in which an alternative approach is necessary. Many of the studies that have supported the development of antimicrobial prophylaxis guidelines are quite old, and antimicrobial susceptibility patterns change over time. Clinicians need to continue to evaluate

Table 3. Summary of the Surgical Infection Prevention Guideline Writers Workgroup consensus positions.

Principle	Consensus position
General dosing	
Antibiotic timing	Infusion of the first antimicrobial dose should begin within 60 min before the surgical incision.[a]
Duration of prophylaxis	Prophylactic antimicrobials should be discontinued within 24 h after the end of surgery.
Screening for β-lactam allergy	For those operations for which cephalosporins represent the most appropriate antimicrobials for prophylaxis, the medical history should be adequate to determine whether the patient has a history of allergy or serious adverse antibiotic reaction. Alternative testing strategies (e.g., skin testing) may be useful for patients with reported allergy [36–38].
Antimicrobial dosing	The initial antimicrobial dose should be adequate based on the patient's body weight, adjusted dosing weight, or body mass index. An additional antimicrobial dose should be provided intraoperatively if the operation is still continuing 2 half-lives after the initial dose.[b]
Antibiotic selection, by procedure	
Abdominal or vaginal hysterectomy	Cefotetan therapy is preferred; cefazolin or cefoxitin are alternatives. Metronidazole monotherapy is also used.[c] If the patient has a β-lactam allergy, use clindamycin combined with gentamicin or ciprofloxacin[d] or aztreonam; metronidazole with gentamicin or ciprofloxacin;[d] or clindamycin monotherapy.
Hip or knee arthroplasty	Use cefazolin or cefuroxime. If the patient has a β-lactam allergy, use vancomycin or clindamycin.
Cardiothoracic and vascular surgery	Use cefazolin or cefuroxime. If the patient has a β-lactam allergy, use vancomycin or clindamycin.
Colon surgery	For oral antimicrobial prophylaxis, use neomycin plus erythromycin base or neomycin plus metronidazole. For parenteral antimicrobial prophylaxis, use cefotetan, cefoxitin, or cefazolin plus metronidazole. If the patient has a β-lactam allergy, use clindamycin combined with gentamicin, ciprofloxacin, or aztreonam, or use metronidazole combined with gentamicin or ciprofloxacin.[d]

[a] When fluoroquinolone or vancomycin are indicated, infusion of the first antimicrobial dose should begin within 120 min before the incision.
[b] See table 2.
[c] Metronidazole monotherapy is included in the Practice Bulletin of the American College of Obstetricians and Gynecologist as an alternative to β-lactams for patients undergoing hysterectomy, although it may be less effective as a single agent for prophylaxis [15].
[d] A single 750-mg dose of levofloxacin may be substituted for ciprofloxacin.

current literature and carefully examine susceptibility patterns in their own institutions.

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The Surgical Infection Prevention Guideline Writers Workgroup included the following organizations and individuals: American Academy of Orthopaedic Surgery: Jason H. Calhoun, University of Missouri (Columbia, MO); American College of Obstetricians and Gynecologists: Vanessa Dalton, University of Michigan (Ann Arbor, MI); American College of Surgeons: Christopher Daly, Duquesne University (Pittsburgh, PA); American Geriatrics Society: Robert A. Bonomo, Cleveland Department of Veterans' Affairs Medical Center (Cleveland, OH); American Society of Health-System Pharmacists: Keith M. Olsen, University of Nebraska Medical Center (Omaha, NE); Centers for Disease Control and Prevention: Chesley Richards, National Center for Infectious Diseases (Atlanta, GA); Healthcare Infection Control Practices Advisory Committee: James T. Lee (Saint Paul, MN); Centers for Medicare and Medicaid Services: Peter Houck (Seattle, WA); Infectious Diseases Society of America: E. Patchen Dellinger, University of Seattle (Seattle, WA), and Peter Gross, Hackensack University Medical Center (Hackensack, NJ); The Medical Letter: Gianna Zuccotti (New York, NY); National Surgical Infection Prevention Quality Improvement Organization Support Center: Dale W. Bratzler, Karina Carr, Michele L. Clark, and Lisa Red, Oklahoma Foundation for Medical Quality (Oklahoma City, OK); Society for Healthcare Epidemiology of America: William R. Jarvis (Atlanta, GA); Society of Thoracic Surgeons: Fred H. Edwards, University of Florida (Jacksonville, FL); Surgical Infection Society: Donald E. Fry, University of New Mexico (Albuquerque, NM); and VHA: John A. Hitt, VHA Mountain States (Denver, CO).

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The following organizations have endorsed this advisory statement: American Academy of Orthopaedic Surgeons, American Association of Critical Care Nurses, American Association of Nurse Anesthetists, American College of Surgeons, American College of Osteopathic Surgeons, American Geriatrics Society, American Society of Anesthesiologists, American Society of Colon and Rectal Surgeons, American Society of Health-System Pharmacists, American Society of PeriAnesthesia Nurses, Ascension Health, Association of periOperative Registered Nurses, Association for Professionals in

Infection Control and Epidemiology, Infectious Diseases Society of America, The Medical Letter, Premier, Society for Healthcare Epidemiology of America, Society of Thoracic Surgeons, and the Surgical Infection Society.

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