Surgery Antibiotic Prophylaxis

recommendations based on ASHP, IDSA, SHEA, SIS

Table 1.
Recommended Doses and Redosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis

Antimicrobial	Recommended Dose		Half-life in Adults With Normal Renal Function, hr[19]	Recommended Redosing Interval (From Initiation of Preoperative Dose), hr[c]
	Adults[a]	Pediatrics[b]		
Ampicillin–sulbactam	3 g (ampicillin 2 g/sulbactam 1 g)	50 mg/kg of the ampicillin component	0.8–1.3	2
Ampicillin	2 g	50 mg/kg	1–1.9	2
Aztreonam	2 g	30 mg/kg	1.3–2.4	4
Cefazolin	2 g, 3 g for pts weighing ≥120 kg	30 mg/kg	1.2–2.2	4
Cefuroxime	1.5 g	50 mg/kg	1–2	4
Cefotaxime	1 g[d]	50 mg/kg	0.9–1.7	3
Cefoxitin	2 g	40 mg/kg	0.7–1.1	2
Cefotetan	2 g	40 mg/kg	2.8–4.6	6
Ceftriaxone	2 g[e]	50–75 mg/kg	5.4–10.9	NA
Ciprofloxacin[f]	400 mg	10 mg/kg	3–7	NA
Clindamycin	900 mg	10 mg/kg	2–4	6
Ertapenem	1 g	15 mg/kg	3–5	NA
Fluconazole	400 mg	6 mg/kg	30	NA
Gentamicin[g]	5 mg/kg based on dosing weight (single dose)	2.5 mg/kg based on dosing weight	2–3	NA
Levofloxacin[f]	500 mg	10 mg/kg	6–8	NA
Metronidazole	500 mg	15 mg/kg Neonates weighing <1200 g should receive a single 7.5-mg/kg dose	6–8	NA

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Table 1 (*continued*)

Antimicrobial	Recommended Dose		Half-life in Adults With Normal Renal Function, hr[19]	Recommended Redosing Interval (From Initiation of Preoperative Dose), hr[c]
	Adults[a]	Pediatrics[b]		
Moxifloxacin[f]	400 mg	10 mg/kg	8–15	NA
Piperacillin–tazobactam	3.375 g	Infants 2–9 mo: 80 mg/kg of the piperacillin component Children >9 mo and ≤40 kg: 100 mg/kg of the piperacillin component	0.7–1.2	2
Vancomycin	15 mg/kg	15 mg/kg	4–8	NA
Oral antibiotics for colorectal surgery prophylaxis (used in conjunction with a mechanical bowel preparation)				
Erythromycin base	1 g	20 mg/kg	0.8–3	NA
Metronidazole	1 g	15 mg/kg	6–10	NA
Neomycin	1 g	15 mg/kg	2–3 (3% absorbed under normal gastrointestinal conditions)	NA

[a]Adult doses are obtained from the studies cited in each section. When doses differed between studies, expert opinion used the most-often recommended dose.

[b]The maximum pediatric dose should not exceed the usual adult dose.

[c]For antimicrobials with a short half-life (e.g., cefazolin, cefoxitin) used before long procedures, redosing in the operating room is recommended at an interval of approximately two times the half-life of the agent in patients with normal renal function. Recommended redosing intervals marked as "not applicable" (NA) are based on typical case length; for unusually long procedures, redosing may be needed.

[d]Although FDA-approved package insert labeling indicates 1 g,[14] experts recommend 2 g for obese patients.

[e]When used as a single dose in combination with metronidazole for colorectal procedures.

[f]While fluoroquinolones have been associated with an increased risk of tendinitis/tendon rupture in all ages, use of these agents for single-dose prophylaxis is generally safe.

[g]In general, gentamicin for surgical antibiotic prophylaxis should be limited to a single dose given preoperatively. Dosing is based on the patient's actual body weight. If the patient's actual weight is more than 20% above ideal body weight (IBW), the dosing weight (DW) can be determined as follows: DW = IBW + 0.4(actual weight – IBW).

Table 2.
Recommendations for Surgical Antimicrobial Prophylaxis

Type of Procedure	Recommended Agents[a,b]	Alternative Agents in Pts With β-Lactam Allergy	Strength of Evidence[c]
Cardiac			
Coronary artery bypass	Cefazolin, cefuroxime	Clindamycin,[d] vancomycin[d]	A
Cardiac device insertion procedures (e.g., pacemaker implantation)	Cefazolin, cefuroxime	Clindamycin, vancomycin	A
Ventricular assist devices	Cefazolin, cefuroxime	Clindamycin, vancomycin	C
Thoracic			
Noncardiac procedures, including lobectomy, pneumonectomy, lung resection, and thoracotomy	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	A
Video-assisted thoracoscopic surgery	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	C
Gastroduodenal[e]			
Procedures involving entry into lumen of gastrointestinal tract (bariatric, pancreaticoduodenectomy[f])	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
Procedures without entry into gastrointestinal tract (antireflux, highly selective vagotomy) for high-risk patients	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
Biliary tract			
Open procedure	Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Laparoscopic procedure			
Elective, low-risk[l]	None	None	A
Elective, high-risk[l]	Cefazolin, cefoxitin, cefotetan, ceftriaxone,[k] ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Appendectomy for uncomplicated appendicitis	Cefoxitin, cefotetan, cefazolin + metronidazole	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Small intestine			
Nonobstructed	Cefazolin	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	C

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Table 2 (*continued*)

Type of Procedure	Recommended Agents[a,b]	Alternative Agents in Pts With β-Lactam Allergy	Strength of Evidence[c]
Obstructed	Cefazolin + metronidazole, cefoxitin, cefotetan	Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	C
Hernia repair (hernioplasty and herniorrhaphy)	Cefazolin	Clindamycin, vancomycin	A
Colorectal[m]	Cefazolin + metronidazole, cefoxitin, cefotetan, ampicillin–sulbactam,[h] ceftriaxone + metronidazole,[n] ertapenem	Clindamycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j], metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Head and neck			
Clean	None	None	B
Clean with placement of prosthesis (excludes tympanostomy tubes)	Cefazolin, cefuroxime	Clindamycin[d]	C
Clean-contaminated cancer surgery	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam	Clindamycin[d]	A
Other clean-contaminated procedures with the exception of tonsillectomy and functional endoscopic sinus procedures	Cefazolin + metronidazole, cefuroxime + metronidazole, ampicillin–sulbactam	Clindamycin[d]	B
Neurosurgery			
Elective craniotomy and cerebrospinal fluid-shunting procedures	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Implantation of intrathecal pumps	Cefazolin	Clindamycin,[d] vancomycin[d]	C
Cesarean delivery	Cefazolin	Clindamycin + aminoglycoside[g]	A
Hysterectomy (vaginal or abdominal)	Cefazolin, cefotetan, cefoxitin, ampicillin–sulbactam[h]	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j] Metronidazole + aminoglycoside[g] or fluoroquinolone[h-j]	A
Ophthalmic	Topical neomycin–polymyxin B–gramicidin or fourth-generation topical fluoroquinolones (gatifloxacin or moxifloxacin) given as 1 drop every 5–15 min for 5 doses[o] Addition of cefazolin 100 mg by subconjunctival injection or intracameral cefazolin 1–2.5 mg or cefuroxime 1 mg at the end of procedure is optional	None	B
Orthopedic			
Clean operations involving hand, knee, or foot and not involving implantation of foreign materials	None	None	C
Spinal procedures with and without instrumentation	Cefazolin	Clindamycin,[d] vancomycin[d]	A

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Table 2 (*continued*)

Type of Procedure	Recommended Agents[a,b]	Alternative Agents in Pts With β-Lactam Allergy	Strength of Evidence[c]
Hip fracture repair	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Implantation of internal fixation devices (e.g., nails, screws, plates, wires)	Cefazolin	Clindamycin,[d] vancomycin[d]	C
Total joint replacement	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Urologic			
Lower tract instrumentation with risk factors for infection (includes transrectal prostate biopsy)	Fluoroquinolone,[h-j] trimethoprim–sulfamethoxazole, cefazolin	Aminoglycoside[g] with or without clindamycin	A
Clean without entry into urinary tract	Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis])	Clindamycin,[d] vancomycin[d]	A
Involving implanted prosthesis	Cefazolin ± aminoglycoside, cefazolin ± aztreonam, ampicillin–sulbactam	Clindamycin ± aminoglycoside or aztreonam, vancomycin ± aminoglycoside or aztreonam	A
Clean with entry into urinary tract	Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis])	Fluoroquinolone,[h-j] aminoglycoside[g] with or without clindamycin	A
Clean-contaminated	Cefazolin + metronidazole, cefoxitin	Fluoroquinolone,[h-j] aminoglycoside[g] + metronidazole or clindamycin	A
Vascular[p]	Cefazolin	Clindamycin,[d] vancomycin[d]	A
Heart, lung, heart–lung transplantation[q]			
Heart transplantation[r]	Cefazolin	Clindamycin,[d] vancomycin[d]	A (based on cardiac procedures)
Lung and heart–lung transplantation[r,s]	Cefazolin	Clindamycin,[d] vancomycin[d]	A (based on cardiac procedures)
Liver transplantation[q,t]	Piperacillin–tazobactam, cefotaxime + ampicillin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	B
Pancreas and pancreas–kidney transplantation[r]	Cefazolin, fluconazole (for patients at high risk of fungal infection [e.g., those with enteric drainage of the pancreas])	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A
	Cefazolin	Clindamycin or vancomycin + aminoglycoside[g] or aztreonam or fluoroquinolone[h-j]	A

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Table 2 (*continued*)

Type of Procedure	Recommended Agents[a,b]	Alternative Agents in Pts With β-Lactam Allergy	Strength of Evidence[c]
Plastic surgery			
Clean with risk factors or clean-contaminated	Cefazolin, ampicillin–sulbactam	Clindamycin,[d] vancomycin[d]	C

[a]The antimicrobial agent should be started within 60 minutes before surgical incision (120 minutes for vancomycin or fluoroquinolones). While single-dose prophylaxis is usually sufficient, the duration of prophylaxis for all procedures should be less than 24 hours. If an agent with a short half-life is used (e.g., cefazolin, cefoxitin), it should be readministered if the procedure duration exceeds the recommended redosing interval (from the time of initiation of the preoperative dose [see Table 1]). Readministration may also be warranted if prolonged or excessive bleeding occurs or if there are other factors that may shorten the half-life of the prophylactic agent (e.g., extensive burns). Readministration may not be warranted in patients in whom the half-life of the agent may be prolonged (e.g., patients with renal insufficiency or failure).

[b]For patients known to be colonized with methicillin-resistant *Staphylococcus aureus*, it is reasonable to add a single preoperative dose of vancomycin to the recommended agent(s).

[c]Strength of evidence that supports the use or nonuse of prophylaxis is classified as A (levels I–III), B (levels IV–VI), or C (level VII). Level I evidence is from large, well-conducted, randomized controlled clinical trials. Level II evidence is from small, well-conducted, randomized controlled clinical trials. Level III evidence is from well-conducted cohort studies. Level IV evidence is from well-conducted case–control studies. Level V evidence is from uncontrolled studies that were not well conducted. Level VI evidence is conflicting evidence that tends to favor the recommendation. Level VII evidence is expert opinion.

[d]For procedures in which pathogens other than staphylococci and streptococci are likely, an additional agent with activity against those pathogens could be considered. For example, if there are surveillance data showing that gram-negative organisms are a cause of surgical-site infections (SSIs) for the procedure, practitioners may consider combining clindamycin or vancomycin with another agent (cefazolin if the patient is not β-lactam allergic; aztreonam, gentamicin, or single-dose fluoroquinolone if the patient is β-lactam allergic).

[e]Prophylaxis should be considered for patients at highest risk for postoperative gastroduodenal infections, such as those with increased gastric pH (e.g., those receiving histamine H_2-receptor antagonists or proton-pump inhibitors), gastroduodenal perforation, decreased gastric motility, gastric outlet obstruction, gastric bleeding, morbid obesity, or cancer. Antimicrobial prophylaxis may not be needed when the lumen of the intestinal tract is not entered.

[f]Consider additional antimicrobial coverage with infected biliary tract. See the biliary tract procedures section of this article.

[g]Gentamicin or tobramycin.

[h]Due to increasing resistance of *Escherichia coli* to fluoroquinolones and ampicillin–sulbactam, local population susceptibility profiles should be reviewed prior to use.

[i]Ciprofloxacin or levofloxacin.

[j]Fluoroquinolones are associated with an increased risk of tendonitis and tendon rupture in all ages. However, this risk would be expected to be quite small with single-dose antibiotic prophylaxis. Although the use of fluoroquinolones may be necessary for surgical antibiotic prophylaxis in some children, they are not drugs of first choice in the pediatric population due to an increased incidence of adverse events as compared with controls in some clinical trials.

[k]Ceftriaxone use should be limited to patients requiring antimicrobial treatment for acute cholecystitis or acute biliary tract infections which may not be determined prior to incision, not patients undergoing cholecystectomy for noninfected biliary conditions, including biliary colic or dyskinesia without infection.

[l]Factors that indicate a high risk of infectious complications in laparoscopic cholecystectomy include emergency procedures, diabetes, long procedure duration, intraoperative gallbladder rupture, age of >70 years, conversion from laparoscopic to open cholecystectomy, American Society of Anesthesiologists classification of 3 or greater, episode of colic within 30 days before the procedure, reintervention in less than one month for noninfectious complication, acute cholecystitis, bile spillage, jaundice, pregnancy, nonfunctioning gallbladder, immunosuppression, and insertion of prosthetic device. Because a number of these risk factors are not possible to determine before surgical intervention, it may be reasonable to give a single dose of antimicrobial prophylaxis to all patients undergoing laparoscopic cholecystectomy.

[m]For most patients, a mechanical bowel preparation combined with oral neomycin sulfate plus oral erythromycin base or with oral neomycin sulfate plus oral metronidazole should be given in addition to i.v. prophylaxis.

[n]Where there is increasing resistance to first- and second-generation cephalosporins among gram-negative isolates from SSIs, a single dose of ceftriaxone plus metronidazole may be preferred over the routine use of carbapenems.

[o]The necessity of continuing topical antimicrobials postoperatively has not been established.

[p]Prophylaxis is not routinely indicated for brachiocephalic procedures. Although there are no data in support, patients undergoing brachiocephalic procedures involving vascular prostheses or patch implantation (e.g., carotid endarterectomy) may benefit from prophylaxis.

[q]These guidelines reflect recommendations for perioperative antibiotic prophylaxis to prevent SSIs and do not provide recommendations for prevention of opportunistic infections in immunosuppressed transplantation patients (e.g., for antifungal or antiviral medications).

[r]Patients who have left-ventricular assist devices as a bridge and who are chronically infected might also benefit from coverage of the infecting microorganism.

[s]The prophylactic regimen may need to be modified to provide coverage against any potential pathogens, including gram-negative (e.g., *Pseudomonas aeruginosa*) or fungal organisms, isolated from the donor lung or the recipient before transplantation. Patients undergoing lung transplantation with negative pretransplantation cultures should receive antimicrobial prophylaxis as appropriate for other types of cardiothoracic surgeries. Patients undergoing lung transplantation for cystic fibrosis should receive 7–14 days of treatment with antimicrobials selected according to pretransplantation culture and susceptibility results. This treatment may include additional antibacterial or antifungal agents.

[t]The prophylactic regimen may need to be modified to provide coverage against any potential pathogens, including vancomycin-resistant enterococci, isolated from the recipient before transplantation.