Table 3. Recommendations for surgical antibiotic prophylaxis

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Breast surgery					
Breast cancer surgery without oncoplastic/reconstruction surgery	Not recommended For patients with risk factors IV cefazolin 2g	Not recommended For patients with risk factors IV clindamycin 600–900mg or IV vancomycin 15–20mg/kg	Single dose	Risk factors: - Post-neoadjuvant chemotherapy - Immunocompromised individuals	Level 1- (Grade B)
Breast cancer surgery with oncoplastic/reconstruction surgery	IV cefazolin 2g Followed by: 1–2g q8h	IV clindamycin 600–900mg Followed by: 600mg q8h or IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h	Up to 24 hours		Level 1+ (Grade A)
Breast lump excision biopsy Wire localisation excision biopsy	Not recommended	Not recommended	NA	If prophylactic antibiotic is used, it should not exceed a single dose. Refer to the above choices if prophylactic antibiotic is used	Level 1- (Grade B)
Cardiothoracic and vascular surgery					
Cardiac (aortic dissection, CABG, TEVAR, valve repair or replacement, LVAD placement, permanent pacemaker/ defibrillator insertion)	IV cefazolin 2g Followed by: 1–2g q8h MRSA colonised IV cefazolin 2g + IV vancomycin 15–20mg/kg Followed by: IV cefazolin 1–2g q8h + IV vancomycin 15mg/kg q12h	IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h	24–48 hours	IV vancomycin dose of 20mg/kg preoperatively may be preferred to achieve sufficient tissue concentrations at the time of surgery At the onset of bypass: May consider an additional 1–2g of IV cefazolin via cardiopulmonary bypass circuit	Level 1+ (Grade A)
Thoracic (decortication, lobectomy, thymectomy, VATS)	IV cefazolin 2g MRSA colonised IV vancomycin 15–20mg/kg	IV clindamycin 600–900mg or IV vancomycin 15–20mg/kg	Single dose		Level 1- (Grade B)
Vascular (artery or vein repair, AVF or AVG creation, excision, jump graft, aortic stent graft)	IV cefazolin 2g Followed by: 1–2g q8h MRSA colonised IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h	IV clindamycin 600–900mg Followed by: 600mg q8h or IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h	Up to 24 hours		Level 1- (Grade B)
Cardiac or vascular (angioplasty, stent insertion)	Not recommended	Not recommended	NA		Level 3 (Grade D)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Gastrointestinal surgery					
Appendectomy	IV cefazolin 2g + IV metronidazole 500mg or IV ceftriaxone 2g + IV metronidazole 500mg or IV amoxicillin-clavulanic acid 1.2g	IV gentamicin 5mg/kg + IV metronidazole 500mg or IV gentamicin 5mg/kg + IV clindamycin 600–900mg[c]	Single dose		Level 1+ (Grade A)
Gastroduodenal and oesophageal	IV cefazolin 2g or IV ceftriaxone 2g or IV amoxicillin-clavulanic acid 1.2g	IV gentamicin 5mg/kg +/- IV clindamycin 600–900mg	Single dose		Level 1+ (Grade A)
Small bowel	IV cefazolin 2g + IV metronidazole 500mg or IV ceftriaxone 2g + IV metronidazole 500mg or IV amoxicillin-clavulanic acid 1.2g	IV gentamicin 5mg/kg + IV metronidazole 500mg or IV gentamicin 5mg/kg + IV clindamycin 600–900mg[c]	Single dose		Level 1+ (Grade B)
Colorectal	IV cefazolin 2g + IV metronidazole 500mg or IV ceftriaxone 2g + IV metronidazole 500mg or IV amoxicillin-clavulanic acid 1.2g	IV gentamicin 5mg/kg + IV metronidazole 500mg or IV gentamicin 5mg/kg + IV clindamycin 600–900mg[c]	Single dose		Level 1++ (Grade A)
	To be used in conjunction with mechanical bowel preparation (MBP) (if given): PO neomycin sulfate 1g + PO erythromycin base 1g or PO neomycin sulfate 1g + PO metronidazole 1g		Three doses in conjunction with MBP	To be administered over approximately 10 hours the day before operation (e.g. 1 pm to 11 pm) Need for MBP + PO prophylaxis to be decided by individual institutions	Level 1++ (Grade B)
Hernia repair Hernioplasty (i.e. with mesh placement)	IV cefazolin 2g	IV vancomycin 15mg/kg	Single dose	Recommendations for prophylaxis are mainly derived from studies on inguinal/femoral hernia repairs. Mixed outcomes for other types of hernias and studies were often of poor quality.	Level 1++ (Grade B)
Herniorrhaphy (i.e. no mesh placement)	Not recommended	Not recommended	NA		Level 1++ (Grade A)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Hepatobiliary surgery					
Biliary tract surgery	IV cefazolin 2g or IV ceftriaxone 2g or IV amoxicillin-clavulanic acid 1.2g	IV clindamycin 600–900mg or IV vancomycin 15–20mg/kg + IV gentamicin 5mg/kg or IV aztreonam 2g	Single dose	It is reasonable to give a single dose of prophylaxis to patient undergoing laparoscopic cholecystectomy although evidence showed that antibiotic is not required for low-risk patients. This is because some of these risk factors cannot be determined prior to surgery.	Level 1+ (Grade A)
Hepatectomy	IV cefazolin 2g Followed by: 1–2g 8h or IV ceftriaxone 2g once	IV clindamycin 600–900mg or IV vancomycin 15–20mg/kg + IV gentamicin 5mg/kg or IV aztreonam 2g	Up to 24 hours	If the procedure is expected to involve the lower gastrointestinal tract, consider adding anaerobic coverage	Level 1+ (Grade A)
Splenectomy or left-sided pancreatic surgery	IV cefazolin 2g	IV vancomycin 15–20mg/kg	Single dose	There is no need to extend the antibiotic duration for patients who are not immunised. Administer the appropriate immunisations	GPP
Whipple's operation (no recent biliary intervention/ stenting)	IV cefazolin 2g Followed by: 1–2g 8h or IV ceftriaxone 2g once or IV amoxicillin-clavulanic acid 1.2g Followed by: 1.2g 8h	IV clindamycin 600–900mg or IV vancomycin 1520mg/kg +/– IV gentamicin 5mg/kg or IV aztreonam 2g	Up to 24 hours	For patients with recent biliary intervention/stenting, there is a higher incidence of bacterobilia with ESBL-producing organisms. Antibiotic should be tailored according to in-house antibiogram or recent bile/ blood cultures from the patient.	Level 2+ (Grade C)
Endoscopic retrograde cholangio-pancreatography (ERCP)	Not recommended except in cases of incomplete biliary drainage or obstructive biliary tract disease IV cefazolin 2g or IV ceftriaxone 2g	Not recommended except in cases of incomplete biliary drainage or obstructive biliary tract disease IV gentamicin 5mg/kg	Single dose	Antibiotic prophylaxis for ERCP was shown to increase the proportion of resistant bacteria[49-51]	Level 1+ (Grade A)
Obstetrics and gynaecology					
Caesarean section (C-section)[e]	IV cefazolin 2g	IV clindamycin 900mg	Single dose	Continuation of antimicrobial prophylaxis (up to 2 days) may be considered for patients with major risk factors for surgical infections, e.g. obesity (body mass index ≥30).	Level 1- (Grade B)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Normal vaginal delivery (non-operative/instrumental)	Not recommended	Not recommended	NA	Antibiotic prophylaxis may be considered in the setting of a third- or fourth-degree perineal laceration Group B *Streptococcus* and preterm premature rupture of membranes prophylaxis are excluded in this guideline.	Level 1- (Grade B)
Normal vaginal delivery (operative/ instrumental)	IV amoxicillin-clavulanic acid 1.2g	IV clindamycin 900mg	Single dose after delivery	Antibiotic prophylaxis may be considered in the setting of a third- or fourth-degree perineal laceration Group B *Streptococcus* and preterm premature rupture of membranes prophylaxis are excluded in this guideline.	Level 1- (Grade B)
Hysterectomy Abdominal/vaginal/ laparoscopic	IV cefazolin 2g + IV metronidazole 500mg	IV clindamycin 900mg + IV gentamicin 5mg/kg	Single dose		Level 2- (Grade C)
Hysteroscopy	Not recommended	Not recommended	NA	The risk of infection is very low, antibiotic prophylaxis generally not necessary unless high risk e.g. dilated fallopian tubes, history of pelvic inflammatory disease, tubal damage or abnormal tubal architecture (associated with risk of postoperative pelvic inflammatory disease/endometritis). If evidence of endometritis/infection found at point of procedure, treat accordingly.	Level 1- (Grade B)
Hysterosalpingography	Not recommended	Not recommended	NA	As above.	Level 2- (Grade C)
Endometrial biopsy, cervical tissue excision, cervical cone procedures	Not recommended	Not recommended	NA		Level 2- (Grade C)
Intrauterine device insertion	Not recommended	Not recommended	NA	Consider sexually transmitted infections screens in high-risk populations and advise to complete treatment prior procedure.	Level 1+ (Grade A)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Orthopaedic/spine surgery					
Clean orthopaedic, non-spinal procedure with no implantation (arthroscopy, tendon repair surgery)	Not recommended For patients with risk factors IV cefazolin 2g MRSA colonised IV cefazolin 2g +/- IV vancomycin 15–20mg/kg	Not recommended For patients with risk factors IV vancomycin 15–20mg/kg or IV clindamycin 600–900mg	Single dose	Risk factors include dermatological conditions, predicted prolonged operative time, malnutrition, immunosuppressant use and poorly controlled diabetes mellitus	Level 1- (Grade B)
Clean orthopaedic surgery with implants Wrist arthroplasty	IV cefazolin 2g Followed by: 1–2g q8h MRSA colonised IV cefazolin 2g + IV vancomycin 15–20mg/kg Followed by: IV cefazolin 1–2g q8h + IV vancomycin 15mg/kg q12h	IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h or IV clindamycin 600–900mg Followed by: 600mg q8h	Up to 24 hours		Level 1++ (Grade A)
Spine surgery (with and without implants)	IV cefazolin 2g Followed by: 1–2g q8h MRSA colonised IV cefazolin 2g + IV vancomycin 15–20mg/kg Followed by: IV cefazolin 1–2g q8h + IV vancomycin 15mg/kg q12h	IV vancomycin 15–20mg/kg Followed by: 15mg/kg q12h or IV clindamycin 600–900mg Followed by: 600mg q8h	Up to 24 hours		Level 1++ (Grade A)
Otorhinolaryngology					
Clean head and neck (thyroidectomy, parotidectomy, salivary gland excisions)	Not recommended	Not recommended	NA		Level 1+ (Grade A)
Clean-contaminated head and neck Neck dissection procedures	IV amoxicillin-clavulanic acid 1.2g q8h or IV cefazolin 2g q8h + IV metronidazole 500mg q8h	IV clindamycin 600–900mg q8h +/- IV gentamicin 5mg/kg once[a]	Up to 24 hours	Prolonged course of oral antibiotics has not been shown to reduce postoperative infections and may increase the risk of complications.	Level 1+ (Grade A) For neck dissection: Level 2+ (Grade C)
Clean otologic procedures	Not recommended	Not recommended	NA		Level 1+ (Grade A)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Clean-contaminated otologic procedures	IV amoxicillin-clavulanic acid 1.2g q8h or IV cefazolin 2g q8h + IV metronidazole 500mg q8h	IV clindamycin 600–900mg q8h +/- IV gentamicin 5mg/kg once[a]	Up to 24 hours		Level 1- (Grade B)
Tonsillectomy	Not recommended	Not recommended	NA		Level 1+ (Grade A)
Simple septorhinoplasty	Not recommended	Not recommended	NA	Infection rates are very low, especially when nasal packing/splint use ≤48 hours	Level 1- (Grade B)
Complex Septorhinoplasty	IV amoxicillin-clavulanic acid 1.2g q8h or IV cefazolin 2g q8h + IV metronidazole 500mg q8h	IV clindamycin 600–900mg q8h +/- IV gentamicin 5mg/kg once[a]	Up to 24 hours		Level 1- (Grade B)
Endoscopic sinus surgery	IV amoxicillin-clavulanic acid 1.2g or IV cefazolin 2g + IV metronidazole 500mg	IV clindamycin 600–900mg +/- IV gentamicin 5mg/kg[a]	Single dose	Post-operative antibiotics should not be given if there is no mucous seen intra-operatively.	Level 1- (Grade B)
Neurosurgery					
Clean wounds Elective craniotomy, external ventricular drain (EVD), intracranial pressure (ICP) monitors	IV cefazolin 2g <u>MRSA colonised</u> IV vancomycin 15–20mg/kg	IV vancomycin 15–20mg/kg or IV clindamycin 600–900mg	Single dose[b]		Level 1+ (Grade A) For EVD and ICP: Level 2++ (Grade B)
Clean wounds with foreign bodies or instrumentation Cerebrospinal fluid shunting procedures	IV cefazolin 2g <u>MRSA colonised</u> IV vancomycin 15–20mg/kg	IV vancomycin 15–20mg/kg or IV clindamycin 600–900mg	Single dose[b]		Level 1+ (Grade A)
Urological procedures					
Lower urinary tract instrumentation					
Cystourethroscopy -With or without minor manipulation, and without a significant break in mucosal barriers -With a significant break in mucosal barriers/significant manipulation	Not recommended, except in those with risk factors, to manage as transurethral cases (refer to the section on transurethral procedure) To manage as transurethral cases (refer to transurethral section)	Not recommended, except in those with risk factors, to manage as transurethral cases (refer to the section on transurethral procedure)	NA	If urine culture shows no growth prior to the procedure, antimicrobial prophylaxis is not necessary Risk factors: poor functional status/ frailty, anatomic anomalies of the urinary tract, chronic steroid use, immunocompromising condition or recent systemic chemotherapy, poorly controlled diabetes mellitus, prior severe urosepsis	Level 1+ (Grade A)

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Transurethral cases and minimally invasive surgical therapy to the prostate	IV/IM gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g	IV/IM gentamicin 3–5mg/kg or PO ciprofloxacin 500mg/IV 400mg[d]	Single dose		Level 1+ (Grade B)
Transrectal prostate biopsy	PO ciprofloxacin 500 mg + IV/IM gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g/ PO 625mg + IV/IM gentamicin 3–5mg/kg or IV ceftriaxone 2g	PO ciprofloxacin 500 mg + IV/ IM gentamicin 3–5mg/kg	Up to 48 hours	For PO ciprofloxacin, dose 1–2 hours before the procedure For PO amoxicillin-clavulanic acid, dose 24 hours before the procedure	Level 1+ (Grade A)
Transperineal procedures e.g. prostate brachytherapy, transperineal prostate biopsy	Not recommended	Not recommended	NA	Prophylaxis may be recommended in patients with risk factors (chronic steroid use, immunocompromising condition or recent systemic chemotherapy, poorly controlled diabetes mellitus), prior severe urosepsis or post-biopsy infection. Antibiotic choice: PO cephalosporins or amoxicillin-clavulanic acid 2 hours before the procedure	Level 2+ (Grade C)
Upper urinary tract instrumentation					
Percutaneous renal surgery, e.g. percutaneous nephrolithotomy	IV cefazolin 2g + IV gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g	IV gentamicin 3–5mg/kg + IV clindamycin 600–900mg or IV gentamicin 3–5mg/kg + IV vancomycin 15–20mg/kg	Single dose		Level 1+ (Grade A)
Ureteroscopy (including laser lithotripsy)	IV gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g	IV gentamicin 3–5mg/kg or PO ciprofloxacin 500mg/IV 400mg[d]	Single dose		Level 1+ (Grade A)
Open, laparoscopic or robotic surgery					

Types of surgery	First line	Alternative for severe penicillin allergy	Duration	Remarks	Level of evidence (Grade)
Urethroplasty; reconstruction of anterior urethra, stricture repair, including urethrectomy; controlled entry into the urinary tract e.g. renal surgery, nephrectomy, ureterectomy, pyeloplasty, radical prostatectomy; partial cystectomy	IV cefazolin 2g + IV gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g	IV gentamicin 3–5mg/kg + IV clindamycin 600–900mg or IV gentamicin 3–5mg/kg + IV vancomycin 15–20mg/kg	Single dose	Consider preoperative urine cultures and treat accordingly For buccal mucosal graft, consider adding anaerobic coverage	Level 2+ (Grade B)
Urinary diversion involving small or large bowel	IV cefazolin 2g + IV gentamicin 3–5mg/kg + IV metronidazole 500mg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g + IV metronidazole 500mg	IV gentamicin 3–5mg/kg + IV metronidazole 500 mg or IV gentamicin 3–5mg/kg + IV clindamycin 600–900mg	Single dose	Metronidazole may be optional for small bowel surgery	Level 2- (Grade C)
Implanted prosthetic devices: AUS, IPP, sacral neuromodulators	IV cefazolin 2g + IV gentamicin 3–5mg/kg or IV amoxicillin-clavulanic acid 1.2g or IV ceftriaxone 2g MRSA colonised IV vancomycin 15–20mg/kg	IV vancomycin 15–20mg/kg + IV aztreonam 2g or IV clindamycin 600–900mg + IV gentamicin 3–5mg/kg	Single dose		Level 4 (GPP)
Others					
Urodynamic study Penile surgery Shockwave lithotripsy	Not recommended except in those with risk factors (see cystourethroscopy section)	NA	NA	For shockwave lithotripsy, consider antibiotic prophylaxis (single-dose IV gentamicin or IV ceftriaxone) only if high risk of infection e.g. infected stones, recent instrumentation, nephrostomy tubes, positive urine culture, or history of recent urinary tract infection/sepsis	Level 1+ (Grade A)

[a] The addition of gentamicin may be appropriate when there is an increased likelihood of Gram-negative contamination of the surgical site.
[b] While single-dose prophylaxis is usually sufficient, the duration of prophylaxis for all procedures should be less than 24 hours.
[c] Clindamycin resistance has been increasing in *Bacteroides* species. Metronidazole may be preferred if the procedure transverses the lower gastrointestinal tract.
[d] Due to the high local resistance of Gram-negative organisms to quinolones, this is only recommended if the organism is shown to be sensitive in the preoperative urine culture.
[e] An additional single dose of IV azithromycin 500mg to routine prophylaxis may be considered for a non-elective Caesarean section. However, the extrapolation of benefit to local centres where rates of post-C-section infections are low still remains to be determined.
AUS: Artificial urinary sphincter; AVF: arteriovenous fistula; AVG: arteriovenous graft; CABG: coronary artery bypass grafting; ERCP: endoscopic retrograde cholangio-pancreatography; GPP: good practice points; IPP: intravesical prostatic protrusion; IM: intramuscular; IV: intravascular; LVAD: left ventricular assist device; MRSA: methicillin-resistant *Staphylococcus aureus*; NA: not applicable; PO: per oral (oral administration); TEVAR: thoracic endovascular aortic repair; VATS: video-assisted thoracoscopic surgery
Superscript numbers: Refer to REFERENCES