Table I Commonly encountered or important organisms and their usual antimicrobial susceptibilities

Gram-positive cocci:

Staphylococcus aureus:

*Resistance to penicillin is almost universal. Resistance to methicillin in both community-acquired and hospital- acquired infections is very common in the USA. Such strains are referred to as “methicillin-resistant Staphylococcus aureus (MRSA)". This means resistance to all penicillins, penicillin/penicillinase-inhibitor combinations, cephalosporins (except the fifth-generation cephalosporins, ceftobiprole, and ceftaroline), and carbapenems. These agents, excepting penicillin, ampicillin, and piperacillin alone, are, however, active against methicillin-susceptible Staphylococcus aureus (MSSA).

Therefore, in areas where MRSA is prevalent (most of the USA), patients with severe infections presumed to be caused by Staphylococcus aureus should be treated with vancomycin. If the cultures demonstrate susceptibility to methicillin, then nafcillin, oxacillin or cefazolin can be used.

Other drugs that can be used in S. aureus infections, including those caused by MRSA, are clindamycin, linezolid, trimethoprim/sulfamethoxazole, and daptomycin.

Although rifampin is very active against S. aureus, it should never be used alone in staphylococcal infections, due to the rapid emergence of resistance to it.

Coagulase-negative staphylococci (e.g., Staphylococcus epidermidis)

Vancomycin

Streptococcus pyogenes (Group A)

Penicillin, ampicillin, cephalosporins, macrolides, clindamycin.

Streptococcus agalactiae (Group B)

Penicillin, ampicillin, cephalosporins (only third-generation for meningitis), vancomycin.

Streptococcus pneumoniae

Penicillin, ampicillin, cephalosporins, vancomycin, macrolides, levofloxacin.

In Streptococcus pneumoniae resistance to penicillin, and/or third-generation cephalosporins, which can be complete or intermediate, has variable prevalence. This has particular significance for patients with meningitis (see below).

Viridans group streptococci

Penicillin, ampicillin, cephalosporins, vancomycin, macrolides, clindamycin.

Enterococcus faecalis

Ampicillin, vancomycin (killing can occur only if there is synergy between these drugs and gentamicin or streptomycin, mainly for cases of infective endocarditis; although ceftriaxone is not active by itself against this organism, the combination of ampicillin and ceftriaxone is also synergistically bactericidal), linezolid; daptomycin, tigecycline; nitrofurantoin can be used for only urinary tract infection.

Enterococcus faecium

Ampicillin (relatively resistant), vancomycin, (killing can occur only if there is synergy between these drugs and gentamicin or streptomycin), linezolid, quinupristin/dalfopristin, daptomycin, tigecycline.

Gram-negative cocci:

Neisseria meningitidis

Penicillin, ampicillin, third-generation cephalosporins.

Neisseria gonorrhoeae

Ceftriaxone PLUS azithromycin (high rate of resistance to penicillin, tetracycline; increasing resistance to fluoroquinolones). Azithromycin is used as a second active drug to prevent the emergence of resistance to ceftriaxone.

Gram-positive rods, aerobes:

Non-spore-forming:

Listeria monocytogenes

Ampicillin, vancomycin, trimethoprim/sulfamethoxazole, linezolid.

Corynebacterium spp. (diphtheroids)

Vancomycin, variable to other antibiotics.

Corynebacterium diphtheriae

Penicillin, macrolides, clindamycin, doxycycline.

Spore-forming, aerobes

Bacillus spp.

Vancomycin, clindamycin, carbapenems, aminoglycosides, fluoroquinolones.

Bacillus anthracis (natural)

Penicillin, ciprofloxacin,

doxycycline.

Bacillus anthracis (bioterrorism)

Ciprofloxacin, doxycycline.

Spore-forming, anaerobes:

Clostridium spp.

C. botulinum

Penicillin, metronidazole, carbapenems.

C. perfringens

Penicillin, metronidazole, clindamycin, carbapenems.

C. difficile

Metronidazole, vancomycin.

Gram-negative rods

These include the Enterobacteriaceae, Pseudomonas aeruginosa, and Acinetobacter.

They are particularly prevalent in intensive care units, where there is a high usage of antimicrobial agents and therefore pressure for the development of resistance.

There is increasing prevalence of organisms that elaborate “extended-spectrum” beta-lactamases (ESBLs), particularly Escherichia coli and Klebsiella.

In addition, there is a group of organisms that have the genes for the production of broad-spectrum beta-lactamases. The genes can be induced by beta-lactams to produce these beta-lactamases, thus inactivating the drugs. This would not be detected in routine susceptibility tests. These organisms include:

Serratia marcescens, P. aeruginosa, Indole-positive Proteus spp., Citrobacter freundii, Enterobacter cloacae, Morganella morganii, and Acinetobacter baumannii. Patients with infections caused by these organisms should not be treated with beta-lactams alone (except for antipseudomonal penicillins or ceftazidime for infections caused by P. aeruginosa.)

In such circumstances, treatment with a carbapenem, fluoroquinolone, or trimethoprim/sulfamethoxazole, should be used, depending on susceptibilities, or an aminoglycoside should be added.

Antimicrobial agents that may be required in the face of infections caused by multi-resistant gram-negative rods are colistin and tigecycline. Two cephalosporin/beta-lactamase inhibitor combinations have recently been licensed in the USA, namely ceftolozane/tazobactam and ceftazidime/avibactam. These are active against some gram-negative rods, including P. aeruginosa, that produce extended-spectrum beta-lactamases and ampC broad-spectrum beta-lactamases, but they are not active against Acinetobacter. Ceftazidime/avibactam is, in addition, active against organisms producing Klebsiella pneumoniae carbapenemase (KPC).

Haemophilus influenzae

Third-generation cephalosporins: for non-meningeal infections, ampicillin/sulbactam, amoxicillin/clavulanate, azithromycin or fluoroquinolones can be used.

E. coli

Cephalosporins, aminoglycosides, fluoroquinolones, piperacillin/tazobactam, ticarcillin/clavulanate, carbapenems, trimethoprim/sulfamethoxazole.

Klebsiella pneumonia

Cephalosporins, aminoglycosides, fluoroquinolones, piperacillin/tazobactam, ticarcillin/clavulanate, carbapenems, trimethoprim/sulfamethoxazole.

Enterobacter cloacae

Beta-lactams - see note above; carbapenems, aminoglycosides, fluoroquinolones, trimethoprim/sulfamethoxazole.

Salmonella

Ceftriaxone, fluoroquinolones, amoxicillin/ampicillin, trimethoprim/sulfamethoxazole, azithromycin.

Shigella

Ceftriaxone, fluoroquinolones, ampicillin, trimethoprim/sulfamethoxazole, azithromycin.

Yersinia enterocolitica

Ceftriaxone, trimethoprim/sulfamethoxazole.

Pseudomonas aeruginosa

Ceftazidime, ticarcillin/clavulanate, piperacillin, piperacillin/tazobactam, meropenem, aminoglycosides, ciprofloxacin.

Acinetobacter baumannii

Third-generation cephalosporins, aminoglycosides, ciprofloxacin, carbapenems; often multi -drug-resistant.

Stenotrophomonas maltophilia

Trimethoprim/sulfamethoxazole, ticarcillin/clavulanic acid, minocycline, ceftazidime, ciprofloxacin; always resistant to carbapenems.

Burkholderia cepacia

Carbapenems, trimethoprim/sulfamethoxazole, ceftazidime, minocycline, ciprofloxacin.

Burkholderia pseudomallei

Ceftazidime, trimethoprim/sulfamethoxazole, doxycycline, chloramphenicol.

Legionella pneumophila

Fluoroquinolone,

macrolide.

Bordetella pertussis

Macrolides

Vibrio cholera

Azithromycin,

ciprofloxacin, doxycycline.

Vibrio vulnificus

Cefotaxime, ciprofloxacin,

doxycycline.

Gram-negative anaerobic rods:

Bacteroides spp., Fusobacterium spp., Prevotella spp., Porphyromonas spp.

Metronidazole, piperacillin/tazobactam; ticarcillin/clavulanate; carbapenems.

Other bacteria:

Mycoplasma pneumoniae

Doxycycline, macrolides, fluoroquinolones.

Chlamydia pneumoniae

Doxycycline, macrolides, fluoroquinolones.

Rickettsiae

Doxycycline

Ehrlichiae

Doxycycline

Francisella tularensis

Gentamicin,

ciprofloxacin.

Yersinia pestis

Streptomycin,

gentamicin.

Fungi:

Candida

Echinocandins (caspofungin, micafungin, or anidulafungin) should be initial therapy for severe candida infections until the species and, for some species, susceptibilities have been determined.

Most species are susceptible to fluconazole; C. krusei is always resistant to fluconazole, and C. glabrata is relatively resistant to this drug; other drugs that can be used are echinocandins (caspofungin, micafungin, and anidulafungin) and amphotericin B.)

(see www.idsociety.org → practice guidelines → by organisms)

Aspergillus

There are many species; most are susceptible to voriconazole and amphotericin B; the echinocandins, are active but only fungistatic. A. terrae is resistant to amphotericin B.

Zygomycetes (Mucor group)

These are resistant to most antifungal agents, except amphotericin B, and posaconazole.

Pneumocystis jiroveci

Trimethoprim/sulfamethoxazole, atovaquone, pentamidine, primaquine + clindamycin.

Glucose-6-phosphate dehydrogenase deficiency should be excluded before primaquine is used.

Viruses:

Herpes simplex virus

Acyclovir

Varicella zoster virus

Acyclovir

Cytomegalovirus

Ganciclovir, foscarnet,

cidofovir.

Human herpes virus 6

Ganciclovir, foscarnet.

Influenza virus

Neuraminidase inhibitors: oseltamivir (po); zanamivir (inhalation).

See Centers for Disease Control website (www.cdc.gov) as susceptibilities vary significantly over time.

HIV

Antiretroviral therapy is complicated and initiation is almost never an emergency, unless in the situation of post-exposure prophylaxis. However, in patients receiving anti-retroviral therapy, one should be aware of potential drug-drug interactions.

Protozoa:

Also see Table 2 for therapy for specific protozoal infections.

Plasmodium falciparum

Quinine, atovaquone/proguanil, quinidine, artemisinin derivatives; chloroquine only in specific geographic areas.

(See cdc.gov/malaria.)

Toxoplasma gondii

Pyrimethamine + sulfadiazine + leucovorin.