MICROBIOLOGY OVERVIEW

Gram Positive Organisms

	Methicillin-resistant *Staphylococcus aureus* (MRSA)		
Definition	Oxacillin minimum inhibitory concentration (MIC) ≥4 mcg/mL		
Resistance mechanism	MecA gene encoding for altered penicillin binding protein (PBP-2a)		
Treatment options	Vancomycin[#]; daptomycin[*]; linezolid; tigecycline; quinupristin-dalfopristin (special access); ceftaroline, cotrimoxazole, clindamycin (# used for vancomycin susceptible MRSA with MIC ≤2 mcg/Ml; * not to be used for MRSA pneumonia due to inhibition by pulmonary surfactant)		
	Vancomycin sensitive Enterococcus (VSE)	Vancomycin-resistant Enterococcus (VRE)	*E. gallinarum, E. casseliflavus*
Definition	Vancomycin MIC≤4 mcg/mL	Vancomycin MIC≥32 mcg/mL	MIC 8 to 16 mcg/mL
Resistance mechanism		Van A and Van B genes encoding D-ala-D-lac which replaces D-Ala-D-Ala (vancomycin binding site) in the cell wall	VanC gene encoding intrinsic low-level resistance to vancomycin
Treatment Options	<u>*E.faecalis*</u> ampicillin; penicillin G; vancomycin; aminoglycoside* (gentamicin, streptomycin) <u>*E. faecium*</u> vancomycin; aminoglycoside *	Linezolid; daptomycin; tigecycline; quinupristin-dalfopristin[#]; aminoglycoside* (gentamicin, streptomycin) (# only used to treat vancomycin-resistant E. faecium; * monotherapy should not be used; may be combined with a cell wall–active agent for synergy in the treatment of infective endocarditis, if reported as 'synergism susceptible')	

Gram Negative Organisms

	ESBL	ampC	Carbapenemase
Definition	Class A β-lactamase which is resistant to all β-lactams except carbapenems, cephamycins (cefoxitin, cefotetan, cefmetazole), cefipime and ß-lactam/ ß -lactamase inhibitor combinations.	Class C β-lactamase, the product of the ampC gene, which is resistant to all β-lactams except carbapenems and cefipime.	Carbapenem-hydrolyzing beta-lactamase, which is resistant to a broad spectrum of beta-lactams including carbapenems.
Common organisms	Most commonly found in *E. coli* and *Klebsiella* spp. but also in other gram negative bacteria.	<u>Plasmid-mediated ampC:</u> *E. coli, K. pneumoniae*, and *Proteus. mirabilis* <u>Chromosome-mediated ampC:</u> SPICE organisms (*Serratia* spp., *Proteus vulgaris/penneri, Providencia,* all *Citrobacter* spp. except *C. koseri, Morganella morganii, Enterobacter* spp., *Hafnia alvei, Pantoea agglomerans, Pantoea dispersa*)	<u>Klebsiella pneumoniae carbapenemase (KPC):</u> Class A β-lactamase, found in Enterobacteriaceae. <u>Metallo-beta-lactamases (MBLs):</u> Class B β-lactamase, the New Delhi MBLs (NDM-1) was found in Enterobacteriaceae and Acinetobacter. <u>OXA carbapenemases:</u> Class D β-lactamase, found in acinetobacter and Enterobacteriaceae.
Treatment options	1st : carbapenems Others depending on susceptibility testing results: ciprofloxacin, aminoglycoside, septra, fosfomycin (only for UTI)		colistin, polymyxin B, aztreonam, tigecycline, fosfomycin (only for UTI). Frequent resistance to aminoglycosides and fluoroquinolones

Pseudomonas aeruginosa

Organism	Aerobic, motile, straight, slender, Gram negative bacilli
Colonial morphology	On blood agar: rough, most often beta-hemolytic with bluish green, red or brown pigmentation; concord grapes or corn tortilla smell with metallic sheen; mucoid colonies commonly seen in patients with cystic fibrosis. On MacConkey agar: colorless colonies
Presumptive identification	Non-lactose fermenter, oxidase +, oxidize glucose, able to grow at 42 °C
Therapeutic Options	ß-lactam/ ß -lactamase inhibitor combinations: Piperacillin/tazobactam Cabapenems: meropenem, imipenem (not ertapenem) Aztreonam Cephalosporins: Ceftazidime, Cefepime Fluroquinolones: Ciprofloxacin>levofloxacin Aminoglycosides

Risk factors for resistant organisms

MRSA	**VRSA**	**VRE**	**CPE** **(Carbapenemase-producing organisms)**	**Acinetobacter**
Antibiotic use (esp. cephalosporin and fluoroquinolone)	Age >50 years	Antibiotic use (esp. cephalosporin, vancomycin)	Use of broad spectrum cephalosporins, carbapenems	Use of beta-lactam use, esp. carbapenems, fluoroquinolone
HIV infection	Vancomycin for >48 hours in the week prior to bacteremia	Significant underlying medical conditions	Significant underlying medical conditions	Prior colonization with MRSA
Hemodialysis	Chronic liver disease	Colonization pressure	Trauma	Mechanical ventilation
Residents of long-term care facilities	History of MRSA bacteremia, central venous catheters (CVL)	Exposure to contaminated surfaces	Mechanical ventilation, CVL	Bedridden status, indwelling catheter