

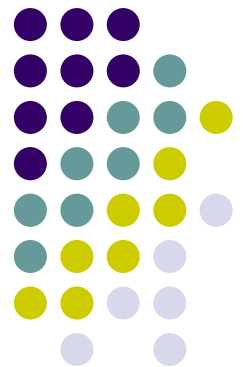
# The Art of Antimicrobial Therapy

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## Essential questions to be answered before prescribing antimicrobials for therapeutic purposes

1. Does the patient have infection?
2. What is the site of infection?
3. What is/are the most likely pathogen(s)?
4. Is antimicrobial therapy indicated?
5. What is the optimal antimicrobial(s) choice?

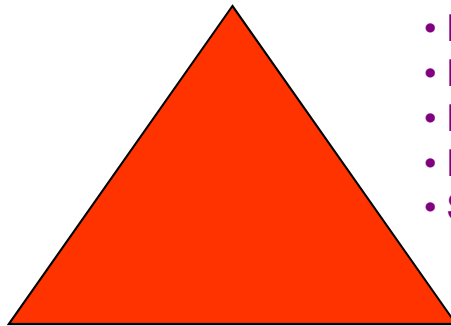
## Essential questions to be answered before prescribing antibiotics for therapeutic purposes

- If you can not answer all of these questions, DO NOT start empiric antimicrobial therapy unless the patient is critically ill or in septic shock.

# Choice of antimicrobial therapy

## Antimicrobial

- Spectrum of activity
- Mechanism of action
- Dose
- Route of administration
- Dose in renal failure
- Side effects ....etc



## Host

- Site of infection
- Age
- Pregnancy
- Renal failure
- Liver disease
- Immune status
- Allergy ....etc

## Organism

- Likely organism according to site of infection
- Antimicrobial sensitivity pattern
- Mechanism of resistance ....etc

# Classification of bacteria

	Aerobic																			Anaerobic					
	G + ve C						G+ve B		G-ve C		G-ve B						Atypi		O	+	+	-	-		
	Staph			Strep			Enter		Li st er ia	Ar ca n	N.g	N. m	Esc Kl Aci En Pr Ser Sal	Ps	St	H in	Mo	Bru	Leg	Myc	Chl	T.p	P	Ac Cl	P r
S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium	N.g	N. m																	

## Gram-positive cocci

<b>Organism</b>	<b>Infection</b>
<i>Staph. aureus</i>	<ul style="list-style-type: none"><li>• Skin (impetigo, wound infection, paronychia, cellulitis, abscesses, staphylococcus scalded skin syndrome ..etc)</li><li>• endovascular catheter infection</li><li>• endocarditis</li><li>• osteomyelitis</li><li>• septic arthritis</li><li>• bursitis</li><li>• lymphadenitis</li><li>• pneumonia</li></ul>

## Gram-positive cocci

<b>Organism</b>	<b>Infection</b>
<i>Staph. epidermidis</i>	Infection of foreign devices (eg. CVC, VP shunts, prosthetic valves, prosthetic joints, screws, plates ..etc)

## Gram-positive cocci

Organism	Infection
Strept. gp A ( <i>Streptococcus pyogenes</i> )	<ul style="list-style-type: none"><li>• Skin (erysipelas, cellulitis, necrotising fasciitis, scarlet fever, impetigo)</li><li>• tonsillitis</li><li>• pharyngitis</li><li>• lymphadenitis</li><li>• pneumonia</li><li>• nonsuppurative diseases<ul style="list-style-type: none"><li>- rheumatic fever</li><li>- glomerulonephritis</li></ul></li></ul>

## Gram-positive cocci

Organism	Infection
Strept. gp B ( <i>Streptococcus agalactiae</i> )	Neonatal sepsis Puerperal sepsis

## Gram-positive cocci

<b>Organism</b>	<b>Infection</b>
Strept. gp C	Pharyngitis

## Gram-positive cocci

Organism	Infection
Viridans streptococci	<ul style="list-style-type: none"><li>• Endocarditis</li><li>• Bacteremia in neutropenic patients</li><li>• Deep abscesses (<i>Strept. milleri</i> group: anginosus, constellatus, intermedius)</li></ul>

## Gram-positive cocci

Organism	Infection
<i>Strept. pneumoniae</i>	<ul style="list-style-type: none"><li>• Meningitis</li><li>• Pneumonia</li><li>• Otitis media</li><li>• Sinusitis</li><li>• Septicemia</li></ul>

## Gram-positive cocci

<b>Organism</b>	<b>Infection</b>
<i>Enterococci</i>	<ul style="list-style-type: none"><li>• UTI</li><li>• Endovascular catheter infection</li><li>• Intra-abdominal infection</li><li>• Endocarditis</li></ul>

## Gram-positive bacilli

<b>Organism</b>	<b>Infection</b>
<i>Listeria monocytogenes</i>	<ul style="list-style-type: none"><li>• Septicemia</li><li>• Meningitis</li><li>• Neonatal sepsis</li></ul>

## Gram-positive bacilli

<b>Organism</b>	<b>Infection</b>
<i>Arcanobacterium haemolyticum</i>	<ul style="list-style-type: none"><li>• Pharyngitis (50% with scarlatiniform rash)</li><li>• Cellulitis</li><li>• Chronic skin ulcers</li></ul>

## Gram-negative cocci

<b>Organism</b>	<b>Infection</b>
<i>Neisseria meningitidis</i>	<ul style="list-style-type: none"><li>• Meningitis</li><li>• Septicemia</li></ul>

## Gram-negative cocci

<b>Organism</b>	<b>Infection</b>
<i>Neisseria gonorrhoeae</i>	<ul style="list-style-type: none"><li>• Urethritis</li><li>• Epididymitis</li><li>• Cervicitis</li><li>• Salpingitis</li><li>• Acute pelvic infection</li><li>• Disseminated gonorrhoea</li><li>• Septic arthritis</li></ul>

## Gram-negative bacilli

<b>Organism</b>	<b>Infection</b>
Enterobacteriaceae ( <i>E.coli</i> , <i>Klebsiella</i> , <i>Proteus</i> , <i>Serratia</i> .etc)	UTI, abdominal sepsis, nosocomial pneumonia, skin and soft tissue infection, septicemia ..etc
<i>Pseud. aeruginosa</i>	Same as enterobacteriaceae, malignant otitis externa ..etc
<i>Stenotrophomonas maltophilia</i>	Pneumonia, endovascular catheter, wound infection ..etc
<i>Moraxella catarrhalis</i>	Otitis media, sinusitis, pneumonia
<i>Haemophilus</i>	Meningitis, pneumonia, otitis media, sinusitis, epiglottitis,

## Gram-negative bacilli

<b>Organism</b>	<b>Infection</b>
<i>Salmonella</i>	Typhoid fever, gastroenteritis
<i>Campylobacter</i>	Gastroenteritis
<i>Brucella</i>	Brucellosis, osteoarticular (especially sacroiliitis), epididymo-orchitis, endocarditis, neurobrucellosis
<i>Legionella</i>	Legionnaire's disease, pontiac fever

# Anaerobes

<b>Organism</b>	<b>Infection</b>
Anaerobes	<ul style="list-style-type: none"><li>• Abscesses</li><li>• Abdominal sepsis</li><li>• Dental infection</li><li>• Aspiration pneumonia</li><li>• Skin and soft tissue infection</li><li>• Chronic sinusitis</li></ul>

# Atypical Organisms

Organism	Infection
<p><i>Mycoplasma</i></p> <p><i>Chlamydia</i></p> <p><i>C. trachomatis</i></p> <p><i>C. pneumoniae</i> (TWAR agent)</p> <p><i>C. psittaci</i></p>	<p>Upper respiratory tract infection, tracheobronchitis, pneumonia</p> <ul style="list-style-type: none"><li>• Trachoma conjunctivitis,</li><li>• Nongonococcal urethritis,</li><li>• Lymphogranuloma venereum,</li><li>• Neonatal pneumonia</li></ul> <p>Pneumonia</p> <p>Psittacosis (ornithosis)</p>

## Classification of antibiotics according to their mechanism of action

Mechanism of action of antibiotics				
Cell wall synthesis inhibition	Protein synthesis inhibition	RNA or DNA synthesis inhibition	Folic acid synthesis inhibition	Miscellaneous
<p><b>I. B-Lactams</b></p> <p><b>1. Penicillins:</b></p> <p><b>A. Simple penicillins:</b> penicillin G, penicillin V, procaine penicillin, benzathine penicillin</p> <p><b>B. Amoxicillin and ampicillin</b></p> <p><b>C. Piperacillin</b></p> <p><b>D. Cloxacillin</b></p> <p><b>E. Penicillin+B-lactamase inhibitor:</b></p> <ul style="list-style-type: none"> <li>- Amoxicillin/clavulanic acid,</li> <li>- Ampicillin/sulbactam,</li> <li>- Piperacillin/tazobactam</li> </ul> <p><b>2. Cephalosporins:</b></p> <p><b>A. 1<sup>st</sup> generation:</b> cefalexin (po), cefazolin (iv)</p> <p><b>B. 2<sup>nd</sup> generation:</b> cefaclor (po), cefuroxime (po, iv/im), cefoxitin (iv/im)</p> <p><b>C. 3<sup>rd</sup> generation:</b> cefixime (po), ceftriaxone (iv/im), cefotaxime (iv), ceftazidime (iv/im)</p> <p><b>D. 4<sup>th</sup> generation:</b> cefipime (iv)</p> <p><b>3. Carbapenems:</b> imipenem, meropenem, ertapenem</p> <p><b>4. Monobactam:</b> aztreonam</p> <p><b>II. Glycopeptides:</b></p> <p>Vancomycin, teicoplanin (Targocid), dalbavancin (Zeven)</p>	<p><b>Aminoglycosides</b></p> <p>Gentamicin, Amikacin, Tobramycin, Streptomycin, Neomycin</p> <p><b>Macrolides</b></p> <p>Erythro, Clarithro, Azithromycin</p> <p><b>Ketolides</b></p> <p>Telithromycin (Ketek)</p> <p><b>Clindamycin</b></p> <p><b>Chloramphenicol</b></p> <p><b>Tetracycline, doxycycline</b></p> <p><b>Glycylcycline</b></p> <p>Tigecycline (Tygacil)</p> <p><b>Oxazolidinones</b></p> <p>Linezolid (Zyvox)</p> <p><b>Streptogramin</b></p> <p>Quinupristin/ Dalfopristin (Synercid)</p> <p><b>Fusidic acid</b></p> <p><b>Nitrofurantoin</b></p> <p><b>Spectinomycin</b></p>	<p><b>Quinolones</b></p> <p>Ciprofloxacin, Ofloxacin, Pefloxacin, Levofloxacin, Moxifloxacin, Gatifloxacin</p> <p><b>Rifampin</b></p>	<p><b>Sulfonamides</b></p> <p>Sulfadiazine, Sulfadoxine, Sulfamethoxazole</p> <p><b>Trimethoprim</b></p> <p><b>Trimethoprim/ Sulfamethoxazole (Cotrimoxazole)</b></p>	<p><b>Metronidazole</b></p> <p><b>Polymixin B and Colistin</b></p>
	<b>Daptomycin (Cubicin)</b>			

Antibiotics	Aerobic																				Anaerobic						
	G + ve C								G+ve B	G-ve C		G-ve B								Atypi		O	+ C	+ B	- C	- B	
	Staph			Strep			Enter			Ng	Nm	Esc kl Pr Ser Sal	Ps	St	Hin	Mo	Bru	Leg	Myc	Chl	T.p	P	Ac Cl	P r	B		
	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium	Li st er ia	Ar ca n																		
Simple penicillins	-	-	-	‡	+	+	±	+		-	‡	-	-	-	-	-	-	-	-	-	-	-	‡	+	+	+	-
Amoxicillin, ampicillin	-	-	-	‡	‡	‡	‡	‡		-	+	±	-	-	±	-	-	-	-	-	-	-	+	+	+	+	-
Piperacillin	-	-	-	+	+	+	±	+		+	+	‡	‡	±	±	±	-	-	-	-	-	-	+	+	+	+	-
Cloxacillin	‡	-	-	‡	+	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Penicillin + B-lactamase inhibitors																											
Amox/ clavulnic acid	‡	-	-	‡	‡	‡	‡			+	+	‡	-	-	‡	‡	-	-	-	-	-	+	‡	‡	‡	‡	‡
Ampicillin/ sulbactam	+	-	-	+	+	‡	‡	+		+	+	‡	-	-	+	+	-	-	-	-	-	+	‡	‡	‡	‡	‡
Piperacillin/ tazobactam	+	-	-	+	+	‡	±	+		+	+	‡	‡	±	+	+	-	-	-	-	-	+	‡	‡	‡	‡	‡



Antibiotics	Aerobic																				Anaerobic							
	G + ve C								G+ve B	G-ve C		G-ve B						Atypi		O	+ C	+ B	- C	- B				
	Staph			Strep		Enter				N.g	N.m	Esc kl Pr Ser Sal	Ps	St	H in	Mo	Bru	Leg	Myc	Chl					T.p			
	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium	Li st er ia	Ar ca n																			
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-	-	-	-
Macrolides	+	-	-	‡	‡	-	-	+	+	±	+	-	-	-	‡	‡	-	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡
Telithromycin	+	-	-	‡	‡	±	-	+			+	-	-	-	‡	‡	-	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡
Clindamycin	‡	-	-	‡	‡	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloramphenicol	‡	-	-	‡	‡	±	±	+			+	‡	+	-	+	‡	+	+	+	+	+	+	+	+	+	+	+	+
Tetracycline Doxycycline	±	±	-	±	+	-	-	+			±	+	±	-	-	+	+	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡
Tigecycline	‡	‡	‡	‡	‡	‡	‡	+			+		+ <sup>1</sup>	-	+	+	+			‡	‡	‡	‡	‡	‡	‡	‡	‡

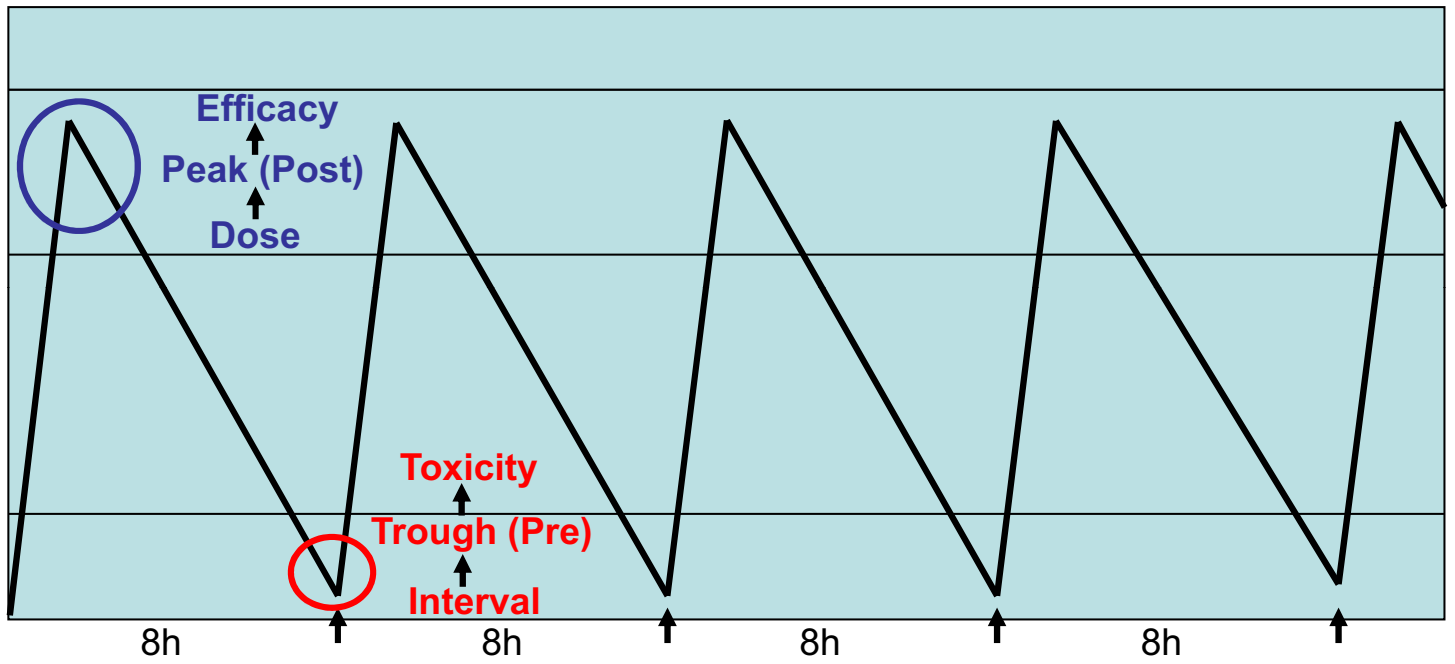
<sup>1</sup> Not active against ESBL-positive *E. coli* and *Klebsiella* species

Antibiotics	Aerobic																				Anaerobic							
	G + ve C								G+ve B	G-ve C		G-ve B						Atypi		O	+ C	+ B	- C	- B				
	Staph			Strep			Enter			N.g	N.m	Esc kl Pr Ser Sal	Ps	St	H in	Mo	Bru	Leg	Myc	Chl					T.p			
	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium	Li st er ia	Ar ca n																			
Linezolid	‡	‡	‡	‡	‡	‡	‡	+			-	-	-	-	±	±	-	-	-	-				+	±	±	±	±
Quinopristin/ dalfopristin	‡	‡	‡	‡	‡	-	‡	+		+	-	-	-	-	±	+			+	+					±	+		
Daptomycin	‡	‡	‡	‡	‡	‡	‡	‡																				
Fusidic acid	‡	‡	‡	±	±	+				+	+	-	-	-	-	-		±	-	-				+	+	+	+	+
Nitrofurantoin	+	+		+	+	+	+					±	-															
Quinolones <sup>1</sup>	+	-	+	±	±	-	-	+		+	+	‡	‡	-	+	+	‡	‡	‡	‡				-	-	-	-	-
Rifampicin	+	+	+	+	+	±	-	+		+	‡ <sup>2</sup>				+	+	‡	‡		+								
TMP/SMX	+	+	±	+	+	-	-	‡		±	+	‡	-	‡	±	‡	‡	‡										-
Metronidazole	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	‡	‡	‡	‡	‡
Polymixin B Colistin	-	-	-	-	-	-	-	-	-			‡	‡	‡	‡	‡												

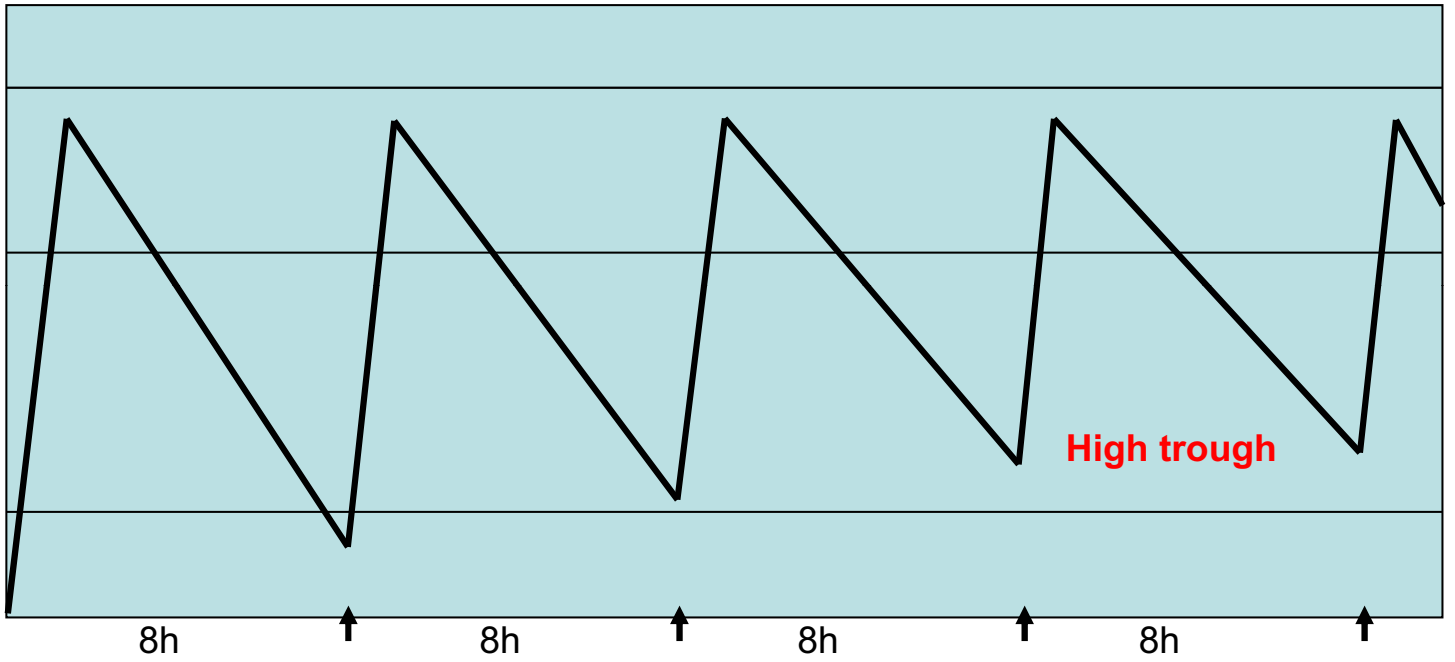
<sup>1</sup> Moxifloxacin has good activity against streptococci (including pneumococcus) and all anaerobes except *C. difficile*

<sup>2</sup> Rifampin is used to prevent (not to treat) *Neisseria meningitidis* meningitis

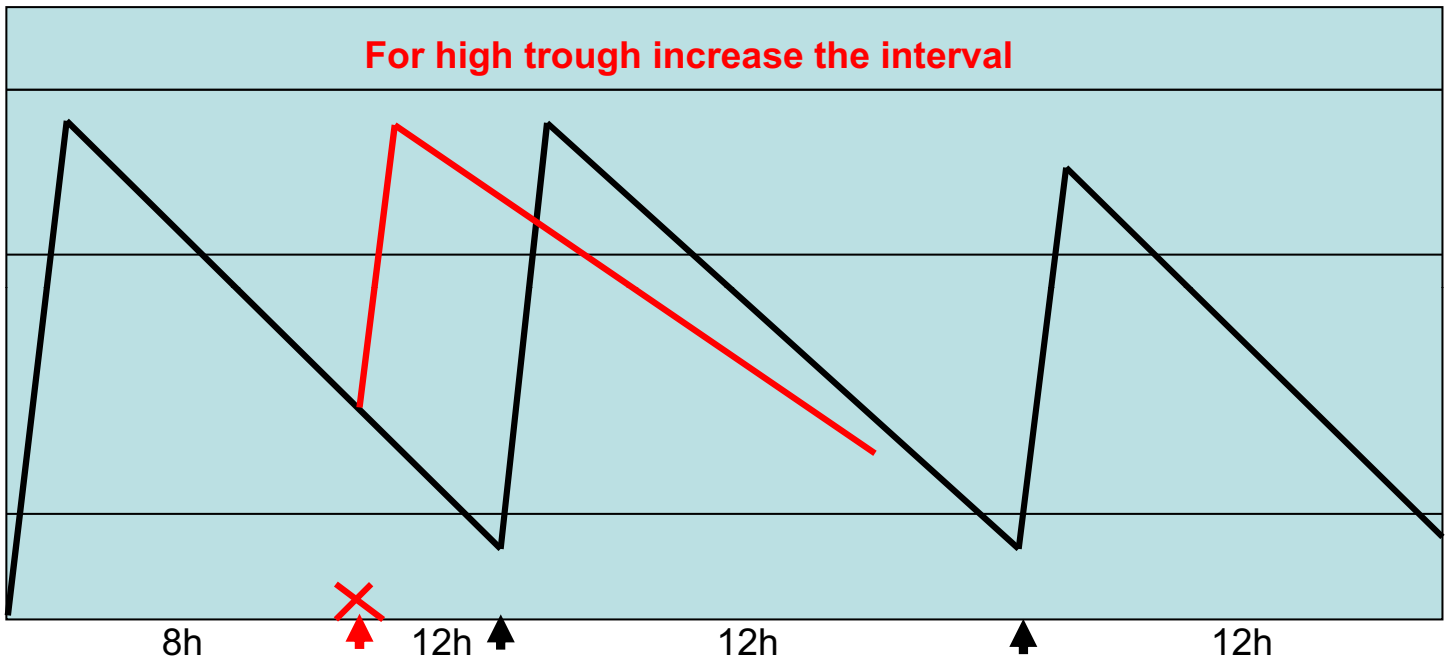
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	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium	Li st er ia																	Ar ca n	
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-	-



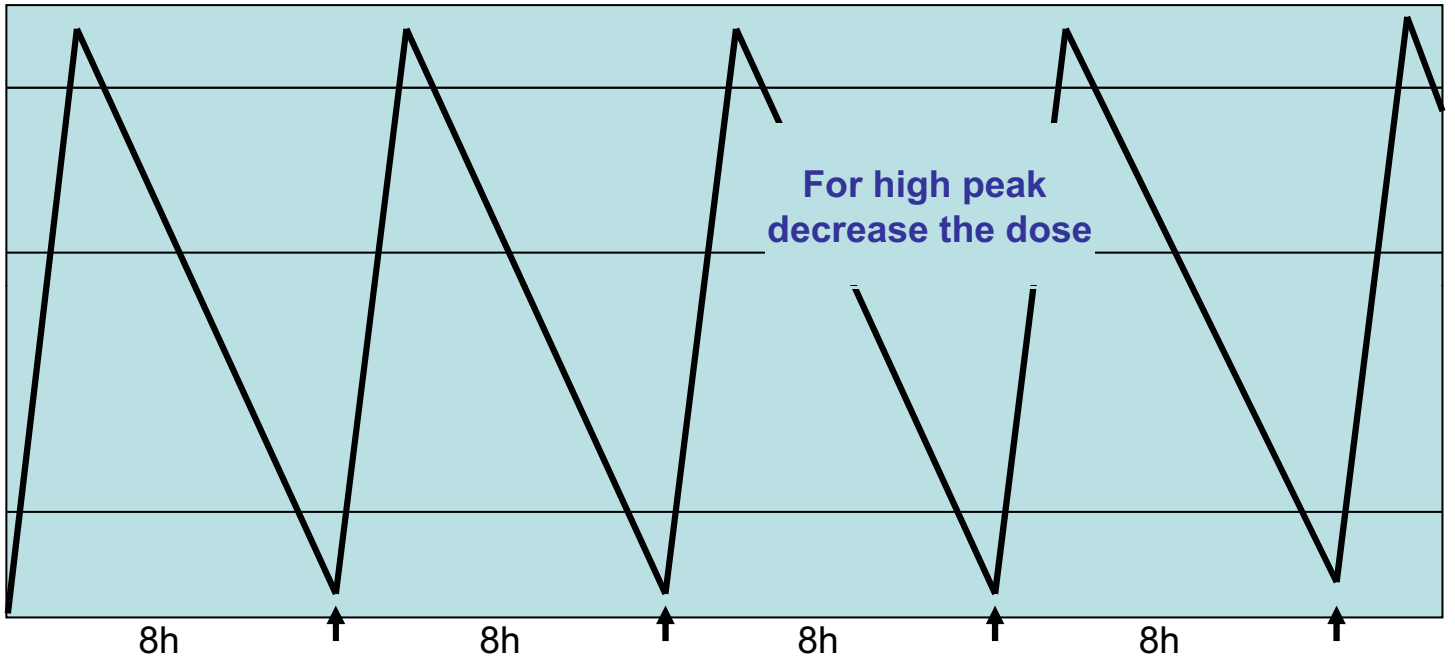
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	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium																			
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-	-



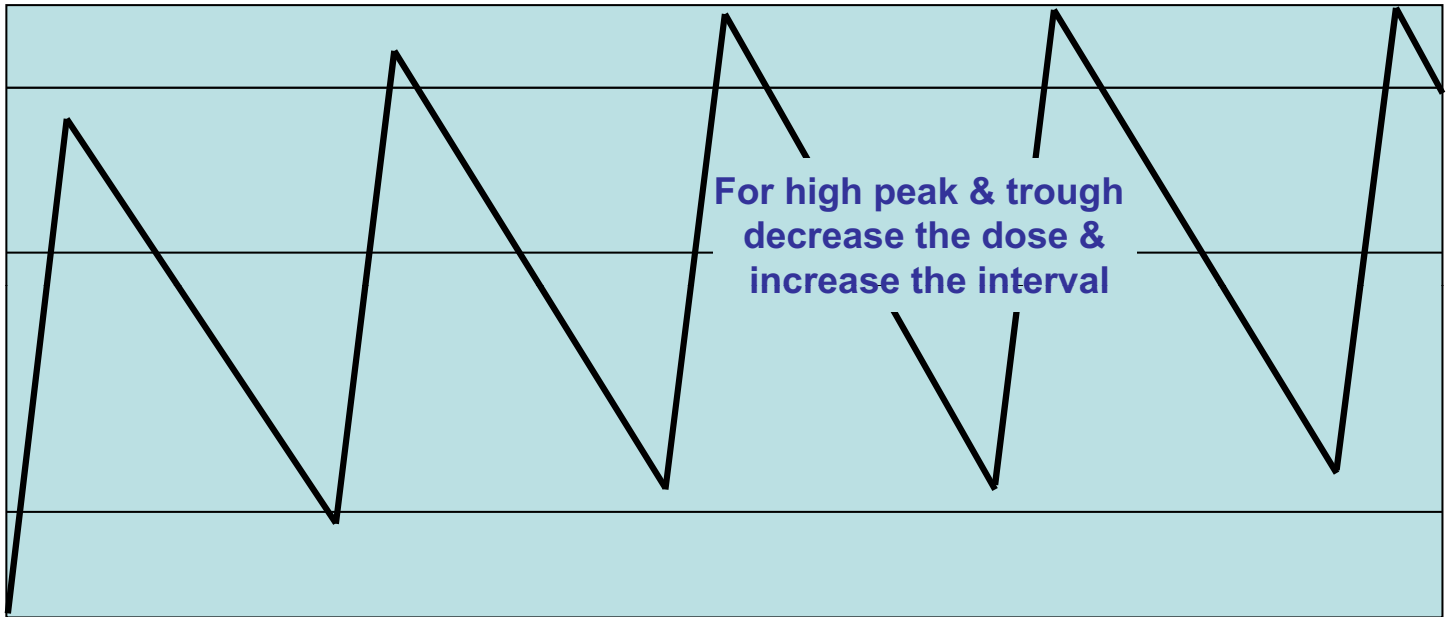
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	Staph			Strep		Enter			Ng	Nm	Esc kl Pr Ser Sal	Ps	St	Hin	Mo	Bru	Leg	Myc	Chl					T.p			
	S. au	M R S A	S. ep	A B C vi	Pn	E. fae c ali s	E. fae c ium	Li st er ia												Ar ca n							
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-	-	-



Antibiotics	Aerobic																			Anaerobic					
	G + ve C							G+ve B		G-ve C		G-ve B						Atypi		O	+	+	-	-	
	Staph			Strep		Enter		Li st er ia	Ar ca n	Ng	N. m	Esc kl Pr Ser Sal	Ps	St	H in	Mo	Bru	Leg	Myc	Chl	T.p	P	Ac Cl	P r	B
	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium																		
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-



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	G + ve C								G+ve B	G-ve C		G-ve B						Atypi		O	+ C	+ B	- C	- B		
	Staph			Strep		Enter				Li st er ia	Ar ca n	Ng	N. m	Esc kl Pr Ser Sal	Ps	St	H in	Mo	Bru	Leg	Myc	Chl	T.p	P	Ac Cl	P r
	S. au	M R S A	S. ep	A B C vi	Pn	E. fa ec ali s	E. faec ium																			
Aminoglycosides	+	-	±	-	-	S	S	S	-	-	-	‡	‡	-	+	+	‡	-	-	-	-	-	-	-	-	-



# Why combine antibiotics

- For synergism against a single organism
- To treat polymicrobial infection
- To broaden coverage in empiric therapy to cover all possible pathogens

## Remember

- Obtain specimens for culture before commencing antimicrobials
- When appropriate, always try to use as narrow spectrum antimicrobials as possible guided by the culture results

## Case Scenario 1

- 26 y old male patient presents to ER with 2 days history of high grade fever, chills, cough productive of blood-stained yellowish sputum, and right pleuritic chest pain.
- O/E: bronchial breath sound and egophony on right base.
- Cxray: right lower lobe consolidation.

## Case Scenario 2

- 50 y old woman who underwent hemicolectomy for colon cancer. On the 7th postoperative day the pt started to have fever of 39°C, cough with greenish sputum and moderate dyspnoea.
- O/E: moderately ill, febrile, p=105. RR=25, BP=110/75.
- Sputum gram stain= GNB 4+, Polys 4+, WBC=18 (85% neut, 5% bands)

## Case Scenario 3

- 17 y old man known to have sickle cell anemia presents with acute febrile illness with severe malaise and confusion.
- On examination the patient looks ill with BP of 70/30, pulse 140/min. Neck was supple and chest was clear. The rest of exam was normal.

## Case Scenario 4

- 56 y old man with COPD transferred from ICU to the ward after being treated for respiratory failure and chest infection in the preceding 2 weeks. He required tracheostomy for difficult ventilator-weaning process.
- As part of “routine” culturing of tracheostomy tubes’ secretions, tracheal aspirate was sent for culture. Results showed MRSA. Patient is afebrile and hemodynamically stable. No increase in the amount of secretions was noted. WBC was normal and chest xray showed no infiltrates.

## Case Scenario 5

- A 50 year old woman who has been ventilated in the ICU for respiratory failure due to severe asthma spikes high grade fever. Examination revealed erythema and tenderness at a peripheral IV site. Tracheal secretion was positive for *Pseudomonas aeruginosa* sensitive to imipenem alone (resistant to ceftazidime, piperacillin, and amikacin). The amount and color of the tracheal secretions have not changed. Chest x ray was normal.

## Case Scenario 6

- A 25 years old male, presented with 1 day history of fever, painful swelling of the left thigh, progressively increasing in size.
- On examination the patient appears toxic, temp. 39.5° C, BP 130 / 70 mmHg, P 110 / min.
- Left thigh examination reveals a diffuse, erythematous, tender swelling with areas of bluish discoloration; the swelling extends from the knee to the lower abdomen. There are no regional lymph nodes palpable. The rest of the examination was free.

## Case Scenario 7

- A 5 years old girl presented with swelling and redness of the right eye for 1 day, with fever. There is no history of trauma, insect bite or discharge from the eye.
- Physical examination reveals a well nourished child, not toxic, with temp 38.8°C( per axilla), normal BP, the right eye was completely shut down, with diffuse swelling and redness involving both the right upper and lower eyelids, there was no tenderness, the child was able to open her eye with difficulty, she could move her eye in all directions with no pain, there was no proptosis, or chemosis. The rest of the examination was normal.

## Case Scenario 8

- 65 year old Bangladeshi woman presented to ER with a history of fever for 2 weeks associated with weakness and fatigue, she denied any history of cough or urinary symptoms. She gave history of weight loss in the last four months of about 6 kg.
- O/E: She looks ill, cachectic, temp 38, BP 120/70, RR 16/min, chest clear, CVS normal exam, abdominal exam revealed hepatomegally.
- Investigation: WBC 5.4, Hgb 10.5g, Plat 312, CXR normal, blood and urine cultures where negative

## Case Scenario 9

- A 25 years old man presented with fever, chills, and swelling of his right leg for 5 days. On examination he had a temp of 38.5°C and diffuse erythematous nontender swelling with no palpable edges measuring about 20 cm involving the Lt. lower leg.

## Case Scenario 10

- 36 year-old male presented with high grade fever, pain and swelling of the right knee for 3 days
- O/E temp 39°C, right knee is hot and tender, swollen with painful limitation of movement.
- WBC 14, mainly polys, Hg 16, Plt 230, uric acid 8 mg/dl (N: 4.2-7.2)

## Case Scenario 11

- 46 year old male presented with cough hoarseness of voice and fever associated with runny nose and myalgia.
- O/E temp 38.5, throat congested and eyes red. The rest of examination were normal

## Case Scenario 12

- 55 y old woman who underwent diskectomy 4 weeks ago. A small amount of pus from the wound was noticed 3 weeks postop. No fever, erythema, or tenderness. The result of a swab culture taken by the spine surgeon revealed *Staphylococcus epidermidis*

## Case Scenario 13

- 47 y old woman who is 2 months post RTA complicated by Rt chest empyema treated with chest tube insertion. Empyema fluid culture revealed Klebsiella sensitive to meropenem, ciprofloxacin, gentamicin. Sputum culture revealed Klebsiella (same antibiogram) and Acinetobacter resistant to all antibiotics except colistin which is not available. Chest x ray: Rt chest tube with minimal residual fluid, no pulmonary infiltrate.

## **Case Scenario 14**

- 35 y old man with cough, fever, night sweating, and weight loss of 6 weeks duration.

## **Case Scenario 15**

- 22 y old IV drug user man with cough, fever, night sweating, and shortness of breath of 3 weeks duration.

## Case Scenario 16

- 60 y old man with malaise, cough, fever, shortness of breath, and vague retrosternal chest pain of 3 weeks duration. He sustained a car accident in 1985 for which he received 4 units of blood.

## Case Scenario 17

- 24 year old Indonesian housemaid with multiple neck painless masses progressively increasing over the preceding 3 months. No fever, weight loss, night sweating, cough, or pruritus.

## Case Scenario 18

- 24 year old man with fever and severe headache for 2 days. Examination revealed fully conscious man in pain, neck stiffness, and photophobia. Positive Kernig's and Brudzinski's sign.

## Case Scenario 18

- CSF
  - High pressure, turbid
  - WBC 356, 90% Neutrophils
  - Glucose 1.2 mmol/L (serum 5.1)
  - Protein: 1.5 gm/L
  - Gram stain: G+ve cocci

سبحانك اللهم ربنا  
وبحمدك أشهد أن لا  
إله إلا أنت أستغفرك  
وأتوب إليك

