

# Bugs and Drugs Handout\*

## Bacterial Characteristics

Bacteria are identified according to cellular wall structure and morphology. Stains aid in the visualization of bacteria under the microscope. **Gram positive** organisms stain blue while **gram negative** organisms stain red.

### *Bacterial Morphology*

- 1) **Cocci**: spherical, may appear as diplococci (pairs) in certain circumstances ie; Neisseria which is a gram negative cocci which causes meningitis
- 2) **Bacilli**: rods, short bacilli are called coccobacilli
- 3) **Spiral forms**: comma or spiral shaped
- 4) **Pleomorphic**: no distinct shape, like jello

### *Metabolic Characteristics and Virulence Factors*

Aerobic bacteria require an O<sub>2</sub> rich environment while anaerobes flourish in the absence of oxygen. Facultative anaerobes prefer an aerobic environment but can survive in an anaerobic environment. Lactose fermenters use lactose as an energy source but can also survive in low levels of oxygen. Non-lactose fermenters (ie; pseudomonas) tend to be hardier bugs and more difficult to kill. Bacteria employ a variety of enzymes and proteins for protection and virulence. Some also have the ability to encapsulate themselves or to shield themselves with endospores until they are in a more favorable environment. Toxins secreted by bacteria cause disease states and inflammatory responses.

## Some Gram Positive Bacteria Common to the ICU

### Streptococci and Staphylococci

- Both are gram positive cocci and can be differentiated by their appearance on a gram stain. **Staphylococci** appear in **clusters** and streptococci in strips. The presence of the enzyme **catalase** further differentiates **staph** from strep while the enzyme coagulase indicates the presence of staph aureus rather than staph epi. Most staph and some strep have developed an enzyme called penicillinase which makes them insensitive to many of the penicillin family drugs.
- Both staph and strep possess hemolysins which destroy RBCs. However only strep is partially identified by the degree of its ability for lysis. For example Group A **beta**-hemolytic strep has the ability for **total** lysis. If the strep was alpha hemolytic the ability for lysis would only be partial.
- VRE is enterococcus (streptococci which are normal bowel flora) which has developed DNA mutation making this difficult to treat bacteria also resistant to Vancomycin. This resistance code can be transferred to staphylococci.

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- MRSA is staph aureus which has developed a DNA encoding making it insensitive to Methicillin, a penicillin family antibiotic which is not disabled by the enzyme penicillinase.

### **Clostridium\***

- Clostridium strains are known as the causative agent for botulism, tetanus, gas gangrene (clostridium perfringens), and C. Diff. (pseudomembranous colitis). The powerful exotoxins secreted by the clostridium bacteria are responsible for these disease states.
- C. Diff is a familiar pathogen in the ICU occurring when normal bowel flora are destroyed by certain antibiotics. Individuals who harbor C. Diff (which is not destroyed by the antibiotics) as a resident bowel flora become vulnerable to potentially lethal watery diarrhea and electrolyte loss as the C. Diff. flourishes in the sterile bowel.
- C. Diff. can be transferred between patients.

### **Some Gram Negative Bacteria Common to the ICU**

#### **Neisseria Meningitidis aka Meningococcus**

- Neisseria are the only gram negative cocci that are pathogenic to humans.
- Once in the bloodstream meningococci rapidly disseminate throughout the body. This can lead to meningitis or to the highly lethal bacteremia known as fulminate meningococemia.

#### **The Enterics and Pseudomonas Aeruginosa**

- The gram negative enterics exist as natural flora in the GI tract or as pathogens of disease in the GI tract and other sites. There are four main groups in the enteric family; **Enterobacteriaceae**, **Vibrionaceae**, **Pseudomonadaceae** and **Bacteroidaceae**
- Pseudomonas A is an aerobic gram negative rod with a weak invasive ability so healthy people don't develop pseudomonal infections but weak, immunocompromised hospital patients do!
- Pseudomonas produces many exotoxins and is difficult to treat as it is very quick to develop resistance to antibiotics.

#### **Antibiotics in the ICU**

Antibiotics are designed to have a high selective toxicity so that they damage bacterial cells but not human cells. This is achieved by targeting characteristics that are unique to bacterial cells. For example the penicillin family and vancomycin target the bacterial cell wall, a structure which is not present in human cells. Antiribosomals inhibit

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protein synthesis by disabling the bacterial ribosomes which are composed of smaller subunits than human ribosomes. Other antibiotics inhibit bacterial nucleic acid synthesis or break DNA structure. Antibiotic efficacy is partially dependent on resistance strategies employed by the bacterial cell ie; most staph is resistant to many penicillin family drugs because of the enzyme *penicillinase*. Beta lactam is another word for penicillin and beta-lactamase is another word for penicillinase. Tazobactam, clavulanic acid and sulbactam are all beta-lactamase inhibitors. The inhibitors are combined with some penicillin family antibiotics to overcome resistance. Other bacteria use *efflux pumps* to send the antibiotic back out of the cell. Bacteria tend to eventually develop a variety of resistance factors to popular antibiotics, hence the saying '*you use it you lose it*'.

## **NURSING RESPONSIBILITIES\***

- The first dose of an antibiotic is always a STAT dose. During the growth phase bacteria multiply exponentially - doubling their numbers every few minutes. Consequently delay in administration can lead to increased mortality.
- Obtaining cultures is not a reason to delay drug administration.
- Monitor for lengthening QTc segments as this is a potential side effect of some antibiotics eg. fluoroquinolones and macrolids.
- Monitor for allergies and adverse drug reactions; particularly with penicillins.
- Monitor treatment efficacy and emergence of new infections while on antibiotics.
- Be suspicious of *C. difficile* if your patient is on antibiotics and has watery diarrhea.
- Most importantly WASH YOUR HANDS before and after each patient contact.

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