Microbe of the month

Breaking The Chain of Infection

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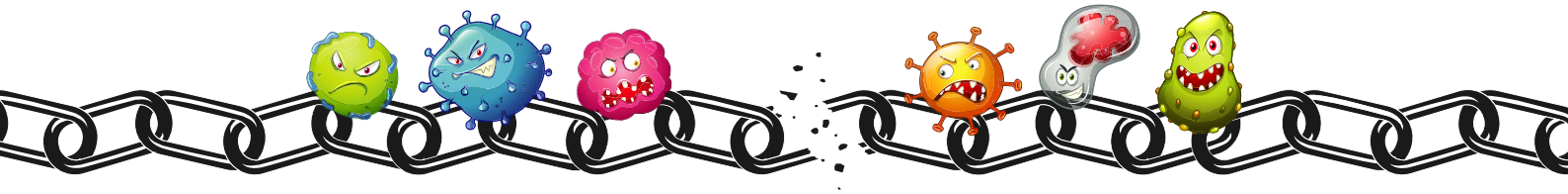
MAY 2019
Newsletter
Compiled by Helen Loudon, Independent IPC Practitioner



Featured this month:

Back to Basics

ALL ABOUT BACTERIA (Part 3) Resistance traits and tricks

ANTIBIOTIC RESISTANCE IN BACTERIA

Antibiotic resistance is when bacteria are able to survive and grow in the presence of one or more antibiotics, which previously would have been effective for treating that infection. Other microbes, like viruses and fungi, can also become resistant to antimicrobial drugs, but this article will focus on bacterial antibiotic resistance.

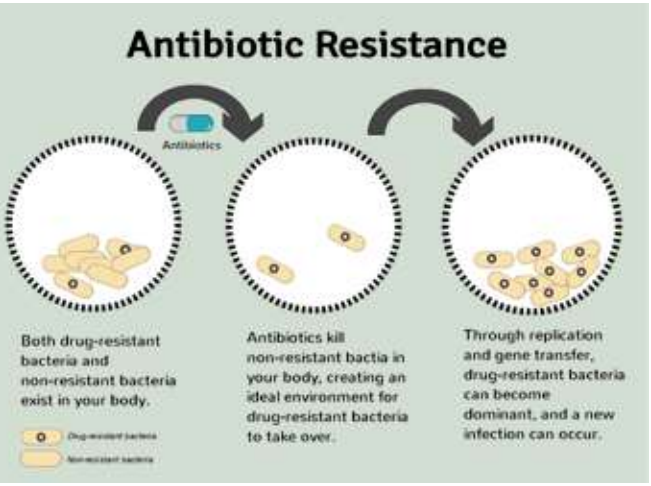
Firstly, *it is important to understand that the development of resistance commonly occurs in nature and has done so for thousands of years*. However, because of the routine use and abuse of antibiotics, bacterial exposure to antibiotics is more frequent and resistance develops at a faster rate.

Without effective antibiotics, common infections such as bacterial pneumonia will once again become life-threatening. Complex procedures, such as chemotherapy and cardiothoracic or joint replacement surgery, will become much more dangerous and deaths from infection more common.

Clinical relevance? The majority of healthcare-associated infections (HAIs) are caused by bacteria that exist harmlessly on the skin, mucous membranes, and in the gut. Wounds and medical devices (endotracheal tubes, intravascular, urinary catheters etc.) are the main contributors to the development of HAI, as these interventions and devices cause breaks in the 'first line of defence'. Imbalance of the normal flora in the gut (dysbiosis), skin and mucous membranes during and after antibiotic therapy cause overgrowth or the selection for bacterial and fungal resistance.

HOW DO BACTERIA BECOME RESISTANT?

There are several ways in which bacteria become antibiotic-resistant, but the main one is through 'selective pressure'. ***Selective pressure*** happens when not all the bacteria are susceptible to the antibiotic used to treat the infection, and the surviving bacteria continue to multiply. *This creates a bacterial population that is resistant to the antibiotic to which the bacteria were exposed.* Antibiotic overuse helps speed up the selection for resistant bacteria.

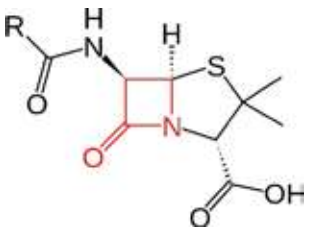


WHO IS MOST AT RISK?

Resistant bacterial infections can affect anyone, but some groups are at higher risk than others. These include:

- People with underlying chronic conditions (e.g., diabetes mellitus, rheumatoid arthritis)
- Those undergoing cytotoxic chemotherapy for malignant tumours, lymphoma or leukaemia
- Those undergoing complex surgery
- People receiving haemodialysis for end stage renal disease
- People receiving therapy that suppresses the immune system
- Organ and stem cell transplant recipients
- Infants and the elderly
- Those hospitalised for longer than 7 days
- Patients admitted to ICU with the use of invasive devices

EXTENDED SPECTRUM BETA-LACTAMASE PRODUCTION



The reader is encouraged to review Part 2 of the 'All about Bacteria' series (Microbe of the Month April 2019) which describes how bacteria further acquire resistance when they pass genetic material back and forth from one bacterium to another, through 3 main processes known as **transformation**, **conjugation** and **transduction**.

Bacterial DNA is transferred between bacteria by plasmids. Some plasmids enable bacteria to produce an enzyme (**beta-lactamase**) which damages the molecular structure of the *beta-lactam class of antibiotics*, rendering them useless.

They include all the **penicillin** derivatives, **cephalosporins**, **monobactams** and **carbapenems** (beta-lactam antibiotic agents contain a **beta-lactam ring** in their molecular structure which is damaged by the bacterial enzyme beta-lactamase).

Thus, when a plasmid carrying the genetic material for antibiotic resistance is inserted into other bacteria, antibiotic resistance can spread quickly and easily among bacteria.

Additionally, if a bacterium's genetic material spontaneously mutates, these genetic changes may also result in resistance.

Clinical relevance?

Have you ever received a microbiology laboratory culture report which states '**ESBL +ve**' next to the bacterial species cultured? This acronym refers to an *extended spectrum beta-lactamase* positive or producing bacterial species, and serves as an '**antibiotic resistance alert**' to the prescriber.

Beta-lactam antibiotics cannot be used to treat infections caused by bacteria which produce beta-lactamase enzymes.

This is especially problematic as it leaves very few options for antibiotics which can be taken orally, so admission to hospital may be necessary.

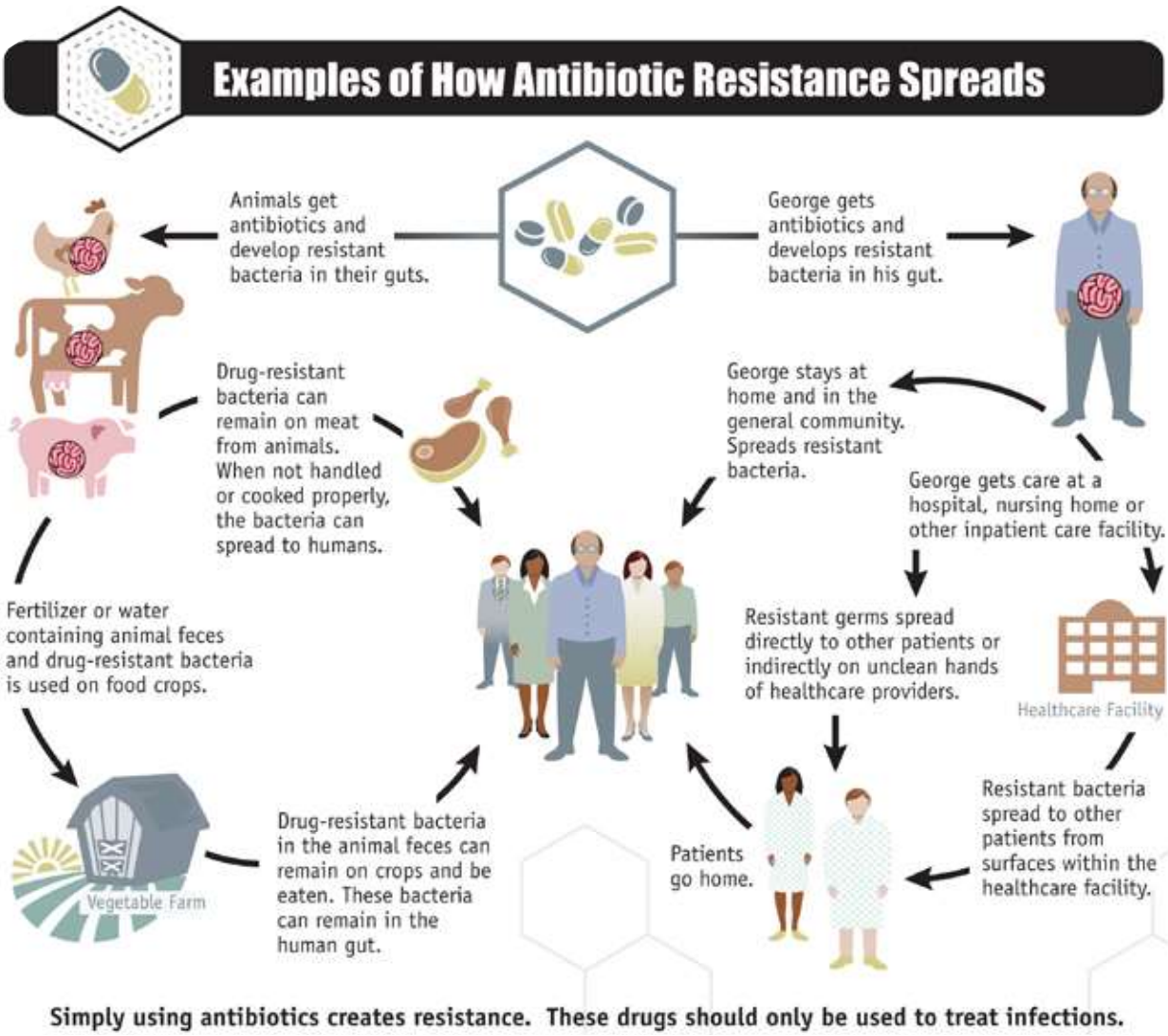
Examples of beta-lactamase-producing bacteria include:

- **MRSA** (methicillin-resistant Staphylococcus aureus): responsible for wound and bloodstream infections, pneumonia (hospital strains), skin abscesses and pneumonia (community strains)
- **MRSE** (methicillin-resistant Staphylococcus epidermidis): causes deep wound infection after joint replacement, and central venous catheter-associated bloodstream infections

Gram-negative pathogens such as **E. coli**, **Enterobacter**, **Klebsiella** and **Serratia species** produce an enzyme called *carbapenemase*, which hydrolyses the molecular structure of the **carbapenem** group of antibiotics (ertapenem, imipenem, meropenem, etc.) - considered 'the drugs of last resort' for such infections - rendering them ineffective.

These deadly bacteria are collectively described as **CRE** organisms (carbapenem-resistant Enterobacteriaceae).

Note: The Gram-negative bacteria **Acinetobacter baumannii** and **Stenotrophomonas maltophilia** are naturally antibiotic-resistant, so infections caused by these bacteria are often *untreatable*, and may be indicators of a *poor prognosis* in critically-ill patients.



https://labtestsonline.org/articles/antibiotic-resistance-bacteria

LESSONS LEARNED FOR INFECTION CONTROL

1. **Antibiotic stewardship:** Changing how antibiotics are used may be the single most important action to combat resistance, since it is estimated that only 50% of the people who receive antibiotics require them! Only using antibiotics when necessary and appropriate, for both people and animals, is known as *antibiotic stewardship*.

   Many healthcare facilities have stewardship programmes to guide best practices for antibiotic use. These stewardship practices include only prescribing antibiotics when needed, choosing the correct drugs, appropriate doses, and the most effective routes of administration and duration. Stewardship programmes have also been shown to improve safety, shorten hospital stays, and reduce pharmacy costs at healthcare facilities.

2. **Accurate diagnosis is an important step towards appropriate antibiotic use**. When a patient is seriously ill, and practitioners don't have a diagnosis for an infection, they may administer multiple antibiotics until they find the best one for treatment, or simply prescribe a *broad-spectrum antibiotic*. This may harm the normal flora in the individual's gut and create selective pressure that contributes to resistance. *Therefore, laboratory specimens for culture should always be taken prior to the commencement of antibiotics*.

   Laboratory results from susceptibility tests usually take 24- 48 hours (although some can take weeks, e.g., tuberculosis culture). These wait-times can hinder appropriate antibiotic use. Fortunately, new molecular techniques (e.g., PCR) can detect bacterial species independent of culture and are removing some of those barriers to appropriate antibiotic use.

3. **Antibiotic therapy should be reviewed after 72 hours**, pending receipt of laboratory culture results and recommendations by the medical microbiologist.

4. Patients may carry antibiotic-resistant bacteria as part of their gut flora (termed 'colonization'). These patients show no symptoms of carrying these bacteria, but may act as a **reservoir** for infection in institutional settings.

5. **Hand hygiene**, standard precautions to avoid contact with body fluids, the use of appropriate PPE (depending on whether the pathogen is spread by contact or airborne means) and isolation methods should be included in all induction programmes and annual updates, supported by easy-to-understand IPC policies. *These measures apply equally to hospital and community-based healthcare workers*.

6. The insertion and after-care of **invasive devices** must be undertaken with strict asepsis.

7. All **waste streams** and **used linen** must be handled and stored correctly to minimize contamination of the environment and the risk of cross infection. **Cleaning chemicals**, **equipment** and **methods** should be closely supervised by IP Practitioners, Unit Managers and Link Nurses.

8. **Keep the patient's relatives and visitors informed**, especially regarding hand hygiene upon entering and leaving the room. Although patient contact should be discouraged, PPE does not have to be worn.

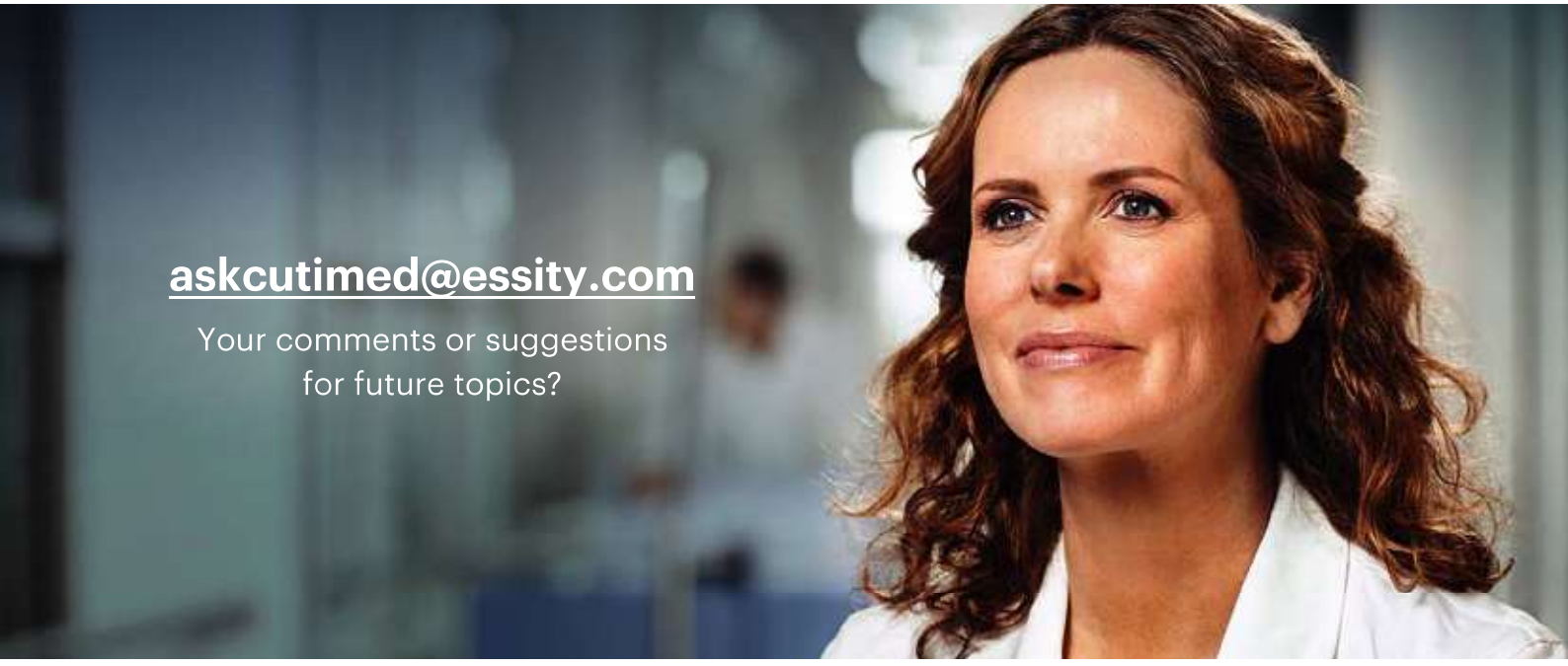
9. **Receiving facilities** should be informed of the patient's status prior to transfer.

10. **Screening and surveillance**: Patients admitted to high-risk units or disciplines (e.g., ICU, cardiac, orthopaedic, oncology, etc.) should be screened for multidrug-resistant pathogens, according to laboratory protocols and current evidence-based guidelines. If electronic records permit, colonised and septic patients should be tagged on the system as an alert.

Information on local disease patterns, trends in antimicrobial resistance (provided by the microbiology laboratory and internal statistics from the IPC department), and antimicrobial usage (pharmacy) is essential to support clinical decisions and to guide the development of treatment guidelines so that they reflect infection and resistance patterns.

Thousands of years ago, the soil in the Boho Highlands in Fermanagh, Northern Ireland, was used to treat infections. With the looming threat of antibiotic-resistant bacteria, more researchers are investigating whether these old stories have any truth to them. Soil from this area has recently been re-examined, looking for signs of the presence of *Streptomyces* bacteria, which are well known for producing antibiotics. A new strain of *Streptomyces* has been discovered (named *Streptomyces myrophorea*) and has been found to be effective at killing several pathogens on the World Health Organization and Centers for Disease Control priority lists. These include carbapenem-resistant *Acinetobacter baumannii*, which is listed as critically threatening, Vancomycin-resistant *Enterococcus faecium* (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA) *and Klebsiella pneumoniae*.

Source: Frontiers in Microbiology 16th October 2018. https://www.frontiersin.org/articles/10.3389/fmicb.2018.02458/full



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1. American Association for Clinical Chemistry: Lab Tests On Line: Available from https://labtestsonline.org/articles/antibiotic-resistance-bacteria **2.** Multidrug-Resistant Gram-negative Organisms (MDRGNO's): Information for Healthcare Workers. Jnl. of Hospital Infection Vol 92; 2016 http://dx.doi.org/10.1016/j.jhin.2015.08.011 **3.** Smith, P. (2008) Making sense of multidrug resistant organisms. Professional Nursing Today Vol. 12; No 5. Sept/Oct 2008.