

MAY 2018

## SYNERGISING MEDICAL MICROBIOLOGY, PATIENT SAFETY AND CLINICAL PRACTICE

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With the MOM series well underway now with this third edition, it is hoped that these fact sheets are reviving your interest in the microbiological aspects of infection prevention and control! The objective is to create better insight into the clever pathogenic and survival strategies used by micro-organisms, backing the rationale for the practical measures which should be implemented at patient level to prevent and/or contain their spread.

### KEY TERMS AND CONCEPTS:

contact transmission, hand hygiene, opportunistic, pathogen, virulence, quorum sensing, biofilm.

With **World Hand Hygiene Awareness Day on 5th May**, the accent this month is on **contact transmission** and the well-known gram-negative bacterium **Pseudomonas aeruginosa** [*Soo' doe' moan-as airoo-ginosa*'] which is commonly encountered in moist environments and highly exuding wounds.

*Pseudomonas* is a large and diverse species – '*aeruginosa*' is from the Latin word meaning "copper rust", which refers to the characteristic blue-green colour and sickly-sweet odour of *Pseudomonas* laboratory cultures from the production of the metabolite 'pyocyanin'. 'Pyo' is also a reference to pus.

This micro-organism is found everywhere however it is also an '**opportunistic pathogen**', implicated in several healthcare associated infections (HAI) such as septicaemia, bronchopneumonia, necrotizing enterocolitis, urinary and wound infections in critically ill and immunocompromised patients. For example, premature neonates, ICU and burns patients and/ or those receiving cortico-steroid and /or cytotoxic chemotherapy, diabetics and patients living with HIV.

An important **virulence strategy** used by *Pseudomonas aeruginosa* is the production of **biofilm**, which facilitates the attachment of these bacteria to medical devices and provides protection from the immune response, antimicrobial agents (E.g. antibiotics) and adverse environmental conditions.



**'Quorum sensing'**: is a revolutionary discovery, whereby bacteria use a complex series of chemical signals to communicate with each other to coordinate the formation of biofilm, invasive infective processes, movement and calculation of their total numbers!

**This organism is resistant to many antibiotics** – although it may initially be susceptible to some cephalosporins, aminoglycosides, quinolones and carbapenems; repeated or indiscriminate antibiotic use may induce the production of the bacterial exotoxins ‘extended spectrum beta lactamase’ (also referred to as ESBL positive) and carbapenemase - enzymes which destroy the chemical structure of these antibiotics rendering them completely ineffective. *In this instance, it is recommended that a medical microbiologist be consulted regarding the treatment of patients with an infection caused by Pseudomonas aeruginosa.*



## CONTACT TRANSMISSION OF MICROORGANISMS

**All microorganisms are spread by the contact route** - either directly by hands or indirectly via contact with contaminated surfaces and shared patient care equipment.

### **‘Bare below the elbows’–**

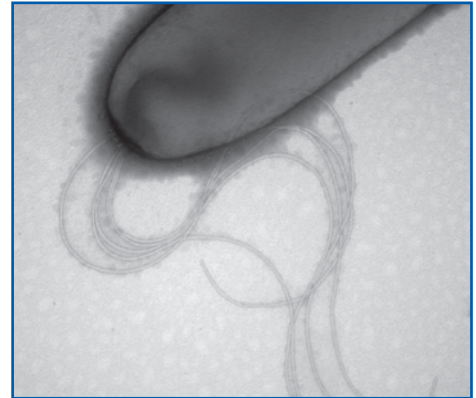
- The wearing of jewellery and watches should not inhibit the ability of the healthcare worker to perform correct hand hygiene.
- Wearing rings increases the carriage rate of gram-negative bacteria and faecal bacteria on the hands of HCW's.
- HCW's who wear nail polish, artificial and/or gel nails are more likely to harbour gram-negative pathogens on their fingertips, both before and after hand washing.

### **Give germs the rub!**

- The use of alcohol-based hand sanitizers on visually clean hands results in a much greater reduction of microorganisms than washing with soap and water.
- They demonstrate excellent broad spectrum germicidal activity against vegetative bacteria (including multidrug-resistant pathogens) and a variety of fungi.
- It only takes 20-30 seconds to decontaminate hands with an alcohol-based sanitizer, which is also less irritating and drying than soap and water.
- Alcohol-based hand sanitizers containing between 60–80% alcohol are the most effective

## DID YOU KNOW?

**All wounds are colonised** with forty or more different microbial species. Colonisation describes the presence of multiplying microorganisms, with no adverse effects or host immune response - it is an entirely normal phenomenon and is referred to as the wound ‘microbiome’.



An electron micrograph illustrating the **flagellae** of Pseudomonas species. A flagellum (single) or flagellae (multiple) are a characteristic of gram negative bacteria, and are long, protein fibres anchored either at one end of the bacterium, or they may even cover the whole bacterial cell. Flagella/e are many times the length of the cell and enable movement and escape from phagocytic neutrophils.



Laboratory culture plates illustrating the characteristic blue-green colonies of Pseudomonas aeruginosa, as well as the ‘zones of inhibition’ produced by the antibiotic impregnated discs.

The pH of the wound directly influences all biochemical reactions which take place during the process of healing. Research has proven that a slightly acidic pH helps to control infection, increase antimicrobial activity, oxygen release, protease activity and angiogenesis. However, **in wound infection** caused by *Pseudomonas aeruginosa*, the growth and multiplication of this and other gram-negative wound pathogens will induce an alkaline wound pH and **promote biofilm formation** – especially in the presence of high exudate levels and occlusive dressings which are not changed frequently enough.

### Biofilm busting and reducing antiseptic agents

#### 1. Polihexanide (Polyhexamethylene biguanide or PHMB)

combined with a surfactant detergent cleanser is a non-cytotoxic antiseptic which disrupts lipoproteins in biofilm, interferes with chemical signalling ('quorum sensing') and slows biofilm regrowth.

2. **Acetic acid** in 1% and 5% solutions (the active component in vinegar) is widely used to reduce the wound pH. However, the duration of this local effect appears to be limited, therefore more success using once daily 5% acetic acid 'soaks' to eradicate *Pseudomonas aeruginosa* has been reported.

3. **Hypochlorous acid (HOCl)** exerts a microbicidal effect against a wide spectrum of bacterial, viral and fungal pathogens. Its action mimics the impact of normal neutrophil activity in the wound whereby hydrogen peroxide is produced and converted to HOCl in the presence of chlorine and hydrogen ions in the exudate.

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### YOUR COMMENTS OR SUGGESTIONS FOR FUTURE TOPICS?

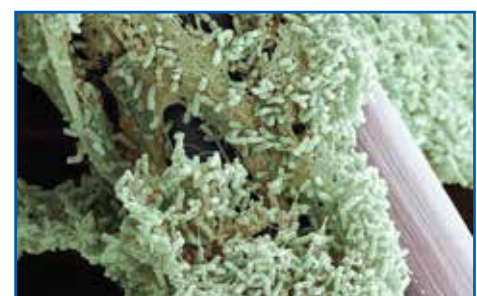
[askcutimed@bsnmedical.com](mailto:askcutimed@bsnmedical.com)

### COMMON RESERVOIRS WHERE YOU WILL FIND PSEUDOMONAS AERUGINOSA

- Chronic wounds, especially those which produce copious exudate. E.g. Deep burns and venous stasis ulcers
- Water sources – taps, shower heads, hand basins
- Bed bath basins stored wet
- Antiseptics and disinfectants decanted from bulk containers
- Liquid soap dispensers which have been 'topped up'
- Intravenous solutions contaminated by repeated access
- Humidifiers in ventilators, incubators
- Haemodialysis effluent points
- Reusable suction bottles



A venous stasis ulcer infected with *Pseudomonas aeruginosa*



An electron micrograph image depicting a *Pseudomonas* biofilm. **Biofilm** is a protective, complex three-dimensional structure comprising extracellular polysaccharides embedded in a thick slimy blanket of sugars and proteins.