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Microbe of the month

Breaking The Chain of Infection

MAY
2024
NEWSLETTER
Compiled by
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IPC Consultant

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FEATURED THIS MONTH:

Pseudomonas aeruginosa

Featured for World Hand Hygiene Day 5th May 2024

10-minute read + QUIZ

Hello readers!

Microbe of the Month aims to provide a concise clinical resource, to help you keep up to date about pathogens of importance, in an easy-to-read and understand format.

Each issue covers the aetiology (sources) and epidemiology of topical bacteria, viruses, or fungi - their mode/s of transmission and the infections they cause; alerts on any antimicrobial resistance (AMR) capability they may have, and the relevant Infection Prevention and Control measures which should be routinely implemented for the safety of patients and healthcare personnel.

There is a quick quiz at the end of the newsletter to test your grasp of the content – please use this newsletter as a teaching tool in your workplace and start an 'infectious dialogue' about topical issues in infection control!

With **World Hand Hygiene Awareness Day** on **5th May**, this month's focus is on **contact transmission** and the well-known Gram-negative bacterium ***Pseudomonas aeruginosa***.

This microorganism is found everywhere in the environment, and is considered to be the kingpin of '**opportunistic pathogens**', which means that it exploits breaks in immune defences to cause infection. **It is among the 'top four' most commonly-isolated nosocomial bacteria** implicated in a variety of healthcare-associated infections (HAIs), such as septicaemia, bronchopneumonia, necrotising enterocolitis, and bone, joint, urinary and wound infections; especially in critically ill and immunocompromised patients; e.g., premature neonates, diabetics, ICU, cystic fibrosis and burn patients, and those receiving corticosteroids or cytotoxic chemotherapy. [1,2]

⚠ *Pseudomonas aeruginosa (P. aeruginosa)* also readily develops resistance mechanisms to antiseptics and multiple classes of antibiotics. [1-3]

Key words: *reservoir, mode of transmission, biofilm, immune-compromised, opportunistic pathogen, healthcare associated infections (HAIs), pandrug-resistant (PDR), infection prevention and control (IPC).*

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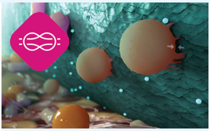
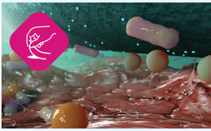
Bind:
Bacteria naturally bind and anchor to the unique Sorbact surface.



Inhibit:
Bacteria are irreversibly bound, and growth is inhibited. Development of bacterial or fungal resistance is not expected.



Remove:
Bound bacteria, fundi and endotoxins are removed.

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RESERVOIRS AND MODES OF TRANSMISSION [2-5]

Within the healthcare setting, there are numerous reservoirs which provide ideal conditions for the growth and transmission of *Pseudomonas aeruginosa* (*P. aeruginosa*).

It is also constantly reintroduced into the hospital environment on plants, fruit and vegetables, as well as by visitors and patients transferred from other facilities.

This is why fresh flowers and pot plants are prohibited in critical care units, as well as salads, non-peelable fruit, vegetables and ice machines in haematology and transplant units.

Cross-infection occurs from patient to patient via the unwashed hands of hospital personnel ('direct contact'), via 'indirect contact' with contaminated surfaces and reservoirs, or by the ingestion of contaminated foods and water.

Common reservoirs where you will find *P. aeruginosa*

- Water sources – taps, shower heads, hand basins, hydrotherapy baths, mops and cleaning equipment.
- Plastic basins and receptacles (stored wet).
- Antiseptics and disinfectants decanted or 'topped up' from bulk containers.

- Intravenous solutions contaminated by repeated access or used as diluent for multiple patients.
- Humidifiers in ventilators and incubators.
- Haemodialysis effluent points.
- Reusable suction bottles.
- Chronic wounds, especially those with high exudate levels (e.g., deep burn injuries, and pressure and venous stasis ulcers).

PATHOGENESIS AND VIRULENCE OF *Pseudomonas aeruginosa* [3,6]

Its nutritional needs are simple, and it is tolerant of a wide variety of physical conditions, including ambient temperature. Although viable at temperatures ranging from 4°C - 42°C, the optimum temperature for the growth of *P. aeruginosa* is 37°C (body temperature).

P. aeruginosa is also a ‘facultative anaerobe’, which means it can adapt to, and proliferate in, conditions of partial or total oxygen depletion.

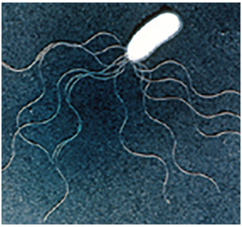
The first step in the infectious process is adherence of the microbe to host tissue, which enhances the capacity of the organism to produce disease.

- The ability of *P. aeruginosa* to invade tissue is derived from the production of extracellular enzymes and cytotoxins which break down physical barriers and damage host cells, while its **bacterial capsule** or **slime layer** effectively protects it from the host’s immune defences, such as antibodies or phagocytosis by leukocytes.

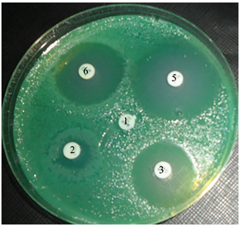
- Another important virulence strategy used by *P. aeruginosa* is the production of **biofilm**, which facilitates the attachment of these bacteria to plastic surfaces, medical devices and wounds. The 3-dimensional structure of biofilm provides protection from the immune response, antimicrobial agents (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, their motility, and density in comparison to other species! *Pseudomonas* species in particular are known to use quorum sensing to gain a competitive advantage over other microbial species. [6]

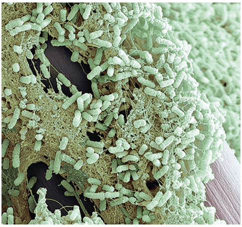
Pseudomonas is a large and diverse species... *'aeruginosa'* is derived from the Latin word meaning 'copper rust', describing the characteristic blue-green colour of *P. aeruginosa* colonies, and sickly-sweet odour from the production of the metabolite 'pyocyanin'. 'Pyo' is also a reference to pus.



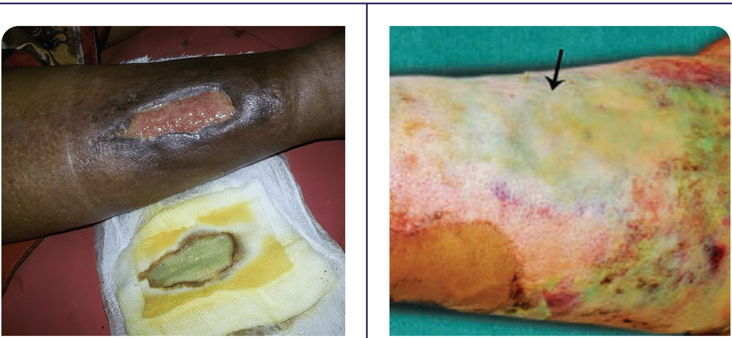
Scanning electron microscopy image of *P. aeruginosa's* 'whip-like' flagellae which aid its attachment, motility and escape from phagocytic neutrophils.



Laboratory culture plate illustrating the characteristic slimy blue-green colonies of *Pseudomonas aeruginosa*.



Scanning electron microscopy image of *P. aeruginosa* biofilm on the fibres of a gauze dressing.



Chronic and heavily exuding wounds (such as venous stasis ulcers and full thickness burns) are prone to infection with *Pseudomonas aeruginosa*.
Note the characteristic blue-green exudate (caused by the pigment pyocyanin).

SAFE
DISEASE
SANITATION
OCTOBER 15
NAILS
PERSONAL
BEFORE EATING FOOD
PREVENTION
HANDLING
CHEMICAL
WIPES
GELS
CLEANER
FINGERS
SOAP
CONTROL
HEALTH
PETS
TOUCHING
FREQUENT
PUBLIC
STAY HEALTHY!
ANTIOXIDANT
FOAM
PALM
SICK
RUB
GELS
CLEANING
DIRTY
BACTERIA
TOWEL
FAUCET
INFECTION
HANDWASHING
CHEMICAL
HYGIENE
AIR DRY
FOAM
DANGER
ALCOHOL BASED
LATHER
WARNING
HANDWASHING
PROTECTION
PROCEDURE
RUNNING WATER
PUBLIC HEALTH
PEOPLE
MICROBES
ANTISEPTIC
CARE
DISPENSER
HANDSOAP
METHODS
RINSE
BASIN
DRY
HEALTH
BACTERIUM
ALCOHOL
AFTER TOILET
NaOH
SOAP
PREVENT
PRESERVATION
SANITIZERS
TOILET
SNEEZE
GERMS
VIRUSES
SEPTIC
INFECTIONS
EFFECTIVE
LEARN
DESTROY
INGREDIENTS
GARBAGE
LATHER
WASTE
HYGIENE
SAVE
DRY
DISEASE
DANGER
WASH
HANDS
SICK
LIQUID SOAP
MICROBES
IMPORTANT
KILL
DISINFECT
VIRUS
WASHING
RUB
WC
FOAM
BASIN
SANITIZER
FAUCET
CLEAN
WATER
HYGIENE
ANTIBACTERIAL
SODIUM HYDROXIDE
AGENTS
DIRT
GERMS
BATHROOM
ILLNESS

P. aeruginosa is easily transmitted and notorious for its resistance to antibiotics, and is therefore a particularly dangerous and dreaded pathogen in both the acute and long-term care settings.

A hospital reported an outbreak of *P. aeruginosa* in its intensive care unit (ICU), affecting five patients and causing three deaths. The healthcare-associated infections (HAIs) comprised central line-associated blood stream infections (CLABSI) and ventilator-associated pneumonia (VAP), occurring along a timeline of approximately 2-5 days between laboratory confirmation of each infection.

Predisposing patient risk factors:

- Critical clinical condition
- Invasive devices
- HIV positive status (3/5 patients)
- Length of stay

Infection prevention and control (IPC) assessment: The principles of an initial assessment are usually based upon the patients' risk profiles, and the known reservoirs and mode/s of transmission of the pathogen involved. Although colonisation usually precedes infection by *P. aeruginosa*, the source and mode of transmission of this pathogen are often initially unclear, because of its ubiquitous presence in the environment. Since *P. aeruginosa* thrives in moisture-rich environments and is spread via 'direct contact' as well as 'indirect contact' transmission, **the following aspects should undergo immediate scrutiny**:

- Enforcement of the 'bare below the elbows' policy; i.e., the wearing of long sleeves, rings, acrylic nails, wristwatches and/or cultural/religious apparel should be prohibited.
- Hand hygiene before and after patient contact; or after contact with the patient's immediate care environment (i.e., surfaces).
- Is alcohol-based hand rub used frequently in between clean tasks?
- Are the liquid soap dispensers a 'closed system' or are they 'topped up'?
- Are standard precautions implemented for all patients irrespective of their diagnosis, suspected or confirmed infectious state; and appropriate PPE (e.g., disposable plastic aprons, gloves and visors) used for anticipated exposure to body fluids?
- Are there breaches in the handling and disposal of used linen and its interim storage?
- Healthcare risk waste and dressing disposal, and interim storage.
- Is cleaning and environmental disinfection appropriate (e.g., 'high touch' surfaces such as stethoscopes, monitors, bedrails, lockers, cardiac trolleys, intravenous therapy equipment, light switches, door handles, etc.)?
- How are 'non-critical' items of equipment cleaned and stored in between use (e.g., plastic basins and measuring receptacles)?

A significant outbreak investigation finding!
A spot check on the sluice room in the ICU revealed that the plastic bathing basins were not correctly stored or inverted after cleaning to promote air-drying; i.e., they were stacked inside one another and were therefore still 'wet' when reused.

Infection prevention and control actions implemented
Stainless steel basins were purchased and clearly marked with bed numbers. Twice as many basins available vs the total number of ICU beds enabled the storage of a basin at its designated bed, whilst the spare basins were stored (inverted) on a designated stainless-steel rack in the sluice room. **The use of plastic basins was immediately discontinued**.

DID YOU KNOW?

Mupirocin (Pseudomonic acid A) is an antibiotic produced by *Pseudomonas fluorescens*, which has a high level of activity against staphylococci and streptococci bacteria.

Mupirocin is used as an intranasal antibiotic to treat patients and healthcare workers who are colonised with **methicillin-resistant *Staphylococcus aureus* (MRSA)**. [7]

THE BIOFILM-BASED APPROACH TO WOUND INFECTIONS CAUSED BY *P. aeruginosa* [8,9]

***Pseudomonas* species thrive in moisture-rich environments; therefore, venous stasis ulcers, stage 2-4 pressure injuries and deep burn wounds are vulnerable to infection if slough and exudate levels are not actively managed.**

Polymicrobial (multiple species) **biofilms are present in chronic wounds** – microscopic structures which cannot be seen with the naked eye. With advances in molecular technology, however, it is now widely recognised that biofilm structures have a negative impact on healing, so the active management of biofilms should be integral to any wound infection treatment plan.

Clinical signs of biofilm activity:

- ✓ Delayed healing despite optimal wound management and support of underlying patient comorbidities
- ✓ Failure or recalcitrance to appropriate topical and/or systemic antimicrobial treatment
- ✓ Increased wound exudate/moisture
- ✓ Low-level chronic inflammation
- ✓ Low-level erythema
- ✓ Poor granulation or friable, bleeding hypergranulation
- ✓ Covert signs of infection

The growth and multiplication of *P. aeruginosa* is likely to induce an alkaline wound pH and promote biofilm formation – especially in the presence of high exudate levels and occlusive dressings. **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 rebalance wound flora, increases antimicrobial activity, oxygen release, protease activity and angiogenesis. [8,9]

Biofilm-busting and pH reducing strategies [8,9]

1. **Debridement** converts a chronic or 'stalled' wound to an acute wound by removing non-viable tissue which stimulates inflammation and microbial growth. It reduces the 'barrier to healing' caused by biofilm and a high bioburden, and helps the wound to progress out of a prolonged inflammatory phase and into the ***proliferative phase***. Senescent cells (which have stopped dividing and are non-responsive to growth factors and cytokines) are also removed, making way for healthy, responsive cells.

2. **Polyhexamethylene biguanide** (a.k.a. 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.

3. **Acetic acid 1% solution** (the active component in vinegar) is widely used as a cleanser and wound 'soak' to reduce wound pH and eradicate *P. aeruginosa*.

4. **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.

5. **Dressings** should be selected for their proven fluid handling capacity (even under compression), and ideally, be able to sequester (contain or isolate) microorganisms and harmful proteases away from the wound bed, to hinder the cyclical inflammatory process which delays healing.

The US Centers for Disease Control and Prevention (CDC) recently identified a multistate outbreak of extensively drug-resistant (XDR) *P. aeruginosa* eye infections associated with 'artificial tears' in multi-use eye drop bottles.
This is the first time the carbapenem-resistant outbreak strain (i.e., Verona integron-mediated [VIM] metallo-β-lactamase and Guiana extended-spectrum-β-lactamase [VIM-GES-CRPA]), has been reported. [10]

The emergence of MDR/XDR bacteria has led to the revival of older antibiotics, with colistin being a good example. In pandrug-resistant (PDR) *P. aeruginosa* infections, colistin is often used in synergistic combinations with other antibiotics (i.e., their combined effect is greater than the sum of the effects seen when each drug is given alone).

Pandrug-resistance (PDR) is defined as non-susceptibility to all agents in all antimicrobial categories (i.e., the bacterial isolates are not susceptible to any clinically available drug). The prevalence of PDR bacteria is difficult to judge as isolates are rarely assessed against all possible antibiotics; however, PDR Gram-negative bacteria have been reported in more than 20 countries across all continents of the world. The mortality rate in patients infected with these bacteria is considered to be at least 50-70%. [1,11]

Liaison with a medical microbiologist is recommended when prescribing antimicrobial agents for drug-resistant isolates.

THE BOTTOM LINE... [2,3,5,6,7]

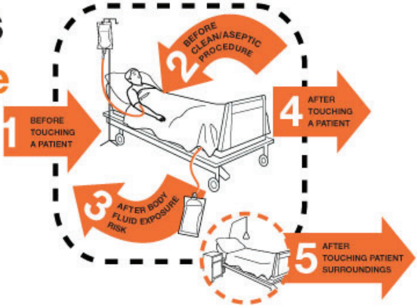
Infection Control
healthcare
investigation
health
sterilization
disinfection
setting
isolation
workers
years
hand
Standardization
training
health care
practice
factors
Precautions
Similarly
practiced every
healthcare-associated
washing
interruption
technique
title equipment
monitoring
hygiene/hand
underrecognized
adopted
available
provide
experience
exam
procedures
preventing
protection
particular
patient-to-patient
discipline
must
invasive
outbreaks
staff
herb
whole
sub-discipline
among-staff
undersupported
demonstrated
prevention
epidemiology
care
hospital
nosocomial
suspected
key
public
septic
infrastructure

- **Standard Precautions** apply to all patient care, regardless of the patient's suspected or confirmed infectious state, and apply to all settings where care is delivered (these practices protect healthcare personnel and prevent healthcare personnel or the environment from transmitting infections to other patients). [4,5]
- **Hand hygiene is the single most important measure to prevent the spread of ALL types of microbes.**
    - > Jewellery and watches get in the way of performing hand hygiene correctly.
    - > Wearing rings also increases the carriage rate of Gram-negative bacteria on the hands of HCWs.
    - > HCWs who wear nail polish, acrylic and/or gel nails are more likely to harbour Gram-negative pathogens such as *P. aeruginosa* on their fingertips, both before and after hand-washing.
    - > An alcohol-based (60-80%) hand sanitiser is the preferred method for sanitising your hands when they are not visibly dirty. [4,5,12]
- **Glove use is NOT a substitute for hand hygiene** – dirty gloves contaminate your hands when they are removed. Always wash or sanitise your hands after removing gloves. [4,5,12,13]
- Practice **strict aseptic technique** for invasive procedures such as vascular and urinary catheterisation, injections and intravenous therapy, and wound care. [4,5,10,12]

- **Prioritise contact transmission prevention measures** with ongoing orientation, training and constant supervision of hand hygiene, the correct donning and doffing of PPE, environmental cleaning, and used linen and waste management. [4,5,12,13]
- Actively manage heavily exuding wounds with biofilm-active wound cleansers and antimicrobial (not antibiotic) dressings that have good fluid handling capacity, and change dressings timeously. [8,9]
- Detergent-based sodium hypochlorite disinfectants with proven efficacy against Gram-negative pathogens should be used for the routine cleaning of non-critical care equipment and environmental surfaces; and 'high touch' points should be disinfected at least twice daily. [4,5]

Your 5 Moments for Hand Hygiene

1 BEFORE TOUCHING A PATIENT
2 BEFORE CLEAN / ASEPTIC PROCEDURE
3 AFTER BODY FLUID EXPOSURE RISK
4 AFTER TOUCHING A PATIENT
5 AFTER TOUCHING PATIENT SURROUNDINGS


1 BEFORE TOUCHING A PATIENT
2 BEFORE CLEAN/ASEPTIC PROCEDURE
4 AFTER TOUCHING A PATIENT
3 AFTER BODY FLUID EXPOSURE RISK
5 AFTER TOUCHING PATIENT SURROUNDINGS

Supply the correct answer!

1. The term used to describe pathogens which exploit breaks in patients' immune defences is __________.
2. Common reservoirs which support the growth of *Pseudomonas aeruginosa* are those where __________ is present.
3. Biofilm enhances the ability of pathogens to__________to host tissue and cause disease.
4. Chronic and complicated wounds with high levels of __________ are prone to infection with *P. aeruginosa*.
5. 'Bare below the __________' is an important infection prevention concept to facilitate effective hand hygiene.

ANSWERS: 1. Opportunistic **2.** Moisture **3.** Adhere **4.** Exudate **5.** Elbows

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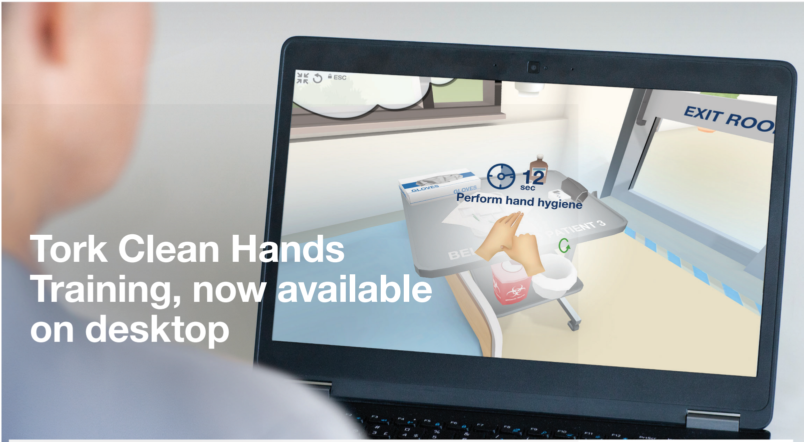

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Sorbact® Technology dressings can form a valuable part of your Antimicrobial Stewardship strategy[1]

Antimicrobial resistance is a heavy burden and optimal wound management is key in fighting it. Dedicated to improving wellbeing through leading hygiene and health solutions, Essity supports the Antimicrobial Stewardship initiative.

- **Sorbact® Technology dressings reduce the bioburden in wounds[2]**
- **Effective against the WHO's top 5 pathogens, as shown in-vitro[3]**
- **Using Cutimed® Sorbact® for acute and hard-to-heal wounds supports Antimicrobial Stewardship (AMS)[1] as part of a multi-modal approach, in line with the Best Practice Statement for AMS Strategies[4]**

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Average bacterial load reduction
-73.1 % 5

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Swab
Pansement interface
Gasa
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MANAGE INFECTION I GESTION DE L'INFECTION

- Sorbact® Technology dressings reduce the bioburden in wounds.[3]
- Effective against the Top 5 WHO (World Health Organisation) pathogens, as shown in vitro.[4]
- Can be used during the entire wound healing process.[2]

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Surgical site infection prevention

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- Up to 57% cost reduction of SSI when treating caesarean sections, using NHS cost model[2]
- Effective reduction of the bacterial burden in critically colonised or locally infected wounds[3]

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1) Stanirowski J, Bizon M, Cendrowski K, et al (2016b) Randomized controlled trial evaluating dialkylcarbomyl chloride impregnated dressings for the prevention of surgical site infections in adult women undergoing caesarean section. Surg Infect (Larchmt) 17(4): 427-35

2) Davies H, McMaster J, et al. Cost-effectiveness of DACC dressing to prevent SSI following caesarean section. Presented at Wounds UK, Harrogate, November 2018

3) Cutting K, Maguire J (2015) Safe bioburden management. A clinical review of DACC technology. Journal of Wound Care Vol 24, No 5

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