AMR - the link between antibiotic resistance and disinfectant resistance.

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A new discovery?

Bacterial resistance to biocides in the healthcare environment – Maillard J 2002
Antibiotic and disinfectant resistant bacteria - RJ Ash 2004
Disinfectants can make bacteria resistant to treatment – L Goodchild 2008
Disinfectants cause some bacteria to adapt and thrive – L S Staff 2009
Euro Commission SCENIHR, Assessment of the AMR effects of biocides – 2009
Is there a correlation between Antibiotic resistance and biocides – I Herruzo 2015
Mechanisms of increased resistance to CHG and cross resistance to Colistin – M Wand et al 2017
Increasing tolerance of hospital VRE's to alcohols – Pidot et al 2018

A big part of the problem?

EFSA and ECDC Scientific report on AMR 2013

EFSA explains AMR 2014

ECDC Europe's fight against AMR 2014

WHO Global Action plan on AMR 2015

ECDC Policy briefing AMR 2016

European Commission Flash Eurobarometer report AMR 2016

GLASS report 2022

WHO AMR Nov 2023

Recent Headlines AMR news

World leaders commit to decisive action on antimicrobial resistance

Global leaders have approved a declaration at the 79th UN General Assembly High-Level Meeting on Antimicrobial Resistance (AMR), committing to reducing bacterial antimicrobial resistance (AMR) by 10% by 2030

Antimicrobial resistance: now is the time to revisit global commitments

WHO Investment case deep dive: antimicrobial resistance

Pharmacies and use of antibiotics: a cross sectional study in 19 Arab countries

Lack of Knowledge of Antibiotic Risks Contributes to Primary Care Patients' Expectations of Antibiotics for Common Symptoms

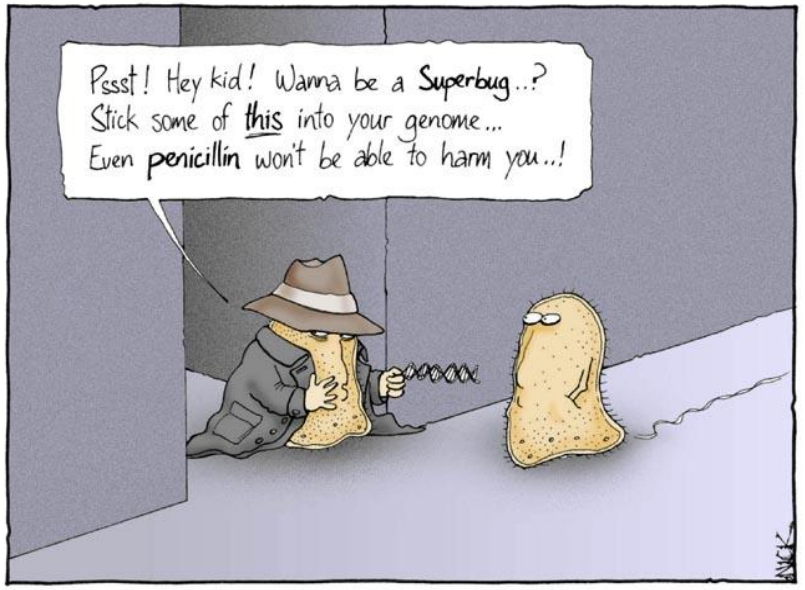
Acquired resistance

Key Strains 70% of EU fatalities

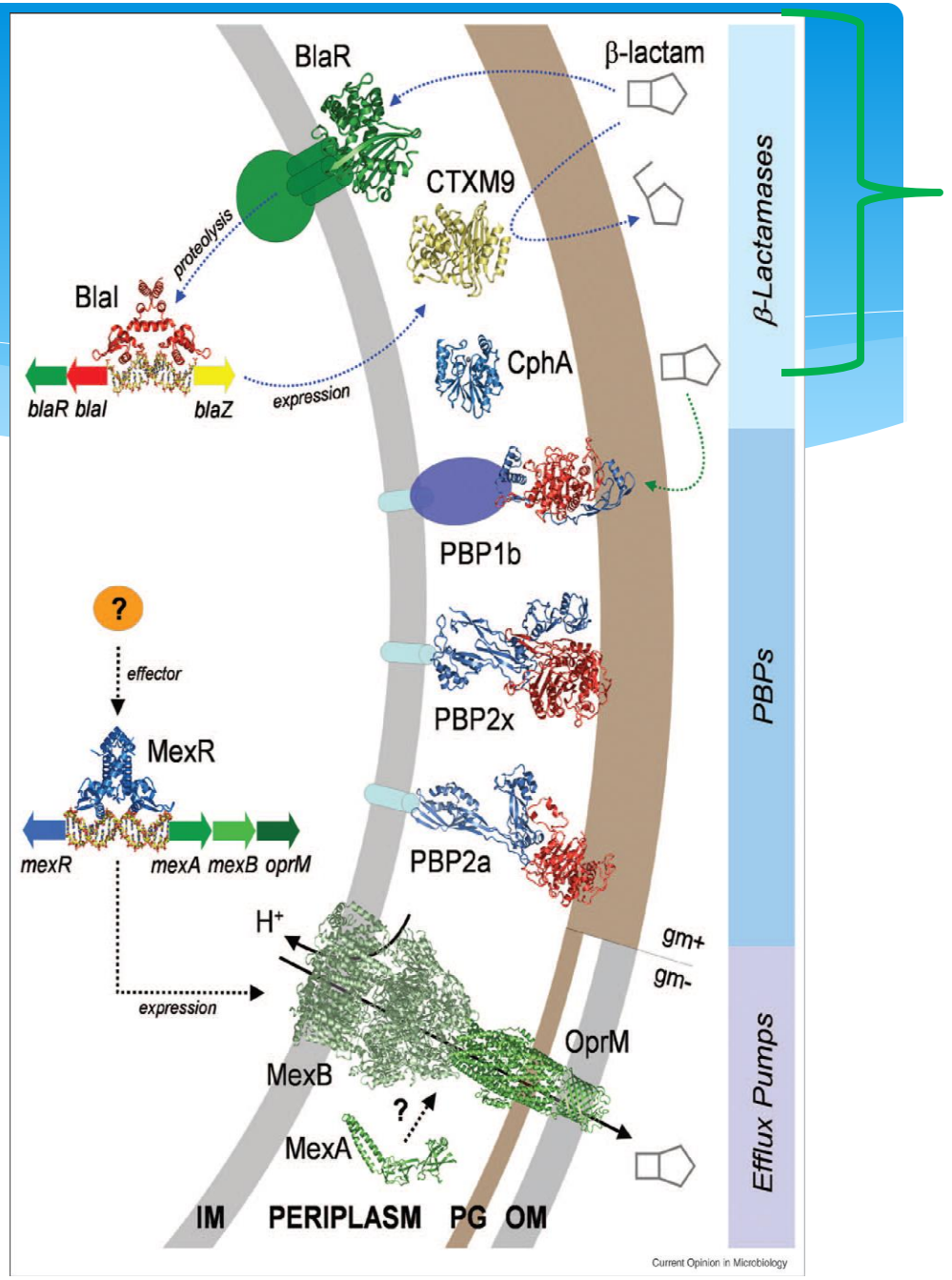
P. Aeruginosa

K. Pneumoniae

A. Baumannii



It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.



* Resistance genes are transferred through out the microbial community into clinically relevant strains

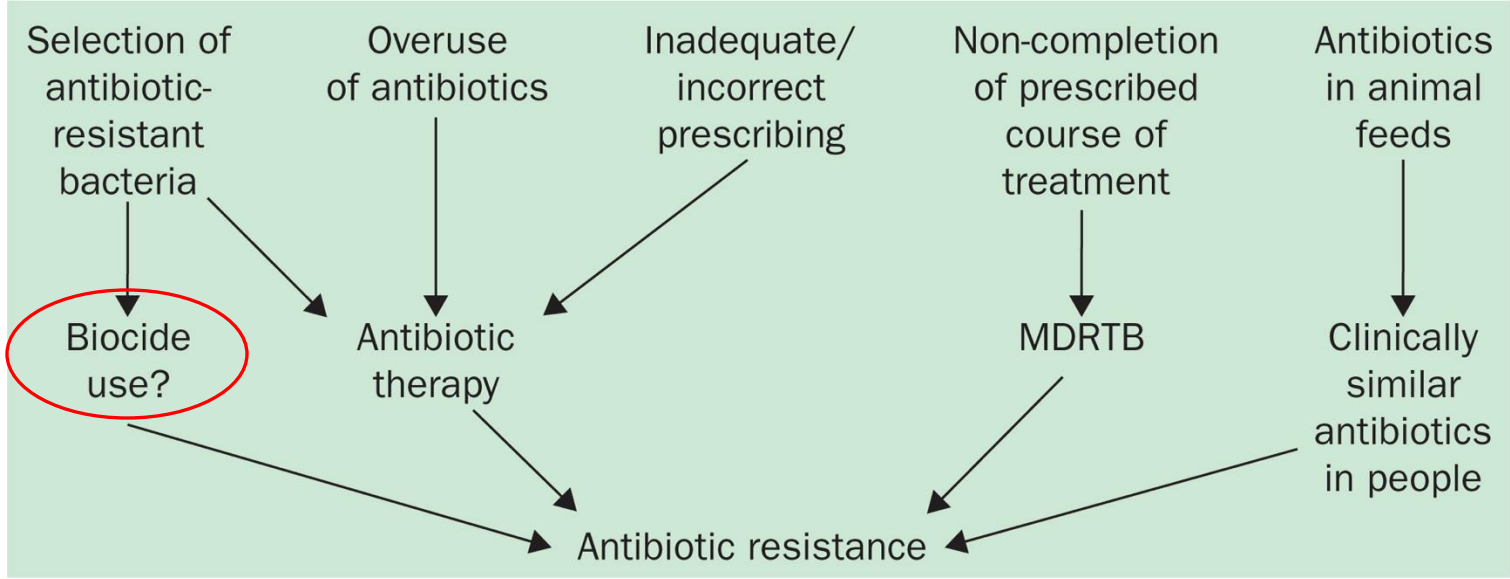
If interested see: Carbapenemases: the Versatile -Lactamases Clin Microbiol Rev. 2007 Jul;20(3):440-58.

Ways in which antimicrobial resistance can arise clinically.

The Problem

What are the mechanisms of resistance?

- Acquired resistance
- Intrinsic resistance



1. Russell, A. D. Biocide use and antibiotic resistance: the relevance of laboratory findings to clinical and environmental situations. The Lancet Infectious Diseases 3, 794-803, doi:https://doi.org/10.1016/S1473-3099(03)00833-8 (2003).

Microbial Resistance to Disinfectants

Except for prions, bacterial spores possess the highest innate resistance to chemical disinfectants.

Microorganisms may be protected from disinfectants by production of thick masses of cells and extracellular materials, or biofilms. Biofilms are microbial communities that are tightly attached to surfaces and cannot be easily removed.

Bacteria within biofilms are up to 1,000 times more resistant to antimicrobials than are the same bacteria in suspension.

3 physiological mechanisms allow bacteria to become resistant to antibiotics and disinfectants.

1. Prevention of interaction of the drug/ chemical with target.
2. Efflux of the drug/ chemical from the cell.
3. Direct destruction or modification of the drug/ chemical.

Possible 4th – Striptease? (Shedding of outer cell membrane in Gram –ve) Seen in antibiotic resistance, not yet reported in disinfectant resistance

Microbial Resistance to Disinfectants

Gram-negative bacteria possess an outer membrane that acts as a barrier to the uptake of disinfectants. Implicit in all chemical disinfection strategies is the consideration that microbial subpopulation controls the sterilization or disinfection time. Killing spores is clearly very difficult, testing for spores and then testing the efficacy of killing spores is even more difficult.

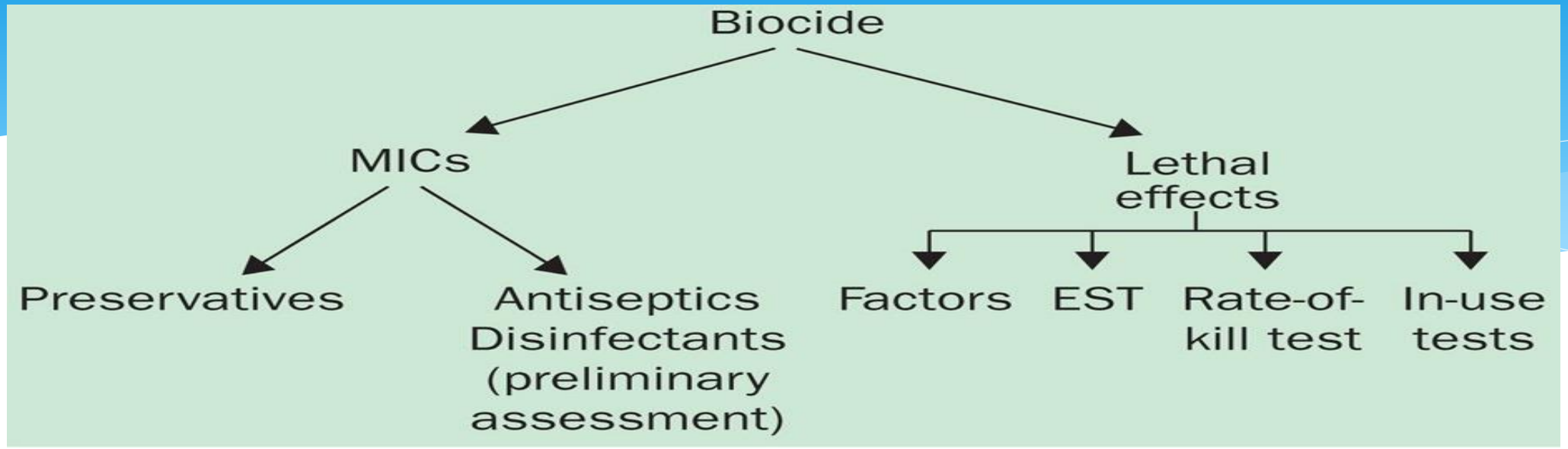
Viruses are usually found inside other living cells. Getting through those cell walls to kill them effectively is a very difficult challenge for disinfecting chemistries. Measuring efficacy of anti viral chemistries becomes even more difficult if the virus is protected by another cell wall. We therefore currently have no way of routinely, accurately testing efficacy of disinfectants against viruses.

In *fungi, a* ubiquitous resistance mechanism is the activation of membrane-associated efflux pumps, which recognize diverse chemicals enabling multidrug *resistance* (MDR). Two different *drug* efflux systems modulate azole *resistance*, the ATP-binding cassette (ABC) superfamily and the major facilitator superfamily (MFS).

Common links between antibiotic resistance and disinfectant resistance.

Antibiotic stewardship (over prescribing – food chain)	- Inappropriate use of biocides
Incorrect selection of antibiotic (?broad spectrum)	- Incorrect choice of disinfectant
Incorrect strength of antibiotic	- Incorrect PPM of disinfectant
Poor quality of lab culture/ PCR test result (NAD)	- Poor choice of test/ no test

Methods of testing the effectiveness of Biocides



Determination of antibacterial activity of biocides and antibiotics. MIC=minimum inhibitory concentrations. MBCs=minimum bactericidal concentrations. EST=European suspension test.

- Not always entirely relevant for all Biocides (**Silane versions of quaternary ammonium salts, show higher activities in dryer conditions) –** Standard EN tests were developed as “wet tests”

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Which Tests Do We Use To Detect surface Microbial Contamination?

Visual inspection – Not a single paper recommends this, and all testing against actual contamination levels has proved it completely inadequate for the task. Useful only for identifying areas of soiling.

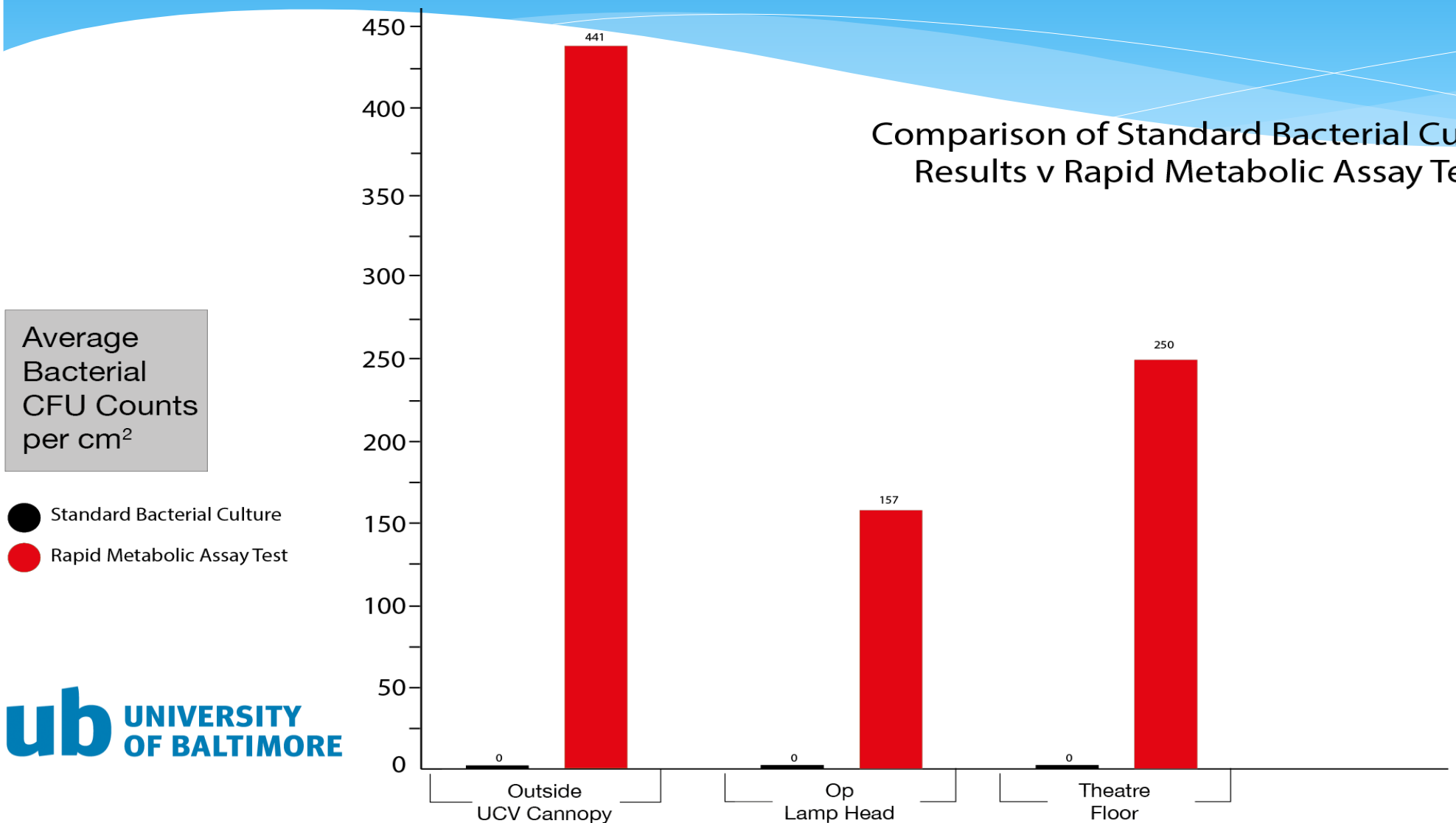
Total ATP – Numerous papers have looked at this, there is no correlation/ relationship between total ATP and levels of bacterial contamination.

Culture – 35% (average) of available bacteria grow. Impossible to count millions of individual bacteria. Human error (technically difficult to get a standard result). Difficult to grow when low number are present. False negatives (wrong media, low numbers present). Good for identifying species. Slow results.

PCR – 70% (average) available microorganisms can be identified. Specialist equipment not available everywhere. Expensive to purchase and non specific broad spectrum tests are expensive. False negatives. Good for identifying species. Faster results.

Metabolic (BSRMA) – 99%+ accurate, low to high numbers. Good for identifying total numbers of live bacteria but not species. Fast results in 3 - 5 mins

The graph shows the difference in bacterial colony counts using a standard culture media in an NHS laboratory versus the latest rapid metabolic assay test kit. The tests were undertaken in an NHS Hospital orthopaedic operating theatre after an annual high level disinfection team had completed their work.



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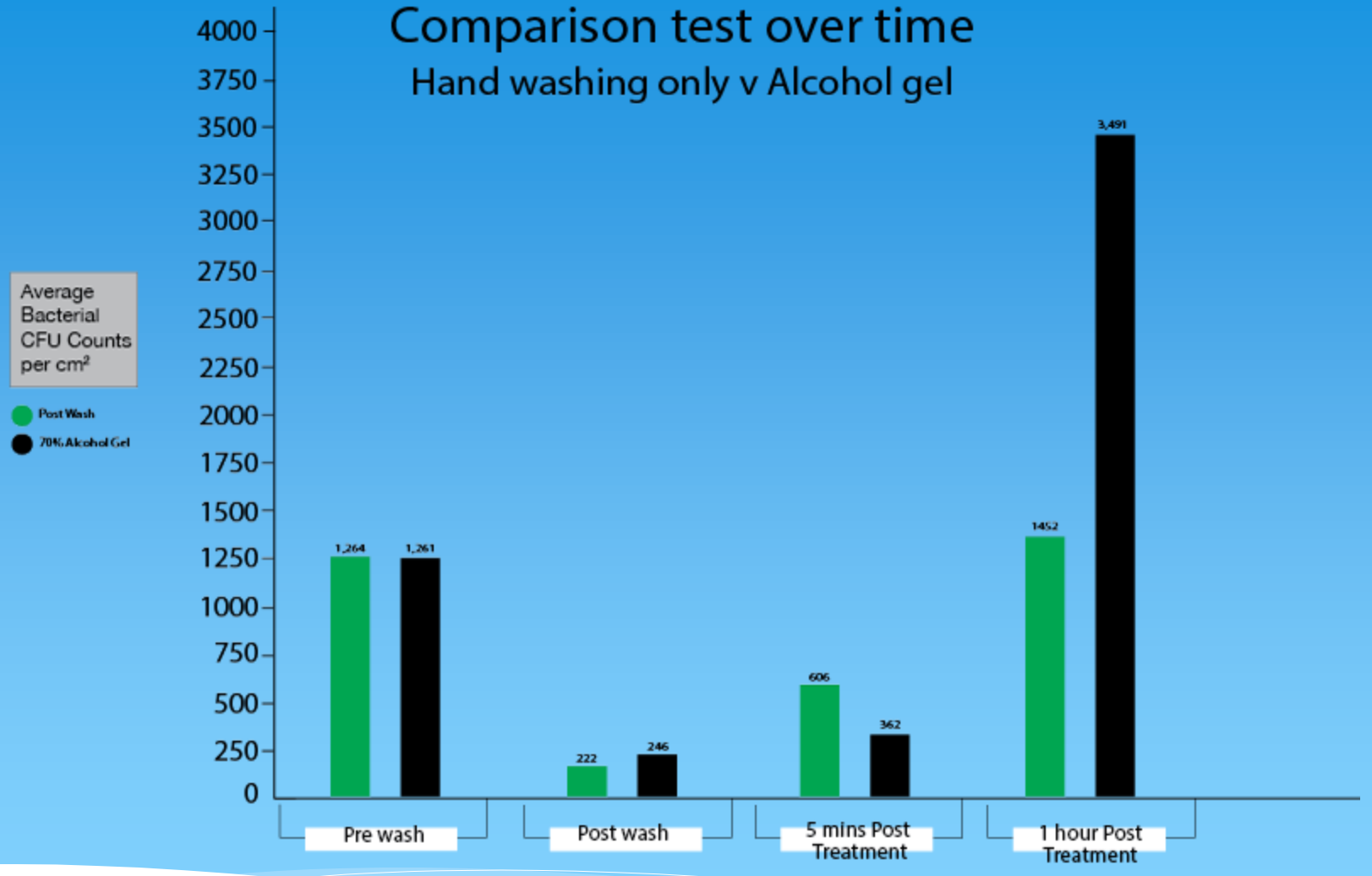

Average CFU counts from 200 hundred hands in each group

Common disinfectant chemicals and their resistance profiles

Sodium Hypochlorite (NP +)
Paracetic acid (NP +)
Ethyl/ Methyl Alcohol (NP +++)
Hydrogen Peroxide (NP +)
Chlorhexidine Gluconate (LP ++)
Chlorine (LP ++)

Quaternery compounds(QUATS) (LP +)
Silaine Quaternery compounds (SiQuats) (P +*)

UVC (NP 0)

P = Persistent
NP = Not persistent
LP = Limited persistence
+ = Low number of resistant bacteria
++ = Multiple resistant bacteria
+++ = Large numbers of resistant bacteria
* Does not apply to 5th Generation SiQuats which are (P 0)

Barriers to dealing with disinfectant resistance

Lack of understanding of how big the problem is.

No investment in new test methods for surfaces and skin, leads to no new investment in new disinfectants/ sanitisers.

Until we develop new tests, it is unlikely there will be much more development of disinfectants and skin sanitisers.

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