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Copper and Silver Water Treatment

Copper and Silver Ionisation effect on Pseudomonas

Pseudomonas Aeruginosa

False-coloured image of individual cells of P. aeruginosa (green) resting on the fibrous surface of a biofilm (purple) that helps protect cells beneath its surface. At top right, two cells incorporated within the biofilm peek out from a fissure in the film's surface.

Pseudomonas aeruginosa is a common biofilm-forming Gram-negative bacterium, often found in soil and ground water, which is implicated in diseases, especially of the lungs. It can, however, cause a wide range of infections in almost any organ or tissue, particularly in patients with a weakened immune system, such as cancer patients, newborns and those with severe burns, diabetes mellitus or cystic fibrosis (DH, Estates & Facilities, 2013). It is an opportunistic pathogen that rarely affects healthy individuals.

Pseudomonas is known to flourish particularly well where it has access to a higher level of oxygen and the temperature is between 11˚C - 44˚C, although some are able to multiply at just 4˚C.

P. aeruginosa is more difficult to control in water systems than Legionella. This is because Pseudomonas is a successful organism in terms of biofilm formation and colonisation, and evidence suggests that the presence of microorganisms within a biofilm substantially increases the problems associated with decontamination of those water systems. Unlike Legionella, Pseudomonas can infect patients directly via hospital workers touching a wound, for example, and by both staff and patients touching contaminated surfaces. P. aeruginosa is also commonly associated with antibiotic resistance.

As a direct result of the deaths of four neonates in Northern Ireland in 2012, an addendum to Health Technical Memorandum 01-04 (DH, England, 2013) was produced to advise National Health Service managers on how to deal with the presence of P. aeruginosa in augmented care units. The guidance was based on current expert opinion and limited scientific evidence (Walker and Moore, 2015), and was concerned with controlling and/or minimising the risk of mortality due to P. aeruginosa associated with water outlets.

An important source of P. aeruginosa contamination is biofilms (Bedford et al. 2012). A study by Quick et al. (2015) showed that plumbing components such as flow straighteners, shower rosettes, flexible hoses, solenoid valves and thermostatic mixer valves (TMVs) are particularly at risk of biofilm formation due to factors including surface areas, complex designs and inadequate pasteurisation. Their study confirmed the presence of P. aeruginosa in scrapings from a TMV from a shower room, and the species covered 95% of the base reference genome used in the study. Although most bacteria will remain fixed within biofilms, some will become detached resulting in free-floating or planktonic forms that can contaminate the water (DH, Estates & Facilities, 2013).

Copper and Silver Ionisation

Copper and silver ionisation is a relatively new modality for the control of Legionella, Pseudomonas and other pathogens in water systems. The use of copper and silver ionisation was first recorded in the USA in 1990 (Lin et al. 2011), although it was pioneered by NASA in the 1960s (Albright et al. 1967). The ProEconomy copper and silver ionisation system is known by its trade name Orca.

Copper and silver ionisation involves the generation of copper and silver ions in water by water flowing through a turbine of a flow sensor. This sends a signal to the control unit, which then passes a low DC current between two copper and two silver electrodes located in an electrode chamber. The current causes ionisation, i.e. the release of copper and silver ions into the flowing water. Being electrically charged the copper and silver ions seek opposite polarity and find this in the negatively charged sites on cell wall of bacteria, such as Legionella, Pseudomonas and E.coli. The ions distort and weaken the cell wall and then damage the cell by binding at specific sites to DNA, RNA, cellular protein and respiratory enzymes denying all life support systems to the cell, causing death.

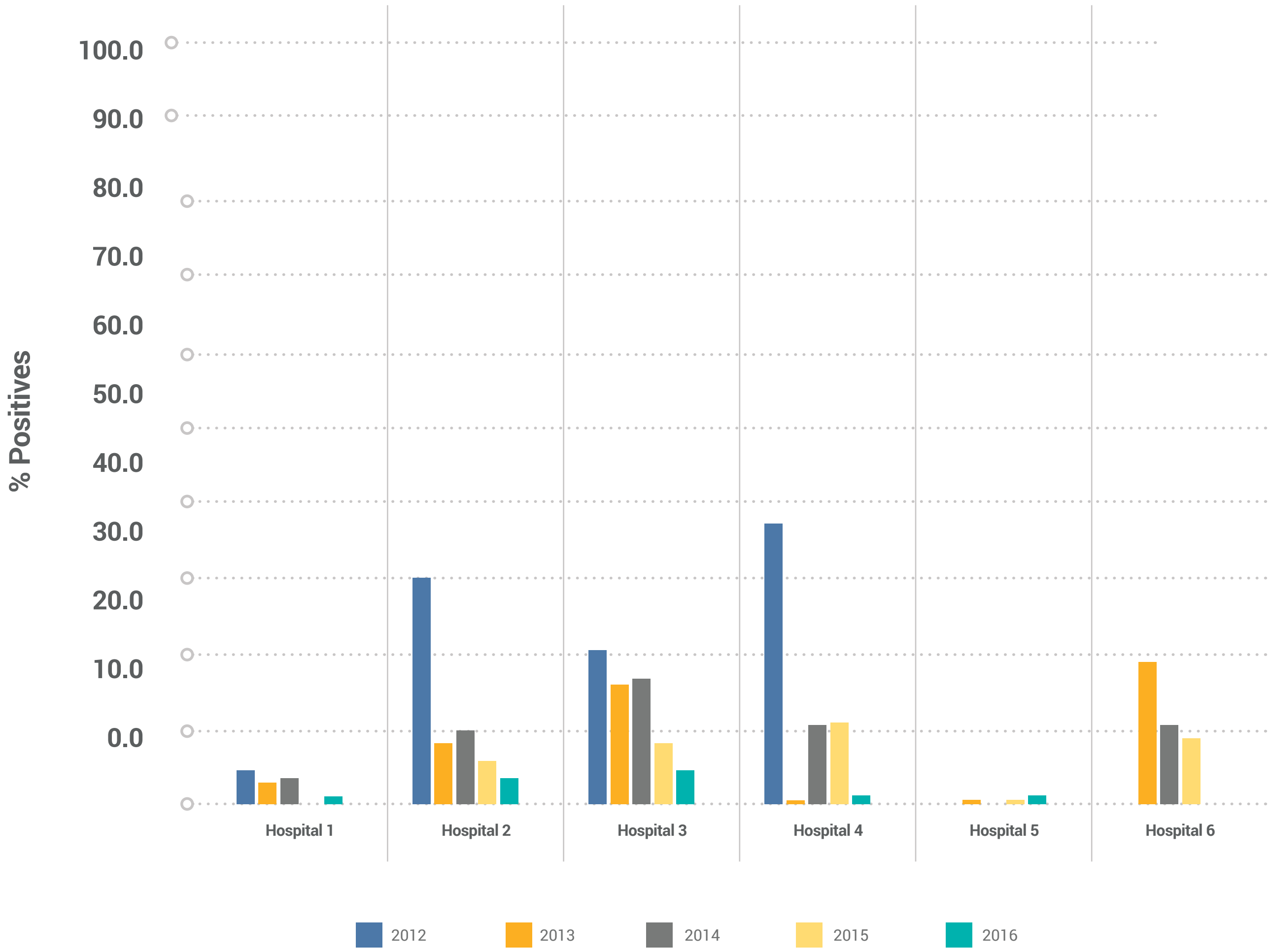
Controlling P. aeruginosa with Copper and Silver Ionisation

A study by Huang et al. (2008) showed that all copper ion concentrations tested, at the concentration applied to Legionella control, in their study (0.1–0.8 mg/L) achieved more than 99.9% reduction of P. aeruginosa which appears to be more susceptible to copper ions than S. maltophilia and A. baumannii. Silver ions concentration of 0.08 mg/L achieved more than 99.9% reduction of P. aeruginosa, S. maltophilia and A. baumannii, after 6, 12 and 96 h, respectively. A combination of copper and silver ions exhibited a synergistic effect against P. aeruginosa and A. baumannii, while the combination exhibited an antagonistic effect against S. maltophilia. They concluded that ionization may have a potential to eradicate P. aeruginosa, S. maltophilia and A. baumannii from hospital water systems.

ProEconomy has compiled data from seven UK hospitals using the copper and silver ionisation Orca system for pathogens control in water systems and table 1 shows the summary data. It can be observed that from a total of 6037 samples obtained from all hospitals over a five-year period, only 545 samples (9%) were contaminated with P. Aeruginosa.

Table 1 - Pseudomonas aeruginosa summary data for a 5-year period at 7 UK hospitals using the Orca System

Summary Table - Pseudomonas Aeruginosa - 7 hospitals				
Location	**Year**	**Samples taken**	**Positives**	**% positives**
Hosp 1	2012	39	2	5.1
	2013	97	3	3.1
	2014	51	2	3.9
	2015	59	0	0.0
	2016	49	1	2.0
	Total	**295**	**8**	**2.7**
Hosp 2	2012	307	92	30.0
	2013	442	34	7.7
	2014	451	48	10.6
	2015	223	14	6.3
	2016	502	23	4.6
	Total	**2040**	**233**	**11.4**
Hosp 3	2012	39	8	20.5
	2013	172	27	15.7
	2014	141	24	17.0
	2015	339	27	8.0
	2016	354	18	5.1
	Total	**1045**	**104**	**9.9**
Hosp 4	2012	111	40	36.4
	2013	140	1	0.8
	2014	180	19	10.6
	2015	282	31	11.0
	2016	134	3	2.2
	Total	**831**	**94**	**11.3**
Hosp 5	2012	10	0	0
	2013	216	2	0.9
	2015	136	2	1.5
	2016	245	4	1.6
	Total	**607**	**8**	**1.3**
Hosp 6	2013	185	36	19.5
	2014	165	17	10.3
	2015	398	35	8.8
	2016	85	5	5.9
	Total	**833**	**93**	**11.2**
Hosp 7	2013	124	1	0.8
	2014	42	0	0.0
	2015	114	2	1.8
	2016	106	2	1.9
	Total	**386**	**5**	**1.3**
GRAND TOTAL		**6037**	**545**	**9.0**



How to reduce Pseudomonas contamination

Taps and sinks cleaning: Taps should be cleaned before the rest of the hand basin as set out by the NHS Cleaning Manual. During cleaning, there is a risk of contaminating tap outlets with microorganisms if the same cloth is used to clean the bowl of the hand basin before the tap. These may be of patient origin, so it is possible that bacteria, including antibiotic resistant organisms, could seed the outlet, become resident in any biofilm and have the potential to be transmitted to other patients.

Body fluids disposal: Do not dispose of body fluids at the wash-hand basin – use the dirty utility area.

Patient equipment: Do not wash any patient equipment in wash-hand basins.

Storage: Do not use wash-hand basins for storing used equipment awaiting decontamination.

Safe water: Wash patients, including neonates, on augmented care units with water from outlets demonstrated as safe by risk assessments and, if necessary, by water sampling.

Environmental fluid: Do not dispose of used environmental cleaning fluids at wash-hand basins.

Flushing: Regularly Flush all taps that are used infrequently on augmented care units, at least daily in the morning for 1 minute (HTM 04-01 Part B).

Replace TMVs: There is some evidence that the more complex the design of the outlet assembly, for example sensor-operated taps, the more prone to Pseudomonas colonisation the outlet may be (DH, 2012). Reports from infection prevention and control groups suggest that those estates that replaced TMV-IR/non-touch taps with more conventional elbow or knee actuated devices saw an end to the outbreak and associated Pseudomonas contamination for the reported period (DH, 2012).

Clean and descale outlets: Regularly clean and descale or replace water outlets/shower heads where there may be direct or indirect water contact with patients (see HTM 04-01).

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