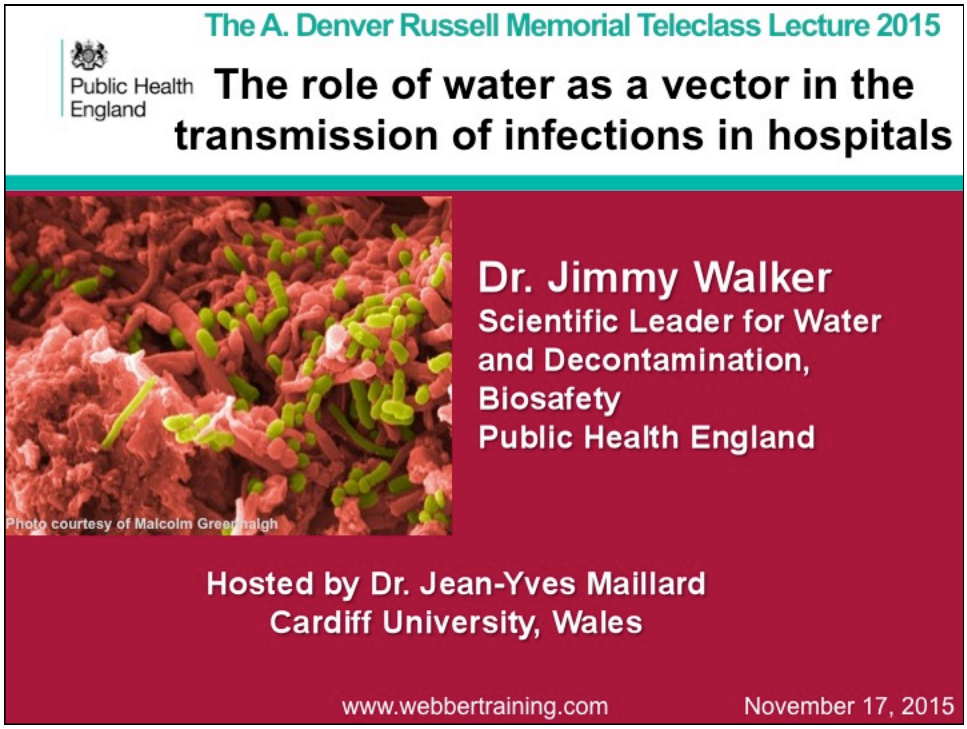
The Role of Water as a Vector for Infection in the Transmission of Infections in Hospitals
Dr. Jimmy Walker, Public Health England
A Webber Training Teleclass



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Outline

- Implications and risks from using water?
- Northern Ireland *P. aeruginosa* outbreak
- What factors in a water system encourage biofilms?
- Guidance and the role of water safety group
- Can the risk be controlled?

Hosted by Prof. Jean-Yves Maillard, Cardiff University, Wales
www.webbertraining.com

Public Health England

Denver Russell
1936-2004

1977, Pharmaceutical microbiology
W.B. Hugo and A.D. Russell

1982, The destruction of bacterial spores. Russell, A. D

1984, The Revival of injured microbes / edited by M.H.E. Andrew and A.D. Russell

1990, Understanding antibacterial action and resistance.
A. D Russell and I Chopara.

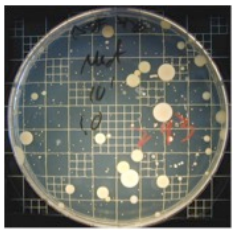
1992, Principles and practice of disinfection, preservation, and sterilization
A.D. Russell, W.B. Hugo, G.A.J. Ayliffe.

3 The A. Denver Russell Memorial Teleclass Lecture 2015

Public Health England

Drinking water standards

Clostridium perfringens	Is a type of bacterium which produces spores and can be present in the gut of warm blooded animals. Spores are particularly resistant to disinfection using chlorine and their presence in drinking water can be used to indicate a historic contamination.	0 per 100 ml
coliform bacteria	These bacteria are widely distributed in the environment and provide a sensitive measure of the microbiological quality of the water supply.	0 per 100 ml
colony counts - 2 day at 37°C - 3 day at 22°C	Are general techniques for detecting a wide range of bacteria. They do not have any direct health significance and are used for trending purposes to assess the microbiological quality of drinking water.	No abnormal change



4 The role of water as a vector in the transmission

Table 7.1 Pathogens transmitted through drinking-water[a]

Pathogen	Health significance[b]	Persistence in water supplies[c]	Resistance to chlorine[d]	Relative infectivity[e]	Important animal source
Bacteria					
Burkholderia pseudomallei	High	May multiply	Low	Low	No
Campylobacter jejuni, C. coli	High	Moderate	Low	Moderate	Yes
Escherichia coli – Pathogenic[f]	High	Moderate	Low	Low	Yes
E. coli – Enterohaemorrhagic	High	Moderate	Low	High	Yes
Francisella tularensis	High	Long	Moderate	High	Yes
Legionella spp.	High	May multiply	Low	Moderate	No
Leptospira	High	Long	Low	High	Yes
Mycobacteria (non-tuberculous)	Low	May multiply	High	Low	No
Salmonella Typhi	High	Moderate	Low	Low	No
Other salmonellae	High	May multiply	Low	Low	Yes
Shigella spp.	High	Short	Low	High	No
Vibrio cholerae	High	Short to long[g]	Low	Low	No
Viruses					
Adenoviruses	Moderate	Long	Moderate	High	No
Astroviruses	Moderate	Long	Moderate	High	No
Enteroviruses	High	Long	Moderate	High	No
Hepatitis A virus	High	Long	Moderate	High	No
Hepatitis E virus	High	Long	Moderate	High	Potentially
Noroviruses	High	Long	Moderate	High	Potentially
Rotaviruses	High	Long	Moderate	High	No
Sapoviruses	High	Long	Moderate	High	Potentially
Protozoa					
Acanthamoeba spp.	High	May multiply	High	High	No
Cryptosporidium hominis/	High	Long	High	High	Yes

5

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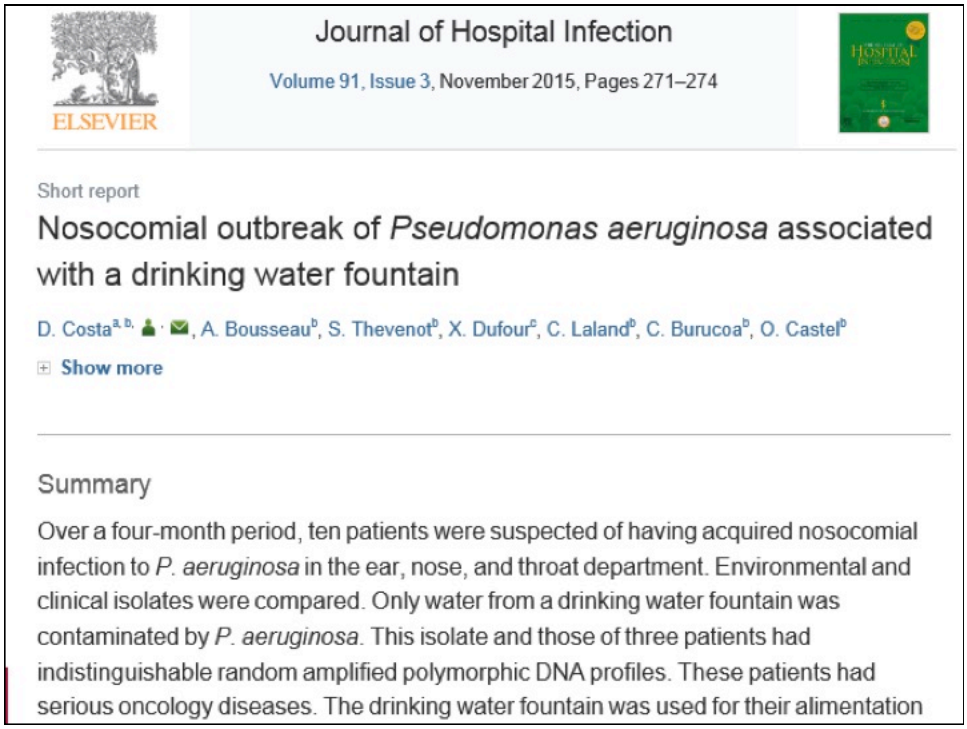
Opportunistic pathogens (OP) in drinking water distribution systems (DWDS)

OP	Detection Frequency in DWDS
Legionella spp.	(57% / 85 cell equivalent, CE L^{-1}),
Mycobacterium spp.	(88% / 324 CE L^{-1}),
Pseudomonas aeruginosa	(24% / 2 CE L^{-1}),
Vermamoeba vermiformis	(24% / 2 CE L^{-1})
Acanthamoeba spp.	(42% / 5 cyst equivalent, CE L^{-1}).

Legionella spp. - leading cause of drinking water disease burden in the USA (Beer et al 2015)

8 Lu et al, 2015 Molecular Detection of Legionella spp. and their associations J Appl Microbiol 2015 Nov 4. doi: 10.1111/jam.12996.



ELSEVIER

Journal of Hospital Infection

Volume 91, Issue 3, November 2015, Pages 271–274

Short report

Nosocomial outbreak of *Pseudomonas aeruginosa* associated with a drinking water fountain

D. Costa[a, b], A. Bousseau[b], S. Thevenot[b], X. Dufour[c], C. Laland[b], C. Burucoa[b], O. Castel[b]

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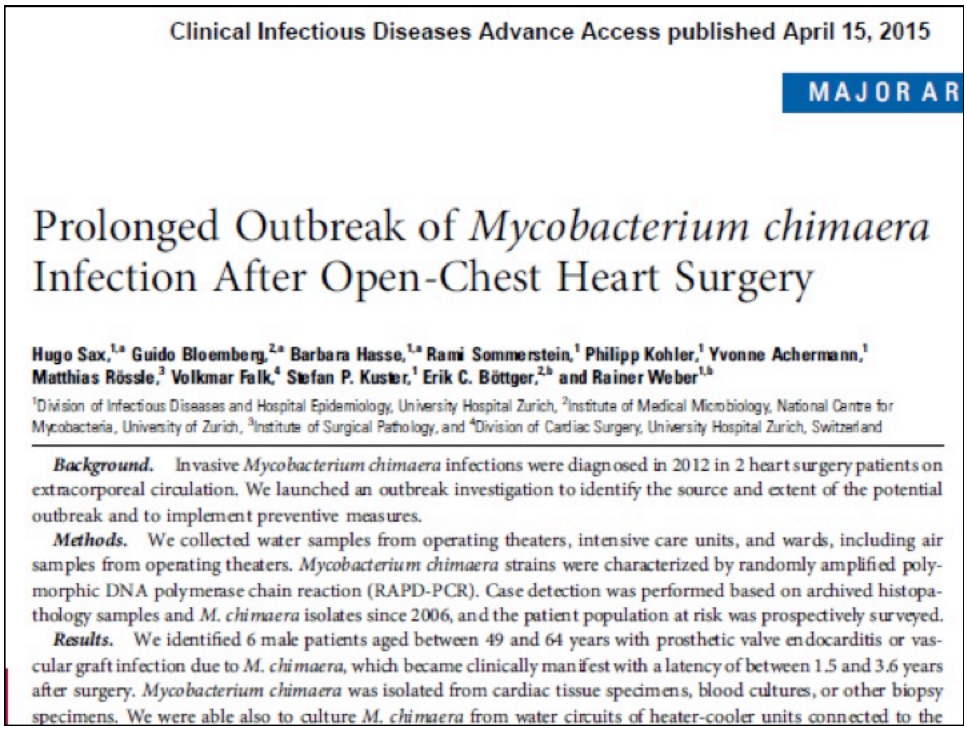
Summary

Over a four-month period, ten patients were suspected of having acquired nosocomial infection to *P. aeruginosa* in the ear, nose, and throat department. Environmental and clinical isolates were compared. Only water from a drinking water fountain was contaminated by *P. aeruginosa*. This isolate and those of three patients had indistinguishable random amplified polymorphic DNA profiles. These patients had serious oncology diseases. The drinking water fountain was used for their alimentation



Clinical Infectious Diseases Advance Access published April 15, 2015

MAJOR AR

Prolonged Outbreak of *Mycobacterium chimaera* Infection After Open-Chest Heart Surgery

Hugo Sax,[1,a] Guido Bloemberg,[2,a] Barbara Hasse,[1,a] Rami Sommerstein,[1] Philipp Kohler,[1] Yvonne Achermann,[1] Matthias Rössle,[3] Volkmar Falk,[4] Stefan P. Kuster,[1] Erik C. Böttger,[2,b] and Rainer Weber[1,b]

[1]Division of Infectious Diseases and Hospital Epidemiology, University Hospital Zurich, [2]Institute of Medical Microbiology, National Centre for Mycobacteria, University of Zurich, [3]Institute of Surgical Pathology, and [4]Division of Cardiac Surgery, University Hospital Zurich, Switzerland

Background. Invasive *Mycobacterium chimaera* infections were diagnosed in 2012 in 2 heart surgery patients on extracorporeal circulation. We launched an outbreak investigation to identify the source and extent of the potential outbreak and to implement preventive measures.

Methods. We collected water samples from operating theaters, intensive care units, and wards, including air samples from operating theaters. *Mycobacterium chimaera* strains were characterized by randomly amplified polymorphic DNA polymerase chain reaction (RAPD-PCR). Case detection was performed based on archived histopathology samples and *M. chimaera* isolates since 2006, and the patient population at risk was prospectively surveyed.

Results. We identified 6 male patients aged between 49 and 64 years with prosthetic valve endocarditis or vascular graft infection due to *M. chimaera*, which became clinically manifest with a latency of between 1.5 and 3.6 years after surgery. *Mycobacterium chimaera* was isolated from cardiac tissue specimens, blood cultures, or other biopsy specimens. We were able also to culture *M. chimaera* from water circuits of heater-cooler units connected to the

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HCAI Water borne microorganisms

1400 deaths per year in the USA as a result of waterborne nosocomial pneumonias due to *Pseudomonas aeroginosa*

4000 cases of *P. aeroginosa* bacteraermia in England, Wales and N Ireland per yr

~ 300 cases of Legionnaires disease per year

~ 500 cases of *Stenotrophomonas maltophila*

Public Health England

Bacteria-infected baby dies at Glasgow 'super-hospital'

3 November 2015 | Glasgow & West Scotland

The Royal Hospital for Children sits alongside the Queen Elizabeth University Hospital

A baby has died at Scotland's newest "super-hospital" campus after

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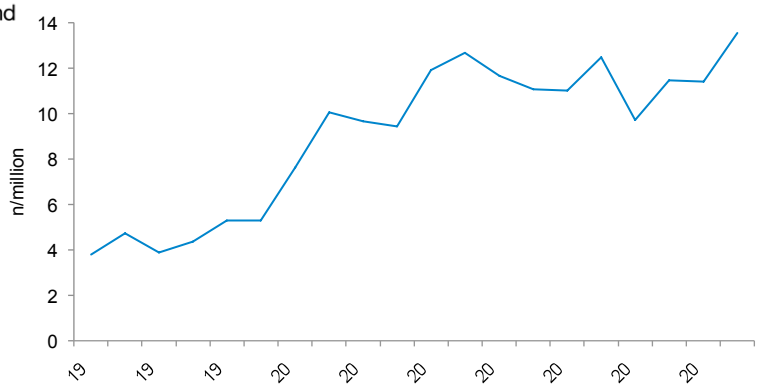
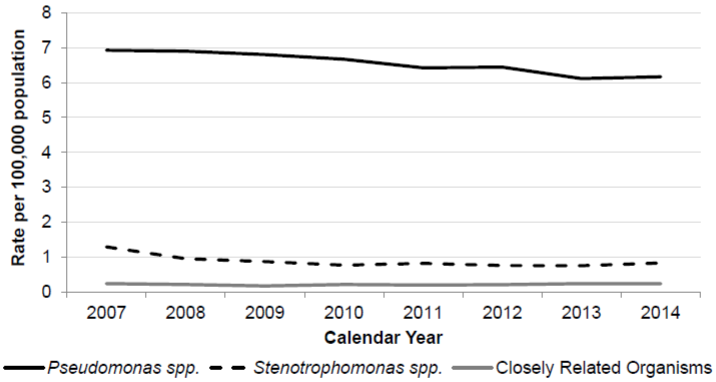
Legionella notification rate by year of onset, EU/EEA, 1995–2014



- The overall notification rate was 13.5 per million inhab. in 2014
- Highest notification rate ever
- 6941 cases reported by 29 countries

13 Courtesy of Birgitta De Jong (ECDC)

Figure 1. Eight year trend in *Pseudomonas* spp., *Stenotrophomonas* spp. and closely related species bacteraemia reports per 100,000 population (England Wales and Northern Ireland); 2007 to 2014



Pseudomonas spp. accounted for 3.1% of mono-microbial bloodstream infections (BSI; all reported bacteraemia and/or fungaemia) in 2014; making them the eighth most commonly reported mono-microbial BSI causing organisms. In contrast, *Stenotrophomonas* spp.

14 The role of water as a vector in the transmission

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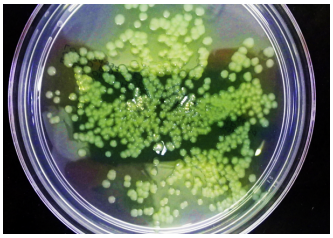
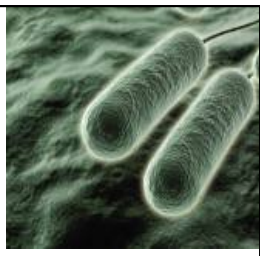
Pseudomonas aeruginosa

- Ubiquitous in the environment
- Versatile; survives in a wide range of conditions
- Prefers warm, moist environments
- Able to form biofilms
- Often has resistance to antimicrobials
- Gram-negative rod bacillus
- Fluorescent under UV



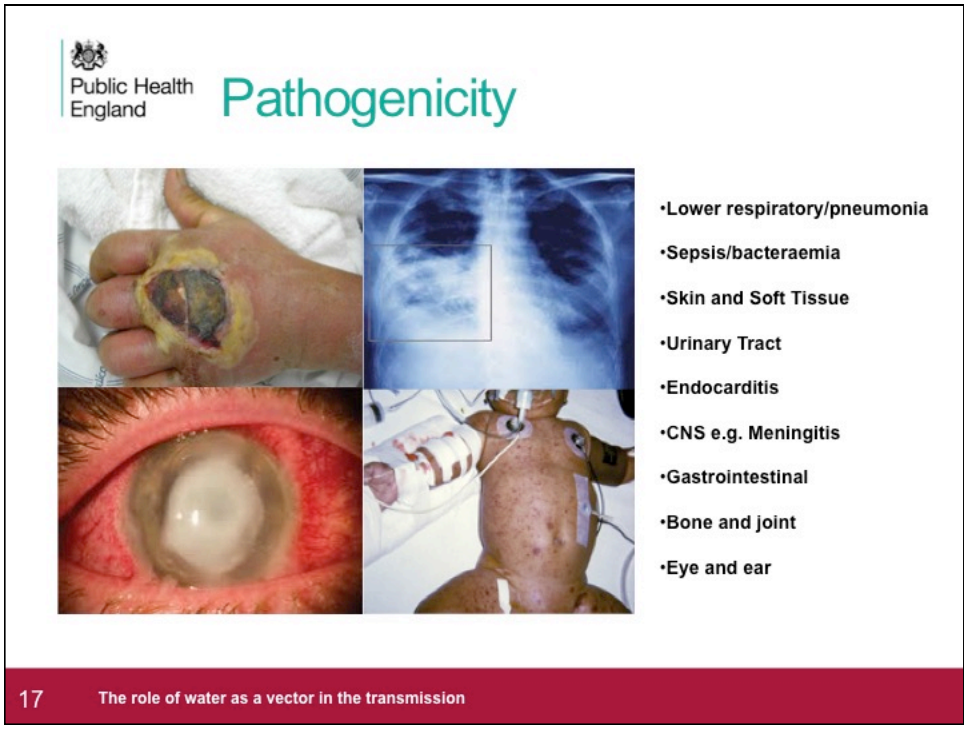
Pseudomonas aeruginosa



Cause of healthcare-associated infections in the neonatal intensive care unit (NICU) environment.

NICU patients causes sepsis, pneumonia, meningitis, diarrhoea, conjunctivitis and skin infections

Various environmental sources including sinks, respiratory equipment and healthcare workers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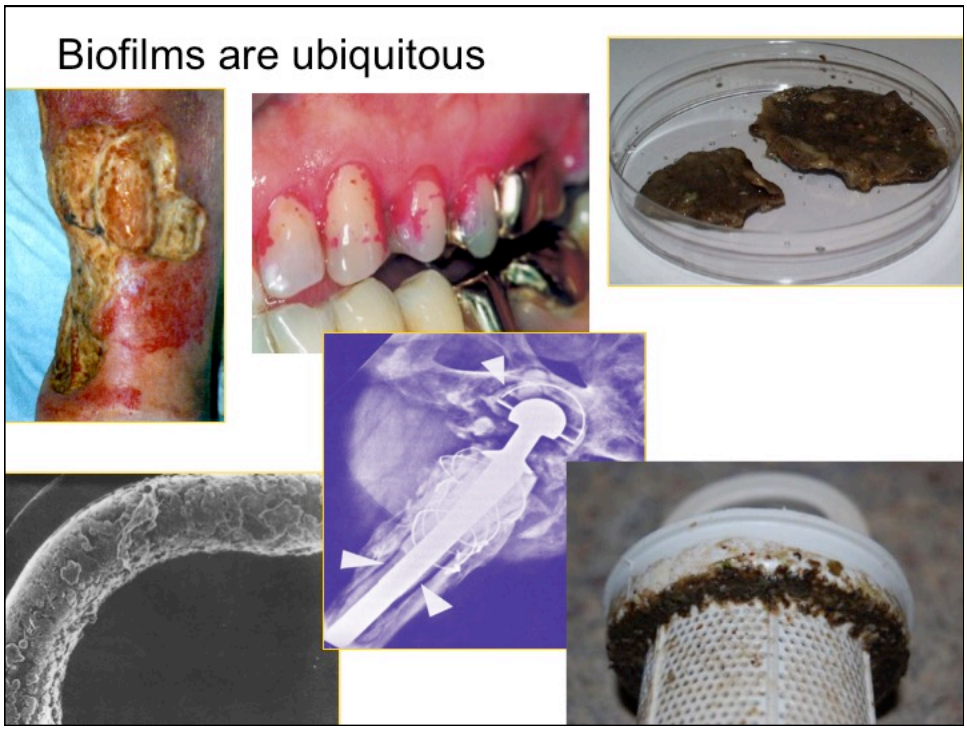
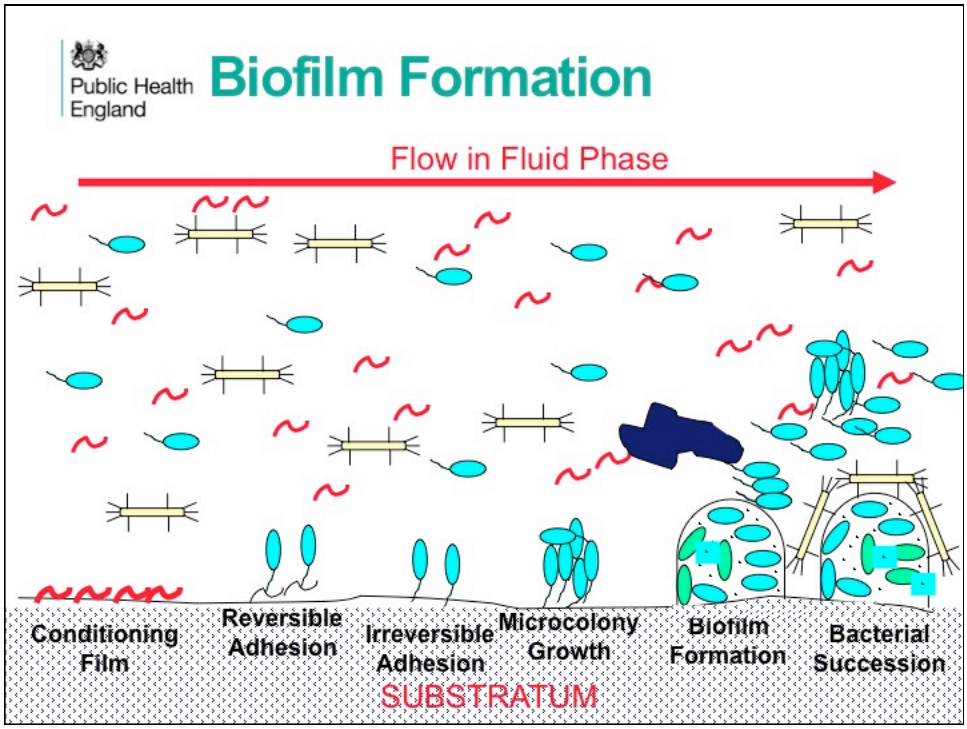
Pathogenicity
•Lower respiratory/pneumonia
•Sepsis/bacteraemia
•Skin and Soft Tissue
•Urinary Tract
•Endocarditis
•CNS e.g. Meningitis
•Gastrointestinal
•Bone and joint
•Eye and ear
17
The role of water as a vector in the transmission


Biofilms are ubiquitous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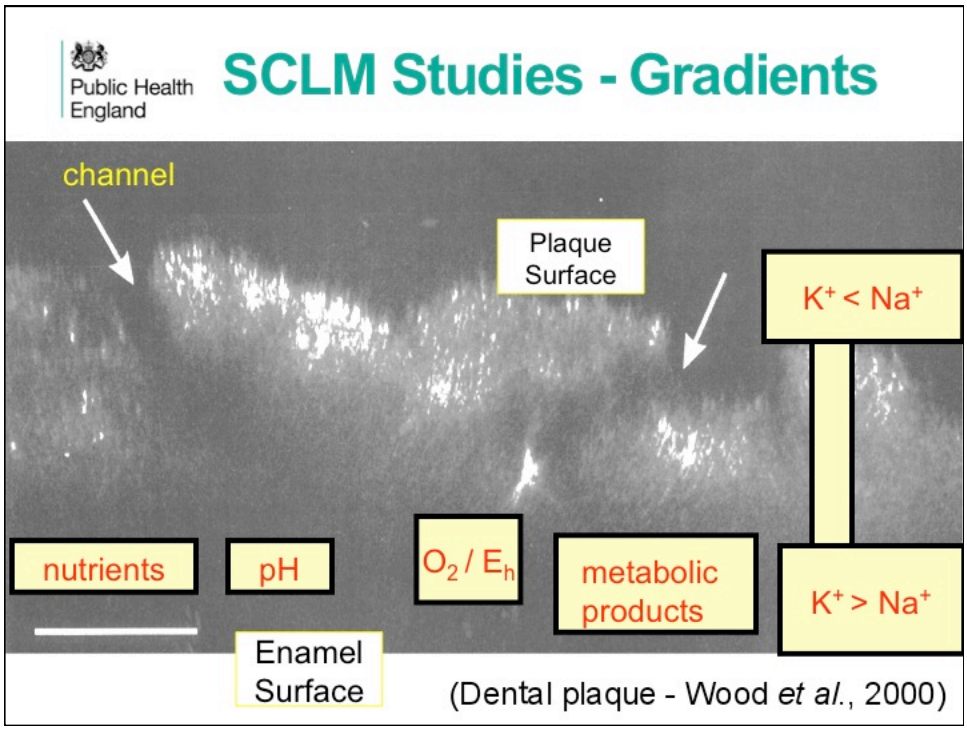
Biofilm Formation
Flow in Fluid Phase
Conditioning Film
Reversible Adhesion
Irreversible Adhesion
Microcolony Growth
Biofilm Formation
Bacterial Succession
SUBSTRATUM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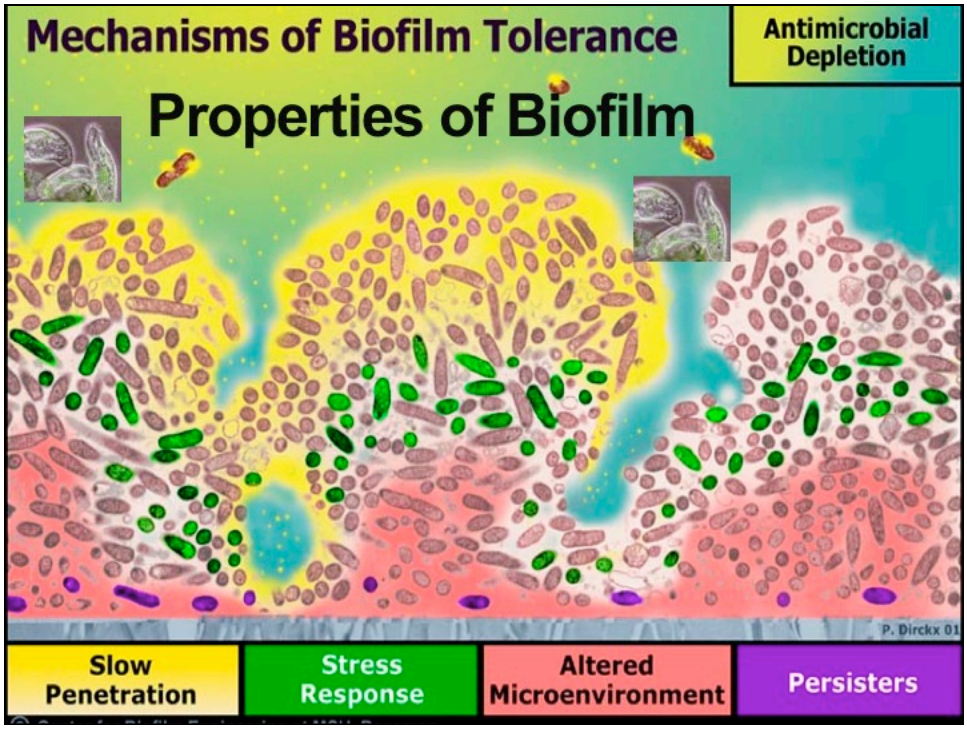
SCLM Studies - Gradients
channel
Plaque Surface
K+ < Na+
nutrients
pH
O2 / Eh
metabolic products
K+ > Na+
Enamel Surface
(Dental plaque - Wood et al., 2000)



Water Outlets are not a new problem.....

Multi-resistant *Pseudomonas aeruginosa* outbreak associated with contaminated tap water in a neurosurgery intensive care unit

F. Bert*, E. Maubec†, B. Bruneau*, P. Berry* and N. Lambert-Zechovsky*

*Service de Microbiologie and †Département d'Anesthésie-réanimation, Hopital Beaujon, Clichy, France

Summary: From July 1995 to November 1996, multi-resistant *Pseudomonas aeruginosa* O11 was isolated from 36 patients admitted to a neurosurgery intensive care unit. The strain was resistant to ticarcillin, ceftazidime, imipenem, gentamicin and ciprofloxacin, and susceptible to amikacin. Nine patients were colonized only; the remaining 27 patients had at least one infected site (17 urinary infections, 10 pneumonias and four with sinusitis). *P. aeruginosa* O11 with the same resistance pattern was isolated from tap water. The strain was also cultured from enteral nutrition solutions given to two infected patients. DNA macrorestriction analysis with *Xba*I established the similarity of the isolates from patients, tap water and solutions. The outbreak was controlled after reinforcement of isolation procedures for infected patients, changing the mode of enteral nutrition and replac… of *P. aeruginosa* during th… aminated with tap water.

Journal of Hospital Infection (1998) **39**: 53–62

Not a new problem.....

The taps were presumably the main source of *P. aeruginosa* during this outbreak, via the hand of nursing staff or nutrition solutions contaminated with tap water

Journal of Hospital Infection (1998) **39**: 53–62

Public Health England

Trautmann *et al* AJIC 2005

Table 1. Studies comparing genotypes of endemic *P aeruginosa* (PA) strains isolated from patients and tap water outlets in ICUs and peripheral wards

Authors, year (reference)	Study period	Setting	Ward(s)	Genotyping method	No. of positive tap water samples/no. tested (%)	No. of patients harboring a clone previously isolated from water taps/total no. of patients harboring PA	Percentage
Ferroni et al, 1998[¶](28)	1994	Pediatric hospital, Paris, France	Pediatric surgical ward	PFGE	21/118 (18.0)	3/14	21.4
Berthelot et al, 2001[†](33)	1995-1996	University Hospital, St. Etienne, France	2 Mixed ICUs	AP-PCR, PFGE	34/n.i. (ICU 1) 34/n.i. (ICU 2)	3/12 (ICU 1) 2/14 (ICU 2)	25 14.2
Trautmann et al, 2000 (27)	1996-1997	University Hospital, Ulm, Germany	16-Bed surgical ICU	RAPD-PCR	49/72 (68.1)	5/17	29.4
Reuter et al, 2002 (38)	1998-1999	University Hospital, Ulm, Germany	16-Bed surgical ICU, peripheral surgical wards	RAPD-PCR	150/259 (58.0)	13/31 (ICU) 5/14 (peripheral wards)	42 35.7
Vallés et al, 2004 (34)	1996-1999	Teaching hospital, Barcelona, Spain	16-Bed mixed ICU	PFGE	93/149 (62.4)	3/8[‡] 13/31[§]	37.5 42
Blanc et al, 2004[#](35)	1998	University Hospital, Lausanne, Switzerland	5 ICUs of different specialities	PFGE	21/216 (9.7)[#]	36/132	27.3
Trautmann et al, 2005[¶]	2001	University Hospital, Ulm, Germany	12-Bed medical ICU	RAPD-PCR	60/143 (42.0)	8/16	50

Trautmann et al AMJIC 2005

A review of prospective studies published between 1998 and 2005 showed that between 9.7% and 68.1% of randomly taken tap water samples on different types of ICUs were positive for *P aeruginosa*, and between 14.2% and 50% of infection/colonization episodes in patients were due to genotypes found in ICU water.

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Persistence of *P. aeruginosa* in the hospital environment (Abreu)

> 50% of the equipment sampled was highly contaminated.

***P. aeruginosa* repeatedly isolated from sinks, tap biofilm, showers and bedside tables**

***P. aeruginosa* contamination was related to the surface humidity, and tap water (biofilm)**

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Abreu et al 2014 Persistence of microbial communities including *Pseudomonas aeruginosa* in a hospital environment: a potential health hazard. BMC Microbiol, 14;118

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Northern Ireland Politics

20 January 2012 Last updated at 08:14

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Two babies dead after infection at Belfast hospital

Two babies have died at the Royal Maternity Hospital in Belfast after an outbreak of an infection called pseudomonas.

The Belfast Trust said the deaths, in the neonatal unit, may be linked to the outbreak. Admission to the unit is being restricted.

The bacteria can cause infections in the chest, blood, and urine.

The health minister said identifying the source of the infection was a priority.

Edwin Poots added: "This is a serious incident.

"I have asked the trust to work with the Public Health Agency to ensure all necessary steps are swiftly taken to identify the source of the infection so that we contain it and reduce the risk of spreading. "

The babies died in the last week to 10 days, but a possible link to the bacteria was only discovered recently.

There are currently 26 babies in the unit, which cares for ill or premature babies.

They are all being tested for the infection and those found to be clear of it will be treated in a different part of the hospital.

The trust is investigating the outbreak at the maternity hospital

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Northern Ireland Politics

24 January 2012 Last updated at 18:34

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Sink taps source of infection that killed three babies

Sink taps were the source of an infection which killed three babies at a Belfast hospital, the Northern Ireland health minister has confirmed.

Edwin Poots told the NI Assembly that the Pseudomonas bacteria had been traced to taps at a neo-natal unit in the Royal Jubilee Maternity Hospital.

The unit was deep cleaned at the weekend after six babies were found to be infected.

The neo-natal unit at the Royal under went a de clean

Northern Ireland - statement by Health Minister Edwin Poots - 31st January 2012

"The presence of *Pseudomonas aeruginosa* has been found in a small number of water outlets in the neonatal intensive care unit of the hospitals"

Taps have been implicated as being a source!

Protect patients in the wards and restore public confidence

Hospital shuts baby unit after infection kills four new-borns

Replace all the taps……..

Public Health England

PHE Team Approach

PHE Experts provided advice as the incidents occurred

Biosafety team organising delivery of components and strategy in place to handle samples and data from a forensic approach

Food Water and Environmental laboratory (PHE Porton) analysing all the microbiology

Jane Turton's laboratory(PHE Colindale) carrying out variable number tandem repeat analysis for isolate identification and strain differentiation

Howard Tolley carrying out SEM analysis

31 The role of water as a vector in the transmission

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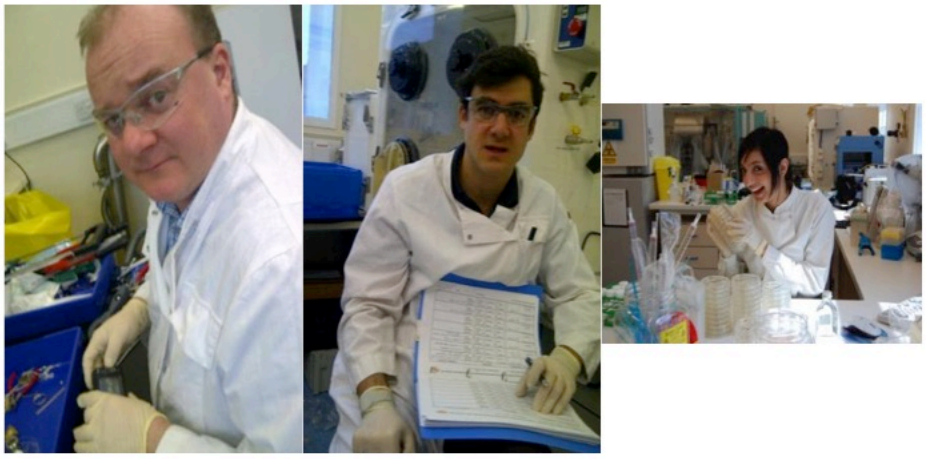
Inspector Clous"*eau*"



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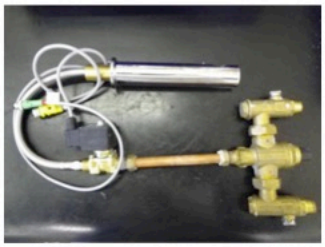
Sampling - Issues to consider

Taps, solenoid valves, thermal mixer units, isolator valves, flexible and metal pipes

- Surprisingly complex, multiple parts, complex shapes, varying materials

Taps potentially contaminated with Pseudomonas aeruginosa

- Complete units may contain contaminated water
- Aerosol risk
- Safety cabinets and Local exhaust ventilation
- Need to preserve the integrity of the biofilms and viability of the contamination



33 The role of water as a vector in the transmission

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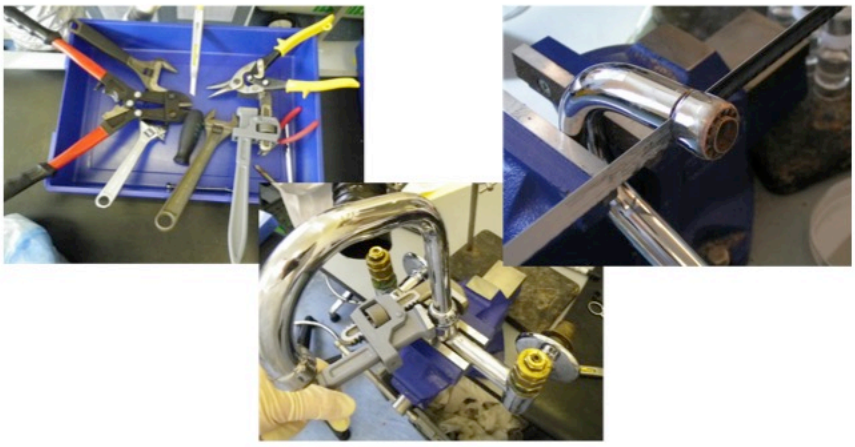
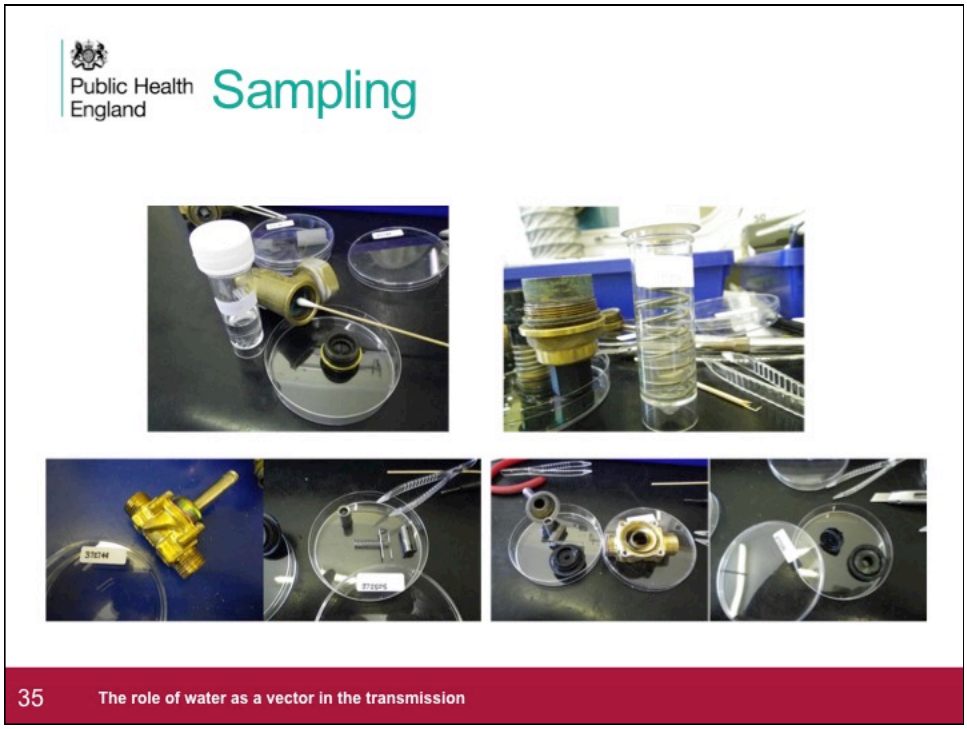
Tools for the job.....



34 The role of water as a vector in the transmission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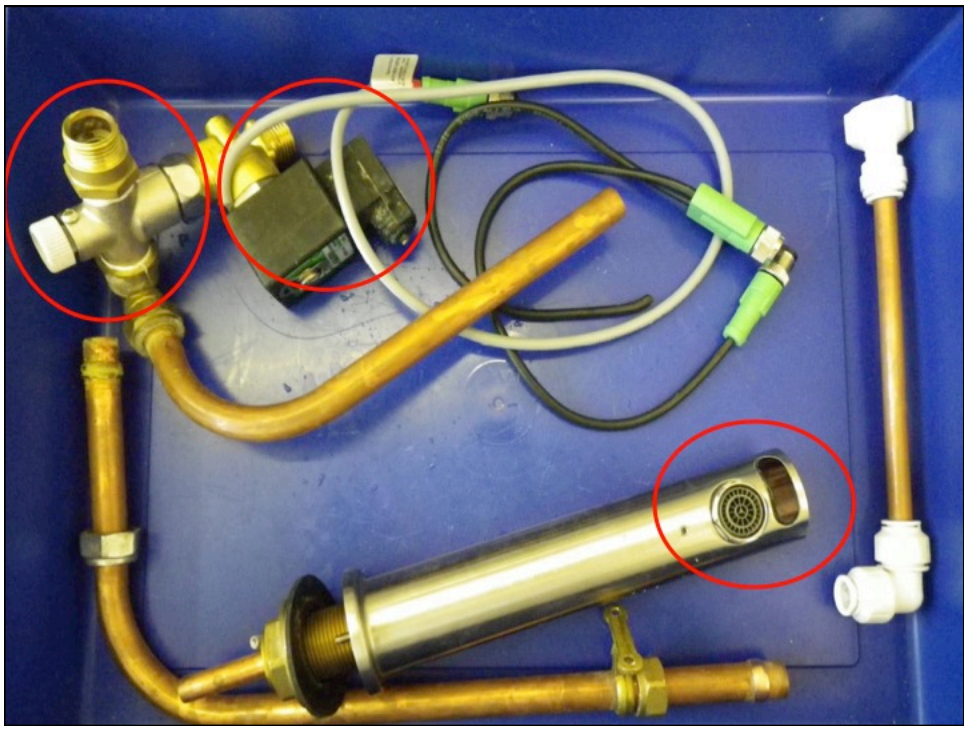
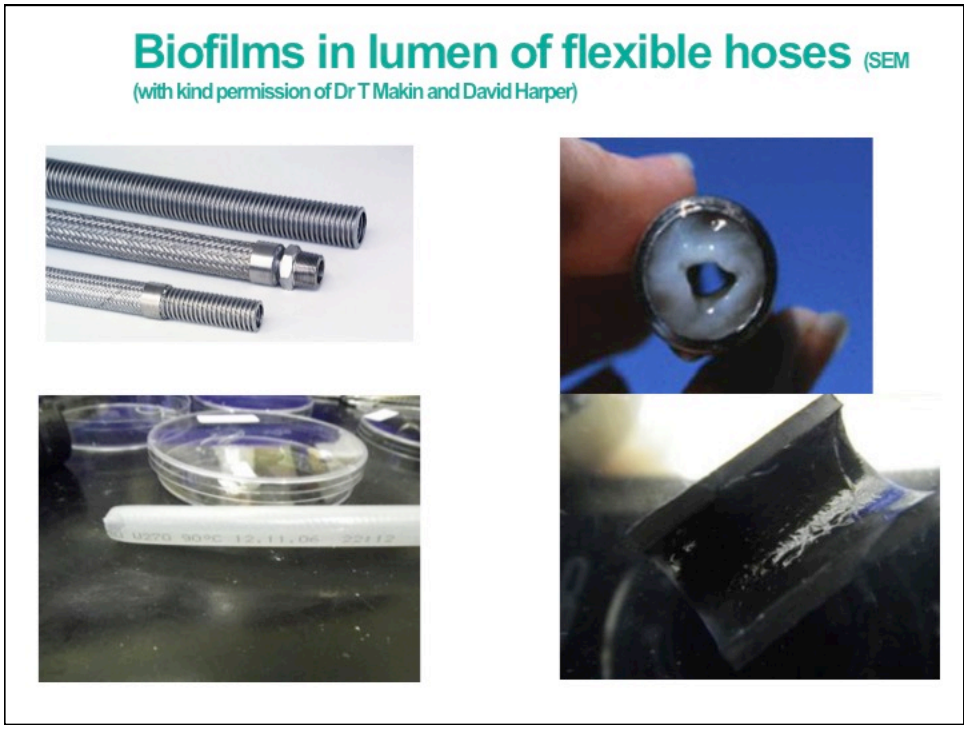
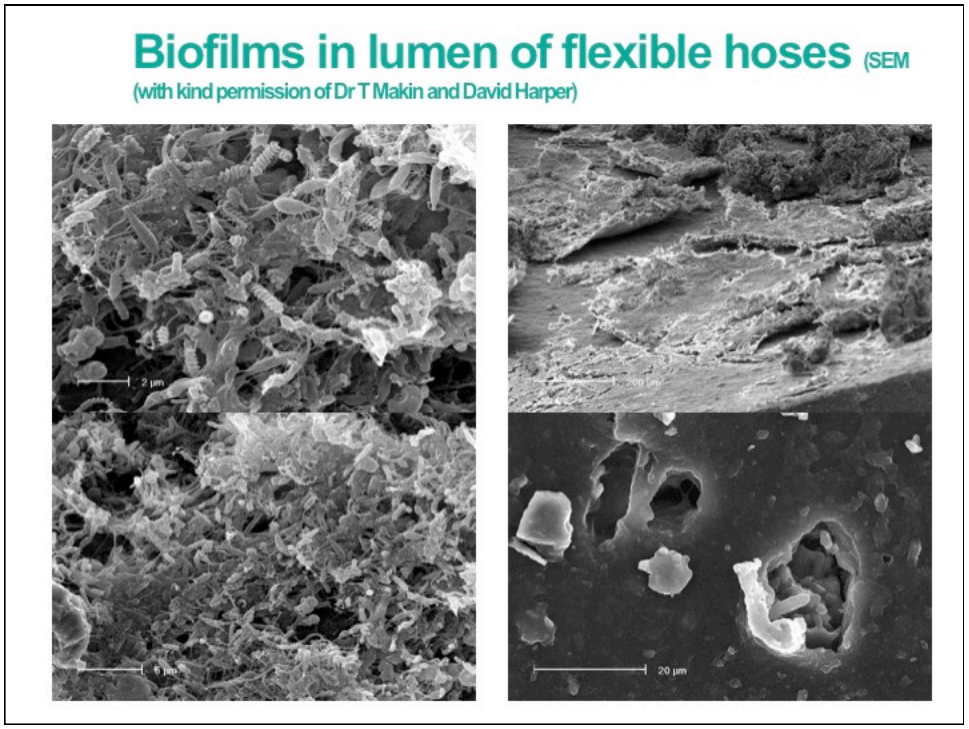
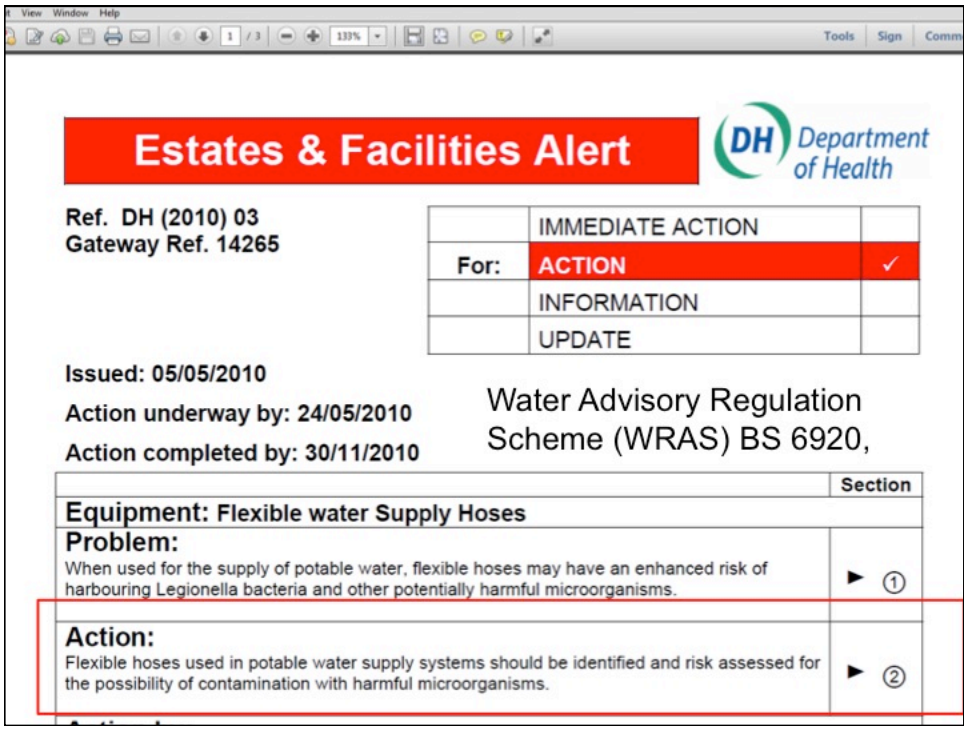
Sampling
35
The role of water as a vector in the transmission



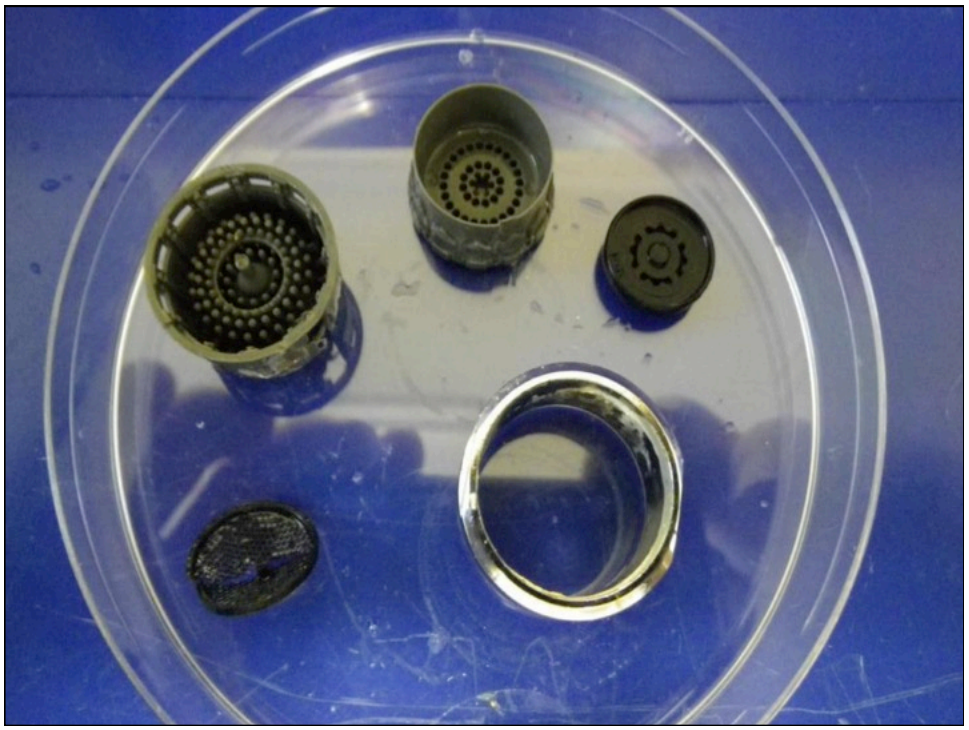

Biofilms in lumen of flexible hoses (SEM
(with kind permission of Dr T Makin and David Harper)

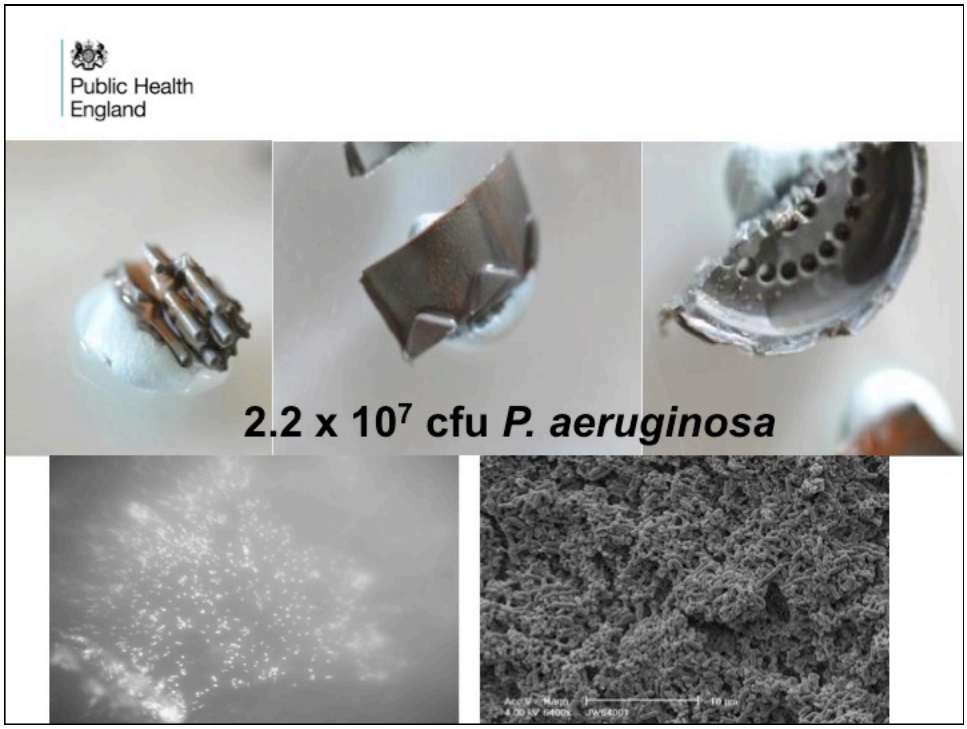

Biofilms in lumen of flexible hoses (SEM
(with kind permission of Dr T Makin and David Harper)
2 µm
20 µm

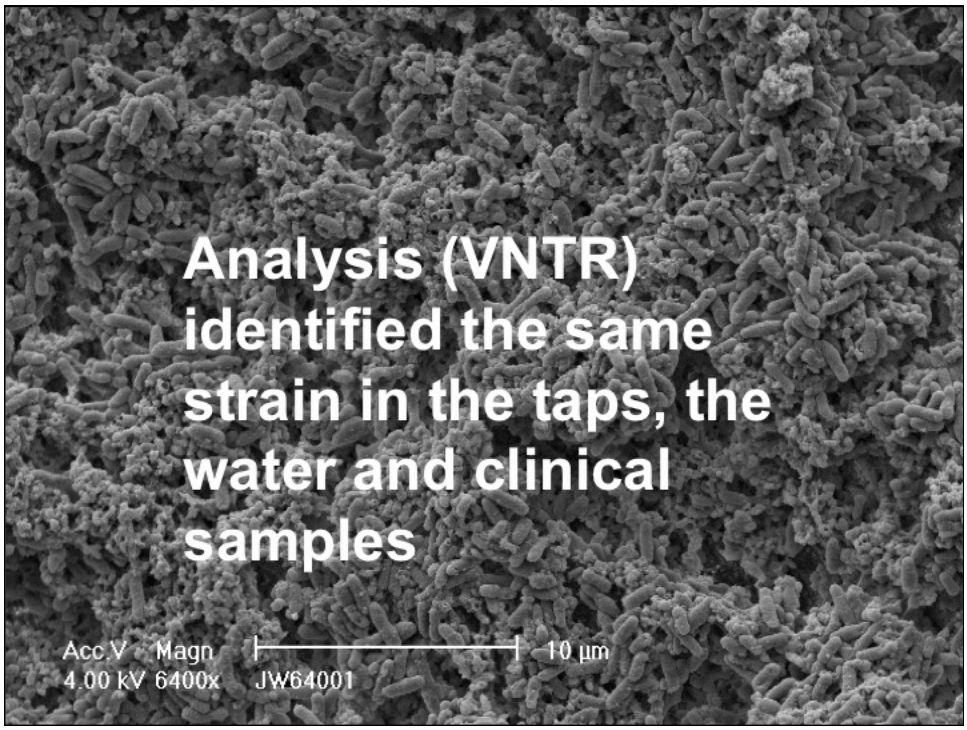

Estates & Facilities Alert
DH Department of Health
Ref. DH (2010) 03
Gateway Ref. 14265
IMMEDIATE ACTION
For: ACTION ✓
INFORMATION
UPDATE
Issued: 05/05/2010
Action underway by: 24/05/2010
Action completed by: 30/11/2010
Water Advisory Regulation Scheme (WRAS) BS 6920,
Section
Equipment: Flexible water Supply Hoses
Problem:
When used for the supply of potable water, flexible hoses may have an enhanced risk of harbouring Legionella bacteria and other potentially harmful microorganisms.
①
Action:
Flexible hoses used in potable water supply systems should be identified and risk assessed for the possibility of contamination with harmful microorganisms.
②

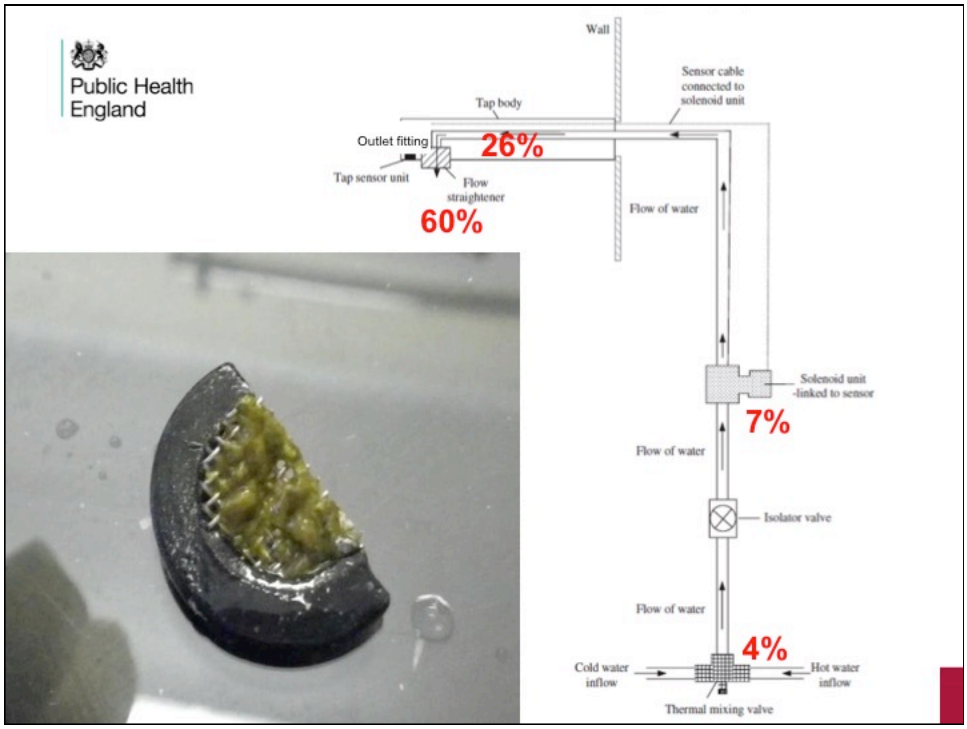
Public Health England

	All components		*P. aeruginosa positive* Components		
	N	%	N	%	Median Pseudomonas CFU (IQR)
Tap component location					
Tap body	126	26	18	26	6,340 (22,580)
Connectors	31	6	0	0	-
Isolation valve	30	6	0	0	-
Integrated Mixer and solenoid	38	8	1	1	60 (0)
Mixer	98	20	2	3	20 (0)
Flow straightener	97	20	41	60	52,033 (816,820)
Solenoid	54	11	5	7	520 (23,380)



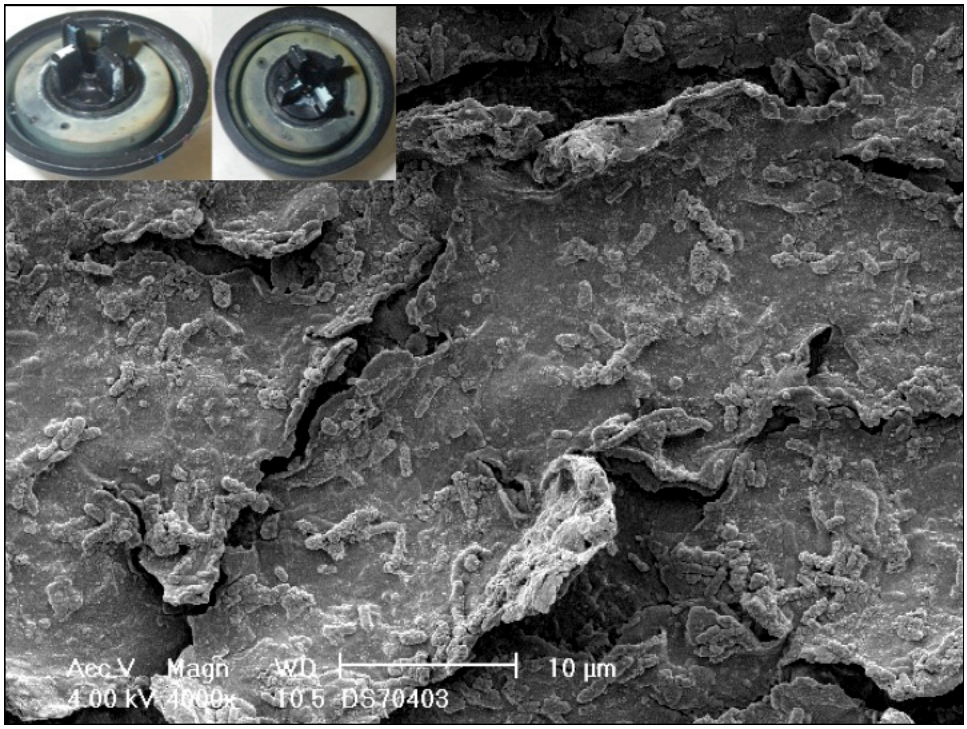

Public Health England
2.2 x 10⁷ cfu *P. aeruginosa*


Analysis (VNTR) identified the same strain in the taps, the water and clinical samples
Acc.V Magn
4.00 kV 6400x JW64001
10 µm

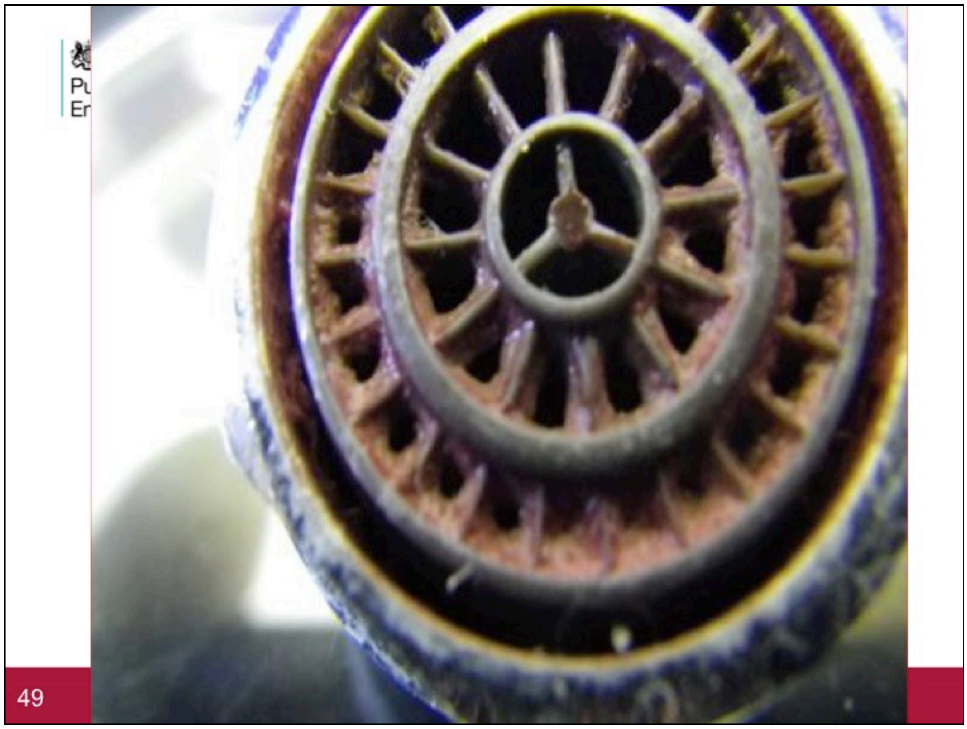

Public Health England
Wall
Sensor cable connected to solenoid unit
Tap body
Outlet fitting
26%
Tap sensor unit
Flow straightener
60%
Flow of water
Solenoid unit -linked to sensor
7%
Flow of water
Isolator valve
Flow of water
4%
Cold water inflow
Hot water inflow
Thermal mixing valve

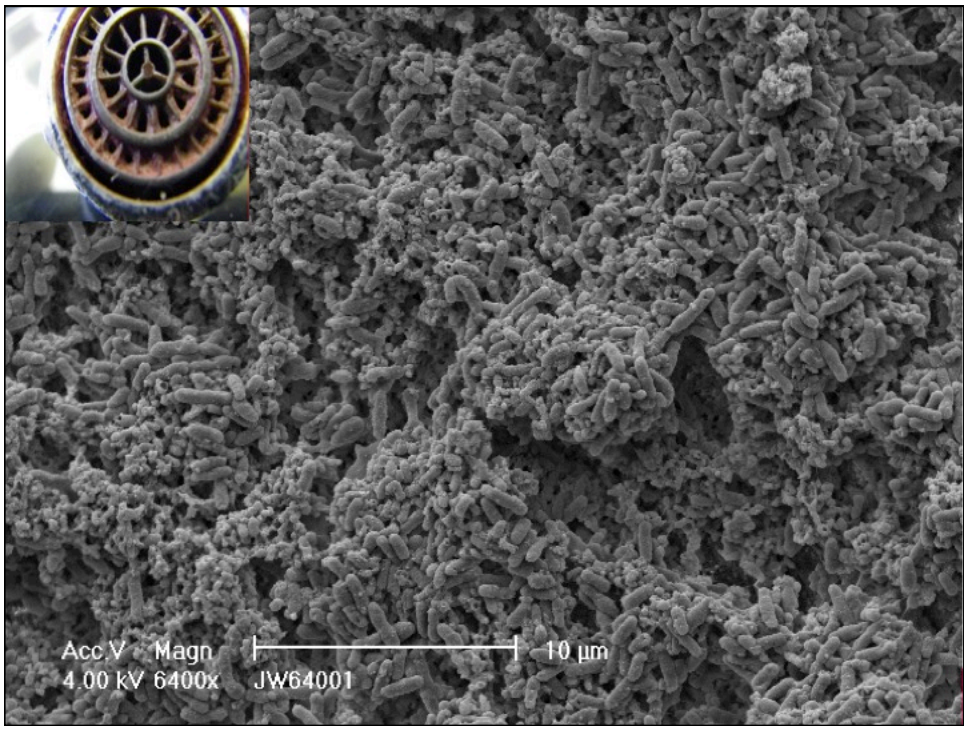

2
5
3
1
4
46
Pseudomonas aeruginosa and UK water systems – Walker et al JHI 2014; 86,16-23


2
1
4
47
Pseudomonas aeruginosa and UK water systems – Walker et al JHI 2014; 86,16-23

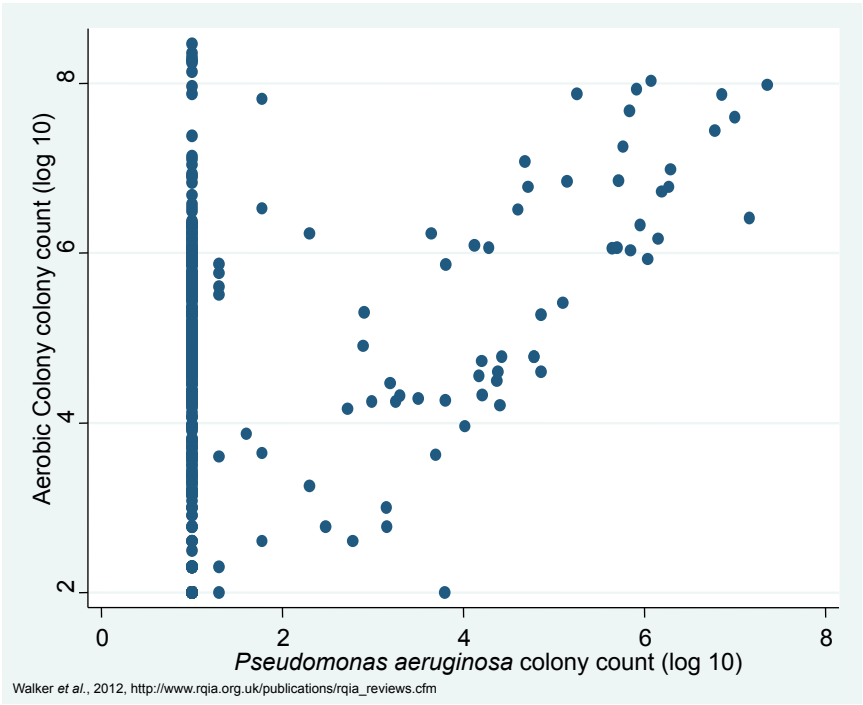

Acc.V Magn WD
4.00 kV 4000x 10.5 DS70403
10 µm

The Role of Water as a Vector for Infection in the Transmission of Infections in Hospitals
Dr. Jimmy Walker, Public Health England
A Webber Training Teleclass





Hosted by Prof. Jean-Yves Maillard, Cardiff University, Wales
www.webbertraining.com



Public Health England

Tap Component Analysis

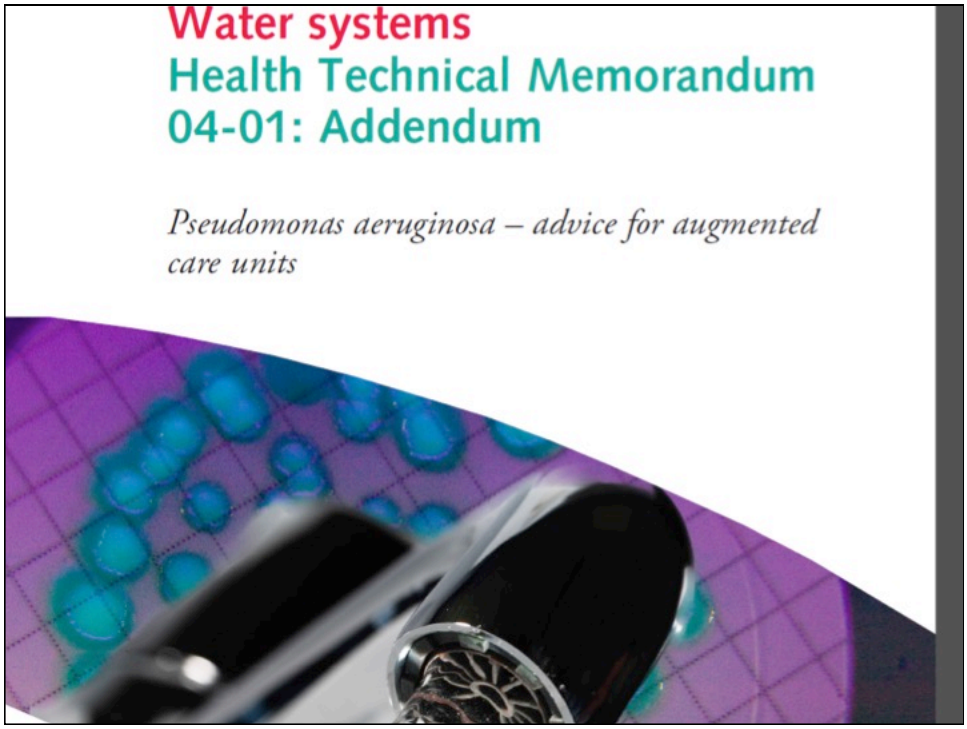
494 components were analysed for aerobic colony count and *P. aeruginosa (14% of components positive)*

Same strain in the taps, the water and clinical samples

Little correlation between ACC and *P. aeruginosa*

Sensor taps were significantly colonised compared to non-sensor

Statistically there were significant differences due to the presence of complex outlet fittings



Public Health England

What does the addendum do?

- **Develop local water safety groups and plans**
- **Assess the risk to patients if water systems become contaminated with *P. aeruginosa or other opportunistic pathogens***
- **Actions to take if water systems become contaminated with *P. aeruginosa***
- **Protocols for sampling, testing and monitoring water for *P. aeruginosa***

Public Health England

Water Safety Group (WSG):

A multidisciplinary group formed to undertake the commissioning and development of the water safety plan (WSP). It also advises on the remedial action required when water systems or outlets are found to be contaminated and the risk to susceptible patients is increased.

- **Director of infection prevention and control (DIPC);**
- **IPC team;**
- **Consultant medical microbiologist;**
- **Estates and Facilities team (including hotel/ cleaning services staff and the Responsible Person (Water));**
- **Senior nurses from relevant augmented care units**

WSP is a risk-management approach to the microbiological safety of water that establishes good practices in local water distribution and supply. It will identify potential microbiological hazards caused by *P. aeruginosa and other opportunistic pathogens, consider practical aspects, and detail appropriate control measures.*

Public Health England

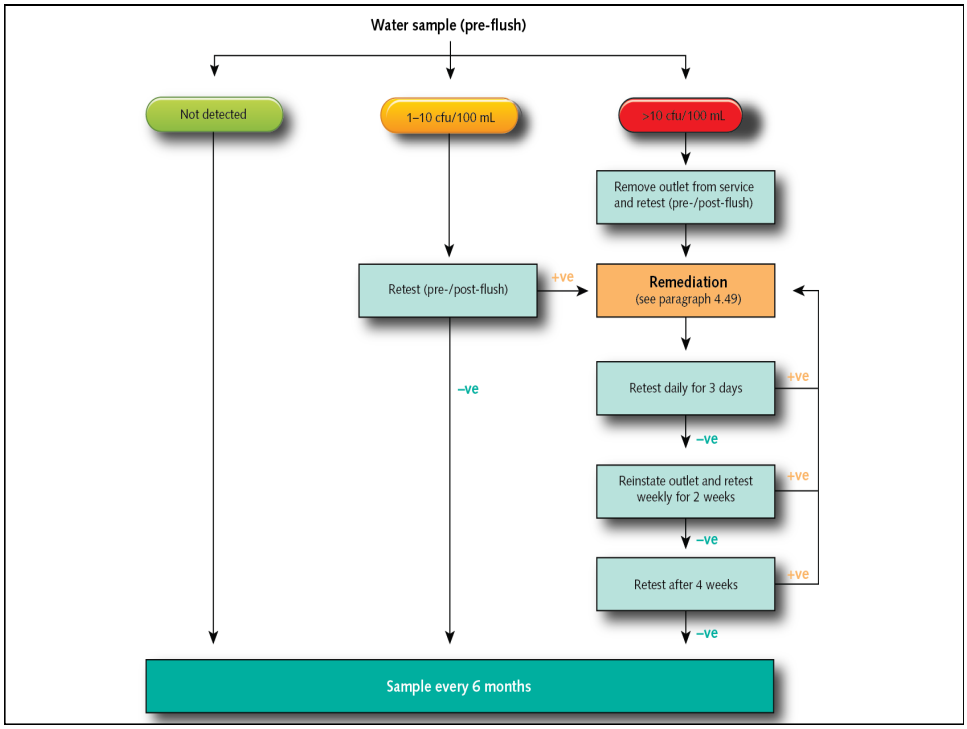
HTM 04-01 Tap outlets and Flow straighteners

Where practical, consider removal of flow straighteners. However, the removal of flow straighteners may result in splashing and therefore additional remedial action may need to be taken. If they are seen to be needed, periodically remove them and either clean/ disinfect or replace them. Replacement frequency should be verified by sampling/ swabbing.

Check for underused outlets – assess frequency of usage and if necessary remove underused outlet(s).

Assess the water distribution system for non-metallic materials that may be used in items such as inline valves, test points and flexible hoses.

Dead legs and thermostatic mixer valves - stagnation of cold supply



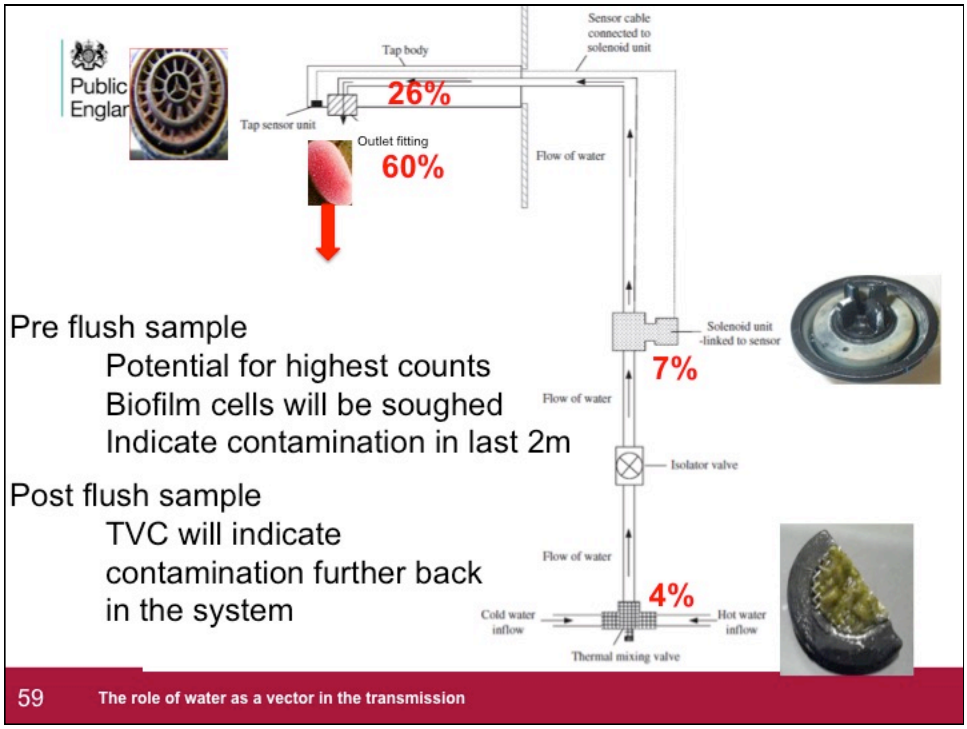
Public Health England

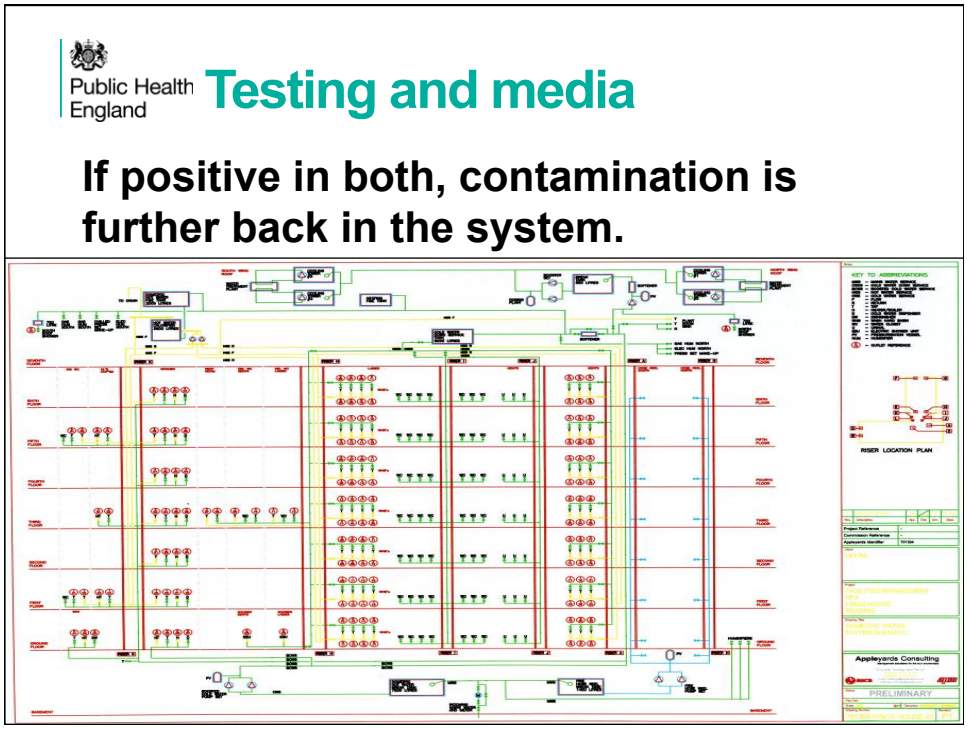
Frequency of testing

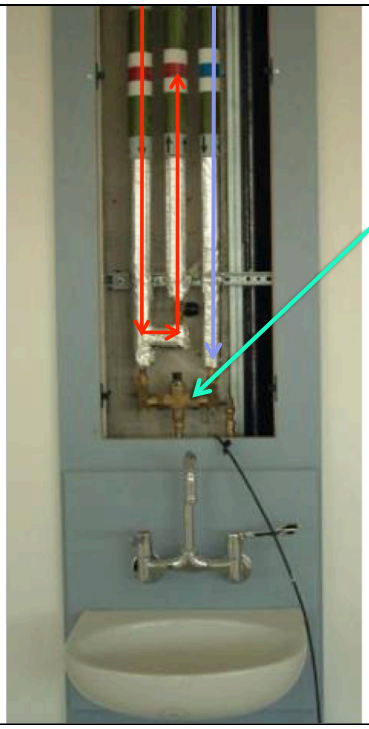
A systematic schedule based on local risk assessment - water safety plan

Risk assess where your augmented patients are located

All taps do not have to be tested at the same time


Public
Englar
Tap body
Sensor cable connected to solenoid unit
26%
Tap sensor unit
Outlet fitting
60%
Flow of water
Solenoid unit -linked to sensor
7%
Flow of water
Isolator valve
Flow of water
4%
Cold water inflow
Hot water inflow
Thermal mixing valve
Pre flush sample
Potential for highest counts
Biofilm cells will be soughed
Indicate contamination in last 2m
Post flush sample
TVC will indicate contamination further back in the system
59
The role of water as a vector in the transmission


Public Health England
Testing and media
If positive in both, contamination is further back in the system.
KEY TO ABBREVIATIONS
RISER LOCATION PLAN
Appleyards Consulting
PRELIMINARY

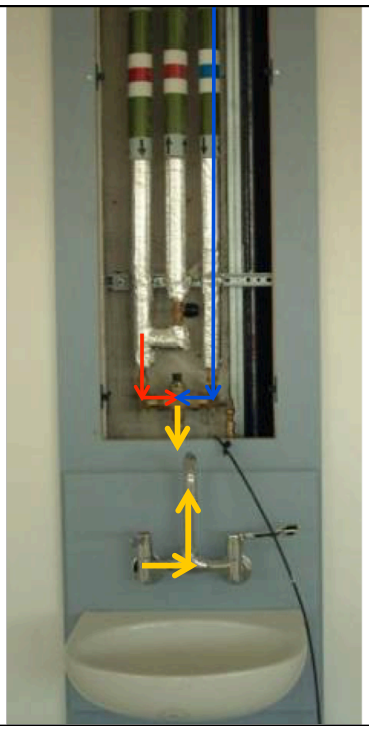


Minimum temperature at the most distant taps or outlets should be 55°C.

TMV prevents hot scalding water at hot outlet

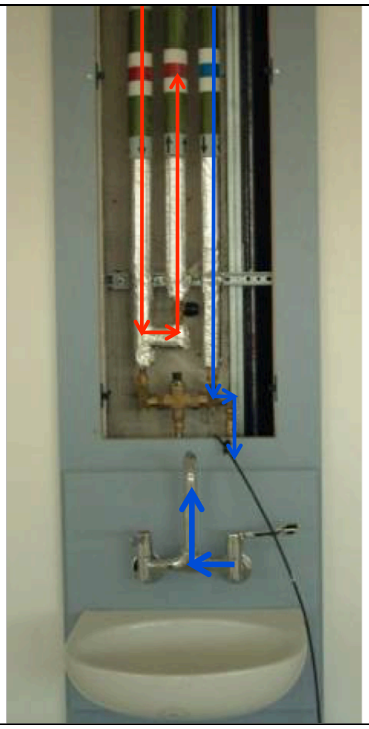
TMV prevents thermal purging of the outlet

No lagging after TMV of hot or cold pipes



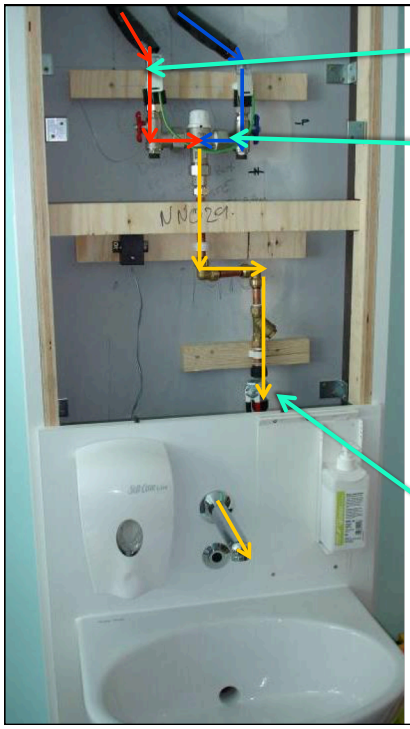
Post TMV water at ~43ºC

Creates a favourable environment for microbial growth



Cold pipe - how often would this cold tap be used?

Forms an immediate dead leg where you could get biofilm growth



Spur from hot water flow and return

TMV

Post TMV water at ~45ºC

Unlagged after TMV

Relatively long dead leg

Sensor reduces hand contact

Solenoid

Public Health England

TMV built into the tap head

Reduces the distance from the TMV to the outlet

This tap unit has now been designed to allow the tap spout to be removed or the whole assembly easily removed.

Public Health England

How do you protect vulnerable patients

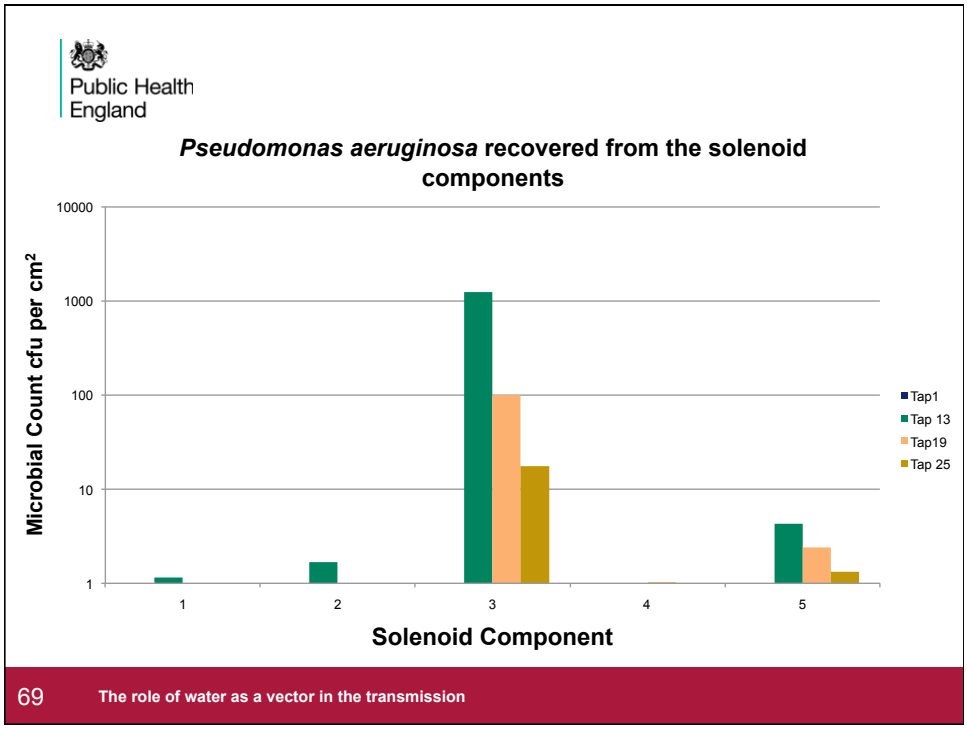
- Identify the source of the contamination
- Remove/replace the contaminated components
  - dismantle, clean, disinfect, refit
  - replace with new/different type of outlet
- Use local control strategy
  - Flushing/Decontamination
- Review overall control strategy
  - temperature as a control
  - other disinfectants
- Review use of sinks
  - potential for retrograde contamination

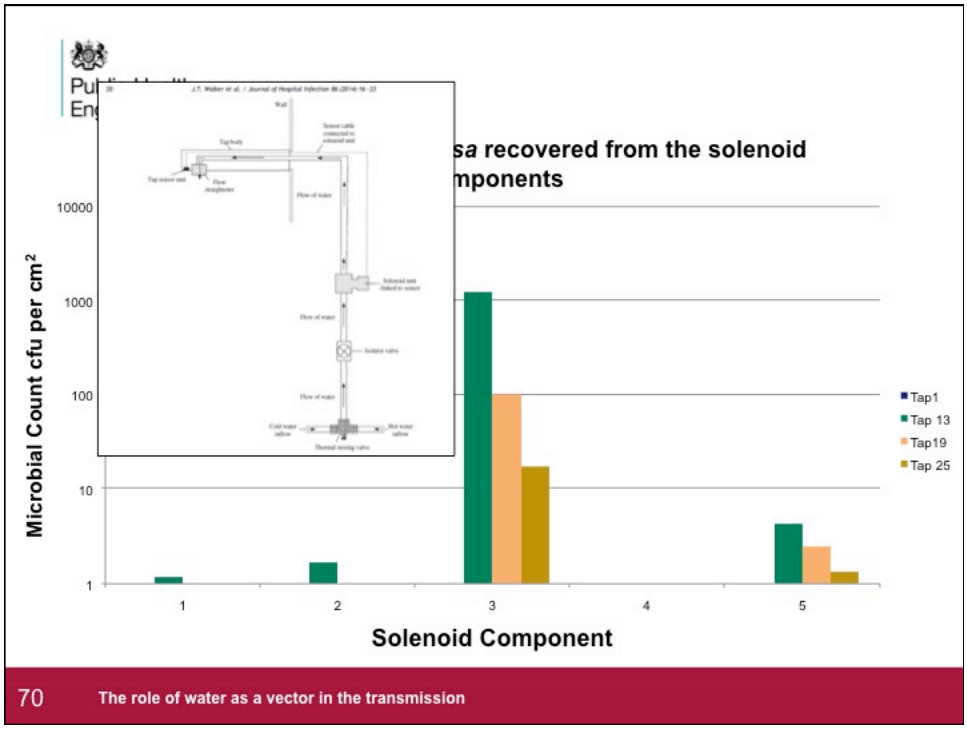
66 The role of water as a vector in the transmission

Design and Commissioning?

Public Health England

PHE Porton Test Rig


Public Health England
Pseudomonas aeruginosa recovered from the solenoid components
Microbial Count cfu per cm²
10000
1000
100
10
1
1
2
3
4
5
Solenoid Component
Tap1
Tap 13
Tap19
Tap 25
69
The role of water as a vector in the transmission


sa recovered from the solenoid
mponents
Microbial Count cfu per cm²
10000
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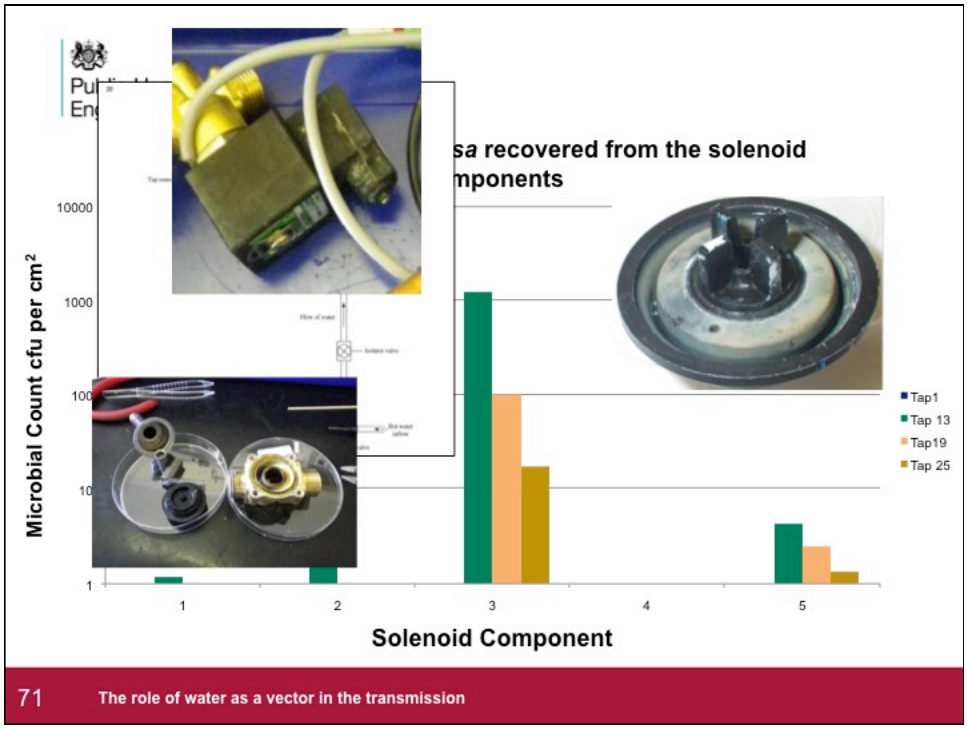
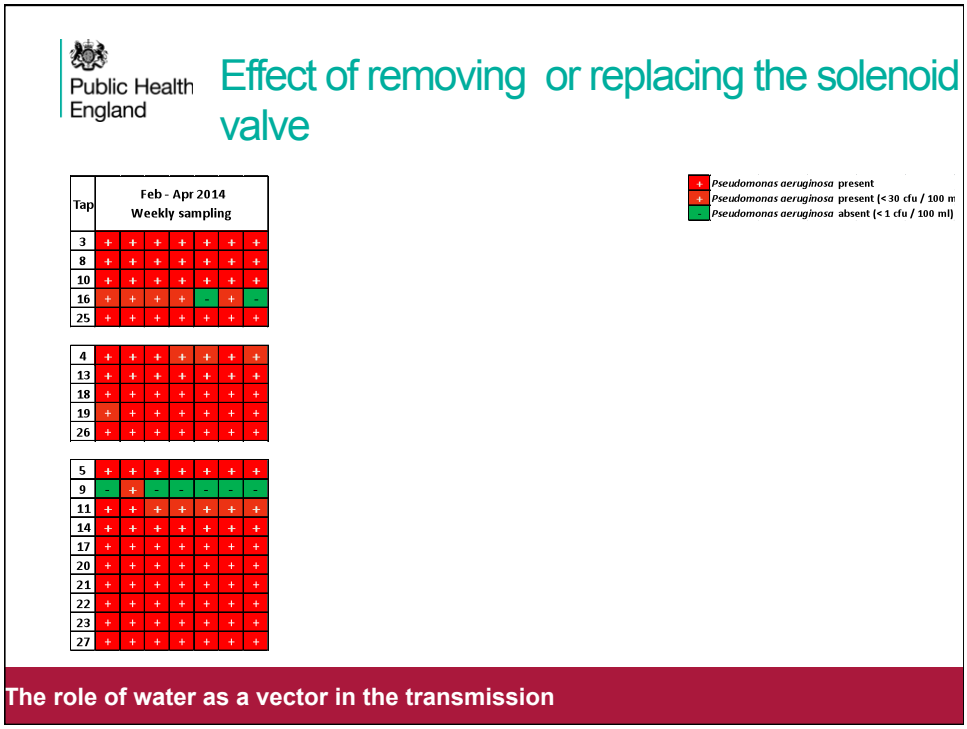
Tap19
Tap 25
70
The role of water as a vector in the transmission


sa recovered from the solenoid
mponents
Microbial Count cfu per cm²
10000
1000
100
10
1
1
2
3
4
5
Solenoid Component
Tap1
Tap 13
Tap19
Tap 25
71
The role of water as a vector in the transmission


Public Health England
Effect of removing or replacing the solenoid valve
Tap
Feb - Apr 2014
Weekly sampling
3 8 10 16 25
4 13 18 19 26
5 9 11 14 17 20 21 22 23 27
Pseudomonas aeruginosa present
Pseudomonas aeruginosa present (< 30 cfu / 100 m
Pseudomonas aeruginosa absent (< 1 cfu / 100 ml)
The role of water as a vector in the transmission

Public Health England

Effect of removing or replacing the solenoid valve

Tap	Feb - Apr 2014 Weekly sampling						
3	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+
10	+	+	+	+	+	+	+
16	+	+	+	+	-	+	-
25	+	+	+	+	+	+	+

Solenoid removed

Apr - June 2014 Weekly sampling							
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

4	+ + + + + + +
13	+ + + + + + +
18	+ + + + + + +
19	+ + + + + + +
26	+ + + + + + +

5	+ + + + + + +
9	- + - - - - -
11	+ + + + + + +
14	+ + + + + + +
17	+ + + + + + +
20	+ + + + + + +
21	+ + + + + + +
22	+ + + + + + +
23	+ + + + + + +
27	+ + + + + + +

+ *Pseudomonas aeruginosa* present
+ *Pseudomonas aeruginosa* present (< 30 cfu / 100 m
- *Pseudomonas aeruginosa* absent (< 1 cfu / 100 ml)

The role of water as a vector in the transmission

Public Health England

Effect of removing or replacing the solenoid valve

Tap | Feb - Apr 2014 Weekly sampling | Solenoid removed | Apr - June 2014 Weekly sampling

3 + + + + + + +
8 + + + + + + +
10 + + + + + + +
16 + + + + - + -
25 + + + + + + +

- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -

4 + + + + + + +
13 + + + + + + +
18 + + + + + + +
19 + + + + + + +
26 + + + + + + +

Solenoid replaced

- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -

5 + + + + + + +
9 - + - - - - -
11 + + + + + + +
14 + + + + + + +
17 + + + + + + +
20 + + + + + + +
21 + + + + + + +
22 + + + + + + +
23 + + + + + + +
27 + + + + + + +

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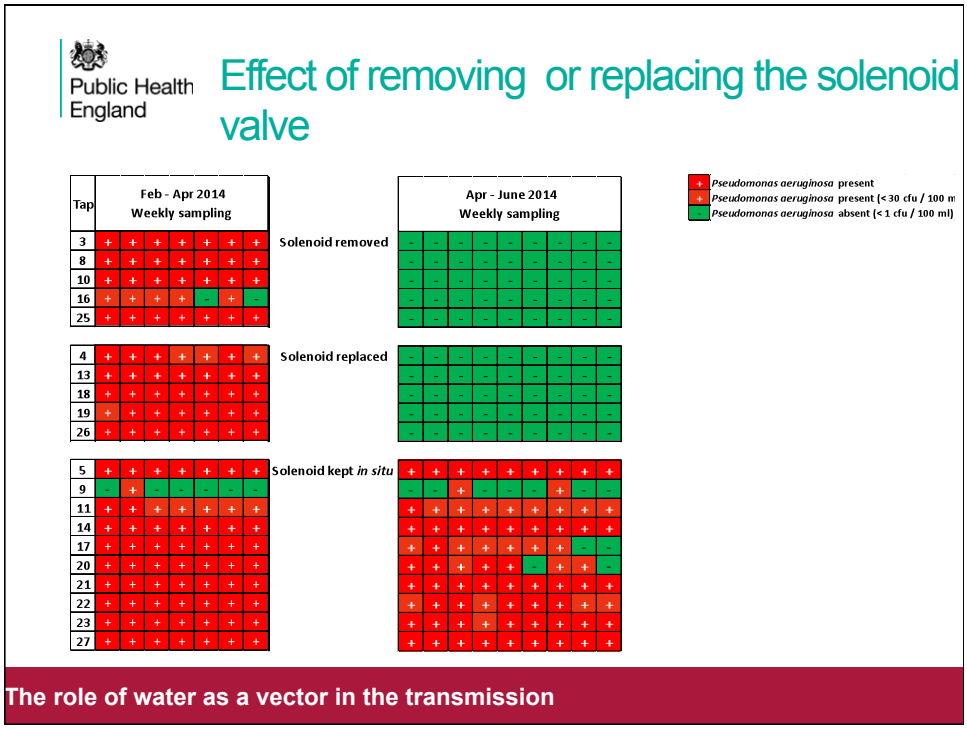
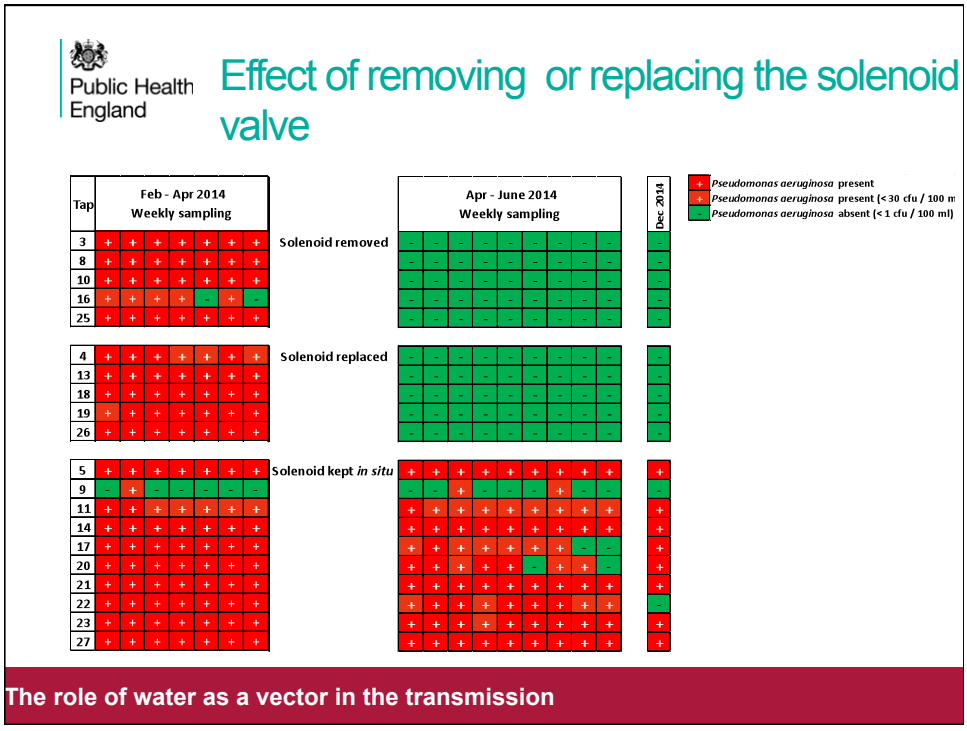
The role of water as a vector in the transmission


Public Health England
Effect of removing or replacing the solenoid valve
Tap
Feb - Apr 2014 Weekly sampling
Apr - June 2014 Weekly sampling
Solenoid removed
Solenoid replaced
Solenoid kept *in situ*
Pseudomonas aeruginosa present
Pseudomonas aeruginosa present (< 30 cfu / 100 m
Pseudomonas aeruginosa absent (< 1 cfu / 100 ml)
The role of water as a vector in the transmission


Public Health England
Effect of removing or replacing the solenoid valve
Tap
Feb - Apr 2014 Weekly sampling
Apr - June 2014 Weekly sampling
Dec 2014
Solenoid removed
Solenoid replaced
Solenoid kept *in situ*
Pseudomonas aeruginosa present
Pseudomonas aeruginosa present (< 30 cfu / 100 m
Pseudomonas aeruginosa absent (< 1 cfu / 100 ml)
The role of water as a vector in the transmission

Waines et al., 2011, Biofouling

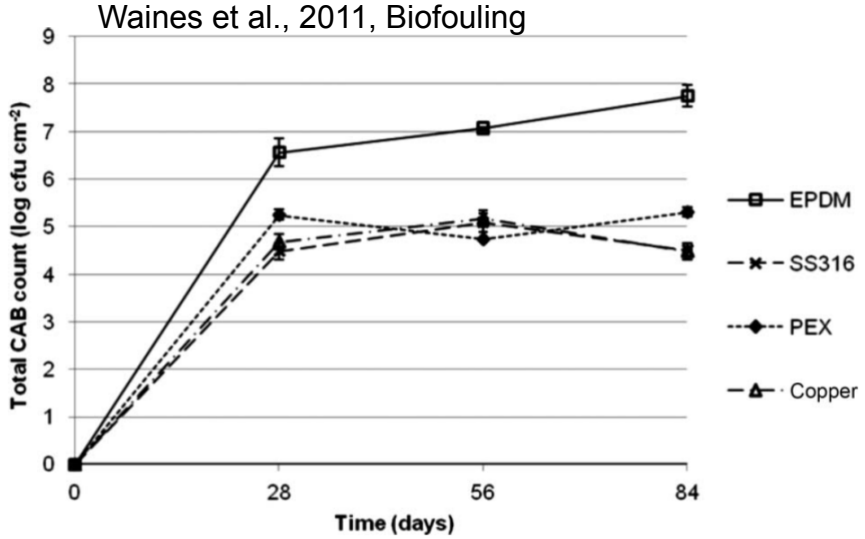


Figure 2. Total culturable aerobic bacteria counts on EPDM, stainless steel 316 (SS316), PEX and copper test rig inserts over 84 days. Error bars = SD.

77

Moritz et al 2010. IJHEH

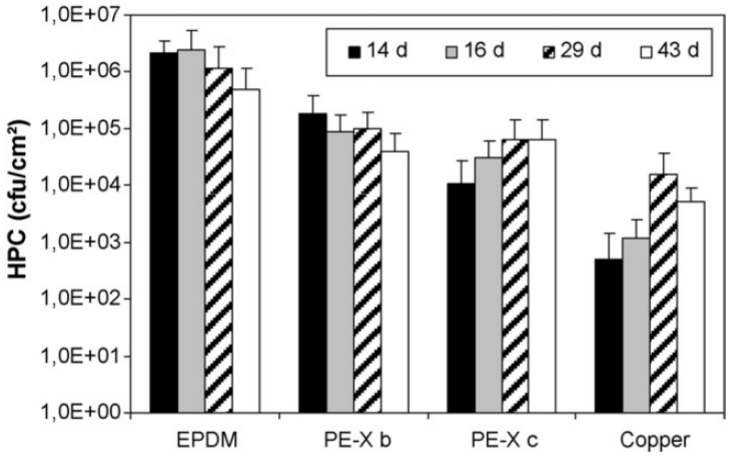
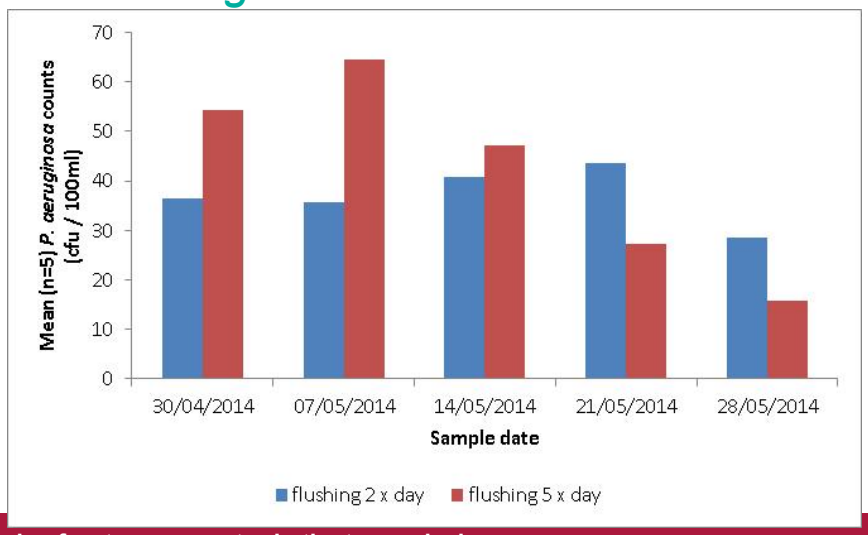


Fig. 2. Heterotrophic plate counts of drinking water biofilms grown on EPDM, PE-X b, PE-X c and copper under constant flow conditions. Heterotrophic plate counts after 14 days were determined in four independent experiments and heterotrophic plate counts after 16, 29 and 43 days were determined in three independent experiments.

78

Public Health England

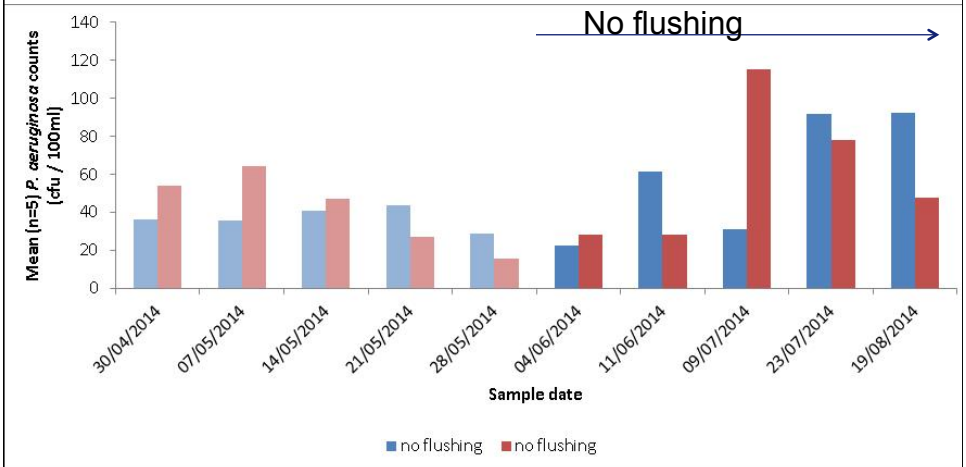
Effect of increased flushing on *P. aeruginosa* counts



The role of water as a vector in the transmission

Public Health England

Effect of no flushing on *P. aeruginosa* counts



80 The role of water as a vector in the transmission

Public Health England

Tracking of *Pseudomonas aeruginosa* in QEH burns unit water

Screening on admission

>7% burns

Wound swabs, stool and Urine for microbiology

- Stool for molecular testing

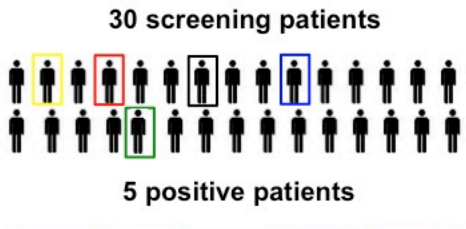
Environmental sampling of the patients room and shower water

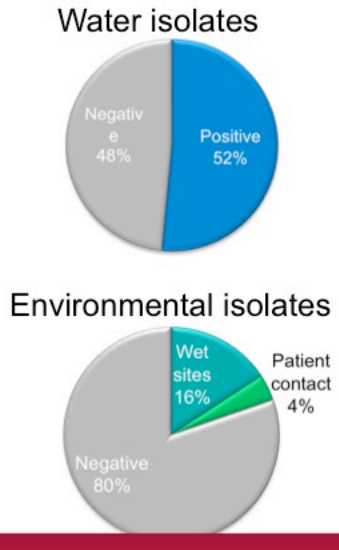
- **Recruited positive patients**
  - Wound swabs at each dressing change
  - Environmental sampling
  - Swabs/tissue for metagenomic analysis
  - Environmental sampling on discharge

81 Quick *et al*., 2014 Seeking the source of Pseudomonas aeruginosa infections in a recently opened hospital: an observational study using whole-genome sequencing BMJ Open

Public Health England

Results from the QEH Burns Unit





82 Joshua Quick 2014 , Beryl Oppenheim, Nick Loman et al., Univ of Birmingham In Press

Public Health England

Summary from QEH Burns Unit

Water was the likely cause of infection in 60% patients

Water outlets and wet/moist sites have high levels of contamination

WGS to be used to track isolates from different rooms and even outlets

Could be used as a powerful surveillance method

Can be used to identify antibiotic resistant strains

83 Joshua Quick 2014, Beryl Oppenheim, Nick Loman et al., Univ of Birmingham In Press

Control Methods


Pub
Eng


Identification?
Barcoding?

Smooth internal bores and removable outlets

POU Filters

Public Health England

POU filters, where they can be fitted, may be used to provide water free of *P. aeruginosa. Where fitted, regard filters primarily as a temporary measure until a permanent safe engineering solution is developed, although long-term use of such filters may be required in some cases.*

Note that the outer casing of a POU filter and the inner surface can become contaminated

First line of defence?

Rapid solution to *P. aeruginosa* free water

Can you fit a filter to your tap?

Does it occlude flow?

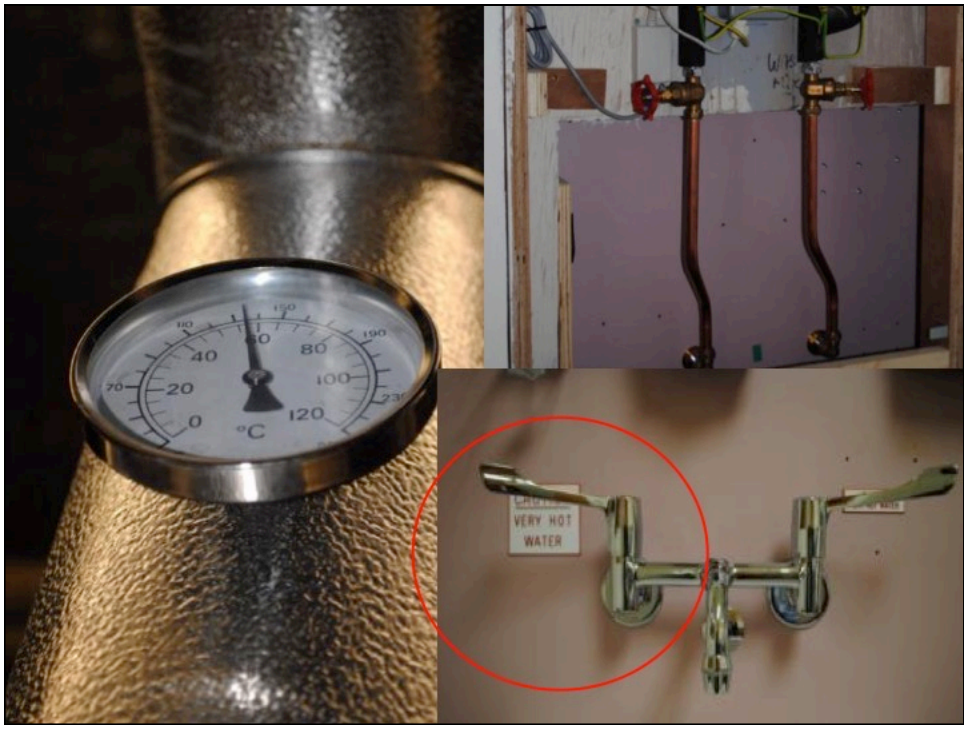
Is there sufficient space between the filter and basin?

Cleaning?

Contamination of casing?

Thermal Control?

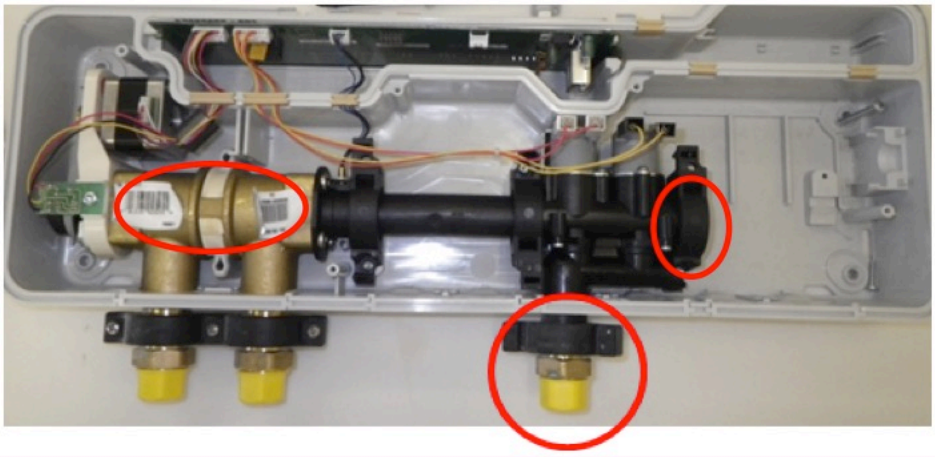
The decision whether to install a TMV in areas not normally accessible to patients should be based on a risk assessment


VERY HOT
WATER


Thermal control
POWER ON
LOCAL
OFF
REMOTE
HIGH
TEMPERATURE

Public Health England

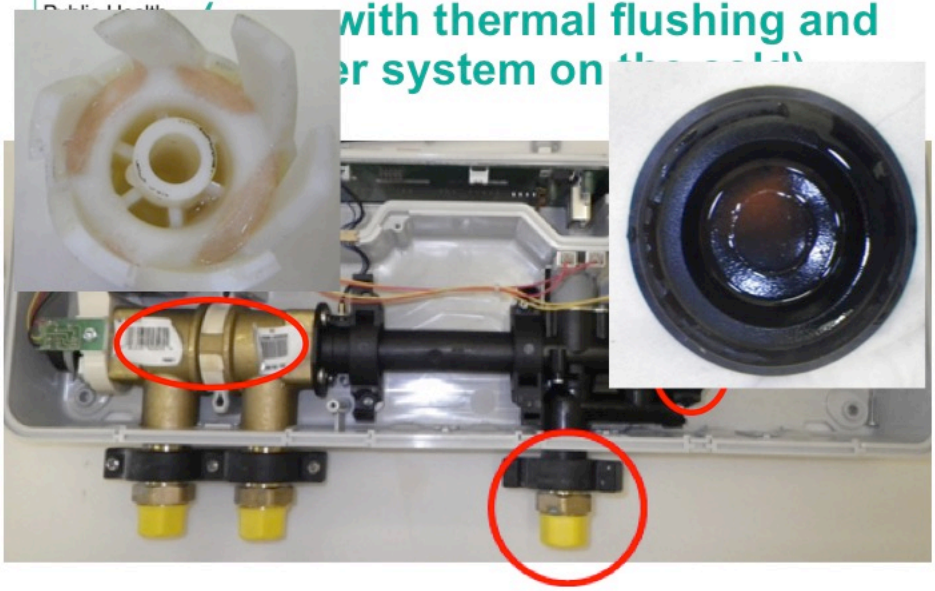
Areas of biofilm detected (even with thermal flushing and Kemper system on the cold)



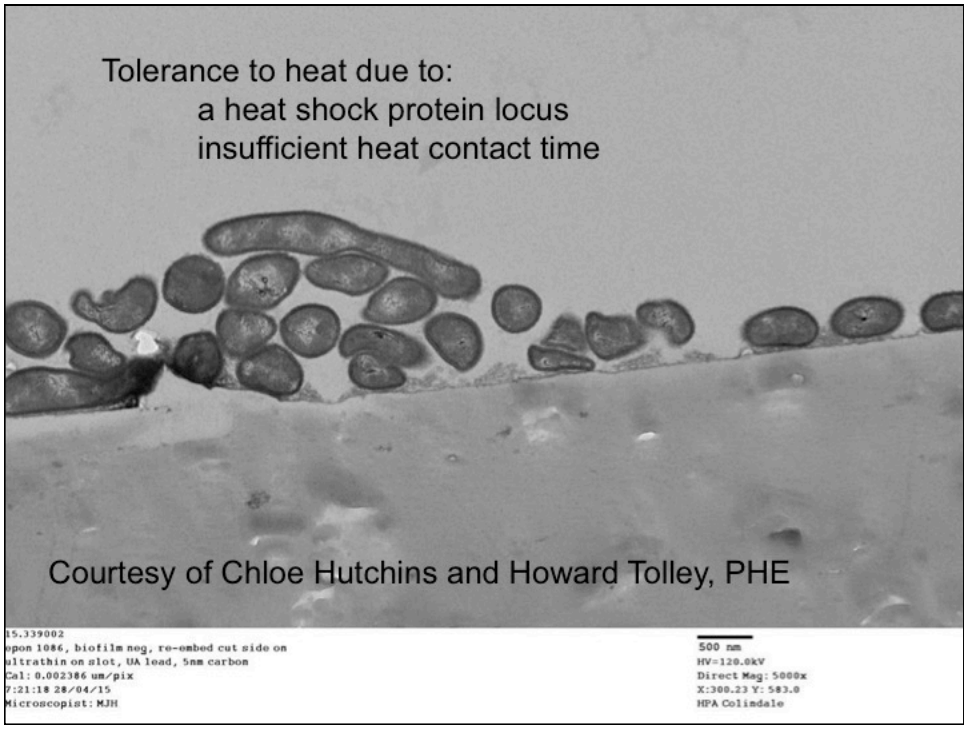
93 *P. aeruginosa*, water and vulnerable patients

Public Health England

Areas of biofilm detected (even with thermal flushing and Kemper system on the cold)



94 *P. aeruginosa*, water and vulnerable patients



Public Health England

Chemical Disinfection

Chlorination - cold water storage tank to 20-50 mg/litre free residual chlorine and flow to all parts of the system. This depends on chlorine concentration (at least one hour at 50 mg/l to at least two hours at 20 mg/l). Mains water: 0.1–0.5 mg/l

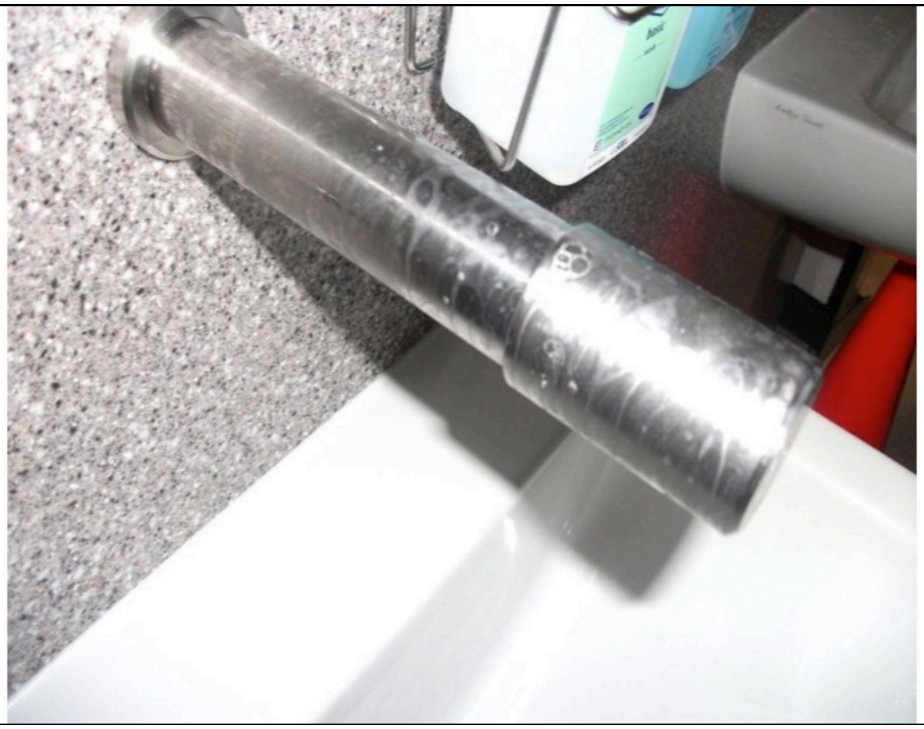
Chlorine dioxide – may need to shock dose at 5ppm and operate at 0.25-0.5ppm (max DWI). Can take long time to get control.

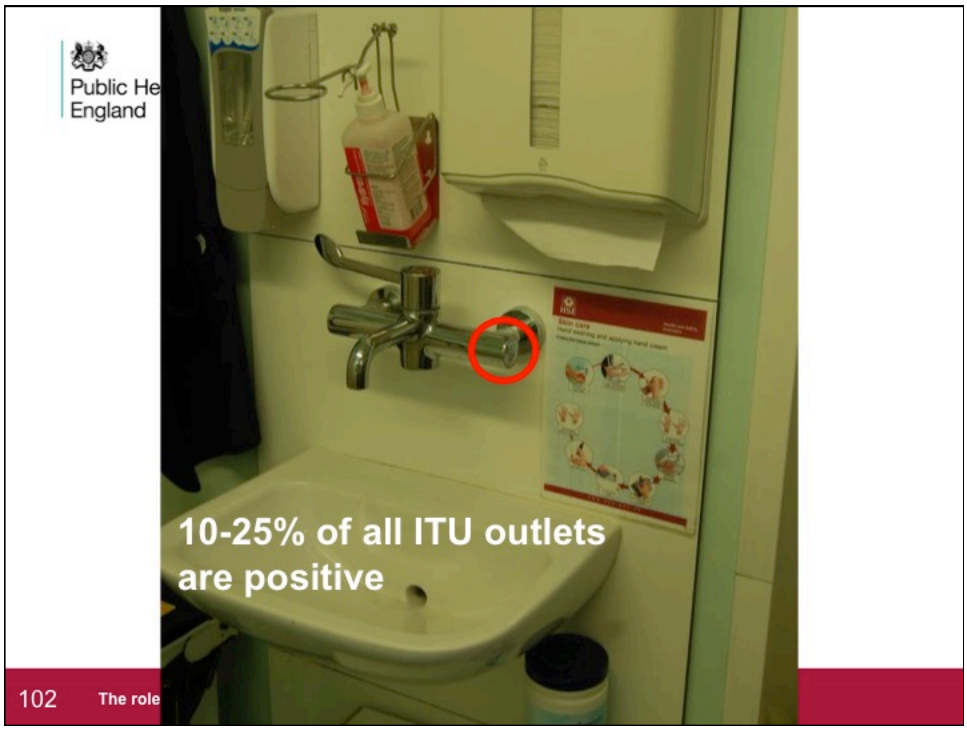
Copper Silver - The recommended concentrations for *Legionella* are 0.2 mg/l copper (up to 0.8mg/l) and more than 0.02 mg/l silver (up to 0.08mg/l) are recommended at outlets

96 L8; Hosien *et al*; 2005. JHI, 61, 100-6; Hood *et al*., 2000. AJIC, 28, 86; Chen *et al*., 2008. JHI; 68; 152.


Are you controlling the biofilm?
Where is your biofilm?
Courtesy of Malcolm Greenhalgh

UV System




Public He
England
10-25% of all ITU outlets
are positive
102
The role

Public Health England

Design and Maintenance

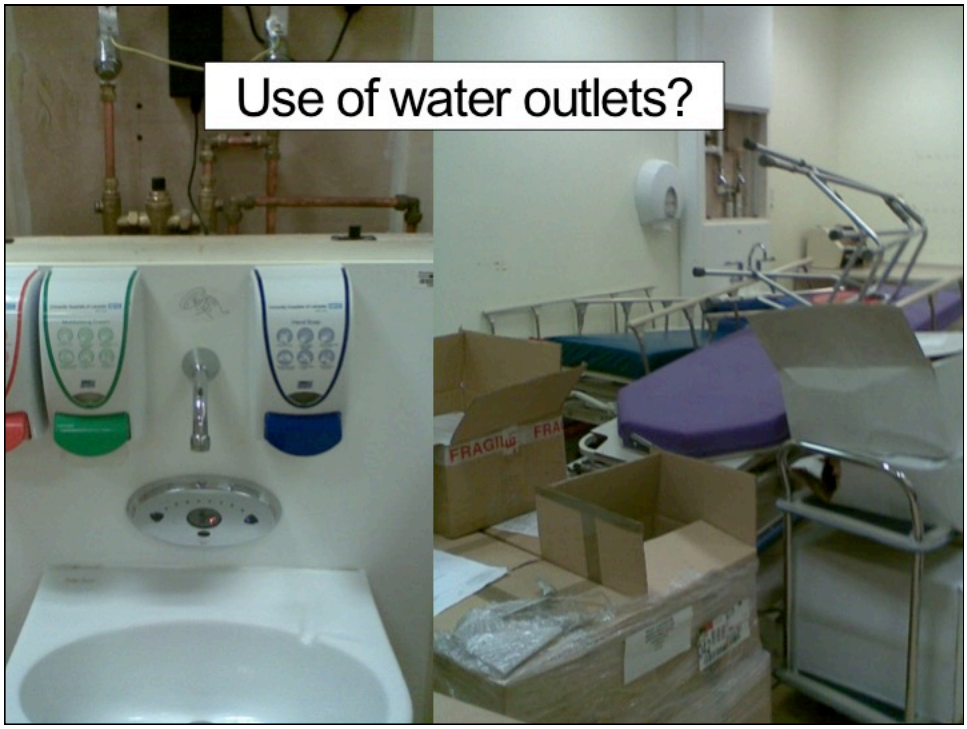
103 *General discussion on water*
- Thanks to Wendy Claasan

Public Health England

Design and Maintenance


Courtesy of John Foxall


Courtesy of John Foxall
Changing a tap may help remove the colonisation


Use of water outlets?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Thanks to Wendy Caarson


Public Health England
Pragmatic issues - water flows
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New fundamental research on presence and control of water borne pathogens


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Baby Bath
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Public Health England
Do drains play a role in microbial distribution and recolonisaiton?
So what do you think is in your drain?
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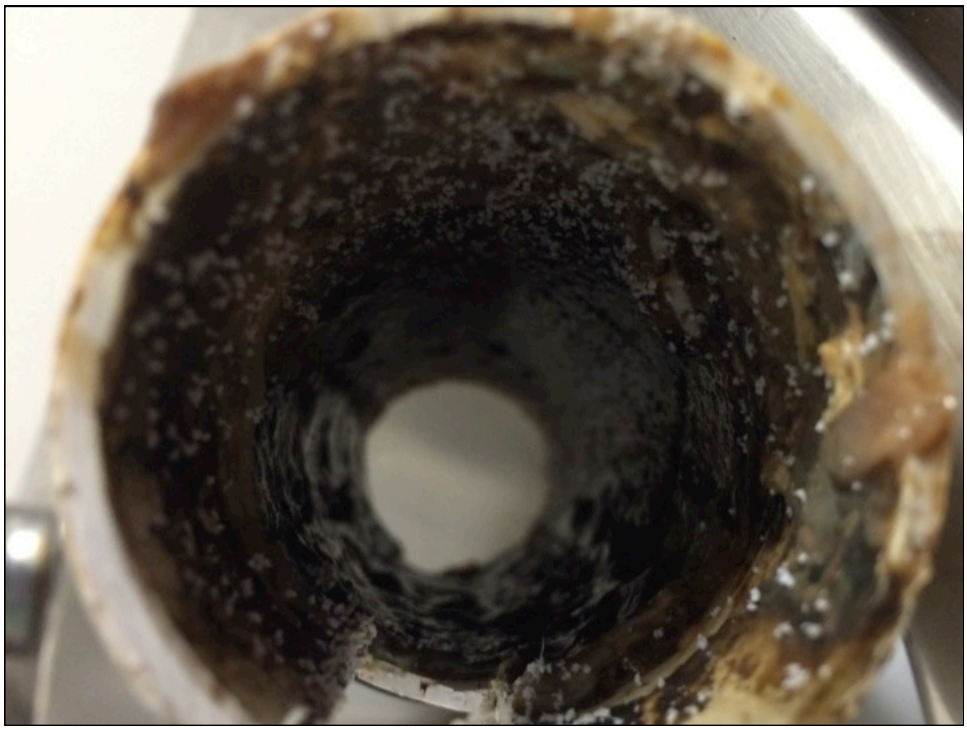
The role of water as a vector in the transmission

The Role of Water as a Vector for Infection in the Transmission of Infections in Hospitals
Dr. Jimmy Walker, Public Health England
A Webber Training Teleclass



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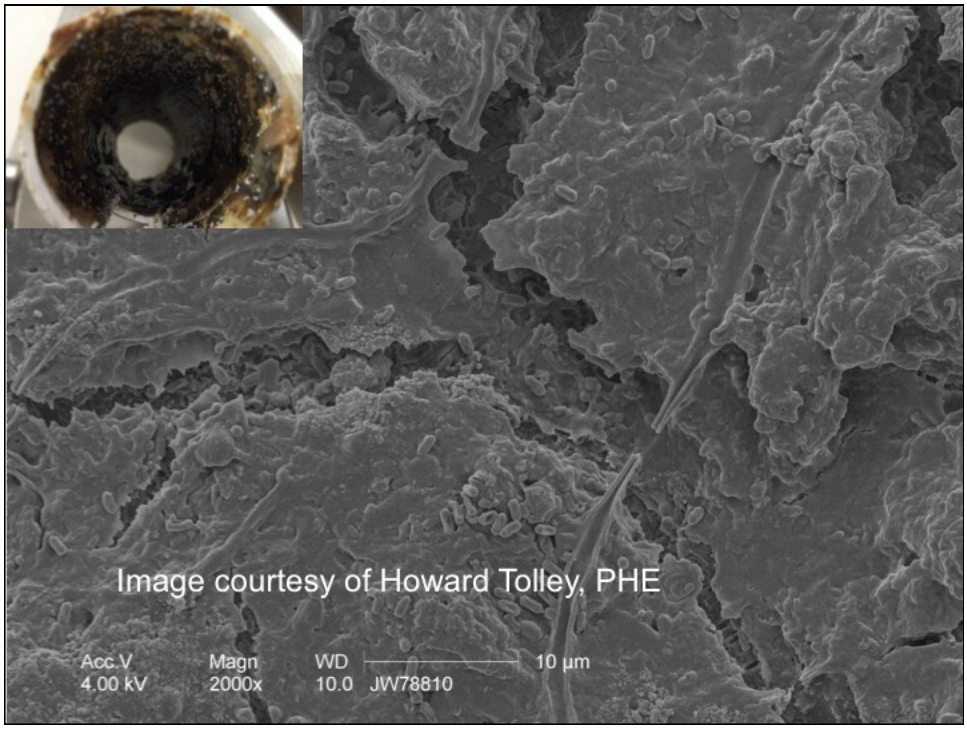

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Best practice advice for clinical wash-hand basins

Use the clinical wash-hand basin only for hand-washing:

a. Do not dispose of body fluids at the clinical wash-hand basin – use the slophopper or sluice in the dirty utility area.

b. Do not wash any patient equipment in clinical wash-hand basins.

c. Do not use clinical wash-hand basins for storing used equipment awaiting decontamination.

d. Do not touch the spout outlet when washing hands.

e. Clean taps before the rest of the clinical wash-hand basin. Do not transfer contamination from wash-hand basin to wash-hand basin.

f. Do not dispose of used environmental cleaning agents at clinical wash-hand basins.

Public Health England

Retrograde contamination

Issue – patient secretions could lead to environmental contamination of HWB and drains(?)

Sluice too far away

put in additional sluice

use the toilet for waste

use gel granules to absorb fluid

If you have to put waste down the hand washing basin – then alert house keeping.

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NEWS BRISTOL

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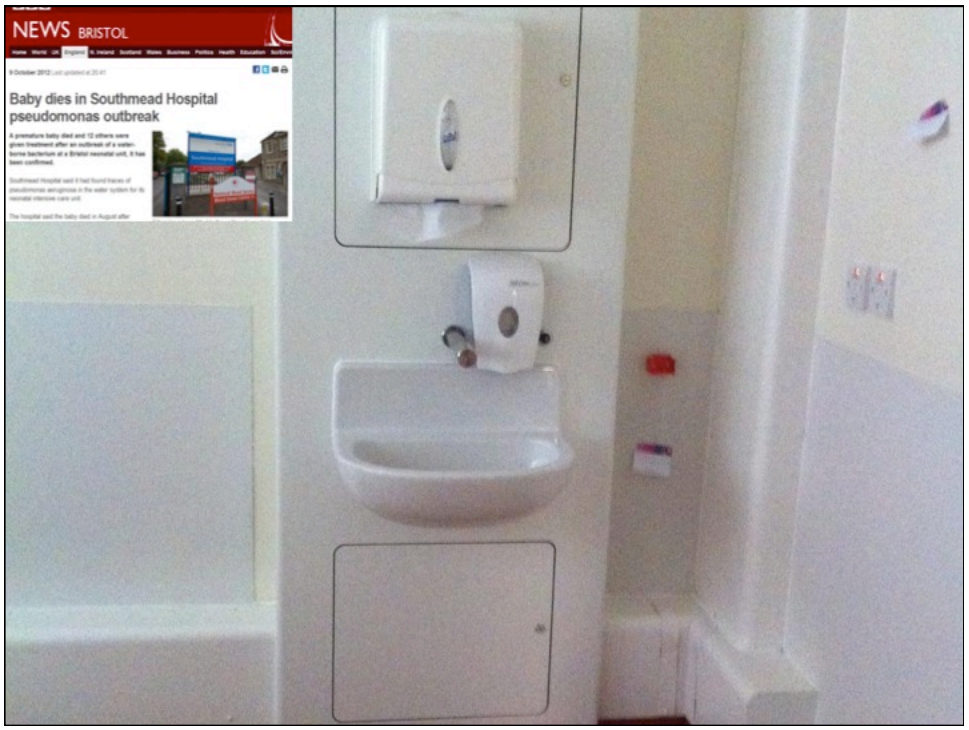
9 October 2012 Last updated at 20:41

Baby dies in Southmead Hospital pseudomonas outbreak

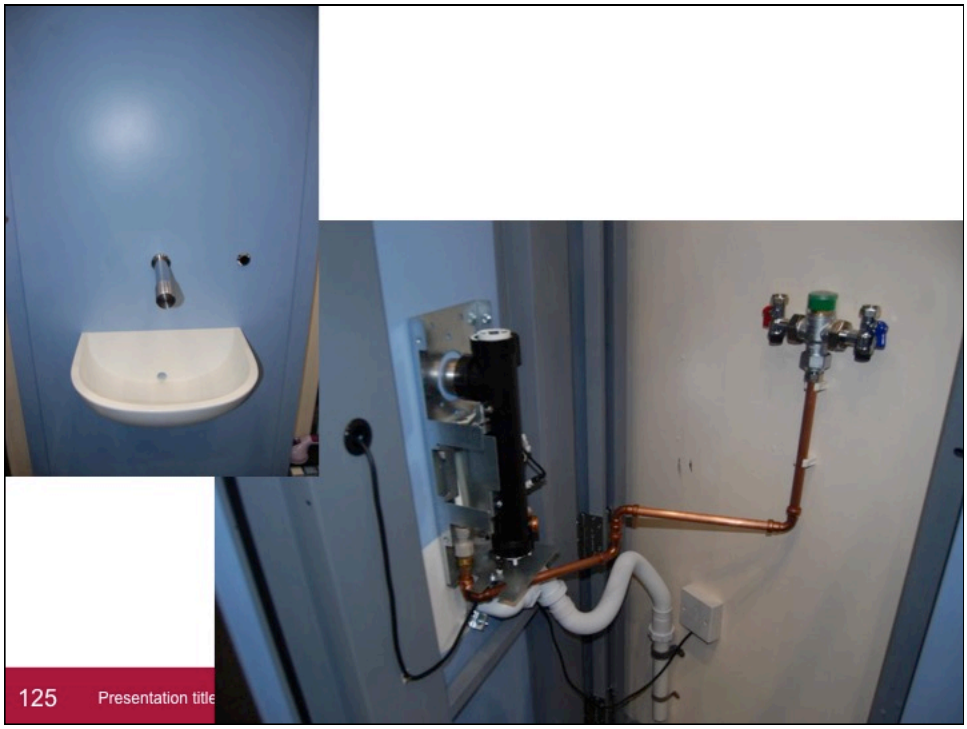
A premature baby died and 12 others were given treatment after an outbreak of a water-borne bacterium at a Bristol neonatal unit, it has been confirmed.

Southmead Hospital said it had found traces of pseudomonas aeruginosa in the water system for its neonatal intensive care unit.

The hospital said the baby died in August after



NEWS BRISTOL
Baby dies in Southmead Hospital pseudomonas outbreak



Published Reports and Guidance

RQIA Independent Review of Pseudomonas Final Report.
http://www.rqia.org.uk/publications/rqia_reviews.cfm.

Addendum for HTM 04-01 *P. aeruginosa* (March 2013)

http://www.dh.gov.uk/health/2013/03/pseudomonas-addendum/

L8 – Legionella control in hot and cold water systems

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Public Health England

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