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## Infection Prevention in Practice

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## Commentary

## Water, life and death



'We spend a great deal of time studying history, which, let's face it, is mostly the history of stupidity.'

Stephen Hawking

Water is essential to life, irrespective of form. The lack of differentiation means this unique substance frequently purveys disease. Life began in the ocean, with biofilm being the bacteria's adaptation to an aquatic environment honed over billions of years. It is biofilm, whose secrets we are still unlocking, that thwarts our ability to provide safe water in hospitals. Is it biofilm alone or are other forces impeding progress?

History might provide an insight. In 1847, despite Semmelweis demonstrating the importance of handwashing, his findings were rejected by the medical fraternity at the time. Move on five years, and the industrial revolution becomes a major driver for sanitation. The large influx of the rural population into cities lacking the infrastructure to supply safe water and remove human waste provided ideal conditions for infectious diseases to flourish. Basements of houses became cesspits. The resulting stench became synonymous with disease in Victorian minds, promoting the 'miasma theory' – spread of disease by malodorous air. Edwin Chadwick, a social reformer, ordered all cesspits to empty into the Thames (up to then a clean river), leading to faecal contamination of the water supply. John Snow's eloquent epidemiological studies proved cholera to be a waterborne infection but again his findings were ignored. The germ theory was not established until later that century, so perhaps the scepticism had a partial basis.

Move on a hundred years to 1967 and microbiology is an established discipline. Responding to a leading article in the *British Medical Journal* on *Pseudomonas aeruginosa* (PA), Joachim Kohn stated the risk from water was underestimated, and detailed transmission of pseudomonas to patients from sinks [1]. However, an unwritten folklore amongst medical microbiologists (organisms went from the patient to the sink and not *vice versa*) prevailed over scientific evidence. In 2009 Professor Kevin Kerr spoke at a conference where he caused consternation by stating organisms went from the sink to the patient. Members of the audience demanded evidence to support this. These educated individuals accepted hands contaminated with PA could lead to transmission, yet not water from a contaminated outlet to wash a high-dependency-unit patient. In 2012, the death of four neonates combined with

press interest in Belfast made the medical profession think afresh. Neonatal deaths from PA were not new, the difference being Belfast excited intense media interest. The ensuing enquiry led by Professor Troop in laying blame locally did not take a holistic view. Rather than local, this was a failure across all strata from the Department of Health downwards. A fresh enquiry might identify the Semmelweis reflex as a major factor – the reflex-like tendency to reject new evidence or new knowledge because it contradicts established norms, beliefs or paradigms. The anger I witnessed when Kevin spoke demonstrated this reflex. The audience did not like to hear that their professional practices were unsound.

2012 put the risk from the periphery of the water system firmly on the map, producing an update to Health Technical Memorandum 04-01. Monitoring effectiveness of control measures is easier in the neonatal setting as PA is not part of their normal flora (a single isolate being an alert). In adults the situation is complex as endogenous carriage of PA clouds the issue. A very high percentage of published waterborne adult outbreaks have been with multi-drug-resistant organisms. Initially these were termed OPPS (Opportunistic Plumbing Premise Pathogens), typically non-fermenting Gram-negative rods and atypical mycobacteria. More recent reports highlight outbreaks due to carbapenemase-producing Enterobacteriaceae (CPE) [2]. Reports increasingly implicate sink drains [3–5]. All drains (be they from kitchen, shower, handwash sink or toilet) are connected by the same pipework. Drain blockages in hospitals are common, often from incorrect disposal of wipes. Due to intractable outbreaks, some intensive-therapy units have taken the step of removing water services. In the Netherlands, this not only eliminated the drug-resistant outbreak strain, but produced reductions in all Gram-negative organisms [6]. Resistant organisms attract our attention, they stand out, but there is no evidence that they have any special adaptation to waterborne transmission. Outbreaks with sensitive endemic organisms are much more difficult to recognize. It took three years to recognize an outbreak on a burns unit with a sensitive PA [7]. The same occurred in our own hospital, but now that measures are in place it appears the incidence of PA has dropped to that of several years ago. No standard for an acceptable level of endogenous PA carriage and/or infection exists. Without this, units are unable to judge whether they might have an outbreak, tending to accept what they are used to seeing. It is very plausible that unrecognized transmission of sensitive PA occurs on augmented-care units.

We have supposedly moved from infection control to infection prevention and control specialists. A quick review of many outbreaks shows they arose due to obvious deficiencies in practice – emptying patient secretions down sinks, drains

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located immediately below the outlet, poor cleaning practices, etc. This should not be the case. The issue of water safety has suddenly been thrown at infection-control teams who have received little or no training in this area. To expect any publication to replace proper training/competency assessment is naïve.

But we go back to history repeating itself. CPEs reside in the human intestine – transmission by hospital water is analogous to faecal contamination of the water supply in the industrial revolution. Methods of either physically or chemically decontaminating drains are being researched/marketed due their involvement in outbreaks. Go back to 1970 when Joachim Kohn published a design for a waste water trap sterilizing unit – he believed the drain is the source of most waterborne pathogens [8]. Saying history repeats itself is surely denying the point, that the Semmelweis reflex flourishes still.

A recent paper points to the dirty sluice as a source of cross-infection [9]. A dirty sluice is a decontamination unit. Visit the hospital CSSD (a decontamination unit) and you will find a very controlled flow from dirty to clean. Visit a ward dirty sluice and the odds are there is no organized flow from dirty to clean. It would seem remiss not to mention a paper from 1949 detailing design of a sluice with flow from dirty to clean [10]. Our reflexes (Semmelweis) would appear to be intact.

### Conflict of interest statement

None.

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M. Weinbren\*

King's Mill NHS Foundation Trust, Sutton-In-Ashfield, UK

\* Address: King's Mill NHS Foundation Trust, Mansfield Rd, Sutton-in-Ashfield NG17 4JL, UK.  
 E-mail address: [mweinbren1@nhs.net](mailto:mweinbren1@nhs.net)

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