Is thermal disinfection appropriate for NICU water? Mitigating risk from water.

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Background

In 2020, Capital and Coast (CC) NICU isolated Pseudomonas aeruginosa in sink drains and tap water in four shared infant rooms. Using pulsed field gel electrophoresis, CC linked it to an outbreak involving three infants, one who had a severe outcome. The sink taps and drains were disinfected and point-of-use bacterial filters were installed on all clinical sinks. Filters are renewed 2-monthly. Routine testing confirmed no further pseudomonas in downstream water

Sensor tap with point of use bacterial filter

Stagnant water and excess nutrients encourage biofilm growth. Water flushed at 60˚C inactivates pseudomonas in biofilm[1], and even at 58˚ can remove biofilm in copper pipes[2]. Preventing stagnant water can reduce risk of colonisation[1]. However, it also indicates biofilm containing P. aeruginosa can recolonise in less than a week[3].

P. aeruginosa is a common environmental/aquatic organism. It is resistant to many toxins, including antibiotics. It forms a biofilm readily which is very hard to eradicate. Disinfected taps can be readily recolonized by upstream biofilm, which is invariably present[1].

In 2024, as part of a larger project, CC replaced the copper pipes, sinks and copper outlet pipes in NICU. It also commissioned a 'smart' plumbing system, which can

- Monitor tap use
- Duty flush (automated flush of tap if not used for 72 hours)
- Thermal disinfect (flush with 60-65˚C for set time) initiated by staff via software.

Monitoring showed almost all clinical taps were used at least daily. Due to cost, CC elects to only thermally disinfect if water testing finds pathogens of concern, or raised colony forming units.

Bad news – good news

9 months after completion, comprehensive testing upstream of filters found one tap growing P. aeruginosa. This tap had been used frequently; it was not a stagnant water risk. Previously the tap would have been disassembled, cleaned, disinfected and reassembled, and drain replaced. On trial for the first time in NICU, the thermal disinfection achieved a maximum of 62 degrees, with 60 degrees achieved after 30 seconds. The flush took 5 minutes. Afterwards the tap proved P. aeruginosa free. 6 months later, P aeruginosa was isolated in a different NICU tap upstream from the filters. Thermal disinfection again removed it.

The dilemma

Is thermal disinfection worth it, to keep NICU taps free of P. Aeruginosa?

Weekly thermal disinfection would help us be reasonably confident our taps are free of P. aeruginosa. However, thermal disinfection in NICU would be expensive in terms of staff time, more staff to ensure no one burns themselves, as well as in energy to heat water. There may also be user error.

Instead, we use thermal disinfection only when water testing indicates colonisation. The water testing schedule in NICU requires testing each clinical tap upstream from the filter every 3 years. Testing is for colony forming units and P. Aeruginosa. Taps in rooms of extremely premature infants are tested every 6 months.

This testing regime provides opportunity for pathogens to colonise taps for months, even years, before detection. Therefore, filters remain in use, at a cost of around $30,000 p.a., but preventing potentially colonised taps from contaminating water used for infant care and hand hygiene.

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Discussion

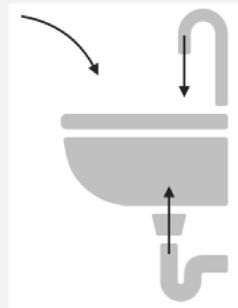
Is thermal disinfection appropriate for NICU?

Most hospitals can thermally disinfect pipes. A bespoke system makes it easier, but systems with tempering valves can also do it. Our bespoke system cost approximately $45k for NICU. Such technology needs to be weighed against the risk, and the cost of other mitigation strategies

Since filters are effective, are they an alternative to thermal disinfection, and even to testing? Testing and disinfection do not reduce NICU risk once filters are in place, although they may reduce risk of pathogen biofilm migrating to other wards with connecting plumbing. Alternatively, we could just use filters in NICU and other high risk units, reserving testing and reactive thermal disinfection for wards which can tolerate unidentified colonisation, reviewing when antibiotic resistant pathogens colonise our ward plumbing.

Will tap management solve our water problems?

Pathogens can enter sinks from taps, drains and users. Mitigation strategies for waterborne pathogens should consider these sources also.



Other risk mitigation strategies we use

- Infants less than 26 weeks gestation in first four weeks of life have no exposure to tap water apart from adult hand hygiene: milk warmed in capped syringes in incubator, sterile water for cares.
- Drains between sink and water trap disinfected/replaced if high risk pathogens found there, although we know pathogens likely to regrow.
- Automated duty flush on underused sinks.
- Point-of-use bacterial filters
- Hand hygiene focus. Hand sanitiser is primary agent for hand hygiene.
- Sinks only used for hand hygiene. Feeding bottles etc. rinsed in non-clinical sinks. Bath water disposed of in sluice.

As MDRO prevalence increases globally, international literature considers water mitigations both for new and existing hospitals, such as regular thermal disinfection[1], bi-weekly peracetic acid drain disinfection[3], built in UVC drain disinfection[5], removing sinks in clinical areas[4] and distancing them from patients[4].

Each mitigation strategy controls for but does not eliminate risk. For example, while reducing sinks in NICU is effective at reducing infection[4], consider how to transport a full baby bath, and how robust our national hand sanitiser supply chain is.

Conclusion

When MDROs threaten our current model of care , we will have to consider these risk mitigation options. Healthcare providers would be wise to plan new builds and renovations to be able to adopt such strategies.

"Throwing everything we've got at infection control!" (image and quote from NICU long line audit report)

References

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