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Research Brief

Testing residual chloramine levels in tap water across sink locations in a US academic hospital setting

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Introduction

Flushing sinks is a useful tactic to mitigate the buildup of opportunistic premise plumbing pathogens (eg, *Legionella*) present in tap water by providing higher levels of disinfectant.[1] This strategy is often included in facilities' water management plans.[2,3] However, there is not a consensus in the literature about how long sinks should be flushed, and protocols for sink flushing appear to vary by study and institution. Therefore, the objective of this study was to test and compare residual chloramine levels at different hospital sinks before, during, and after multiple minutes of flushing.

Methods

This longitudinal study was done as part of a quality improvement project. No chloramine supplementation or routine testing was done at the study facility. Local water is treated with chloramine for 11 months and treated with chlorine in March annually. Eleven sinks were chosen for sampling across the hospital to achieve a distribution of water service line distances and plumbing designs and ages: one ground floor, six fourth floor, two fifth floor, and two sixth floor sinks were sampled. Hospital units sampled in this study included the MRI department, the cardiothoracic stepdown unit (CTSU), the cardiothoracic intensive care unit (TICU), the burn intensive care unit (BICU), 6 West, and 6 Neuroscience Hospital (6NSH). When available, both room and bathroom sinks were sampled (total locations sampled = 9; room/bathroom pairs = 2).

Water samples were collected in 1-liter glass containers. Prior to sample collection, these containers were soaked in a dilute bleach solution (1 mL of commercial bleach to 1 liter of deionized water) for 1 hour and rinsed with deionized water. Equal amounts of hot and cold water were collected from each sink by simultaneously opening both taps to the furthest point when sampling began. Water samples were collected in individual containers at zero (directly from the tap when first turned on), 1, 2, and 3 minutes of simultaneous flushing for each sink. Following these results, additional samples were collected at 0, 15, 30, and 45 seconds to determine if there was a minimum time for flushing to raise residual chloramine levels. Normal drinking water chloramine residual levels range from 1.0 to 4.0 mg/L.[4]

Residual chloramine levels for 5 mL water samples were measured using the HACH DR300 colorimeter total chlorine protocol. Samples were analyzed immediately after collection. Chlorine standards were used for quality control before each series of residual chloramine measurements. The 5-mL sample cuvettes were rinsed three times with deionized water before and after each water sample was tested. Two 10-mL DPD Total Chlorine Reagent Powder Pillows were added to each 5 mL sample cuvette and allowed to dissolve for 20 seconds. After 3 minutes, the sample was placed in the HACH DR300 reader for residual chloramine measurement.

Results

For the first series of samples, the average residual chloramine level at 0 minutes of flushing was 2.01 mg/L and ranged from 1.3 mg/L in the CTSU (fourth floor) to 2.9 mg/L found in the TICU (fourth floor). One minute of flushing brought all sinks to 2.9 mg/L of residual chloramine or above (Figure 1A). No notable increase in residual chloramine levels was observed past 1 minute of flushing.

When the same sinks were flushed for 15-second intervals in the second stage of the study, 30 seconds of flushing was sufficient to raise all sinks to above 2.5 mg/L of residual chloramine (Figure 1B). The average residual chloramine level at 0 seconds of flushing for this series of samples was 2.06 mg/L.

Discussion

This study demonstrated that 1 minute of flushing was sufficient to raise residual chloramine levels to levels considered highly acceptable for disinfection, as 100% of sinks reached high levels (2.9 mg/L residual chloramine or higher) after 1 minute of flushing, even though residual chloramine levels measured before flushing occurred were highly variable across sinks. Smaller intervals of flushing for the same sinks showed that 30 seconds of flushing may be sufficient to reach high levels of disinfectant.

These findings are comparable to other studies that collected water samples following flushing. For example, a study of

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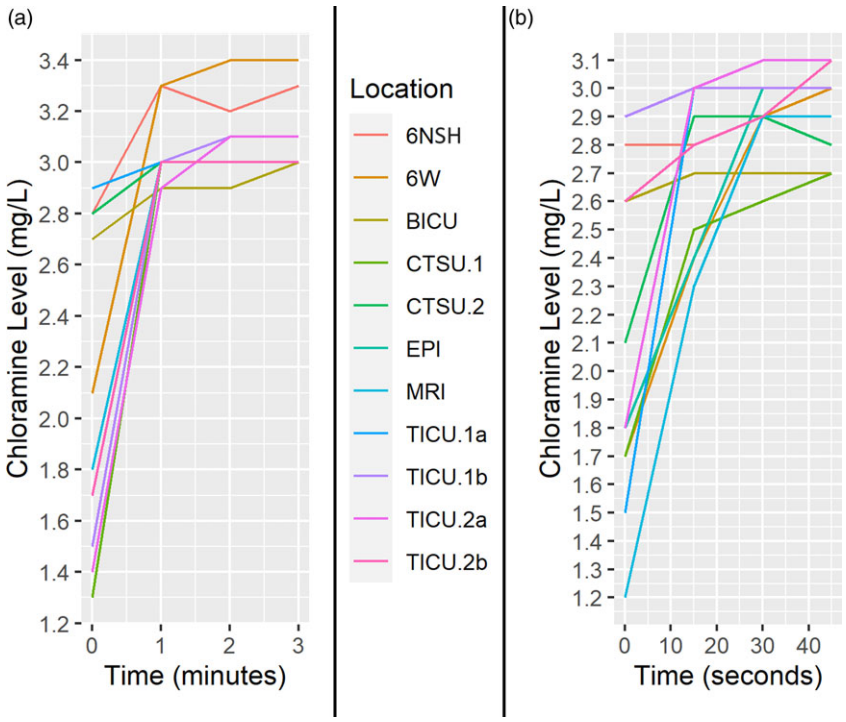

Figure 1. Chloramine residual levels (mg/L) at (A) 0, 1, 2, and 3 minutes and (B) at 0, 15, 30, and 45 seconds of flushing across multiple hospital units.

waterborne pathogens in tap water in a research building found that residual chlorine levels increased after 3 minutes of flushing.[5]

This is one of the first studies to address the need to evaluate flushing. Because notable improvement was not seen by increasing flushing times from 1 to 2 minutes or from 1 to 3 minutes, it is likely that 1 minute of flushing would be sufficient to raise disinfectant levels as part of a flushing protocol. Limiting flushing to 30 seconds may also help raise disinfectant levels while reducing the burden on staff.

This study has multiple strengths. For one, sinks were sampled across a variety of hospital locations so that multiple distances from water entry points were collected, which is more likely to represent the variable chloramine residual levels across a large institution. Additionally, a range of rarely used to frequently used sinks were sampled. However, this study also has several limitations. Although we attempted to achieve breadth in our sampling, only a relatively small sample of sinks could be tested, which may influence the chloramine residual results. We also have no quantitative information on when the sinks were last used. Additionally, the residual chloramine levels in this hospital were high even before flushing, which is likely related to the facility-specific plumbing. Therefore, this study may not be generalizable to other healthcare settings. Lastly, the first round of sink sampling and the follow-up sampling were done during winter and summer, respectively, which may have impacted the levels of chloramine residuals.[6]

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Competing interests. The authors report no conflicts of interest.

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