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A Controlled Study of *Legionella* Concentrations in Water from Faucets with Aerators or Laminar Water Flow Devices

TO THE EDITOR—Water aerators and laminar water flow devices are used to decrease water flow by forcing air through faucets. Washing with the air and water combination feels the same as it does with constant water flow, but the combination dramatically reduces water consumption by as much as 60%.[1,2] The use of these items is recommended by the US Environmental Protection Agency for water conservation in various locations, including office buildings, hotels, and hospitals.

However, faucet aerators have been colonized by waterborne pathogens, and these pathogens have been epidemiologically linked to hospital-acquired infections.[3-7] Removal of aerators from faucets in the healthcare setting has been an accepted infection control practice for decades, and guidelines from the Centers for Disease Control and Prevention, the Healthcare Infection Control Practices Advisory Committee,[8] the American Society of Heating, Refrigerating, and Air Conditioning Engineers,[9] and others[10] recommend removal of aerators or laminar water flow devices to prevent colonization by *Legionella* species and other waterborne pathogens. Specific recommendations have been made, especially for areas housing high-risk patients, according to which aerators either should not be used,[10]or if used, they should be designed with radially and vertically arranged lamellae (which do not lead to the collection of sediment or water stagnation) and cleaned regularly.[7]

Because hospitals in Taiwan have been experiencing water shortages during the drought season, during which patient care may be compromised, we conducted a study to test the hypothesis that installation of aerators and laminar water flow devices would actually promote the growth of *Legionella* species in a healthcare facility.

A model plumbing system (Figure) was built in a hospital with history of colonization by *Legionella* species and gram-negative bacteria. The system consisted of 3 sets of duplicate faucets arranged in parallel: 2 faucets with aerators (A1205; Tien Kuang), 2 faucets with laminar water flow devices (LF2043; Tien Kuang), and 2 faucets without any aerating attachment (control faucets). The entire model system was steam autoclaved before use. The model was then attached to a water pipe with an existing water outlet on top of a laboratory basin. When the water outlet was used at random times, water also flowed uniformly through all 6 faucets. Water samples of 500 mL were collected from each faucet and concentrated to 5 mL by use of a 0.22 μm–pore filter. After removal of the aerators or laminar water flow devices, a sterile swab (BBL CultureSwab; Becton Dickinson) with transportation media was inserted into each faucet outlet and rotated against the interior surface 2 times clockwise and 2 times up and down to dislodge sediment in the faucet. Each swab was vortexed vigorously in 2 mL of sterile deionized water to resuspend the sediment from the swab into the aliquot of water. One hundred μL from each acid-treated sample was directly inoculated onto buffered charcoal yeast extract culture media and buffered charcoal yeast extract selective media containing dyes, glycine, vancomycin, and polymyxin B. Culture media were incubated at 37°C in a humidified atmosphere for 3-7 days. Paired *t*-tests were performed with Excel software (Microsoft).

During the 27-week study period, a total of 102 biofilm

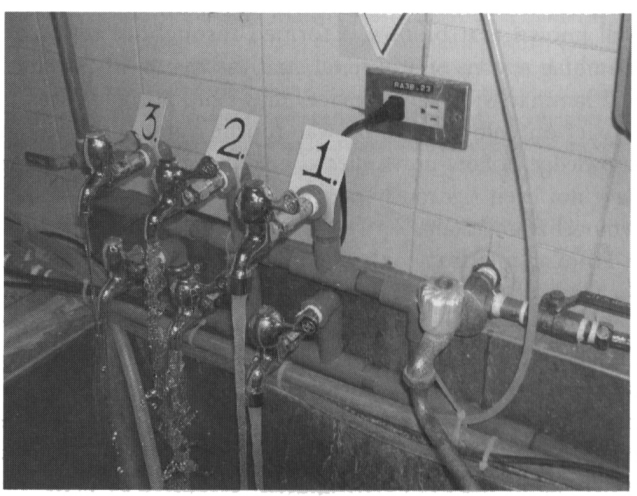

FIGURE. Experimental set up of the model plumbing system (1, faucets with aerators; 2, control faucets; 3, faucets with laminar water flow devices).

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and water samples were collected from control faucets, faucets with aerators, and faucets with laminar water flow devices. The mean concentration of *Legionella* species in water samples collected from control faucets was 3,529 cfu/L. In faucets with aerators, the mean concentration was 2,412 cfu/L; in faucets with laminar water flow devices, the mean concentration was 5,912 cfu/L. Water samples from faucets with aerators yielded the lowest concentration of *Legionella* species. No significant difference was found in the concentration of *Legionella* species in water samples from control faucets, compared with samples from faucets with aerators ($P = .53$), and no significant difference was found when samples from control faucets were compared with samples from faucets with laminar water flow devices ($P = .45$). The mean concentration of *Legionella* species from biofilm samples collected from control faucets was 530 cfu/L, the mean concentration in faucets with aerators was 515 cfu/L, and the mean concentration in faucets with laminar water flow devices was 647 cfu/L. Similarly, no significant difference was found in the concentration of *Legionella* species when biofilm samples for control faucets and faucets with aerators were compared ($P = .56$) or when samples from control faucets and faucets with laminar water flow devices were compared ($P = 0.38$). *Legionella* species were observed in faucets with aerators, faucets without aerators, and faucets with laminar water flow devices, and no significant difference was found in the bacterial concentration in either water or biofilm samples from the 3 types of faucet. The volume of water saved was also tested by measuring the flow rate of water from the 3 types of faucet. The mean flow rate was 6.0 L/min for faucets with aerators and 1.2 L/min for faucets with laminar water flow devices, compared with 11.0 L/min for the control faucets.

It is conceptually possible that aerators and laminar water flow devices obstruct the water flow, thus promoting the growth and amplification of microorganisms inside faucets with aerators and laminar water flow devices. However, it is well known that biofilm is formed throughout the water plumbing system of a hospital, and the removal of aerators and laminar water flow devices may not have a significant impact on colonization by waterborne pathogens. To our knowledge, follow-up studies after removal of these devices have not been rigorously performed, so the efficacy of such removal is uncertain.

From an infection control point of view, our study showed that lack of aerators or laminar water flow devices did not reduce the concentration of *Legionella* species in the faucets. *Legionella* could still be detected in faucets with and faucets without aerators. Thus, removal of or routine cleaning of contaminated faucet aerators or laminar water flow devices may not prevent hospital-acquired infections if the hospital's water supply has been systematically colonized by *Legionella* species.

In conclusion, we were unable to confirm the generally accepted perception that installation of aerators and laminar water flow devices promote the bacterial amplification of *Legionella* species in water and biofilm samples. The use of aerators and laminar water flow devices was effective in reducing water usage. A large-scale study is needed to validate our finding so that the risk-benefit ratio of using these devices can be accurately estimated.

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