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Mission of the *Academy Journal*

As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of health care architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affect all involved in those fields.

About AAH

AAH is one of 21 member communities of The American Institute of Architects (AIA). AAH is unique in the depth of its collaboration with professionals from all sectors of the health care community, including physicians, nurses, hospital administrators, facility planners, engineers, managers, health care educators, industry and government representatives, product manufacturers, health care contractors, specialty subcontractors, allied design professionals, and health care consultants.

AAH currently consists of approximately 7,000 members. Its mission is to provide knowledge which supports the design of healthy environments by creating education and networking opportunities for members of – and those touched by – the healthcare architectural profession.

Please visit our website at aia.org/aah for more about our activities. Please direct any inquiries to aah@aia.org.

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About the journal

As we start the 23rd year of the Academy Journal, published by the AAH Knowledge Community, this edition includes articles that support the enhancement of the built environment for health care. As the official publication of the Academy, the Journal publishes articles of particular interest to AIA members and the public involved in the fields of health care architecture, planning, design, research, and construction. The goal has always been to expand and promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affects all involved in those fields.

Articles are submitted to, and reviewed by, an experienced, nationally diverse editorial review committee (ERC) of medical and architectural professionals. Over the years, the committee has reviewed hundreds of submissions, responded to writers' inquiries, and encouraged and assisted writers in achieving publication. In its over 20-year history, the Journal has provided valuable opportunities for new and seasoned authors from the architecture and health care professions, including architects, physicians, nurses, other health care providers, academics, research scientists, and students from the US and foreign countries.

Published articles have explored a broad range of medical topics, including research trends, the future of health care architecture, cardiac care, future and evolving technology, patient rooms and patient safety, lighting design for health care, psychology, workplace design, cancer care environments, emergency care, women's and children's care, and various health care project delivery methods.

We encourage graduates who have received health care research scholarships and others involved with research within the health care architecture field to submit their research to the Journal for publication consideration. We will continue to develop a cross-referenced article index and a broader base of writers and readers. The deadline for the 2021 call for papers is May 27, 2021.

Since the late 1990s, this free publication has expanded to include worldwide distribution. And we are proud to report that as our readership continues to grow, it also expands internationally. Readers have viewed the Journal online from the US, Canada, Europe, the Caribbean, Asia, Africa, India, and Saudi Arabia, just to name a few. The Journal is available to the 94,000 AIA members and the public on the AIA website at aia.org/aah.

Special thanks to AIA for its continued support and hard-working staff and to the many volunteers who have contributed to our growing and continued success including Doug Paul and Southern Ellis for their leadership on behalf of the AIA and AAH. I would especially like to thank the other members of the 2020 ERC: Donald L. Myers, AIA, NCARB; Angela Mazzi, AIA, ACHA, EDAC; Sharon Woodworth, FAIA, FACHA; Dale A. Anderson, AIA, NCARB, LEED AP BD+C, CSBA, EDAC, MBA, GGP, ACHA; and Erin Mcnamara, EDAC. As always, we appreciate your feedback, comments and suggestions by emailing aah@aia.org.

Letter from the editor

2020 has been a difficult year.

The COVID-19 global pandemic has impacted our lives in a profound way. Collectively, people have gained a new appreciation for the power of a virus and its potential impact to our hospitals, economy, and social networks. Our friends and colleagues in healthcare have been tested in a manner that will have meaningful consequences on the industry and what it means to dedicate one's life to care for another. Many of us have waited on news from scientists, cheered for progress, and followed FDA trials with great anticipation and awareness for the enormity of the pursuit. Never have I felt so appreciative of the people, networks, supply chains, and infrastructure that support our healthcare system.

As this journal goes to print, the dealth toll, in the United States, for COVID-19 stands around 300,000 and the first vials of vaccine are being administered to people on the frontline. There is great hope that we are at the beginning of the end of this saga, but still reeling from the exposed vulnerabilities to both the healthcare industry and society at large. We have learned so much and yet there is so much left to understand about the last ten months.

I look to 2021 and the years to follow as an opportunity to both celebrate our successes and learn from our missteps so that we are better and more prepared for future generations of frontline workers, patients in need, and vital equipment suppliers. There is great promise at the juncture between healthcare, design, and research. I applaud Orlando Maione for his vision to foster this journal and thank him for his many years of leadership and service as The Academy Journal Editor. We close out this year with an appreciation for the work accomplished and excitement for what is to come. I look forward to exploring with and learning from you in the years to come.

Cheers to a happy new year.

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Editor, *Academy Journal*

Eliminating hot water handwashing: Five reasons to act

Brian Hageman, Associate Principal MAZZETTI

ABSTRACT

Health care planners, architects, and providers should consider eliminating hot water from handwashing fixtures for the following reasons:

1. Contrary to some prior suggested guidance, hot water is not required for effective handwashing.
2. It is arguably an unnecessary expense.
3. It wastes energy.
4. It presents potential risks for patients and health care providers.
5. There are cheaper and safer design options for water systems that are as effective for handwashing.

Hot water is not required for effective handwashing

Over the last several years, experts in infection control have been uprooting old assumptions that hot water is an essential component in handwashing. The World Health Organization (WHO) says, "Apart from the issue of skin tolerance and level of comfort, water temperature does not appear to be a critical factor for microbial removal from hands being washed."[1] The US Centers for Disease Control and Prevention (CDC) published guidance stating, "The temperature of the water does not appear to affect microbe removal; however, warmer water may cause more skin irritation and is more environmentally costly[2]. Water in the temperature range we can tolerate is not hot enough to kill bacteria. Water would have to be scalding hot before its temperature could improve upon the simple act of scrubbing with soap.[3]

Hot water for handwashing is an unnecessary expense

Health care planners and architects should examine the cost-benefit aspect of using hot water for handwashing. Availability of hot water is important for health care-related areas, such as soiled utility rooms, sterile processing, and food service, where very hot water is effective in sanitizing surgical and procedure tools and removing food service-related soil and grease. Hot water is also clearly beneficial for patient and staff showers, where full-immersion bathing calls for water temperatures to be higher than body temperature for comfort. The cost associated with these systems can be considered money well-spent. However, in terms of feet of pipe and energy use, the bulk of the hot water distribution system is designed, installed, and maintained to provide water to handwashing fixtures. From my personal experience, a recently completed 198-bed hospital in California has 693 handwash fixtures spread throughout the facility to meet the requirements of the California building code. By the guidance of the CDC and the WHO, the functionality of those 693 fixtures is not improved by supplying them with hot water—except for the added comfort.

A typical hospital domestic water system requires a two-pipe system to bring "cold" water (water at roughly the same temperature as the municipal system) and "hot" water (water at or over 110° F or 120° F, depending on the applicable code) to every hot water-using fixture in the building. This equates to thousands of feet of insulated pipe in a midsize hospital or medical office building.

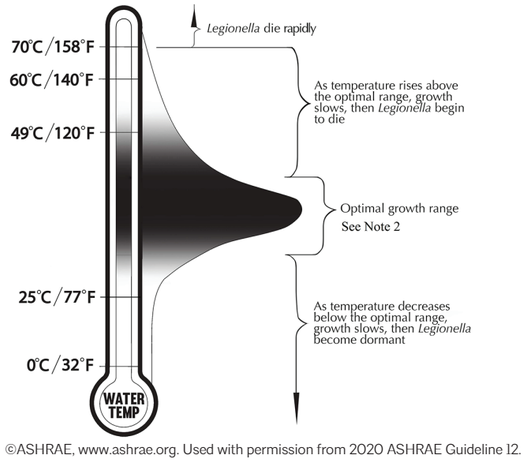
Hot water systems for handwashing waste energy

Throughout all that piping, energy is constantly being wasted by heat loss. Even though the tanks and piping may be well-insulated, the system will constantly dissipate heat into the building. That heat loss is compensated by adding more heat back into the water. This requires circulating pumps and more piping to bring the hot water back to the water heater so it can be reheated. In a hospital, this process of circulating and reheating is a 24/7/365 operation.
A Vanderbilt Institute for Energy and the Environment study indicated that if everyone in the US washed their hands in cooler water, it would equate to eliminating the energy-related carbon emissions of 299,700 homes. Nearly 800 billion handwashes performed by Americans

each year result in more than 6 million metric tons of CO2-equivalent emissions annually.[4] Unfortunately, we do not have data available that separates hospital hot water energy used for handwashing versus other hot water uses. However, it may be possible to gather this granularity of data in the future through smart-sensor faucets.

Potential risk to patients and staff

Poorly designed and/or maintained hot water systems can host waterborne pathogens. These include Giardia, Cryptosporidium, and the current leading cause of US waterborne diseases, Legionella.[5] Under the right conditions, Legionella exposure can lead to infection and Legionellosis, a potentially fatal illness.[6] We know that Legionella is naturally present in our water systems, and it is usually not a public health problem—unless the water is warm enough to support amplification and maturation of the bacteria. Stagnation can contribute to this as well. ANSI/ASHRAE and the National Sanitation Foundation (NSF) have put a tremendous amount of effort into developing standards and guidelines for the industry to mitigate risks related to waterborne pathogens like Legionella. One of the more difficult aspects of that effort has been trying to define the temperature ranges that support pathogen growth. Part of the challenge is the nature of testing—typically conducted in laboratory settings that do not reflect the conditions in operating buildings. Variable environmental conditions, including water quality, temperature, and the nature of biofilm in the piping system, cause difficulties in accurately predicting a pathogen's behavior within various temperature ranges. That said, the ASHRAE Guideline 12, "Managing the Risk of Legionellosis Associated with Building Water Systems," provides this graphic with the understanding that it is based on lab testing:



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Poorly designed hot water systems may include dead-end branches of piping to fixtures and/or poorly circulated piping loops that result in water temperatures that hover in the range where pathogens can grow to dangerous levels. In addition, providing hot water for handwashing nearly doubles the volume of water waiting to be used at fixtures. This increases the amount of time water spends in the building piping system before it is replaced with fresh water. The longer water sits in pipes, the more the disinfectant from the municipal system dissipates. This can also contribute to waterborne pathogens growth and infection control problems. By not heating the water to the range where Legionella thrives, the system behaves much like the cold-water system, in that Legionella bacteria remain largely dormant.[7]

Given the detrimental effects of using hot water for handwashing, why would any plumbing code require it? The mission of code authors is to protect the public's safety. Toward that end, the two most prominent model plumbing codes—the Uniform Plumbing Code (UPC) and the International Plumbing Code (IPC)—limit the maximum safe temperature of water coming out of showers and bathtub fillers, etc. to prevent conditions that could expose people to scalding-hot water. The IPC requires hot water at a temperature equal to or greater than 110° F for "bathing and washing purposes" in commercial buildings. That is generally interpreted by AHJs and design engineers to include handwashing. One might assume this minimum temperature is codified either to ensure comfort for bathers, or it is an unexamined assumption that it is effective in preventing growth of pathogens in piping and/or the removal of bacteria from hands.

The UPC states: *"Hot and Cold Water Required. Except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction, each plumbing fixture shall be provided with an adequate supply of potable running water piped thereto in an approved manner, so arranged as to flush and keep it in a clean and sanitary condition. ..."*[8] The UPC defines "hot water" as exceeding or equal to 120° F. The UPC does not clearly require hot water for handwashing fixtures; however, in my experience, AHJs generally interpret the code's intent as having the water up to each fixture hot enough to limit pathogen growth and that further code provisions, such as mixing valves, prevent water over 120° F from leaving the faucet and creating a scald risk. It appears to me the intent is that if you are going to provide hot water to a handwash fixture, you must have a minimum temperature serving it to prevent pathogen growth, and you must have a maximum temperature leaving the faucet to prevent scalding.

For reference: The ASHRAE Handbook on service water heating lists the "typical temperature requirement" for handwashing lavatories as 105° F. [9]

The Facilities Guidelines Institute (FGI), an independent, not-for-profit organization dedicated to developing guidance for the planning, design, and construction of hospitals, outpatient facilities, and residential health, care, and support facilities, is very clear in its stance on this subject. FGI guidelines state: *"*(b) For hand-washing stations, water shall be permitted to be supplied at a constant temperature between 70°F and 80°F using a single-pipe supply. For showers and other end-use devices requiring heated water, water shall be permitted to be supplied by this low-temperature circulation system and heated with point-of-use heaters. A2.1-8.4.2.5 (4)(b) One way to limit the potential growth of Legionella in a heated potable water system is to distribute water at a temperature of less than 80°F (26.6°C) for hand-washing use. Water at this temperature may be warm enough to encourage good hand-washing practice but cooler than the ideal growth conditions for Legionella."*[10] Many states have adopted the FGI guidelines, but it remains to be seen if this section will have traction.

There are cheaper and safer design options for water systems that are as effective for handwashing

I propose a single pipe system to deliver 75° F water to the handwashing fixtures in a hospital or clinic. For this argument, I am proposing 75° F because that temperature is high enough so as not to seem "cold" to most of us while low enough to avoid Legionella amplification and maturation.

Several benefits of using this single-pipe, single-temperature approach include:

- No reduction in efficacy of handwashing—if the regular protocols are followed
- Reduced water heater size
- Reduced energy used to heat and maintain water temperature
- Reduced amount of piping, valves, hangers, and mixing valves
- Reduced insulation installation
- Reduced maintenance on point-of-use mixing valves and faucets
- Reduced overall volume of water in pipes = less water age and related waterborne pathogens in the system
- Reduced overall volume of biofilm that can harbor waterborne pathogens
- Reduced infection control issues at faucets
- Reduced dermatological impact of frequent washing

There are several possible ways to design a system. For example, if your municipal water supply comes into the building at 50° F, you could use a variety of energy sources to increase the temperature to 75° F and send one branch of that water to the handwashing fixtures. That piping would not require insulation or recirculation if properly sized. You could also route the piping to have a toilet at the end of the line, so the occasional flush keeps fresh water coming into the system. Another branch of the 75° F water would be used as preheated cold-water makeup for the regular hot water system's heaters. You would still want to have cold water for most of the toilet flushing and tempering of hot water at showers, etc. However, a large portion of the hot water infrastructure could be eliminated.

For many hospital buildings, the lower floors house diagnostic and treatment functions, while the upper floors are typically patient floors. These are often split into two pressure zones, with street pressure serving the lower floors and boosted-pressure systems for the patient floors. For these, using a central hot water system for the patient floors may be sensible (particularly given the showers) with localized heaters for the diagnostic and treatment areas. Point-of-use heaters could play a role in some scenarios as well.

The water heat sources (aiming for 75° F) could include a variety of creative options, such as waste heat from HVAC systems or data centers or drain line heat recovery from sterile processing, etc. Every building type and location will have different characteristics and different design approaches that warrant different solutions. For some, this system may not be a good fit or perhaps 70° F is preferred. Some localities have municipal water temperature closer to 75° F, in which case, a single-pipe, single-temperature system for handwashing and toilet fixtures would be most appropriate, thus eliminating even more piping.

Health care planners should consider these reasons to eliminate hot water from handwashing in health care settings:

1. Contrary to some prior suggested guidance, hot water is not required for effective handwashing.
2. It is arguably an unnecessary expense.
3. It wastes energy.
4. It presents potential risks for patients and health care providers.
5. There are cheaper and safer design options for water systems that are as effective for handwashing.

Architects and engineers should work with their health care clients and code authorities to foster a new attitude about how we use resources in our building systems. If we uproot outdated assumptions and take a fresh look at our codes, how they are being interpreted, and how they may be inhibiting healthy innovation, we may be able to take this one positive step.

References

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