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Quantitative Analysis of Recommendations Made in Handwashing Signs

ABSTRACT

Handwashing is important in preventing microbial cross-contamination. The US FDA Model Food Code requires that handwashing sinks have a sign or poster nearby that is visible to employees washing their hands. This research collects and reviews existing handwashing signs and subjects them to quantitative analysis. An Internet search produced a database of handwashing signs. Lather time, rinse time, overall wash time, water temperature, water use, drying method, technique, and total number of steps were recorded. Eighty-one unique handwashing signs were identified. Each sign had between one and thirteen steps. Thirty-seven signs indicated a specific lather time, with average time ~18 s. No sign suggested > 20 s lather, and none suggested < 10 s lather. Twenty-four signs recommended use of warm water. Two signs recommended 100°F (37.8°C) water and one recommended hot water. Sixty-two signs made a recommendation on drying hands, and fifty-three suggested using a paper towel. Our analysis reveals that handwashing sign instructions can vary quite widely. Lack of consistent hand wash guidance on signage may contribute in part to a lack of handwashing consistency and compliance. Our study serves as a foundation for future research on handwash signage.

INTRODUCTION

Handwashing is an important part of preventing microbial cross-contamination in food service and healthcare settings *(16, 21, 22, 25, 34, 44, 57, 63, 72)*. The US Food and Drug Administration (FDA) Model Food Code specifies when handwashing is required during food preparation, and both the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) suggest frequent handwashing in healthcare settings *(7, 68, 72)*. The FDA Model Food Code and the CDC Guideline for Hand Hygiene in Health-Care Settings recommend washing hands for 20 s, under warm running water, with soap, and using either single-use towels or a forced air dryer to dry hands *(7, 68)*. The WHO Guidelines on Hand Hygiene in Health Care recommend washing hands for 40–60 s, with soap, and using a single-use towel to dry hands *(72)*.

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Research over more than 30 years has shown that the way hands are washed (including technique, duration, and drying method) can significantly affect the microbial reduction. Increased handwashing duration has been shown to improve microbial reduction, although the rate of improvement is less after 20 s of handwashing *(30, 42, 48, 62)*. Research has also shown that washes below 10 s may be of little effectiveness *(30, 42, 48, 62)*. Moist hands transfer significantly more bacteria than dry hands; therefore, drying, regardless of drying method used, is an essential step in preventing cross-contamination *(30, 49, 59, 68)*. Use of paper towels appears to provides multiple benefits, including faster drying, improved microbial reduction, and the possibility of using the towel as a barrier to protect against recontamination from doorknobs and sink faucets *(24, 30, 49, 56, 57, 68, 72)*. Knowing which techniques/interventions most improve a hand wash is one way to determine which instructions should appear on a handwashing sign and which ones can be omitted.

Both WHO and CDC recommend hand hygiene signs as part of hand hygiene promotion/education programs *(7, 72)*, and the US FDA Model Food Code indicates that handwashing sinks are not considered fully equipped unless a handwashing sign is clearly visible to any employees washing their hands (section 6-301.14) *(68)*. Recommendations and mandates aside, research is scanty and results inconsistent as to whether these signs improve compliance. Some foodservice studies show improvement of hand hygiene compliance with the use of signs *(10)*, whereas others show only slight effect *(1)*. Healthcare research shows handwashing reminders (including signs) can improve handwashing compliance when used as part of a promotion/education program *(4, 14, 26, 28, 33, 38, 46, 51, 52, 53, 60, 66, 67)*, although the specific contribution of signs as a discrete entity is hard to identify, as few studies have studied signs alone *(11, 60)*. Additionally, their long-term efficacy is still unclear *(60, 71)*. Education programs (not necessarily hand hygiene focused) that used signs only as the method of communication have produced mixed results *(2, 11, 23, 27, 45)*; such programs can usually improve knowledge of the target subject researchers, but not necessarily induce the intended behavior changes *(2, 23, 27)*. Many researchers have noted that even when handwashing sinks are easily accessible and handwashing signs are visible, the workload of the food handler can undermine compliance *(1, 21, 22, 63)*, and similar results have been observed in healthcare settings *(6, 54)*.

Handwashing signs are intended to reinforce in people's minds the need to wash hands as well as to provide information on proper handwashing technique *(1, 29, 33, 38, 46, 53, 68)*. Determining what constitutes an effective handwashing sign is difficult, as little research has been done on the subject *(29)*, with no comprehensive study of retail food establishment signs.

MATERIALS AND METHODS

A search by the authors compiled a representative database of handwashing signs. Keywords used in the Internet search included: handwash, sign, poster, employees, soap, hand hygiene, notice, and guide. A Google (Mountain View, California) search was followed by a targeted search of US state and county health department websites. Although many health departments used the words sign, guide, and poster interchangeably, the word "sign" will be used from this point forward. All signs collected were in active use in restaurants, cafeterias, hospitals, or schools.

The data were compiled and analyzed by use of Excel (Microsoft, Redmond, WA). Means, medians, minimums, maximums, and frequencies were calculated. Instructions for lather time, rinse time, overall wash time, water temperature, pre-moistening of hands, drying method, and technique, as well as total number of handwashing steps, were recorded. A "step" was defined as a direction (either written or pictured) that indicated a specific task to be completed as part of the handwash procedure. These steps were usually, but not always, numbered or presented in a sequential manner. Categories for "when to wash" or "how to wash" were generated as they emerged during examination of the signs *(29)*. The requirements for inclusion were not stringent; the sign needed only to mention or show a picture of handwashing. Multiple copies of some signs were located during the search, but only unique entries were compiled for analysis. All signs analyzed in this study were retrieved from U.S.-based sources and intended for U.S. populations. Some handwashing signs located by the search were translated copies of the 2009 WHO handwashing guide sign *(72)*, but as they provided duplicate information, they were not added to the database. Signs that utilized the same figures or technique instructions, but that either provided additional information or removed certain steps, were included in the database.

RESULTS

The 81 unique handwashing signs that were identified were split into three groups, according to target audience: healthcare, foodservice, and the general public. Healthcare signs were those specifically intended for use in healthcare facilities (e.g., hospitals, nursing homes, etc.), while the general public group included signs intended for use in schools, and office buildings and at-home use. Overall, 31 (38.3%) unique signs targeted the public, 26 (32.1%) targeted foodservice, and 21 (25.9%) targeted healthcare audiences. A small number of signs, 3 (3.7%) targeted both healthcare and foodservice audiences. These 3 signs were added to both groups when the groups were being analyzed separately, but were counted only once when the overall dataset was being analyzed. Sixty (74.1%) signs included

Table 1. Number of steps observed in the handwashing sign collection

	Number of Steps			
	All Data Sets	Foodservice	Healthcare	General Public
Mean	5.5	4.7	6.1	5.7
Median	5	5	5.5	5
Minimum	1	1	1	1
Maximum	13	13	12	13

Table 2. Summary of handwash duration instructions in 81 handwashing signs

	Signs Indicating This Step			Average (s)	Median (s)	Min (s)	Max (s)
	Step	Number	Percent				
All Signs							
	Lather	37	45.68%	18.4	20	10	20
	Rinse	3	3.60%	13.3	10	10	20
	Overall	58	71.60%	22.2	20	10	60
	No time Indicated	23	28.40%	-	-	-	-
Food Service Signs							
	Lather	13	50.00%	19.2	20	15	20
	Rinse	0	-	-	-	-	-
	Overall	19	73.08%	21.3	20	15	60
	No time Indicated	7	26.92%	-	-	-	-
Healthcare Signs							
	Lather	6	28.57%	18.3	20	15	20
	Rinse	1	4.76%	20.0	20	20	20
	Overall	16	76.19%	27.5	20	15	60
	No time Indicated	5	23.81%	-	-	-	-
General Public Signs							
	Lather	20	64.52%	18.0	20	10	20
	Rinse	2	6.45%	10.0	10	10	10
	Overall	26	83.87%	19.2	20	10	30
	No time Indicated	5	16.13%	-	-	-	-

figures, which were defined as any graphical representation (e.g., drawings or photographs) of a handwashing step. Twenty-one (25.9%) unique signs specified when to wash hands. Sixty-three (77.8%) unique signs were published by government agencies and 18 (22.2%) by private companies.

Table 1 summarizes the number of steps, or directions, given in the handwashing sign collection. Each sign had at minimum one step (e.g. wash your hands), and the highest number of steps was thirteen. Sixty-six (81.5%) signs recommended more than one step. The average number of steps per sign was 5 for foodservice signs and 6 for healthcare signs.

Table 2 summarizes handwashing time recommendations, grouped into three categories: lather time, rinse time, and total time. The total time group includes the rinse and lather time groups; 18 signs (22.2%) indicated only a total handwash time, with no specific breakdown into rinse and lather times. Twenty-three signs (28.4%) did not indicate any duration. Thirty-seven (45.7%) signs indicated a specific lather time, with the average lather time being ~18 s. No sign suggested a lather time greater than 20 s, and none suggested a lather time less than 10 s. Three (3.6%) signs indicated a specific rinse time, with an average rinse time of ~ 13 s. No sign suggested more than a 20 s rinse or less than a 10 s rinse. With regard to total handwash time, 58 (71.6%) signs gave an average of ~22 s. No total wash time was greater than 60 s, and no total time was less than 10 s.

No foodservice signs suggested a specific rinse time, but 13 (50% of all foodservice signs) indicated a specific lather time, with the average being ~19 s. Seven foodservice signs (26.9%) did not indicate any handwash duration. No foodservice sign suggested a lather time greater than 20 s and none suggested a lather time less than 15 s. The average total wash time from the nineteen signs (73.1% of all foodservice signs) was ~21 s. No foodservice total wash time was greater than 60 s, and none was less than 10 s. It should be noted, that only one foodservice sign recommended a wash time greater than 20 s.

Only one healthcare sign (4.8% of all healthcare signs) indicated a specific rinse time (20 s), and 6 (28.6% of all healthcare signs) signs indicated a specific lather time, with the average lather time being ~18 s. No healthcare sign suggested a lather time greater than 20 s or less than 15 s. The average overall wash time from sixteen healthcare signs (76.2% of all healthcare signs) was ~27.5 s. Five healthcare signs (23.8%) did not indicate any handwash duration. No healthcare wash time was greater than 60 s or less than 10 s.

Two signs intended for the general public (6.5% of all public signs) suggested a rinse time (10 s in both cases) and 20 (64.5% of all public signs) suggested a specific lather time, with the average being 18 s. No general public signs suggested a lather time greater than 20 s or less than 10 s. The average total wash time from 26 general public signs (83.9% of general public signs) was 19.2 s. Five general public signs (16.13%) did not indicate any handwash duration. The greatest wash time recommended in the general public signs was 30 s, and the minimum was 10 s.

Table 3 summarizes the recommendations made in the handwashing signs related to water temperature, wetting the hands with water, drying the hands, towel use and various other aspects of handwashing technique. Twenty-four (29.6%) signs recommended using warm water but did not specify an exact temperature; 2 signs (2.5%) recommended using 100°F (37.8°C) water; 1 (1.2%) sign recommended using hot water, and 54 (66.7%) signs made no water temperature recommendations. Forty-six signs (56.8%) recommended wetting hands before applying soap, 12 (14.8%) suggested wetting the hands while applying soap, and only 2 (2.5%) suggested wetting hands after applying soap. Twenty-one signs (25.9%) made no recommendation about when to wet the hands. Not surprisingly, all signs recommended using soap (data not shown). Sixty-two (76.5%) of all signs made a recommendation to dry hands in some manner (data not shown); 53 (65.4%) signs suggested using a paper towel, 4 (4.9%) suggested hot air hand dryers, and 5 (6.2%) recommended hand drying but made no suggestion on how to dry. Interestingly, 31 (38.3%) suggested turning off the tap with a paper towel, and 3 (3.7%) signs suggested opening the door with the same towel used to dry hands.

Table 3 also summarizes various other handwashing technique instructions. As noted in the methods, these other instructions were any specific direction on what to do with the hands during the wash. Forty-one (50.6%) signs suggested one or more techniques. Most techniques involved targeting specific areas: 33 signs (40.7%) suggested targeting between fingers, 31 (38.3%) the fingernails, 29 (35.8%) the back of the hands, 27 (33.3%) the palms, 17 (21.0%) the back of fingers, 16 (19.8%) the thumbs, and 14 (17.3%) the wrists. Additionally, 6 signs (7.4%) suggested using a fingernail brush, while 2 (2.5%) signs suggested removing jewelry before handwashing.

Table 4 summarizes the directions given on handwashing regarding when a handwash is needed. About 29% (6 of 21) of healthcare signs, ~46% (12 of 26) of foodservice signs, and ~13% (4 of 31) of general public signs, described when to wash hands (percentages not shown in *Table 4*). In total, 21 signs out of 81 indicated when to wash hands. Many "when to wash" suggestions were found, all of which are shown in *Table 4*, but only key aspects will be described here. Almost all signs that did give a "when to wash" suggestion directed the reader to wash the hands after using the restroom, the most common recommendation both overall and within each of the three categories. Aside from their recommendation, no other key "when to wash" recommendations are evident from healthcare sign data. Other "when to wash" suggestions appear on 5 of the 6

Table 3. Handwashing procedure or technique instructions in 81 handwashing signs

Technique area	Technique suggestion	Number of signs
Water temperature	No water temperature indicated	54
	Warm water	24
	100°F water	2
	Hot water	1
Wetting the hands	Before soap	46
	With soap	12
	After soap	2
	No wetting suggestion indicated	21
Drying method	Drying with paper towel	53
	Drying, not specified	5
	Air drying	4
Towel use besides drying	Turning off tap with towel	31
	Open door with towel	3
Other technique instructions	Any other instructions	41
	Target between fingers	33
	Target fingernails	31
	Target back of hands	29
	Target palms	27
	Target back of fingers	17
	Target thumbs	16
	Target wrist	14
	Use fingernail brush	6
	Remove jewelry	2

healthcare signs that had "when to wash" recommendations, but they are varied. The four public signs that included specific "when to wash" information all recommended washing hands after coughing or sneezing as well as after using the restroom. Three out of four of these signs also recommended washing hands before eating or drinking.

A number of key "when to wash" recommendations occur frequently on the foodservice signs. Following "after using the restroom," the most common recommendation, was to wash hands after eating or drinking (on 9 signs) followed by washing hands after coughing or sneezing (7 signs). The next most frequent recommendations were to wash hands after handling dirty utensils or dishes and to wash them before preparing food (6 signs each). Other recommendations, which appeared on 5 signs, were to wash hands after contact with skin, after using tobacco products, or after handling raw food.

DISCUSSION

Both the FDA and the CDC currently recommend washing hands for 20 s, under warm running water, with soap, and using either single-use towels or a forced air

Table 4. Summary of handwashing sign "when to wash" recommendations. Values indicate the number of signs that specified "when" and are listed in descending frequency for all signs

		All Signs	Healthcare	Foodservice	General Public
When to Wash	**Specific Event**	**21**	**6**	**12**	**4**
After	Using restroom	18	4	11	4
	Coughing or sneezing	12	2	7	4
	Drinking or eating	10	1	9	1
	Contact with skin (not hands/arms)	7	1	5	1
	Using tobacco products	7	2	5	0
	Handling dirty utensils or dishes	6	0	6	0
	Handling raw food	6	0	5	1
	Touching animals	6	2	3	2
	Handling raw meat	5	0	4	1
	Contact with body fluids	4	1	1	2
	Any work break	3	1	2	0
	Contact with wound	3	1	2	1
	Handling garbage	3	0	2	1
	Contact with blood	2	1	0	1
	Contact with ill individual	2	0	1	1
	Returning from outside	2	0	0	2
	Answer phone	1	0	1	0
	Contact with mucous	1	1	0	0
	Contact with vomit	1	0	0	1
	Contact with waste water or sewage	1	0	0	1
	Cross-contamination	1	0	1	0
	Handling chemicals	1	0	1	0
	Contaminated (not specific)	1	1	0	0
	Removing gloves	1	1	0	0
	Touching clothing	1	0	1	0
	Touching door	1	0	1	0
Before	Resuming work	7	2	4	1
	Preparing food	6	0	6	1
	Putting on or changing gloves	4	0	4	0
	Drinking or eating	3	0	0	3
	Handling RTE foods	3	0	3	0
	Entering kitchen	2	0	2	0
At the time	If hands are visibly soiled	4	1	1	2
	As needed	3	0	3	0

dryer to dry hands *(7, 68)*. Previous studies suggest that a minimal wash (<10 s) is not as effective as a 20 s wash *(30, 42, 48, 62)*, and Allwood et al. *(1)* noted that one of the most common problems observed in food workers' hand wash regimes was a failure to wash for 20 s. Almost three-quarters of all handwash signs collected (~72%) gave a recommended wash time that averaged slightly more than 20 s, as did the foodservice-specific signs. Healthcare signs recommended a longer average wash time (27.5 s), while those aimed at the general public recommended an average wash time of ~ 19 s.

One-third of all the signs surveyed (27 or 33.3%) made either a qualitative or quantitative water temperature recommendation. The FDA Model Food Code (section 5-202.12-A) states that a handwash sink must be equipped to provide water at a temperature of at least 100°F (38°C) *(68)*, and only two signs (one foodservice, one healthcare) specifically mentioned 100°F as the wash temperature. It should be clarified, however, that although the code states a sink must deliver water of at least 100°F, the code does not mandate that hands be washed in water at 100°F, only that "clean, running warm water" be used (Section 2-301.12-B-1) *(68)*. Twenty-four (29.6%) signs (5 healthcare, 12 food service, and 9 general public) recommend washing hands with warm water. Despite the appearance in the Model Food Code as well as on some handwashing signs of a recommendation on water temperature, scientific support for a link between higher water temperatures for washing and improved microbial reduction does not appear to exist. Research studies have found no correlation between the temperature of water and the microbial reduction *(41, 42)*.

Hand drying plays a significant role in the reduction of microbes on hands after handwashing *(13, 24, 30, 56, 72)* and in mitigation of cross-contamination risk *(20, 40, 49, 57, 64, 68)*. Even with the established importance of hand drying as part of a thorough hand wash in the published literature already cited, 19 (23.4%) signs did not make a recommendation on drying. Six foodservices signs, 7 healthcare signs, and 6 general public signs did not include a recommendation to dry hands after a wash. Three studies indicated that paper towels provide a ~0.5 log CFU greater microbial reduction than standard air-drying *(13, 24, 30)*, and a majority of handwashing signs surveyed (65.4%) suggested using paper towels. We were surprised to see that 31 (38.3%) signs suggested turning off the faucet with a paper towel as a cross-contamination risk mitigation measure. The use of this measure is supported by one study that showed that ~2% of bacteria present on a faucet tap could be transferred to the hand *(12)* and another that documented the high bacterial populations on faucet handles in homes *(31)*. The FDA Model Food Code suggests that paper towels may be used as a barrier against recontamination "when touching surfaces such as manually operated faucet handles on a handwashing sink or the handle of a restroom door" (2-301.12-C) *(68)*.

Microorganisms may be present over the entire hand, and therefore washing may be complete only when all areas of the hand are given attention *(32, 37, 47)*. The subungal region of fingernails can act as a reservoir for transient Gram-negative organisms, and while 31 (38.27%) signs suggested targeting nails, only 6 (7.41%) suggested use of a fingernail brush, which has been identified as the most efficient way to remove bacteria from under nails *(1, 61)*. Research has also reported that microbial counts are higher on hands with artificial nails than on those with natural nails and that microbial cell numbers were correlated with fingernail length, with numbers being greater beneath longer nails *(35)*. While a nailbrush has been shown to provide an additional 1–1.5 log microbial reduction over the standard hand wash *(61)*, no data currently exist to suggest that targeting the fingernails, without use of a nailbrush, provides any additional microbial reduction. Similarly, risk of transfer of bacteria from under the nails to foods or food contact surfaces is also not documented in the literature. The FDA Model Food Code states that a nailbrush can be used, as part of a cross-contamination prevention regime, before handling ready- to-eat foods with bare hands (section 3-301.11-E-6-b) *(68)*.

Only 2 (2.5%) food service signs suggest removing jewelry during a wash, but this may be because the FDA Model Food Code prohibits all jewelry, except for plain rings, during food preparation (section 2-303.11) *(68)*. A risk assessment determined that wearing a ring during a wash could cause the wash to be less effective *(43)*. Studies on the impact of ring wearing have found that hands with rings have, at minimum, a 1 log greater concentration of skin microorganisms *(17, 58, 65)*. Salisbury et al. determined that healthcare workers who were wearing rings had a less effective hand wash than those not wearing rings *(58)*. Yildirim et al. determined that wearing a ring significantly reduced the effectiveness of hand sanitizers; however, the type of ring worn (smooth versus rough band with stones) had no observable effect on hand sanitizer effectiveness *(73)*. Fagernes et al. observed no significant difference in microbial concentration between hands with and without rings but did notice that hands with rings were more likely to carry bacteria in the family *Enterobacteriaceae*, which includes *Salmonella* and *E. coli (15)*.

When to wash recommendations are a detailed part of U.S. hand hygiene guidelines for both healthcare and foodservice *(7, 68)*. The FDA Model Food Code (section 2-301.14-A-I) recommends washing hands after a number of activities *(68)* that are also mentioned to varying degrees in the handwash signs we surveyed. Following the order in which they are presented in the Model Food Code they are: after touching bare human body parts

(mentioned in 5 signs); after using the restroom (11 signs); after caring for or handling service animals (3 signs); after coughing, sneezing, or using a handkerchief or disposable tissue (7 signs); after using tobacco (5 signs), eating, or drinking (9 signs); after handling soiled equipment or utensils (6 signs); when switching between working with raw food (5 signs, with 4 more mentioning raw meat specifically, and none specifically mentioning raw vegetables/fruits); before donning gloves for working with food (4 signs); and after engaging in other activities that contaminate the hands (3 signs).

Some of these "when to wash" recommendations appear to have scientific support, while others do not. Those that do have scientific support are summarized as follows. Individuals infected with foodborne pathogens can continue to shed these organisms for extended periods *(3)*. *Salmonella* outbreaks associated with dry pet foods resulted in some human cases resulting from handling pets *(8, 9)*. Multiple manuscripts have documented quantifiable cross-contamination from dirty cooking utensils to hands *(12, 19, 57, 69)*. Likewise, cross-contamination to and recontamination of hands have been documented as sources of foodborne outbreaks *(57, 64)*. Cross-contamination to hands directly from raw meat *(39)*, and outbreaks associated with raw meat, with hands as cross-contamination vehicles *(25)*, are well documented.

Given that washing hands can help prevent cross-contamination during food preparation *(12, 18, 19, 50, 70)* and that in many cases foodborne illness outbreaks can be linked to improper hand hygiene *(5, 55, 64)*, it is somewhat surprising that more signs did not include details on when to wash hands.

The WHO recommends "5 moments" of when to wash hands in healthcare settings *(72)*, and the CDC recommends several "indications" for when to wash hands in their hand hygiene guide for healthcare *(7)*. The five WHO moments are before patient contact, before an aseptic task, after body fluid exposure, after patient contact, and after contact with patient surroundings *(72)*. The CDC's indications are when hands are visibly dirty, before contact with patients, before donning sterile gloves, before using equipment intended to remain sterile, after contact with a patient's skin, after contact with bodily fluids, between dirty and clean patient sites, after contact with inanimate objects near a patient, after removing gloves, before and after eating, and after using a restroom *(7)*. Handwashing signs can provide a reminder for healthcare employees of what may be mandated by their agreed-upon hand hygiene code; however, only ~29% of healthcare signs included details on when to wash hands. One healthcare sign suggested washing hands after any work break. None suggested washing hands when returning from areas outside the work area. One healthcare sign suggested washing hands after contact with blood, mucous, skin, a wound, or body fluid. One sign also mentioned washing hands when visibly soiled. No signs suggested washing hands after contact with vomit, despite the fact that norovirus can be transmitted by vomitus *(36)*. One healthcare sign suggested washing hands after changing or removing gloves. Two healthcare signs suggested washing hands after touching animals. Four healthcare signs suggested washing hands after using the restroom. No healthcare sign suggested washing hands after contact with waste/sewage, or after contact with raw food. No healthcare sign mentioned washing hands after suspected cross-contamination, and this includes touching clothing (oneself or other's) or doors. The lower frequency of signs that indicate "when to wash" in healthcare compared to food service may be because WHO and CDC have separate "when to wash" educational materials, so sign creators may not be similarly inclined to add this information to handwash signs designed for the two areas *(7, 72)*.

What constitutes an "ideal" handwashing sign is difficult to determine, and while the FDA, CDC, and WHO have a basic sign in their respective hand hygiene guides, no guidance currently exists on how to design a sign or what to include. The majority of the 81 signs we collected were focused on hand washing techniques, cross-contamination prevention, and when to wash instructions. Highlighting the best techniques and prevention methods by using information from the published literature may serve better educate individuals *(2, 23, 27)*, but research on exactly how to use this information to achieve the best compliance is still needed. This is especially true in food service, where the FDA Model Food Code *(68)* mandates handwashing signage.

This quantitative review was intended to serve as a guide to future hand hygiene research by highlighting the current state of handwashing sign instructions. We envision future research that would involve various model signs, with varying degrees of complexity, as well as human observational research to see whether different signs affected compliance differently.

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