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Major Article

Use of a verbal electronic audio reminder with a patient hand hygiene bundle to increase independent patient hand hygiene practices of older adults in an acute care setting

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Background: We hypothesized that the addition of a novel verbal electronic audio reminder to an educational patient hand hygiene bundle would increase performance of self-managed patient hand hygiene.
Methods: We conducted a 2-group comparative effectiveness study randomly assigning participants to patient hand hygiene bundle 1 (n = 41), which included a video, a handout, and a personalized verbal electronic audio reminder (EAR) that prompted hand cleansing at 3 meal times, or patient hand hygiene bundle 2 (n = 34), which included the identical video and handout, but not the EAR. The primary outcome was alcohol-based hand sanitizer use based on weighing bottles of hand sanitizer.
Results: Participants that received the EAR averaged significantly more use of hand sanitizer product over the 3 days of the study (mean ± SD, 29.97 ± 17.13 g) than participants with no EAR (mean ± SD, 10.88 ± 9.27 g; $t_{73} = 5.822$; $P \leq .001$).
Conclusions: The addition of a novel verbal EAR to a patient hand hygiene bundle resulted in a significant increase in patient hand hygiene performance. Our results suggest that simple audio technology can be used to improve patient self-management of hand hygiene. Future research is needed to determine if the technology can be used to promote other healthy behaviors, reduce infections, and improve patient-centered care without increasing the workload of health care workers.
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Infection prevention principles, guidelines, and standards have established a solid foundation for improvement of health care worker hand hygiene practice. Nevertheless, the ever-changing practice environment and the continued prevalence of health care–associated infections (HAIs) highlight the need to expand our efforts, including investigating the role of patients in infection prevention. In the United States, HAIs are the fifth leading cause of death in acute care hospitals, harming >1.9 million patients and taking the lives of nearly 100,000 people each year.[1] In recent years, researchers and quality improvement leaders have focused their attention on hand hygiene strategies, technologies, and behavioral change to prevent HAIs. Of note, substantial research has indicated that hand hygiene is one of the most important, easiest, and inexpensive practices in preventing infection. Instances that warrant improved patient hand hygiene in health care settings stem from documentation of pathogenic organisms on patient hands and skin,[2-6] in human body substances[3,7] and on surfaces surrounding or attached to the patient, such as bedrails and medical devices.[8-11] Furthermore, patients are at risk for cross-contaminating themselves[8] because pathogens on their hands can serve as vectors transmitting pathogenic organisms

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Conflicts of interest: S.C.K. received 8-oz bottles of hand sanitizer from GOJO Industries (unsolicited) but sought to use as resource for study; and C.D. has received funding in the past for research support from GOJO Industries, Ecolab, 3M, and Clorox.

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to other parts of the body while eating or taking medications or to or from an indwelling medical device, such as a urinary catheter or central line. Consequently, inadequate patient hand hygiene could contribute to HAIs.

Hospitalized patients report that although they know hand hygiene is universally important, they clean their hands less frequently in the hospital than at home.[12] Patients' minimal hand cleansing is confirmed by studies that measured hand hygiene practice via real-time ultrasound tracking systems,[13] product use,[14] number of colony forming units,[11] and observation studies.[15-17] Patients frequently attribute poor hand hygiene practices to feasibility issues including health care staff being too busy.[18,19] Clinicians also recognize poor patient hand hygiene practice and barriers for patients' practice, citing mobility issues especially for older adults,[20] a knowledge deficit about HAIs and hand hygiene importance,[21,22] and difficulty using existing hand hygiene products.[23-25] Therefore, patient hand hygiene in institutional settings can be challenging and frequently underused. Studies that attempted to improve patient hand hygiene reported sustainability issues, in part because of the dependence on health care staff.[15-18,26]

Theoretical framework

The study's framework, the patient hand hygiene model, was developed from the theory of planned behavior[27] and the health belief model.[28] The theory of planned behavior proposes that a person's attitudes and behavior result from consideration of available information.[27] The health belief model posits that a person's behavior is dependent on perceptions of the benefits and barriers related to health behavior and that a cue or trigger is needed to prompt engagement in health behaviors.[28] The audiovisual intervention, patient hand hygiene education, is designed to change attitudes and behaviors about hand hygiene. Cues to action, defined as the trigger for action, is the verbal electronic audio reminder (EAR). The outcome, patient hand hygiene behavior, is measured by alcohol-based hand sanitizer use. The framework also draws on infection prevention studies indicating the effectiveness of multiple informational approaches to communicate the same message.[29-32]

For this 3-day, 2-group comparative effectiveness study, we sought to test the influence that a novel verbal EAR would have to an educational patient hand hygiene bundle to improve patient hand hygiene in older adults hospitalized for elective lower extremity orthopedic or podiatry surgery, which to our knowledge has been rarely studied. The assumption can be made for older adults hospitalized immediately after a nonemergent lower extremity surgery would have mobility issues. Two arms of the intervention study were compared: (1) patient hand hygiene bundle 1 (PHHB1) (n = 41), which received an educational video, a handout, and a tabletop digital clock with a personalized verbal EAR; and (2) patient hand hygiene bundle 2 (PHHB2) (n = 34), which received the identical video, the handout, and the tabletop digital clock without the activated EAR. The outcome measure was alcohol-based hand sanitizer product use. We also sought to test for associations between participant characteristics (grip strength; self-reported arm, hand, or shoulder disability; and postoperative surgical pain) and determined to what extent the EAR influenced patient hand hygiene behavior as measured by alcohol-based hand sanitizer product use.

Based on our model and previous work, which demonstrated that education and audible cues contribute to behavior change, we hypothesized that both groups would use the hand hygiene product, but the PHHB1 group, which used the EAR, would demonstrate greater use of the hand sanitizer product.

MATERIALS AND METHODS

Sample and setting

A convenience sample of older patients in an urban Veteran Affairs hospital was recruited based on the following inclusion criteria: (1) nonemergent lower extremity surgery (orthopedic or podiatry) <8 hours prior to enrollment, (2) ≥55 years of age, (3) ability to communicate in English, and (4) Mini-Cognitive Assessment score >5.[33] Exclusion criteria were as follows: (1) vision, hearing, or physical impairments that limited interaction with the EAR or prevented the patient from using the alcohol-based hand sanitizer product, such as chronic skin disease such as atopic dermatitis; and (2) staff recommendation because of patient's psychological or social issues. Of the 87 patients who were eligible, 3 (3.4%) were unavailable because of postoperative diagnostic testing and 9 (11%) declined, leaving a sample size of 75 enrolled participants. One participant declined because of their belief in handwashing over hand sanitizer use. All 75 participants acknowledged that they had previous experience with using hand sanitizer and viewed it as an effective alternative to handwashing. There was no attrition because of postoperative complications and no observed or documented postoperative complications. All participants (100%) were administered a patient-controlled analgesic pump with hydromorphone or morphine the day of surgery and the day after surgery and switched to an oral narcotic by day 3. This is a standard postoperative treatment for orthopedic and podiatry patients. All patients admitted to the Veterans Affairs are tested for methicillin-resistant *Staphylococcus aureus* (MRSA) in the nares, and contact precautions were used during their hospitalization within 24 hours of testing and results (Table 1).

As the first known use of an EAR to increase patient use of a hand hygiene product, we followed the Cohen recommendation to use a medium to moderate effect size of $R^2 = 0.15$.[34] Using G-Power 3.0 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany), a tool to compute statistical power analyses[35] multiple regression with 4 predictors, an α of .05, and power of .80, and a moderate effect size

Table 1
Participant characteristics for PHHB1 and PHHB2

Participant characteristics	PHHB1 (n = 41)	PHHB2 (n = 34)	*P* value
Participant age, y			
Mean ± SD	66.3 ± 1.3	65.50 ± 1.4	>.99
Range	55-87	55-81	
Sex			
Male	40 (97.6)	30 (88.2)	.72
Female	1 (2.4)	4 (11.8)	
Ethnicity			
White	31 (75.6)	28 (82.4)	.89
Black	9 (22)	6 (17.6)	
Methicillin-resistant *Staphylococcus aureus* (nares)			
Positive	4 (9.8)	6 (17.6)	.91
Negative	37 (90.2)	28 (82.4)	
Highest level of education attended			
Less than college	29 (70.7)	25 (73.5)	.75
College	12 (29.3)	9 (26.5)	
Type of surgery			
Toe or foot	10 (24.4)	14 (41.2)	.59
Hip or knee	31 (75.6)	20 (58.8)	
Surgical pain score average (0-10)			
Mean ± SD	4.8 ± 0.27	5.0 ± 0.36	
Total QuickDASH score (0-100)			
Mean ± SD	2.82 ± 1.50	5.48 ± 1.94	.44
Range	0-54.55	0-40.91	

NOTE. Values are n (%) or as otherwise indicated.
PHHB1, patient hand hygiene bundle 1; *PHHB2*, patient hand hygiene bundle 2.