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Point-of-care Stethoscope Disinfection Improves Hand Hygiene Compliance

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ABSTRACT

Background: Hospital Acquired Infections (HAIs) can be contracted from a variety of sources, including contaminated devices such as stethoscopes, and unwashed hands of caregivers. In order to lower HAI risk, we investigated use of a point-of-care Stethoscope Disinfection Device (SDD) in both an Urgent Care Clinic Setting (UCC), and an academic medical center Emergency Department (ED). We hypothesized that presence of the wall mounted SDD would reinforce infection control behaviors, and Hand Hygiene (HH) compliance in particular.

Methods: Research nurses observed HH compliance the day before, and after installation of the SDDs. Devices were placed outside exam rooms next to hand gel dispensers. Caregivers were considered compliant with WHO recommendations if hand sanitizer was applied before or after patient interaction. Use of the SDD itself was also recorded. Chi square analyses were performed.

Findings: A total of 168 patient room entries were logged during the pre-installation observation periods. After SDD placement, 199 patient room entries were recorded. Overall HH compliance increased from 19% before to 54% after device installation ($p<0.0001$). Among those who used the device for stethoscope disinfection, HH compliance was 94%, as opposed to 46% in those who did not ($p<0.0001$).

Interpretation: SDD installation in 2 distinct medical settings improved HH compliance. Use of the device itself resulted in further optimization of HH rates, likely from the mutually reinforcing nature of infection control behaviors. We speculate that the device's visual presence in proximity to hand gel dispensers will serve as an enduring stimulus to HH guideline conformity.

Keywords: Hospital Acquired Infections (HAIs); Stethoscope Disinfection Device (SDD); Hand Hygiene (HH); Urgent care

INTRODUCTION

Hospital Acquired Infections (HAIs) are the most common complication of hospital care and are one of the top ten leading causes of death in the United States, accounting for an estimated 1.7 million infections and 99,000 associated deaths per year [1]. The financial burden attributable to these infections is estimated at US $ 28 to $ 33 billion in excess health care costs each year [2]. The potential preventability of HAIs is well recognized, and the approach broadly recommended for HAI risk

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reduction includes maintaining a safe, clean, hygienic hospital environment, contact isolation of patients colonized with epidemiologically significant pathogens, medical staff education regarding the importance of infection prevention, proper antibiotic stewardship, appropriate disinfection of medical instruments, and perhaps most importantly, consistent attention to hand hygiene [3].

Hand Hygiene (HH) practice is critical to infection prevention because caregiver hands are well documented as vectors of disease [4,5]. Weber, et al. (2013) recently estimated that 20%-40% of HAIs are attributable to cross-infection *via* the hands of healthcare personnel who have become contaminated from direct contact with patients, or by touching contaminated healthcare surfaces [6]. Accordingly, numerous strategies aimed at raising HH compliance have been implemented. The use of reminder charts and posters throughout clinical care areas, ubiquitous placement of alcohol-based hand rub dispensers, sinks with hand soap in every room, and liberal supply of disposable gloves have improved HH rates. As a result, when strictly applied, these efforts have reduced nosocomial infections by between 40% and 70% [7,8]. Despite this knowledge, multiple research studies have reported that regular HH by healthcare workers often does not go beyond 40% [9-11]. This lack of compliance with published HH recommendations has had public health consequences, including spread of nosocomial diarrheal disease and acute respiratory infections, significant cost burden, and preventable mortality from infectious outbreaks [12,13]. It has also led to the emergence of multi-drug resistant organisms such as methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococci, and certain gram-negative bacilli, whose presence in U.S. hospitals and medical centers has increased steadily over the last few decades [14,15].

Given the gravity of the HAI problem, the need to address other sources of pathogen spread within healthcare facilities has increased. The stethoscope is the most commonly used medical instrument, and there is a significant body of literature documenting that it is highly contaminated with harmful organisms, and it can spread those organisms to patients [16,17]. Furthermore, the ubiquity of stethoscopes distributes their infectious risk across both children and adults, men and women, and in virtually all settings where healthcare is provided. Several infectious outbreaks traced back to stethoscopes have been published, yet caregivers rarely clean this important diagnostic tool [18-21]. Therefore, we created a point-of-care Stethoscope Disinfection Device (SDD) [Skope Station, Skope, Inc., Austin, TX] to address the problem of stethoscope hygiene. The device allows providers to swipe their stethoscope diaphragms (i.e., the part of the instrument that comes in contact with the patient's skin), down a central channel in about 1 second-2 seconds, during which time it is wetted with a hypochlorous solution. The solution disinfects the diaphragm of the stethoscope, killing bacteria, viruses, and bacterial spores.

As part of the product development process, our SDD underwent evaluation by providers in several clinical environments where it was placed on the wall next to the alcohol-based hand gel dispensers. While the intent during these evaluations was to assess the SDD user experience, we also hypothesized that the proximity of the device to the hand sanitizer would provide a visual reminder to engage in HH. Therefore, in the course of conducting a product evaluation study for user feedback, we performed an observational investigation to assess whether the presence of the SSD and its use in a clinical environment would increase HH rates.

METHODS

The plan for the investigation was submitted to the Institutional Review Boards of both University of Texas, Austin, Dell Medical School and Ascension Research Group prior to initiation. Leadership approval of the product evaluation and observation process was granted at all participating sites.

In October 2023, 2 SDD product evaluation studies were conducted, one at an urgent care (UC) franchise with 3 locations in southern California (Urgent Care Pros, Lakewood, CA), and one in the Emergency Department (ED) at a university-affiliated teaching hospital (UT Dell Medical School, Austin, TX). Sites were chosen for their support of the product innovation process, and the high room turnover and expected stethoscope use by caregivers. The investigations were organized across 4 hour-6 hour time periods of observation at each location over 2 days, as approved by facility leadership. Study aims were to gather caregiver feedback about the SDD, observe clinician interaction with the device, and document HH compliance. Pre-installation observations were made the day before study initiation, and staff were not apprised of HH monitoring.

On the day of investigation, devices were mounted to the wall outside of examination rooms, next to existing hand sanitizers, using adhesive strips. An instructional poster was mounted to partially frame the SDD, reinforcing the usage directions shared by the research nurse (**Figure 1**). Use of the SDD was recorded, as was HH guideline adherence.

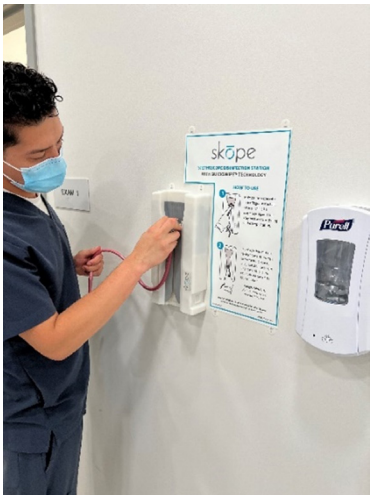

Figure 1: Stethoscope disinfection device placement. Note proximity to hand gel dispenser

Caregivers were considered compliant with HH if either alcohol-based hand sanitizer or hand washing with soap and water was completed in accordance with the World Health Organization "Five Moments for Hand Hygiene" framework upon entry to the patient room, or upon exit after glove removal [22]. The sole use of examination gloves was not considered a substitute for HH [23].

Statistics

The combined number of observations needed at both study sites was estimated to be 124 assuming a 20% improvement in HH rates, p<0.05 and beta=0.8. Data were reported using a percentage of observations for which HH behaviors satisfied WHO recommendations. Comparisons between pre and post-installation behaviors, and between those who did or did not engage in SDD use, were made using Chi-square analysis.

RESULTS

There were 38 observations of caregivers entering examination rooms at the 3 UC locations before SDD installation, and 130 pre-installation observations in the ED. The rates of HH compliance were 24% and 18%, respectively. After SDD installation, 74 UC and 125 ED observations were made, and the rate of HH improved to 68% and 46%, respectively. Overall, HH compliance increased from 19% before to 54% after SDD installation (p<0.00001) (**Table 1**).

Table 1: Hand hygiene data for Chi-square analysis, before vs after device installation

-	HH compliance-no	HH compliance-yes	Total
Pre-installation	136	32	168
Post-installation	91	108	199
Total	227	140	367
Chi-square statistic is 47•9011, p<0.00001			

Not all UC and ED patients underwent stethoscope examination, nor did room entries not associated with physical exam performance necessitate SDD use. Therefore, out of the total post-installation observations, the SDD was employed 34 times. Among those who used the SDD for stethoscope disinfection, HH compliance was 94%, as opposed to 46% in those who did not (p<0.0001) (**Table 2**).

Table 2: Hand hygiene data for Chi-square analysis, SDD use vs non-use

-	HH compliance-no	HH compliance-yes	Total
SDD swipe-No	89	76	165
SDD swipe-Yes	2	32	34
Total	91	108	199
Chi-square statistic is 26•234, p<0.00001			

DISCUSSION

This investigation has demonstrated that installation, as well as use, of a point-of-care SDD is associated with significantly improved rates of HH compliance. Overall HH increased from 19% before, to 54% after SDD installation (p<0.00001). The results suggest that the 2 infection control activities, i.e. stethoscope and hand disinfection, are mutually reinforcing behaviors. This seems plausible because a. Use of either patient protection method suggests a sensitivity to and a heightened awareness of the need for the other, and b. The proximity of the devices to each other creates a visual reminder of the need to disinfect.

This latter assertion may explain why presence of the SDD, even without its use, improved HH compliance.

The observed rates of HH compliance prior to SDD installation, while low, are consistent with those reported in the literature. Muller, et al. (2015) noted a HH compliance rate of 29% in a tertiary referral center ED, with better performance occurring after contact with the patients compared to HH performed before patient contact [24]. Similarly, a systematic review of HH compliance among ED health care workers found a median rate of 14%, though all studies reported improvement with multimodal or single intervention strategies [25]. Since HH rates appear to be optimized by combining hospital-led education with HH vendor reinforcement, SDD installation could be considered such a "vendored" intervention which would explain the compliance increase seen in this study [26].

The magnitude of the effect upon HH seen in this investigation was substantial compared to other interventions in the literature. For example, the global implementation pilot of the WHO's "Five Moments for Hand Hygiene" campaign showed improvement in scores from 18.7% to 24.7% after education about the importance of HH [27]. Arbogast, et al. (2023) employed multimodal strategies including system education and training, just-in-time coaching, incorporation of habit-building strategies, optimization of workflow, appropriate dispenser placement, and collaboration with unit leadership, and saw an improvement in HH compliance from 37.5% to 46.9% [26]. Our observed HH improvement might have been augmented by the novelty of the SDD, and the Hawthorne effect of caregivers knowing they were being watched by our research nurses after device installation. Though this benefit could decrease over time, data from the literature suggests that this is not inevitable. Iversen, et al. (2023) used light displays on hand sanitizer dispensers as a nudge to improve HH in a university hospital setting. They sought to overcome the 'present bias' contribution to HH non-compliance-that is, the behavioral tendency to overweight immediate costs (difficulty of HH compliance) relative to future benefits (HAI reduction)-using visual reminders and positive feedback. Pre-intervention HH rates in healthcare workers were approximately 20%, and these increased post-intervention to approximately 34%. The effect of their protocol was sustained over the observation period of 4 months, even after the visual stimulus was removed, suggesting a new steady-state compliance level was achieved [28]. Therefore, one could speculate that presence of the SDD could function as a similar visual reminder to caregivers to engage in infection control practices. If that is so, the SDD effect upon HH might be maintained over time. Future investigations should seek to answer this important question.

Stethoscope disinfection itself is increasingly recognized as a critical need, especially given the challenges of the recent pandemic [29]. Hospitals, long-term care facilities, and outpatient clinics (and thus their patients) face the significant threat of iatrogenic infection from stethoscopes used on a daily basis. This threat exists because stethoscopes a. are highly con aminated, b. carry deleterious infectious organisms, including viruses, c. pick up and pass along organisms in the course of normal use, in a manner similar to human hands, and d. such passage has been responsible for proven hospital acquired infections with serious sequelae [16,19,30-33].

The CDC, WHO, Association for Professionals in Infection Control, and the Society for Healthcare Epidemiology in America

all recommend cleaning stethoscopes frequently, and recent papers have called for even more stringent cleaning protocols [34,35]. However, these suggestions have largely been ignored due to the lack of an effective and convenient stethoscope cleaning system, and the difficulty of tracing hospital-acquired infections to a particular vector (such investigations are rarely undertaken), leading to under-recognition of the problem.

Institutions which have attempted to address the issue of stethoscope hygiene, usually on behalf of an immunocompromised population or more broadly within a "do no harm" culture, have often done so by providing disposable stethoscopes for repeated use on an individual patient. Beside concerns of diagnostic inferiority and significant cost, these instruments are ineffective at infection control because multiple providers and soiled surfaces touch the disposable stethoscope and contaminate it throughout the day [36,37]. Furthermore, it is rarely cleaned since it is wrongly perceived as hygienic. Therefore, use of disposable stethoscopes creates a potential impediment to care, with a burdensome associated cost not justified by infection prevention benefit. Other approaches to stethoscope hygiene commonly seen in the clinical setting also have significant drawbacks. These include

1. Use of isopropyl alcohol pads which do not kill C. Difficile spores, nor Acinetobacter baumannii and Enterococcus faecium and
2. Use of harsher disinfectant wipes which are not skin safe for patients or caregivers (providers must wear gloves to use them), and they degrade stethoscope materials [34].

The deficiencies in the stethoscope hygiene status quo are particularly serious in the current era. The Covid-19 pandemic has made the spread of viral disease from stethoscope vectors a greater threat in terms of morbidity and mortality [38]. In addition, medico-legal considerations strongly suggest the need for attention to stethoscope hygiene. Meritorious HAI lawsuits may not require demonstration of a causative relationship between stethoscope vector and recipient infection-only that precautions against the possibility of transmission (i.e. stethoscope disinfection) were not taken, creating a climate of negligent hygiene practice [39].

All of these considerations support the notion that a clinically useful, point-of-care method of stethoscope disinfection must be made available to healthcare practitioners to ensure patient safety. The SDD employed in this investigation addresses many of these issues to reduce nosocomial infection risk. It uses hypochlorous solution (which is skin and mucous membrane safe) to kill organisms on the stethoscope's diaphragmatic surface, does not corrode stethoscope materials, and is quick and easy to use. Though the primary function of the SDD is valuable in itself, its association with improvement in HH provides a significant additional benefit in the fight against HAIs. It is probable that a convenient SDD will gain wide acceptance rapidly, since providers are aware of their obligation to clean their personal medical equipment [40].

There are several limitations to this study. Data were collected in the context of an SDD product evaluation, and the resultant periods of observation (4 hours/day-6 hours/day on consecutive days) were limited. This, in turn, limited the number of HH observations. Research nurses did not enter the examination rooms with providers for patient privacy reasons, so some use of hand sanitizer within rooms might have been missed. However, the gel dispensers at all study locations made a distinct and easily audible sound when activated, and this inferred activation was counted toward HH compliance. Finally, as previously mentioned, our data could be skewed by the Hawthorne effect, though research nurses did not divulge their interest in HH compliance to providers during the observation period.

CONCLUSION

In conclusion, use of a point-of-care SDD placed in proximity to hand sanitizer dispensers offers promise for HAI reduction through enhanced stethoscope hygiene and significantly improved HH compliance. These mutually reinforcing infection control behaviors could provide critical patient protections across a broad range of clinical settings. They should be promoted *via* widespread SDD adoption, and continued dedication to provider infection prevention training.

CONTRIBUTORS

DS served as principal investigator. DS, MS, AW, and DB conceptualized and implemented the study, including data collection. MT, RK, EB, NS, KR, and KS contributed to the methodology and project administration. DB was responsible for funding acquisition. DS and DB undertook data analysis and table/figure generation. DS wrote the original draft. All authors reviewed and approved the final manuscript and were responsible for the decision to submit the paper for publication.

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DECLARATION OF INTERESTS

DS, KR, KS, and DB are equity holders of Skope, Inc. MS and AW are research coordinators paid by Skope, Inc.

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