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Effects of Audio-Visual Stimulation on Hand Hygiene Compliance among Family and Non-Family Visitors of Pediatric Wards: A Quasi-Experimental Pre-post Intervention Study

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ABSTRACT

Purpose: This study aimed to identify the differences in interventional effects on hand hygiene compliance (HHC) among families and visitors in pediatric wards.
Design & methods: A total of 2787 family and non-family visitors entering through the glass sliding door of 6 pediatric wards at a university children's hospital were observed for 4 h, respectively, before and after interventions between April 27 and May 20, 2018. In the first intervention, a visual stimulus emphasized the location of the hand sanitizer. In the second intervention, an additional auditory stimulus transmitted a cue through a motion sensor speaker.
Results: During the preliminary observation, the HHC rates of family and non-family visitors were 0.0% and 1.5%, respectively; after the visual stimulus, they were 0.6% and 5.4%, and after the audio-visual stimulus, 1.8% and 8.2%. There was a significant increase in the overall HHC with the visual (OR, 5.22; 95% CI, 1.76–20.90) and audio-visual (OR, 8.67; 95% CI, 3.08–33.70) stimuli (Fisher's exact test, $p < .05$).
Conclusions: The HHC of family and non-family visitors entering pediatric wards was very low and the audio-visual stimulus was found to be more effective than was the visual stimulus alone.
Practice implications: To reduce healthcare-associated infection, pediatric wards must actively implement effective interventions. Using audio-visual stimulation to increase HHC among visitors will provide advantages. Follow-up research should examine the current state of HHC among visitors in various locations and conditions.

Introduction

Hand hygiene is the most convenient and effective way to protect individuals and prevent the spread of infection and disease (World Health Organization, (WHO), 2009). It is also a fundamental act and critical infection control strategy that can reduce healthcare-associated infection (HAI) (Wolfe & O'Neill, 2012). For this reason, the WHO and each country's Center for Disease Control and Prevention (CDC) have established standard precautions to prevent the spread of infectious diseases and reduce HAI; they have also developed a monitoring system to ensure that health care providers comply with these precautions.

In 2015, Korea experienced the Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak. According to a report, 34.4% of those diagnosed with MERS-CoV were family members of patients, caregivers, and visitors who spent time at locations where MERS-CoV patients were being treated (Korean Society of Infectious Diseases, 2015). This fact provided a clue that it is necessary to expand the scope of major contributors of cross infection to patients, families, and visitors, as well as hospital employees (Park, Kim, Yoo, & Choi, 2016).

At the same time, in Korea, visiting and caring for patients in the hospital is considered an act of courtesy and filial duty; thus, it is difficult for hospitals to restrict families and visitors (Kim, Kim, & Bae, 2017). Since the MERS-CoV outbreak in 2015, hospitals at various levels have announced visiting hours. They have also installed glass sliding doors to block infection routes. However, pediatric wards are an exception; they issue one access card per pediatric patient to authorize access to guardians for reasons such as mental security of hospitalized children and consent for treatment procedures. Given that young children are more likely to cross-infections in ambulatory settings and hospitalized facilities (Buet et al., 2013; McBride, 2018), visitors (family and non-family) must engage in minimum health behaviors for infection prevention before entering pediatric wards. The easiest prevention measure is engaging in hand hygiene using alcohol-based hand sanitizer.

Most studies measuring hand hygiene compliance (HHC) rates have used observational methods. Hospital visitors were observed at hospital entrances (Birnbach et al., 2012; Hobbs, Robinson, Neyens, & Steed, 2016; Vaidotas et al., 2015), ward entrances (Fakhry, Hanna,

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Anderson, Holmes, & Nathwani, 2012), and intensive care unit entrances (Taylor & El-Kafrawy, 2012). Interventions included visual stimulation using posters (Birnbach et al., 2012; Hobbs, Robinson, Neyens, & Steed, 2016) or flashing lights on alcohol-gel dispensers to increase compliance (D'Egidio et al., 2014), and audio stimulation using motion-sensor speakers (Fakhry, Hanna, Anderson, Holmes, & Nathwani, 2012; Taylor & El-Kafrawy, 2012). However, research has not examined HHC at entrances to pediatric wards where at least one family member is living at the hospital with her/his child. Thus, this study attempted to determine intervention effects for HHC among family and non-family visitors entering pediatric wards.

Methods

Study design

This quasi-experimental pre-post intervention study compared HHC pre- and post-intervention for family and non-family visitors entering the pediatric ward.

Participants

Participants were visitors entering through the glass sliding doors installed at six ward entrances at a university children's hospital in Seoul.

Those with access cards were regarded as family and those without access cards were regarded as non-family visitors; patients and hospital staff were excluded. An access card is provided to a guardian, which is most often the mother, when the child is hospitalized. The sampling number was estimated to be 2223 based on a sample power of 0.95 for Fisher's exact test, while adjusting for an odds ratio of 1.3 according to the results of a previous study (Hobbs, Robinson, Neyens, & Steed, 2016). A total of 2787 (family, 1904; non-family, 883) persons was ultimately observed.

Ethical considerations

This study did not include personal identification data since it targeted many unspecified persons visiting the children's hospital. It was thus exempted from deliberation of the College of Medicine of Seoul National University/Medical Research Ethics Committee of Seoul National University Hospital. The research was conducted with permission from the executive director of the nursing department. After permission was obtained, the researcher visited the person in charge of the ward to explain the purpose and method of the study and obtain consent.

Study procedure

Observations

Data were collected three times between April 27 and May 20, 2018 from 6 pediatric wards with 315 beds at a children's hospital in Seoul. Participants were observed for 4 h during visiting hours (when more non-family visitors visit), from 6 p.m. to 8 p.m. on Friday, and 1 p.m. to 3 p.m. on Sunday.

The observed wards were located on either side of the elevator, facing each other, each with glass sliding doors as the entrance (Fig. 1). Most visitors entered the wards by taking the elevator from the hospital lobby. Hand sanitizers were placed in four spots: at the hospital entrance, information desk, elevator, and glass sliding doors without any signage. Since the purpose of installing ward entrance sliding doors was to block infection sources, HHC before entering through the sliding doors of the wards was measured. People were observed as they entered the wards from the couch in front of the sliding doors at the entrance (Fig. 1).

Observer error control

Ten observers aged 20–49 years were recruited and informed of the research objectives and methods twice; first via email and second via a face-to-face meeting that lasted for about 20 min before the first practice. They collected data for 2 h a day for 6 days at 6 wards. They were allocated to each ward after 15 min of practice with a checklist organized to record characteristics of participants and HHC. Gender, age (youth, adult, and older adult), and type of visit were classified according to the intuitive judgment of the observers. Details on having/not having an access card (family/non-family visitor) and visiting individually/in a group were also recorded. The researcher walked around at 30-minute intervals during the observation period to check the progress and authenticity of the recorded information. To minimize the Hawthorne effect (Srigley, Furness, Baker, & Gardam, 2014), observers studied people on the couch while pretending to be a guardian (holding a discharge form and waiting to complete discharge procedures).

Observers recorded details on all participants entering the ward repeatedly as individual cases. Pump-type hand sanitizer dispensers were used that contained 83.0% ethanol. The dispensers were fixed on the sliding doors at the ward entrance, and the act of applying sanitizer on the hands was recorded as HHC.

Fig. 1. Glass sliding door of a pediatric ward (before intervention).

Fig. 2. Visual stimulation (left), audio stimulation (right).

Interventions

Visual stimulation

A hand sanitizer image (18.5 cm × 12.5 cm) was attached above the dispenser installed on the right side of the sliding doors, along with a notice (17.5 cm × 14 cm) that read "Bring your love with clean hands only. Sanitize your hands before entering" above the access card reader (Fig. 2).

Audio-visual stimulation

Audio-visual stimulation was provided using a motion-sensor speaker (60 mm × 90 mm × 26.6 mm) that announced "Just a moment! Please use the hand sanitizer before entering the ward" for 5 s in a child's voice when body movements were detected. The "Microsound V22" motion-sensor speaker, manufactured by Waytronic, was used. It was designed to play the file set as 90 dB when capturing body movements detected through infrared rays within the scope of 120°, 4 m from the installed spot. The motion-sensor speaker was attached above the hand sanitizer, along with a sign indicating that it was a "motion-sensor speaker" (17.5 cm × 11 cm) to keep people from mistaking it to be a CCTV (Fig. 2).

Data analysis

This study regarded the number of entries through the sliding doors as hand hygiene opportunities, and the number of hand sanitizer uses as HHC. Data were analyzed using R version 3.3.2. General characteristics of the participants were analyzed in terms of frequency and percentage, and for each intervention, HHC was analyzed in terms of frequency, percentile, and verified by odds ratio, Chi-square test, and Fisher's exact test, with the level of significance set at <0.05.

Results

General characteristics of participants

A total of 2787 persons were observed: 894 (32.1%) before the interventions, 960 (34.4%) after the visual stimulus, and 933 (33.5%) after the audio-visual stimulus.

There were more families than non-family visitors and more women than men. Most were adults and there were more individual visits than group visits (Table 1). Some of the youth wearing access cards were likely brothers or sisters staying at the hospital room. Similarly, older adults were likely temporary visitors who borrowed access cards, rather than family members constantly staying with the patients.

We tested homogeneity of the general characteristics of all participants before the intervention and after the first and second interventions: homogeneity was found for wearing an access badge, gender, and type of visit ($p > .05$), but not for age group.

HHC level by intervention according to general characteristics

It was observed that 4 (0.4%) out of 894 people used hand sanitizer before the intervention and they were adults visiting in groups (Table 2). After visual stimulation, 22 visitors (2.3%) performed hand hygiene. After audio-visual stimulation, 35 (3.8%) out of 933 people performed hand hygiene (Table 2).

It was found that families wearing access cards did not perform hand hygiene at all, but after the first and second interventions, compliance increased to 0.6% and 1.8%, respectively. As for non-family visitors,

Table 1
Characteristics of the participants.

Variable	Category	Homogeneity χ^2 (p)	Before intervention	Visual stimulation	Audio-visual stimulation
			n(%)	n(%)	n(%)
Access badge	Yes (Family)	0.01 (0.906)	625(69.9)	625(65.1)	654(70.1)
	No (Non-family)		269(30.1)	335(34.9)	279(29.9)
Gender	Male	1.91 (0.167)	303(33.9)	288(30.0)	344(36.9)
	Female		591(66.1)	672(70.0)	589(63.1)
Age group	Youth	15.98(<0.001)	45(5.1)	64(6.7)	92(9.9)
	Adult	27.69(<0.001)	820(91.7)	841(87.6)	780(83.6)
	Older adult	9.97(0.002)	29(3.2)	55(5.7)	61(6.5)
Type of visit	Group	0.008	290(32.4)	322(33.5)	301(32.3)
	Individual	(0.929)	604(67.6)	638(66.5)	632(67.7)

Table 2
Characteristics of participants complying with hand hygiene ($N = 61$).

		Family			Non-family			Total[a]
		Before n(%)	Vis n(%)	AV n(%)	Before n(%)	Vis n(%)	AV n(%)	n(%)
Gender	Male	–	–	7	–	7	13	27/344(2.9)
	Female	–	4	5	4	11	10	34/589(1.8)
Age	Youth	–	–	1	–	4	3	8/92(2.7)
	Adult	–	4	11	4	14	13	46/780(1.9)
	Elderly	–	–	–	–	–	4	4/61(2.8)
Type of visiting	Group	–	1	4	4	13	14	36/301(3.9)
	Individual	–	3	8	–	5	9	25/632(1.3)
Subtotal[a]		0/625(0.0)	4/625(0.6)	12/654(1.8)	4/269(1.5)	18/335(5.4)	23/279(8.2)	61/2787(2.2)

Abbreviations: Before, before intervention; Vis, visual stimulation; AV, audio-visual stimulation.
[a] Frequency of hand hygiene compliance over observations.

compliance increased from 1.5% to 5.4% and 8.2%, respectively, after interventions (Fig. 3).

Audio-visual stimulation effect test

Fisher's exact test showed that audio-visual stimulation had a significant effect on hand hygiene of families and visitors, and visual stimulation and audio-visual stimulation increased HHC by 5.2 times and 8.7 times, respectively, compared to before intervention (Fisher's exact $p < .05$) (Table 3).

Discussion

This study was conducted to determine the effects of visual and audio-visual stimulation on HHC of visitors entering the pediatric ward. The characteristics of the participants were similar before intervention and during the first and second interventions. Visitors without access cards were mostly adults and gender was evenly distributed, which was similar to the findings of previous studies (Hobbs, Robinson, Neyens, & Steed, 2016).

There were more female adults among families, because it is mostly the mothers who take care of hospitalized children (Jin, Song, Han, Seo, & Kim, 2015). Family members wearing access cards were frequently observed because, after installing the sliding doors, some facilities such as a room with cupboards and a laundry room were shared by the two wards. This frequent need to leave the ward should be considered along with developing remedial measures to minimize the inflow of external sources of infection (Carter, Cohen, Murray, Saiman, & Larson, 2015). Regarding type of visit, the HHC rate of groups was significantly higher than that of individuals, which was regarded as resulting from the influence of social pressure (Hobbs, Robinson, Neyens, & Steed, 2016). Since observation of the initial user or leader of the group was not included in this study, we suggest further research to measure social pressure or peer pressure among group-type visitors.

Before intervention, the HHC rate of visitors was only 1.5%, which showed a large gap from that of healthcare workers, which was 75.9% at general hospitals and 95.3% at pediatric hospitals (Oh, 2015). However, regarding visitor HHC, results were similar to those of previous studies such as 0.52% reported by Birnbach et al. (2012), 4.1% at a pediatric ward reported by Wolfe and O'Neill (2012), and 10.6% reported by Fakhry, Hanna, Anderson, Holmes, and Nathwani (2012), but lower than that reported by Taylor and El-Kafrawy (2012) at 36.4%.

After visual stimulation, the HHC of all visitors increased from 0.4% to 2.3%, which is a marginal increase compared to the results of previous studies. Birnbach et al. (2012) reported that HHC of hospital visitors increased from 0.52% to 0.67% and did not show a significant increase after merely adding signage to the hand sanitizer, but increased by 9.33% when there was a freestanding AHS dispenser. Hobbs, Robinson, Neyens, and Steed (2016) claimed that HHC increased significantly by 5.28 times when the AHS dispenser was placed at a noticeable spot at the center of the lobby. This emphasizes the need to consider visibility and accessibility of visual stimulation to increase HHC, aside from signage merely suggesting the use of HHC (Cure & Van Enk, 2015).

After the audio-visual stimulation, HHC showed a significant effect that was larger than that for visual stimulation (Fisher's exact $p < .05$), which is consistent with the result of Fakhry, Hanna, Anderson, Holmes, and Nathwani (2012). Audio-visual stimulation to increase HHC has many advantages as it is inexpensive and requires no prior education or training (Hobbs, Robinson, Neyens, & Steed, 2016; Taylor & El-Kafrawy, 2012).

Among those observed, family members showed a lower HHC rate than did non-family visitors, despite being more likely to be educated on using hand sanitizer at the moment of hospitalization via a brochure by the nurse in charge. However, the hospital did not appear to provide any additional education to family or non-family visitors regarding to hand hygiene, except for posters at the hospital lobby and next to the elevators, unless contagious infection control was necessary. Further research should examine the HHC persistence of family of pediatric patients and performance feedback methods. Previous studies suggest methods such as verifying compliance rates using recorders or electronic surveillance systems (Ellison, Barysauskas, Barton, Rundensteiner, & Wang, 2015; Srigley, Furness, Baker, & Gardam, 2014), and analyzing related factors such as knowledge, beliefs, attitudes, and education experiences regarding hand hygiene through

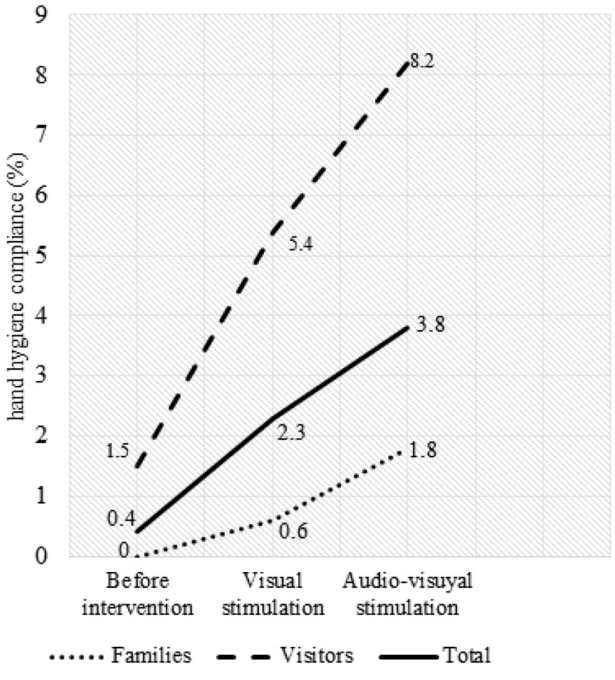

Fig. 3. Percentiles of Hand Hygiene Compliance by Interventions.

Table 3
Odds ratios of hand hygiene compliance by audio-visual stimulation.

Variable	Category	Odds ratio	CI < 95%	CI > 95%	χ^2	*df*	*p*	Fisher's exact *p*-value
Audio-visual stimulation	Before intervention	1			23.35	2	<0.001	<0.001
	Visual stimulation	5.22	1.76	20.90	19.76			
	Audio-visual stimulation	8.67	3.08	33.70	20.51			

self-report surveys and interviews (Alsubaie et al., 2013; Kumar, Arya, Chellani, Deb, & Shankar, 2018).

Non-family visitors likely showed a higher HHC rate because they paid attention to unfamiliar surroundings including signage and audible directions. Fakhry, Hanna, Anderson, Holmes, and Nathwani (2012) reported visitors showed higher persistence of HHC than healthcare providers to an audible hand hygiene reminder. Furthermore, it could be a consequence of family members' need for reminders through various methods to increase their HHC. One such method, audio-visual stimulation, has many advantages including its low cost, high effectiveness, and ability to use without prior knowledge. However, further research should be conducted to examine knowledge, attitudes, persistence, and causes of non-compliance toward hand hygiene among family members wearing access cards, especially in pediatric wards.

Finally, this study showed that while audio-visual stimulation leads to a statistically significant increase in HHC, the HHC remains clinically low. That is, more active infection control education is needed for family and non-family visitors. Future research should also explore how demographic characteristics, dispenser location, monotony of audio-visual stimulation, time of day, type of visit, and country can affect HHC rate and persistence.

Limitations

This observatory study was conducted with visitors entering the pediatric ward of one children's hospital. Thus, there are limitations in broadly interpreting the results of this study. The location, space, and layout may vary among hospitals; visitors are likely to use a hand sanitizer dispenser at a different place other than the observation spot in this study. Furthermore, visitors in the study were classified by access cards into family and non-family visitors, which may not be accurate in different hospital cultures. This study was also limited in that it did not include preference between water and alcohol-based sanitizer and excluded the HHC persistence of hospital visitors.

Conclusions

The Korean government has carried out national campaigns on “hospital visiting etiquette” to prevent HAI after the MERS-CoV outbreak in 2015. These practices are more critical in pediatric wards that house children with low immunity, and where families, friends, and other visitors may be the source of infection. Regardless of demographic characteristics, the HHC of visitors at the entrance of the pediatric ward was 0.4% before intervention. The HHC of family members who stayed longer with pediatric patients was lower than that of temporary visitors. However, the HHC of participants increased significantly when visual stimulation was provided (2.3%), and even more when audio-visual stimulation was provided (3.8%) (Fisher's exact, $p < .05$). HHC should be expanded to not only infection-sensitive wards but also long-term care hospitals.

Practical implications

Medical institutions must develop effective interventions and actively implement them to reduce HAI. Audio-visual stimulation was identified as an effective method of increasing HHC. Although the improvement in HHC was significant, the overall HHC of family and non-family members remained low. Based on the results of the study, follow-up research by medical institutions should examine the current state of HHC of visitors in various interventions and conditions.

Conflict of interest

None declared.

Ethical statement

This study targets many unspecified persons visiting the children's hospital, and thus was exempted from deliberation of the College of Medicine of Seoul National University/Medical Research Ethics Committee of Seoul National University Hospital.

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