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ORIGINAL RESEARCH

Improving Healthcare Worker Hand Hygiene Adherence Before Patient Contact: A Multimodal Intervention of Hand Hygiene Practice in Three Japanese Tertiary Care Centers

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BACKGROUND: Though hand hygiene is an important method of preventing healthcare-associated infection, we found suboptimal hand hygiene adherence among healthcare workers in 4 diverse Japanese hospitals (adherence rates of 11%–25%).

OBJECTIVE: Our goal was to assess multimodal hand hygiene intervention coupled with a contest to improve hand hygiene adherence.

SETTING: A total of 3 to 4 inpatient wards in 3 Japanese hospitals.

DESIGN: Pre-post intervention study.

INTERVENTION: The intervention was a multimodal hand hygiene intervention recommended by the World Health Organization that was tailored to each facility. The hospital with the highest adherence after the intervention was given $5000 US dollars and a trophy, provided by an American coinvestigator unaffiliated with any of the Japanese hospitals.

MEASUREMENT: We tracked hand hygiene adherence rates before patient contact for each unit and hospital and compared these to pre-intervention adherence rates.

RESULTS: We observed 2982 postintervention provider-patient encounters in 10 units across 3 hospitals. Hand hygiene adherence rates were improved overall after the intervention (18% pre- to 33% postintervention; $P < 0.001$), but postintervention adherence rates varied considerably: hospital A + 29%, B + 5%, C + 8%. Hospital A won the contest with 40% adherence after the intervention.

CONCLUSIONS: Using a novel contest coupled with a multimodal intervention successfully improved hand hygiene rates among Japanese healthcare workers. Given the overall low rates, however, further improvement is necessary. *Journal of Hospital Medicine* 2016;11:199–205. © 2015 Society of Hospital Medicine

Healthcare-associated infections are a major cause of illness and death in hospitalized patients, and preventing healthcare-associated infection is a global challenge.[1] Worldwide, the prevalence of healthcare-associated infections in developed and undeveloped countries ranges from 5.1% to 11.6% and 5.7% to 19.1%, respectively.[2] In the United States, roughly 2 million such infections occur annually, resulting in approximately 99,000 deaths[3] and estimated annual direct medical costs between $28.4 and $33.8 billion.[4] In Japan, nearly 9% of patients admitted to the intensive care unit (ICU) develop an infection during hospitalization,[5] and 5% of all patients hospitalized become infected with methicillin-resistant *Staphylococcus aureus*.[6] The management of healthcare-associated infections in Japan accounts for up to 5% of total annual healthcare costs, with an estimated $6.8 billion estimated to be potentially preventable.[7] In addition, healthcare-associated infections are associated with increased length of stay in the hospital. Studies estimate surgical site infections extend length of stay by 9.7 days,[8] and bloodstream infections increase length of stay by 10 days.[9]

Improving hand hygiene practice for healthcare workers is considered a core strategy to decrease the incidence of healthcare-associated infection.[6,10] Specifically, the use of alcohol-based hand rub is strongly recommended in acute care hospitals by both the World Health Organization (WHO) and the US Centers for Disease Control and Prevention.[11,12] Improving hand hygiene adherence may reduce healthcare-associated infection by 9% to 50%,[13,14] and multiple studies have reported that greater use of alcohol-based hand rubs results in significant reductions in healthcare-associated infections.[14,15]

Due to the difficulty in improving hand hygiene in various settings across the world, the WHO strategy for improving hand hygiene has been adopted and implemented by several studies in varying locations,

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TABLE 1. Characteristics of Participating Hospitals

	Hospital A		Hospital B		Hospital C	
	Preintervention	Postintervention	Preintervention	Postintervention	Preintervention	Postintervention
Hospital characteristics						
Location	East Japan		Midwest Japan		Northern Japan	
Hospital type	University affiliated		Community based		Community based	
Level of care	Tertiary care		Tertiary care		Tertiary care	
Residency program	Yes		Yes		Yes	
No. of beds	250	312	428	428	550	562
No. of employees	398	475	1,035	1,263	1,500	1,568
No. of physicians	73	91	179	188	207	217
No. of nurses	172	210	410	540	616	800
Infection control practice						
Establishment of infection prevention units (year)	N/A	Yes (2012)	N/A	Yes (2012)	Yes (2010)	Yes
Employment of certified nurses in infection control (FTE)	0	1 (1)	0	1 (1)	3 (1.5)	3 (1.5)
Employment of ABIM-ID–certified physician	0	0	1	1	1	0

NOTE: **Abbreviations**: ABIM-ID, American Board of Internal Medicine, Infectious Disease; FTE, full-time equivalent; N/A, not applicable.

such as Costa Rica, Italy, Mali, Pakistan, and Saudi Arabia.[16] Implementations of these multimodal strategies, following WHO–based guidelines, have been shown to increase the level of hand hygiene adherence among healthcare workers and reduce infections at these locations.[14,17,18] This study expands upon that work by extending the same implementation strategy to assess the effectiveness of the introduction of alcohol-based hand rub on hand hygiene practice at multiple hospitals in Japan.

In a previous article[19] we reported results from an observational study assessing healthcare worker hand hygiene adherence before touching the patient in 4 geographically diverse hospitals in Japan. The study reported that hand hygiene adherence in Japanese hospitals was lower than reported mean values from other international studies, and that greater adherence to hand hygiene should be encouraged. In this article, we present the results of a multimodal intervention intended to improve levels of healthcare worker hand hygiene in 3 of these hospitals.

METHODS

Participating Institutions

Three of the 4 hospitals participating in the prior observational study chose to participate in this intervention. Evaluation of hand hygiene practice was performed in at least 3 wards of each hospital including an inpatient surgical ward, an inpatient medicine ward, an ICU, or an emergency ward.

Table 1 lists the characteristics of the participating hospitals. Hospital A is a university-affiliated, tertiary care medical center with 312 beds in East Japan. Although the hospital did not have an infection prevention unit or designated infection control nurses during the preintervention periods, the hospital hired a designated infection prevention nurse and established a department of infection prevention before this intervention in April 2012. Hospital B is a community-based, tertiary care medical center with 428 beds, located in Midwest Japan. Although the facility had no infection control nurses at the outset of the study, a physician certified by the American Board of Internal Medicine and Infectious Diseases provided educational sessions of hand hygiene. Hospital B hired a designated infection prevention nurse and established a department of infection prevention in April 2012. Hospital C, located in Northern Japan, is a community-based, tertiary care medical center with 562 beds. The department of infection prevention was established in 2010 and has 1 full-time and 2 part-time infection prevention nurses.

Role of the Funding Source

This study was unfunded. The prize for the contest was provided by an American collaborator (S.S.) who was not affiliated with any of the participating hospitals.

Intervention

In the prior preintervention study, hand hygiene adherence rates of healthcare workers were evaluated between July 2011 and November 2011.[19] To improve hand hygiene adherence in these facilities, we initiated a multimodal intervention based on WHO recommendations and the findings from the prior study. Each facility was provided the same guidance on how to improve hand hygiene adherence (Table 2) and encouraged to tailor the intervention to their local setting. As an added incentive, we initiated a contest, where the facility obtaining the highest hand hygiene adherence postintervention would win a trophy and 500,000 Japanese yen (approximately $5000 US dollars). The recommended strategies consisted of 15 components (Table 2): infrastructure (3 components), training and education (2 components), evaluation and feedback (5 components), reminder in the workplace (1 component), and institution safety climate (4 components). Of note, the participating institutions had already implemented a varying number of the

TABLE 2. Recommended Multimodal Hand Hygiene Intervention Components

Intervention Components	Description
1. Infrastructure (3 components)	
Hand-washing faucets for each room	At least 1 faucet and sink for each room was available.
Placement of alcohol hand rub at patient's room entrance	Alcohol hand rub was placed at all patient room entrances.
Portable alcohol hand rub distributed for each healthcare worker	Personal, portable alcohol hand rub dispensers were provided for healthcare workers who contact patients.
2. Training/education (2 components)	
Educational resources	At least 1 physician or 1 nurse who provides educational sessions regarding hand hygiene practice was available.
Periodic seminars and lectures regarding hand hygiene education	Hospital-wide hand hygiene seminar or educational activities were held during the intervention period.
3. Evaluation and feedback (5 components)	
Evaluation of hand hygiene practice by direct observation	Hospitals utilize direct observation for healthcare worker's hand hygiene practice.
Evaluation of hand hygiene practice by monitoring the amount of alcohol hand rub consumption	Hospitals utilize the amount of alcohol hand rub consumption as a parameter for healthcare worker's hand hygiene practice.
Hand hygiene rate feedback at infection control committee	Hand hygiene adherence rate was reported and discussed at hospital infection control committee.
Hand hygiene rate feedback to the designated wards/units	Hand hygiene adherence rate was reported and discussed with healthcare workers at the designated wards/units where hand hygiene observation was performed.
Granting the award of top-rated person of hand hygiene	Hospitals established the system to assess individual healthcare worker's hand hygiene adherence rate.
4. Reminder in the workplace (1 components)	
Poster notification	Poster notification for hand hygiene practice was performed in the intervention period.
5. Institutional safety climate (4 components)	
Commitment of hospital president or hospital executives	Hospital executives including the president agreed on the importance of hand hygiene practice and declared to healthcare workers to enhance hand hygiene practice during the intervention period.
Commitment of nurse managers and physician leaders	Commitment of improving hand hygiene practice by representative healthcare workers at the designated wards/units (eg, meeting by nurse manager or physician leaders at the designated wards/units and collaborative work with infection prevention services).
Meeting at the designated wards/units	A ward/unit-level meeting or voluntary session for hands-on hand hygiene practice by healthcare workers at the designated wards/units.
Identifying champions at the designated wards/units	An individual healthcare worker who contributed to improving hand hygiene practice was appointed.

intervention components prior to the start of the intervention. Each facility conducted a 6-month intervention to improve hand hygiene adherence; however, the actual timing of interventions varied slightly by institution. Hospitals A and C conducted an intervention from October 2012 through March 2013, whereas hospital B's intervention was from April 2012 to September 2012. Details of the multimodal intervention performed at each participating hospital are shown in Table 3.

Observation of Hand Hygiene Practice

The same methods for hand hygiene observation used for the preintervention study was used for postintervention assessment. Ten distinct units across the 3 participating hospitals were evaluated for healthcare worker hand hygiene prior to patient contact. Three to 4 units were observed at each facility. One of the study authors (T.S.), a Japanese board-certified infection control nurse, conducted all of the hand hygiene observations for both the preintervention and postintervention studies. Intraobserver variation was minimized by providing the same training outlined in the previous study.[19] Appropriate hand hygiene was defined as the use of soap and water or alcohol-based hand rub before patient contact, which corresponds to the first moment of the WHO's 5 moments of hand hygiene.[11]

Hand hygiene practice prior to patient contact for each individual provider-patient encounter was observed and recorded using the hand hygiene observation form adapted from a previous study by Saint et al.[6,20] Identical to the preintervention study,[19] the form captured the following information: unit in which observations were performed, time of initiation and completion of observations, healthcare worker subgroup (physician or nurse), and the type of hand hygiene before patient contact (ie, hand washing with soap and water, use of alcohol-based hand rub, or no hand hygiene). Unit physicians and nurses were informed that their clinical practices were going to be observed, but were not informed of the purpose of the observations (eg, hand hygiene adherence). To avoid interfering with clinical care delivery, the observer was given strict instructions to maintain a certain distance from the observed healthcare workers. The observer was instructed to leave immediately if asked for any reason by the unit staff or patients.

Statistical Analysis

Overall hand hygiene adherence rates were calculated and compared between the pre- and the postintervention periods. Comparison of hand hygiene adherence by healthcare worker subgroup and by hospital unit between the pre- and postintervention periods was also performed. Hand hygiene adherence rates were compared using JMP 9.0 and SAS 9.3 (SAS Institute Inc., Cary, NC). Comparison of hand hygiene adherence rates by observational periods was calculated by Pearson χ^2 tests, and 95% confidence intervals (CIs) were estimated using binomial distribution. Pearson correlations were used to determine the relationship of hand hygiene between physicians and nurses in the same unit. Two-tailed P value ≤ 0.05 was considered statistically significant. The study protocol was

TABLE 3. The Multimodal Intervention Performed at Each Participating Hospital

	Hospital A		Hospital B*		Hospital C	
Intervention period	October 2012–March 2013		April 2012–September 2012		October 2012–March 2013	
Evaluation of hand hygiene in the postintervention period	May 2013–July 2013		October 2012		June 2013	
Suggested intervention components	Preintervention	Postintervention	Preintervention	Postintervention	Preintervention	Postintervention
No. of implemented components	2/15	10/15	9/15	10/15	6/15	8/15
Infrastructure (3 components)						
Hand-washing faucets for each room	No	No	Yes	Yes	Yes	Yes
Placement of alcohol hand rubs at patient's room entrance	Yes	Yes	Yes	Yes	Yes	Yes
Portable alcohol hand rub distributed for each healthcare worker	No	Yes***	No	Yes***	No	No
Training/education (2 components)						
Educational resources	No	Yes***	Yes	Yes***	Yes	Yes
Periodic seminars and lectures regarding hand hygiene education	No	Yes***	Yes	Yes	Yes	Yes
Evaluation and feedback (5 components)						
Evaluation of hand hygiene practice by direct observation	No	Yes***	Yes	Yes	No	No
Evaluation of hand hygiene practice by the amount of alcohol hand rub consumption	No	No	Yes	Yes	Yes	Yes
Hand hygiene rate feedback at infection control committee	No	Yes***	Yes	Yes	No	Yes***
Hand hygiene rate feedback to designated departments	No	Yes***	Yes	Yes	No	Yes***
Granting the award of top-rated person	No	No	No	No	No	No
Reminders in the workplace (1 component)						
Poster notification	Yes	Yes	Yes	Yes	Yes	Yes
5. Institutional safety climate (4 components)						
Commitment of hospital president or hospital executives	No	Yes***	No	No	No	No
Commitment of nurse managers and physicians leaders	No	Yes***	No	No	No	No
Meeting regarding hand hygiene practice by the designated wards/units	No	No	No	No	No	No
Identifying champions at the designated wards/units	No	No	No	No	No	No

*NOTE: Hospital B newly hired an infection prevention nurse prior to the postintervention period.

***New component implemented as part of this intervention.

reviewed and approved by the ethics committees at the participating hospitals.

RESULTS

Data were collected from May 2013 to July 2013 in hospital A, in October 2012 in hospital B, and June 2013 in hospital C to ensure data were collected after the 6-month intervention at each site. A total of 2982 observations of hand hygiene were performed in 10 distinct units across the 3 participating hospitals during the postintervention periods. Hand hygiene observations were performed during the day Monday through Friday between 8:30 AM and 7:30 PM, with the majority occurring prior to 1:00 PM.

The overall postintervention hand hygiene adherence rate (in all 3 hospitals) was significantly higher at 32.7% (974/2982) adherence compared to 18.0% (482/2679) adherence in the preintervention period ($P < 0.001$). An increased hand hygiene adherence rate in each participating hospital in the postintervention period was observed (Figure 1). Similar trends of higher overall hand hygiene adherence rates for both nurses and physicians in the postintervention period were seen. Use of alcohol-based hand rub among those with appropriate hand hygiene was significantly higher, with 90.0% (880/974) using hand rub in the postintervention period versus 67.0% (322/482) in the preintervention period ($P < 0.001$). Comparison of overall hand hygiene adherence rates by unit type and healthcare worker subgroup between the pre- and postintervention periods are shown in Table 4. Detailed comparisons of hand hygiene adherence rates for each hospital are available in the supplementary appendix. Although a significant improvement of hand hygiene practice was observed in the majority of participating units (6/10), there was a significant decline in hand hygiene practice in 2 units for nurses and 1 unit for physicians. Hand hygiene adherence rates by healthcare worker subgroups (both physicians

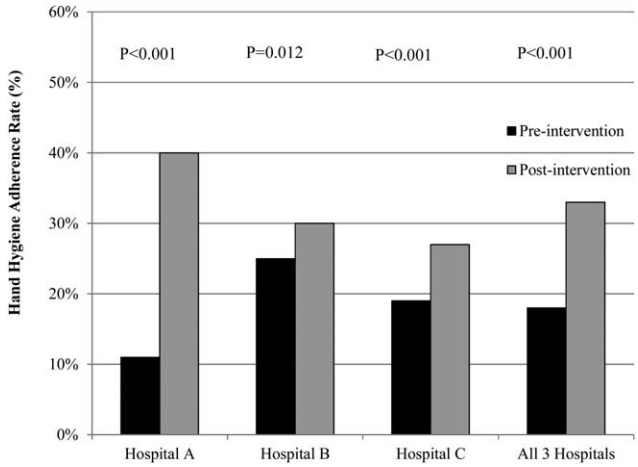

FIG. 1. Comparison of hand hygiene adherence rates between pre- and postintervention periods by hospital. Hand hygiene adherence improved in hospital A by 29% (11% pre- to 40% postintervention; $P < 0.001$), by 5% in hospital B (25% pre- to 30% postintervention; $P = 0.012$), and by 8% in hospital C (19% pre- to 27% postintervention; $P < 0.001$). Across all hospital units, hand hygiene adherence improved by 15% (18% pre- to 33% postintervention; $P < 0.001$).

TABLE 4. Comparison of Overall Hand Hygiene Adherence Rates for Each Unit and Each Healthcare Worker Subgroup Between the Pre- and Postintervention Periods

		Preintervention Period		Postintervention Period			
Ward/Unit	Healthcare Worker Subgroup	No. of Observations	Hand hygiene Adherence (%)	No. of Observations	Hand Hygiene Adherence (%)	Improvement After Intervention (%)	*P* Value
All 3 hospitals							
Surgery	Nurse	455	20	480	40	20	<0.001
	Physician	424	18	448	43	25	<0.001
	All	879	19	928	41	22	<0.001
Medicine	Nurse	455	23	508	39	16	<0.001
	Physician	435	15	452	33	18	<0.001
	All	890	20	960	36	16	<0.001
ICU	Nurse	305	21	379	25	4	0.17
	Physician	203	9	268	28	19	<0.001
	All	508	16	647	26	10	<0.001
ED	Nurse	170	16	173	27	11	0.01
	Physician	232	14	274	9	-5	0.07
	All	402	15	447	16	1	0.64
All units	Nurse	1385	21	1540	35	14	<0.001
	Physician	1294	15	1442	30	15	<0.001
	All	2679	18	2982	33	15	<0.001

NOTE: **Abbreviations**: ED, emergency department; ICU, intensive care unit.

and nurses) were significantly higher in the postintervention period than those in the preintervention period. Trends toward higher hand hygiene adherence rate of nurses in the postintervention period were observed (34.8% adherence for nurses compared to 30.4% adherence for physicians); the difference between nurses and physicians were not statistically significant ($P = 0.07$).

Hospital A achieved the highest postintervention adherence rates (39.9% adherence postintervention), as well as the greatest absolute improvement in hand hygiene (increase of 29.0%). There were significant improvements in 3 of the 4 participating units in hospital A, with the emergency department showing improvements only in the nurse subgroup. In hospital B, total hand hygiene adherence increased from 24.7% to 30.0% ($P = 0.01$); however, this increase was mainly due to increase in hand hygiene adherence rates of nurses. There were significant increases in hand hygiene adherence rates for nurses in the medicine (+11%, $P = 0.04$) and surgery wards (+14%, $P = 0.01$), with nonsignificant increases for physicians (+10% medicine, $P = 0.07$; + 2% surgery, $P = 0.78$). However, in the emergency department, nurses showed no significant improvement, and physicians had a significant decrease in adherence (15.7% preintervention vs 7.4% postintervention; $P = 0.02$). In hospital C, total hand hygiene practice rates were significantly improved (from 18.9% to 26.5%; $P < 0.001$); however, this was driven by improvements only in the surgical ward (14.6% preintervention to 42.3% postintervention; $P < 0.001$). The rates for nurses declined significantly in both the medicine and ICU wards, leading to no observed improvements on those wards.

DISCUSSION

Our multicenter intervention study in Japan included observations from almost 3000 encounters between clinicians and patients. Before the intervention, the overall rate of hand hygiene adherence was 18%. After the multimodal intervention, the absolute increase in healthcare worker hand hygiene adherence was 15%. Although there was overall improvement, the adherence rates varied by hospital, with hospital A increasing by 29% and hospital B and C only attaining increases of 5% and 7%, respectively.

Despite the importance of hand hygiene of healthcare workers, it is challenging to increase hand hygiene adherence because it requires behavioral modification. Moreover, it remains uncertain what factors will affect healthcare worker behavior. We implemented pragmatic strategies to evaluate the efficacy of hand hygiene multimodal interventions based on internationally recognized WHO hand hygiene adherence strategies[11] and an institutional-level contest with financial incentives. The findings in the current study help us understand not only how a multimodal intervention importantly improves hand hygiene adherence, but also what factors potentially make healthcare workers modify their behaviors.

In this study, we evaluated whether an institutional-level contest with financial incentives contributed to improved hand hygiene adherence of healthcare workers. This study demonstrated improvement of hand hygiene practice after implementation of a multimodal hand hygiene intervention combined with an institutional-level contest with financial incentives. The contest might have had a modest effect to help motivate the participating hospitals to improve their hand hygiene adherence rate. This is consistent with a

previous study that demonstrated financial incentives were associated with modifying healthcare workers' hand hygiene practice.[21] However, we did not strictly standardize how the contest information was distributed in each participating institution and the objective assessment for changes in motivation by the contest was lacking in this study. Thus, changes in motivation by the contest with financial incentives likely varied by each participating institution. Further studies are needed to assess if this type of approach is worth pursuing.

We observed several noteworthy associations between the intervention components that were implemented at each facility and their improvement in hand hygiene adherence. Among the participating hospitals, hospital A was most successful with improving hand hygiene adherence, although all participating hospitals achieved a similar number of the 15 recommended intervention components during the intervention (8 to 10 per hospital). Interestingly, hospital A initiated the most new components during the intervention period (8 new components for a total of 10 out of 15), whereas hospital B and hospital C initiated only 1 or 2 new components during the intervention period. Hospital A also successfully involved hospital executives, and elicited the commitment of a nurse manager and physician leader. Consistent with a previous study,[22] we believe that involvement of hospital executives appears to be important to increase overall hand hygiene rate among healthcare workers.

In contrast, hospitals B and C did not involve senior executives or identify nurse or physician champions for all participating units. Based on the results in this study, we believe that the involvement of hospital executives is likely a key for the penetration of hospital-wide hand hygiene culture among healthcare workers.

Although this study was unable to determine which components are precisely associated with improving hand hygiene adherence, the findings suggest initiating multiple intervention components at the same time may provide more motivation for change than initiating only 1 or 2 components at a time. It is also possible that certain intervention components were more beneficial than others. For example, hospital A, which achieved the most success, was the only hospital to obtain leadership support. Other studies have demonstrated that the presence of leadership appeared to play a key role in improving hand hygiene adherence.[23,24] Moreover, a recent Japanese nationwide survey demonstrated higher safety centeredness was associated with regular use of standard infection prevention practice.[25] Consistent with a previous study, improving hand hygiene adherence cannot be simply achieved by improving infrastructure (eg, introduction of portable alcohol-based hand rub) alone, but it depends on altering healthcare worker behavior.[26]

This study has several limitations. Because participating hospitals could tailor the specific interventions chosen for their facility, the improvement in hand hygiene adherence was likely multifactorial. We are unable in the existing study to determine a direct causal relationship between any of the individual intervention components and hand hygiene adherence. We are also unable to determine whether the improvements seen in hospital A were due to participation in the contest or due to the specific intervention components that were implemented. However, WHO hand hygiene guidelines point out that recognition of the importance of hand hygiene varies in different regions and countries, and the goal for hand hygiene interventions is to establish a culture of hand hygiene practice through pragmatic intervention strategies, frequent evaluation, and feedback to healthcare workers.[27] Thus, we prioritized pragmatic strategies to include in our intervention to promote hand hygiene adherence. Another limitation was the date of implementation of the multimodal intervention was slightly different at each facility. It was challenging to implement the intervention simultaneously across institutions due to competing priorities at each facility. Although the primary goal of hand hygiene is to reduce the burden of healthcare-associated infection, we were unable to measure infection rates at the participating facilities. It is possible the presence of an external observer had an impact on the healthcare workers' behavior.[28] However, the healthcare workers were not informed as to what the observer was monitoring to minimize this potential effect. Lastly, the findings in this study provide immediate intervention effects but further study will be required to determine if these effects are sustainable.

Altering healthcare worker behavior is likely the key element to improve hand hygiene adherence, and behavioral modification may be achieved with the support of leadership at the unit and facility level. However, even though we found significant improvements in healthcare worker hand hygiene adherence after the intervention, the adherence rates are still relatively low compared to reported adherence rates from other countries,[29] suggesting further intervention is needed in this setting to optimize and hygiene practice. Because hand hygiene practice is a crucial strategy to prevent healthcare-associated infections, every effort should be made to enhance the hand hygiene practice of healthcare workers.

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