Major article

Impact of implementation of the World Health Organization multimodal hand hygiene improvement strategy in a teaching hospital in Taiwan

Jui-Kuang Chen MD, Kuan-Sheng Wu MD, Susan Shin-Jung Lee MD, PhD, Huey-Shyan Lin PhD, Hung-Chin Tsai MD, PhD, Ching-Hsien Li RN, ICN, Hsueh-Lan Chao RN, ICN, Hsueh-Chih Chou RN, Yueh-Ju Chen RN, ICN, Yu-Hsiu Huang RN, ICN, Chin-Mei Ke RN, ICN, Cheng Len Sy MD, Yu-Ting Tseng MD, Yao-Shen Chen MD,*

*a Division of Infectious Diseases, Department of Internal Medicine, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan
b School of Medicine, National Yang-Ming University, Taipei, Taiwan
c School of Nursing, Fooyin University, Kaohsiung, Taiwan
d Department of Health Services Policy and Management, University of South Carolina, Columbia, SC
e Graduate Institute of Environmental Education, National Kaohsiung Normal University, Kaohsiung, Taiwan
f Infection Control Unit, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan
g Department of Nursing, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan

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Background: Hand hygiene (HH) is considered to be the most simple, rapid, and economic way to prevent health care–associated infection (HAI). However, poor HH compliance has been repeatedly reported. Our objective was to evaluate the impact of implementing the updated World Health Organization (WHO) multimodal HH guidelines on HH compliance and HAI in a tertiary hospital in Taiwan.

Methods: We conducted a before-and-after interventional study during 2010-2011. A multimodal HH promotion campaign was initiated. Key strategies included providing alcohol-based handrub dispensers at points of care, designing educational programs tailored to the needs of different health care workers, placement of general and individual reminders in the workplace, and establishment of evaluation and feedback for HH compliance and infection rates.

Results: Overall HH compliance increased from 62.3% to 73.3% after 1 year of intervention (P < .001). The rate of overall HAI decreased from 3.7% to 3.1% (P < .05), urinary tract infection rate decreased from 1.5% to 1.2% (P < .05), and respiratory tract infection rate decreased from 0.53% to 0.35% (P < .05). This campaign saved an estimated $940,000 and 3,564 admission patient days per year.

Conclusion: The WHO multimodal HH guidelines are feasible and effective for the promotion of HH compliance and are associated with the reduction of HAIs.

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Health care–associated infection (HAI) is the major cause of increasing patient mortality and morbidity during hospitalization. It also increases hospital length of stay and other medical costs. In addition, the emergence of multiple drug-resistant organisms render treatment increasingly difficult. Hand hygiene (HH) is a simple, important, and economic measure to prevent HAI. However, poor HH compliance has been repeatedly reported in healthcare workers (HCWs). Multifaceted interventions are suggested to be more effective and achieve a sustained improvement in HH compliance.

In 2009, the World Health Organization (WHO) guidelines on HH provided comprehensive plans for the promotion of HH, including the concept of patient zones and health care zones, points of care, 5 indications of HH, 5 strategies for HH, and 5 steps for long-term promotion of HH. The guidelines have been tested in hospitals worldwide to assess their applicability and practicality.
The Taiwan Centers for Disease Control and Prevention initiated a program to establish 3 HH model hospitals, geographically located in Southern and Northern Taiwan, to develop local HH guidelines. Our hospital was selected as one of the model centers, and the program aimed to establish and implement local HH guidelines that are feasible, practical, culturally tailored, effective, and sustainable. This study aimed to assess the impact of implementation of the WHO multimodal HH improvement strategy on several indicators, including the rates of HH compliance and rates of HAI.

METHODS

Study setting

Kaohsiung Veterans General Hospital is a 1,408-bed tertiary care teaching hospital in Southern Taiwan, with 100 intensive care unit (ICU) beds (77 adult ICU beds, 11 pediatric ICU beds, and 12 neonatal ICU beds) and 18 respiratory care center beds. There are 2,463 HCWs, with 542 physicians, 1,197 nurses, 514 technicians, and 215 nursing assistants in the hospital.

Our hospital had a successful experience in HH promotion prior to the campaign. In December 2003, we started the provision of alcohol-based handrub dispensers on the walls by the doorway outside of patient rooms. From July 2008-July 2009, we began the first hospital-wide HH promotional activity for 1 year, which increased compliance and effectively reduced the daily accumulated numbers of carbapenem-resistant Acinetobacter baumannii (CRAB) colonization-infection and methicillin-resistance Staphylococcus aureus colonization-infection January 2009-October 2014 (unpublished, Koosiuing Veterans General Hospital, Kaohsiung, Taiwan).

Study design

We conducted a HH promotion campaign from January 2010-September 2011 following the WHO guidelines and using toolkits. The campaign used the 5 steps and 5 strategies as essential components and was implemented hospital-wide, except in the emergency room.

Five steps

Step 1: Facility preparedness—readiness for action (January-March 2010)

A HH promotion team was formed, with the deputy director of the hospital leading the team, and team members included 3 infectious disease specialists, 5 infection control nurses, and 3 research assistants. The team devised teaching materials according to the WHO HH guidelines and developed different versions of the teaching materials in Chinese, tailored to the different health care worker groups. Teaching materials were targeted to leaders and chiefs in various departments, trainers, observers, and general HCWs. An innovative logo to represent the HH promotion campaign was created and placed on all training and promotional material.

Step 2: Baseline evaluation and preparation—establishing knowledge of the current situation (April-June 2010)

A baseline ward infrastructure survey was conducted hospital-wide, including baseline HH compliance in each ward, alcohol-based handrub consumption, and a questionnaire about the perception and knowledge of HH and HAI in HCWs, patients, and the patient’s family. Preparedness included the setting up of alcohol-based handrub dispensers on the walls of each patient room and training of HH observers with lectures and videos of clinical scenarios. We applied the WHO HH observation method to assess HH compliance. In short, an unobtrusive trained observer observed HCWs openly for 20-minute sessions every month and recorded at least 10 HH opportunities with different HH indications each session. A HH opportunity was defined as the occurrence of HH indications during clinical care sequences. The HH indications include before touching a patient, before clean-aseptic procedure, after risk of body fluid exposure, after touching a patient, and after touching patient surroundings. Infection control nurses recorded cases of HAI, including urinary tract, respiratory tract, and bloodstream infections, according to modified definitions of the U.S. Centers for Disease Control and Prevention. The HAI rate is defined as follows: the number of overall HAIs (with and without catheters) in the hospital per 1,000 admission patient days.

Step 3: Implementation—introducing the improvement activities (July-November 2010)

Posters were displayed to explain the 5 indications of HH, and a HH ambassadors campaign was run hospital-wide. Each service, department, and ward voted for an ambassador from their unit; a life-sized poster was then made of the ambassador to promote HH and was placed just outside of their unit. The director and deputy director of the hospital were voluntary ambassadors. In addition, using slideshows and a training video, we educated heads of departments and wards and HCWs hospital-wide. Alcohol-based handrub dispensers were distributed at the point of patient care, including at the end of the beds and on medication trolleys. Trained observers started to record HH compliance monthly from September 2010, and we gave feedback to observers and heads of departments and wards bimonthly.

Step 4: Follow-up evaluation—evaluating the impact of implementation (November-December 2010)

A postintervention questionnaire was conducted to evaluate the perception and knowledge of HH practice of HCWs, patients, and family members of the patients. We began to promote patient empowerment, including the use of HH corps badges, which pledged the commitment to HH by HCWs, including willingness to be reminded by patients and their family to perform HH, therefore encouraging patients to ask the HCW if he or she washed their hands.

Step 5: Impact and cost-saving evaluations

After 1.5 years of implementing the HH promotion campaign, we estimated the impact and cost-savings of the campaign by comparing the period before (June-September 2010) and after the intervention (October 2010-September 2011). The assumed infection rate in the postintervention period was defined as the pre-intervention rate. The number of reduced infection events was defined as the number of assumed infection events minus the number of true infection events in the postintervention. In the Sheng et al study, done in Taiwan, the extra cost of 1 health care–associated urinary tract infection was estimated to be $3,822, and the costs were $3,903 for a respiratory tract infection and $3,384 for a bloodstream infection. The reduced number of length of admission stay with regard to preventing an HAI was 14 days for surgical site infection, and 16 days for bloodstream infection. The cost-savings and reduced number of total admission days during the campaign were estimated to analyze the effectiveness and economic benefits of the HH promotion campaign.

Five strategies

Strategy 1: System change

We set alcohol-based handrub dispensers at the points of care hospital-wide from June-August 2010.
Strategy 2: Training and education
We educated our directors and department leaders about the importance and impact of HH on HAI in March 2010. We trained HH observers in June 2010 with standardized, educational videos. We educated first-line HCWs in July 2010. We held separate HH workshops in different wards from July-September 2010 to discuss the incorporation of HH into clinical workflows, which may vary widely between services. We educated the public about HH concepts and techniques from November-December 2010. We shared our successful experience on HH compliance and effect on HAI in our hospital from September-November 2011 to encourage HCWs to follow the principles of HH.

Strategy 3: Evaluation and feedback
We started our observation from June-August 2010. Then we conducted monthly observation and feedback to every health care unit beginning September 2010. We also conducted surveys using questionnaires for HCWs and the public on the concept of HH and patient-family empowerment from May-November 2010.

Strategy 4: Reminders in the workplace
We set up posters of the WHO’s My 5 Moments for Hand Hygiene and handwashing techniques by the sinks and on the walls in the wards beginning in September 2010. We placed life-sized posters of HH campaign ambassadors at the entrance of the wards from August 2010. We also held a poster contest to develop creative HH posters and increase awareness of HCWs on HH in March 2010. We distributed leaflets and posters for patient empowerment from August 2010.

Strategy 5: Institutional safety climate
Our hospital director wrote letters to leaders and HCWs to declare our determination to promote HH in August 2010. We started hospital-wide broadcasts of vocal recordings of our hospital director and deputy director talking on the importance of HH, every 2 hours, beginning August 2010. The HH ambassador campaign was carried out from May-July 2010. HH corps badges were worn by HCWs to pledge commitment to the HH program and promoted patient empowerment beginning in November 2010. A press conference for HH corps was held in November 2010 and May 2011 to promote the culture of HH within the hospital.

Statistical analysis
HH compliance was compared by χ² test, and the differences in HAI rates between the pre- and postintervention periods were compared by the paired t test. All data were analyzed by SPSS 18.0 for Windows (SPSS, Chicago, IL). The results were considered statistically significant if the 2-tailed P value was <.05.

RESULTS

Infrastructure
After the intervention, alcohol-based handrub dispensers were equipped at the points of patient care hospital-wide. The number of alcohol-based handrub dispensers increased from 885 to 1995 in the general wards and 157 to 290 in the ICUs. The ratio of beds to alcohol-based handrub dispensers increased from 1:0.91 to 1:2.05 in the general ward and 1:1.69 to 1:3.12 in the ICUs.

HH compliance
Between June 2010 and September 2011, we observed a total of 7,232 HH opportunities, with 6,426 (76.6%) occurring in nurses, 1,172 (20%) occurring in physicians, 282 (3.4%) occurring in nursing assistants, and 409 (5.7%) occurring in other professional categories. The average monthly number of HH opportunities observed was 441.8 ± 62.89 (range: 318–575), with 388.2 ± 45.5 (range: 250–429) in nurses, 61.68 ± 18.4 (range: 29–98) in physicians, 14.84 ± 6.00 (range: 3–26) in nursing assistants, and 24.2 ± 8.2 (range: 9–44) in other professional categories.

After the implementation of multimodal interventions, the overall HH compliance improved from 62.3% during the first 4 months of the preintervention phase to 73.3% during the 12 months of the postintervention phase (P < .001). The HH compliance of nurses increased from 69.1% to 81.2% (P < .001*); from 67.8% to 85.8% in indication 3 (after body fluid exposure risk; P < .001*); from 72.4% to 81.9% in indication 4 (after touching a patient; P < .001); and from 68.9% to 71.1% in indication 5 (after touching patient surroundings; P < .013).

Sustainability of HH compliance in the postintervention era
The overall HH compliance increased from 56.7%–69.44% from June-December 2010. After February 2011, the overall HH compliance was sustained at 70%-80%. The HH compliance of nurses improved from 58.2% in June 2010 to 88.6% in February 2011 and was maintained at 80%-85% in the postintervention period (March-September 2011). The HH compliance of physicians increased from 20.7% in July 2010 to 50% in November 2010 and remained between 50% and 60%. However, HH compliance of nursing assistants increased from 33.3% in July 2010 to 61.1%
in December 2010, but then it decreased gradually. This trend was also observed in other professional categories. From January-July 2015, the overall HH compliance for HCWs was maintained at 83.4% at 4 years postintervention. The average HH compliance according to professional categories and the 5 indications is as follows: nurses (84.9%), physicians (79.4%), nursing assistants (81.6%), other professional categories (52.4%), indication 1 (79%), indication 2 (75.7%), indication 3 (94%), indication 4 (90.1%), and indication 5 (81.8%).

Impact on HAIs and costs

When comparing the pre- and postintervention phases, the overall HAI rates decreased from 3.71 to 3.07 episodes per 1,000 patient admission days ($P = .002$). Rates of urinary tract infection decreased from 1.5 to 1.17 episodes per 1,000 patient admissions ($P = .009$), and bloodstream infection rate decreased from 1.18 to 1.00 episodes per 1,000 patient admissions ($P = .085$). The overall rates of HAIs were estimated to be reduced to 237.6 episodes per year, with 121.2 episodes of urinary tract infections, 67.2 episodes of respiratory tract infections, and 68.4 episodes of bloodstream infections. The campaign saved a total of $950,000 and resulted in a reduction of 3,799 admission patient days (Table 2).

**DISCUSSION**

The WHO multimodal HH program is feasible, sustainable, and was associated with a decrease in hospital-acquired infections and their associated costs. All 5 strategies contributed to the increase in HH compliance. The updated HH guidelines emphasize the availability of alcohol-based handrubs at the point of patient care. A fundamental strategy of the HH program is to ensure that alcohol-based handrub dispensers are provided with convenience and in noticeable locations.8 Targeted educational materials tailored to multidisciplinary groups are important to establish a deeper understanding of such programs and facilitate effective promotional activities. In addition, promoting the concept of the 5 indications and the differences in patient zones and health care zones is essential to ensure that HCWs can easily comply with the rules of HH. The individual HH ambassador posters distributed hospital-wide, in front of every ward and major entrances of the hospital, drew attention to the program and acted as a reminder to HCWs. However, the most effective and sustainable strategy is the monthly observation of compliance to HH and subsequent feedback to HCWs. Although the Hawthorne effect is unavoidable, and may falsely increase the rates of compliance,19 nevertheless, the compliance rates demonstrate that HCWs have a clear understanding of the concepts and the 5 indications of HH promoted by the HH promotion campaign initiative.

In our study, the overall baseline HH compliance was 62.3%, which was higher than in other reports.9,19-21 This may be because of the impact of our 1-year HH promotional activities prior to the intervention (June 2007-June 2008) and the fact that most HCWs already had a basic understanding of HH, as shown by the high scores on the baseline HH questionnaire (data not shown).

The highest compliance among the professional HCW categories was the nurses.10,12,20,21 Nurses were more skilled to meet the challenge of complicated clinical conditions than other professional categories. This is attributed to the impact of specialized training workshops, conducted at the ward level, to discuss the occurrence of HH indications targeted to clinical scenarios that occur in the particular service and ward. The compliance of physicians increased after intervention, but it was maintained at approximately 50%-60%. This is similar to previous reports.12,20,22 Most HH indications that occur in clinical practice for physicians are before and after touching a patient. It appears to be simple to perform; however, their compliance was lower than nurses. One possible reason is the lack of advocacy by leadership and lack of participation in the hospital-wide education program in step 3. The lack of concern or belief in HH being able to prevent cross-infection and the lack of positive role models may be the potential causes of lower compliance among physicians.23 The great variation observed in the compliance among nursing assistants may be caused by variability in effectiveness of targeted educational program. Many of the nursing assistants were hired by the family and were foreign laborers from the Philippines, Indonesia, and Thailand, which made effective communication difficult. Efforts to educate them require conquering the language barriers. Lower compliance rates that were highly variable were also observed in other professional categories. The successful implementation of the program requires focusing on each group, designing teaching materials tailored to each group, and holding workshops to discuss the workflow of each group to effectively incorporate the 5 HH indications into clinical routines.24

Lower compliance to the HH indications was observed before touching a patient and before clean-aseptic procedures and after touching a patient’s environment, similar to previous reports.11,25 It appears that HCWs know how to protect themselves but may at times inadvertently overlook patient’s safety. However, this may be because of the difficulty in application of the 5 HH indications to complicated clinical practice and workflow. An example of different tasks involving the same patient includes drawing drug from the vial and then injecting the drug into an intravenous bag. The controversy arises as to whether HH should be performed once or twice during this flow of work when indication 2 occurs twice. The performance of HH during controversial scenarios should be defined clearly during training workshops to avoid confusion and facilitate HH compliance among different categories of HCWS.

HAIs are preventable, and HH is the basis of infection control policies. HH reduces the transmission of multiple drug-resistant organisms. Several studies showed a decrease in the incidence of methicillin-resistant *S. aureus* infection and patient colonization after the implementation of HH promotion.6 Our study demonstrated that improved HH compliance is associated with decreased HAIs. Some reports support our findings.23,24,27 and 1 study failed to show the influence of HH on HAIs.15 The reduction in HAIs may...
be a combined effect of HH and other infection control policies in place before the intervention, including the reminder to remove urinary catheters by our health information system since 2000, the policy of isolation and cohort care of CRAB since 2004, cohort care and contact precautions for patients colonized or infected with multiple drug-resistant bacteria since 2006, and active surveillance for CRAB colonization in intensive care and respiratory care units since 2008. Rates of HAIs were available with consistent data since 2006, eliminating temporal trends as a cause in the observed reduction in rates of HAIs. Other potential confounding factors, such as changes in patient population, therapies, and antibiotic use, were not observed during the study period.

The additional benefits of HH programs, besides a reduction in HAI and saving lives, include shortened hospital stay and decrease in hospital costs. In the United States, recent studies done in the geriatric population showed that the mean length of stay attributable to bloodstream infection was 10 days, with a mean cost of $43,208. Another recent study found that catheter-related urinary tract infection in the ICU costs $8,548, which is much higher than in the non-ICU setting, which costs $1,479; it also created an increased length of stay (ICU vs non-ICU: 8.1 vs 3.6 days, respectively). For ventilator-associated pneumonia in the ICU, the extra cost was $39,828, with a mean excess length of hospitalization of 13.1 days.

The health care system in Taiwan differs vastly from western countries, mainly because of our National Health Insurance scheme. Medical daily costs are much lower, resulting in longer hospitalization. The National Health Insurance has pushed for lower costs over the years; therefore, there has only been minor increases in medical costs over the last decade. The estimated cost of HAIs in medical centers in Taiwan was based on the Sheng et al case-control study done in 2005, which approximates current costs in medical centers in Taiwan. In our study, we spent $250,000 for the HH promotion program and saved an estimated $950,000 after intervention. With continued multimodal HH promotion based on the 5 steps and 5 strategies, compliance of HCs to HH was not only sustainable, but became better, especially in physicians, nursing assistants, and for HH indications 3, 4, and 5.

There are several limitations in our study. First, our HH program is associated with a reduction of HAI, but it was not the only intervention in place. However, although several infection control policies were in place for years prior to the intervention, a further and significant reduction in HAIs was observed after the intervention. Second, the study design is quasi-experimental. It was not possible to randomize units into case and control groups because of patient safety and ethics considerations. Third, the method used to estimate the reduction in HAIs and cost-savings was approximated using local published data in 2005, and there are some uncertainty regarding current costs. However, the cost-savings is likely to be larger with increased medical costs in Taiwan, and the costs were a close approximation based on previous published study. Fourth, we used overall HAIs as the outcome measure, which included catheter and non–catheter-related infections. Although we did not measure catheter-related infections, which better reflects the effects of HH to prevent critical site infections (indication 2, before clean–aseptic procedure), overall HAIs were reduced. Finally, the effect of the Hawthorne effect on HH compliance cannot be measured. To avoid the Hawthorne effect on HH compliance, our next program will train HH observers for covert observation and compare HH compliance with overt observation.

CONCLUSION

The WHO multimodal HH guidelines are feasible and cost-saving for the promotion of HH and are associated with the reduction of HAIs. Considering the global budget of National Health Insurance in Taiwan, HH is a simple, effective, and cost-saving measure to prevent HAIs.

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