

7-1-2020

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Available at: <https://digital.car.chula.ac.th/clmjjournal/vol64/iss3/12>

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Original article

Impact of a multimodal intervention program on hand hygiene compliance at Bangkok Tertiary Care Hospital

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Background: Implementation of handwashing in real life healthcare settings is challenging. Immense clinical benefits from hand hygiene (HH) compliance can be gained in resource-limited settings such as Thailand. Customized multimodal strategies to promote HH are advocated by World Health Organization.

Objectives: Good HH practices are a simple and cost-effective strategy to limit pathogen transmission between patients. This study explores the effect of a multimodal hand hygiene promotion program on HH compliance amongst healthcare workers.

Methods: A prospective study was conducted at the pediatric intensive care unit and pediatric immunocompromised ward. A baseline attitudes survey was performed by asking perceived barriers and motivators to HH compliance. Interventions performed were tailored according to this and included: HH promotion videos sent to staff via mobile phone, HH signs at the bedside, distribution of portable alcohol gel bottles, HH promotion culture led by senior staff members and fob watch prizes. HH compliance was assessed by direct observation using the WHO's 5-moments for hand hygiene (WHO5HH) – before touching patients, before clean/aseptic procedures, after body fluid exposure risk, after touching patients, and after touching patient surroundings. A minimum of 200 opportunities in total were observed at pre-intervention and three times following intervention commencement. Hospital acquired infection rates (HAIs) were routinely monitored during the study period.

Results: In December 2015, pre-intervention, overall HH compliance rates were 51.0% (95%CI 44 - 58). Between January and June 2016, post-intervention, overall HH compliance increased to 70.0% (95% CI 67 - 74) ($P < 0.001$). When divided into the five moments for HH, handwashing prior to touching patients significantly improved the following intervention from 44.0% to 87.0% ($P < 0.001$). HH after touching patient surroundings remained low. HH compliance was highest amongst nurses (55.0% at baseline and 83.0% with intervention). HAI rates were unchanged during the study period.

Conclusions: A multimodal HH promotion campaign tailored towards the local population was effective in increasing HH compliance overall. HAI rates were unchanged following HH compliance improvement.

Keywords: Hand hygiene compliance, handwashing, hospital acquired infections.

Worldwide, good hand hygiene (HH) practices remain the most simple and cost-effective contributor of limiting pathogen transmission between patients

in healthcare settings. ^(1, 2) HH standards include handwashing using soap and water or alcohol handrub. ⁽³⁾ Good HH compliance was taken to

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Received: June 12, 2019

Revised: July 26, 2019

Accepted: September 8, 2019

arbitrarily be 60.0% or more from direct observation based on previous worldwide studies on HH compliance levels. However, implementation of this in real-life practice is challenging, particularly in low to middle income countries.^(1,2) In such countries one major international study found HH to be only 22.0%.⁽²⁾ Studies in Thailand have found this figure similar or lower.⁽⁴⁻⁶⁾ Given that the effects of HH compliance interventions are known to be higher in resource limited settings such as Thailand, the value of such a study is potentially immense.⁽²⁾

As the reasons for non-adherence to HH are multifactorial, effective and lasting HH compliance is consequently best dealt with as a multimodal strategy as recommended by the World Health Organization (WHO).⁽³⁾ Known barriers to HH compliance include: interventions that are not customized to specific problem areas within an organization, lack of knowledge, lack of external stimuli influencing behaviors, absence of social norms promoting hand hygiene, and systemic failure in HH practice.⁽³⁾ The WHO's advocates multimodal HH programs be implemented with explicit support from administration as the most effective approach to this issue.⁽³⁾ Examples of such interventions include: routine observation and feedback, reminders in the workplace, obtaining active participation at individual and institutional levels, and administrative rewards.⁽⁷⁾ Danchaivijitr S, *et al.* found that HH compliance increased from 4.5% to 13.4% following a multimodal intervention program, including distribution of posters, leaflets, a HH promotion parade, provision of alcohol-based handrubs and performance feedback.⁽⁸⁾ Similarly, Picheansathian W, *et al.* found improvement in HH among nurses in neonatal intensive care unit from 6.0% to 81.0% following a multimodal intervention program.⁽⁵⁾

The primary objective of this study was to determine whether a multimodal intervention program would improve HH compliance rates in the pediatric intensive care and immunocompromised wards. Our hypothesis in this study was that with an effective multimodal HH intervention program, HH rates would improve by 15.0%. A secondary objective was whether improved HH compliance rates actually led to reduced hospital acquired infection (HAI) rates, based on figures seen with similar program in other low to middle income countries.⁽²⁾

Materials and methods

This prospective study was performed at King Chulalongkorn Memorial Hospital, Bangkok, Thailand, a tertiary referral center and teaching hospital in Bangkok, Thailand that houses 1,500 beds and receives approximately 9,000 pediatric inpatient admissions annually. It was conducted from December 2015 to June 2016. The two wards studied were the pediatric intensive care unit (PICU) and immunocompromised wards, both open plan wards. The PICU accommodates a maximum of 9 beds, including 3 positive - pressure - isolation rooms and 3 negative - pressure - isolation rooms. The immunocompromised ward accommodates a maximum of 22 beds which comprises 2 bays, each containing 10 beds and one isolation room which could accommodate up to 6 beds. All aforementioned isolation rooms were visible from the main ward through their glass doors and windows. All healthcare staff, including nurses, doctors, healthcare students and all allied healthcare professionals working on both wards were included in this study. The protocol of the study has been approved by the Institutional Review Board; informed consent of the subjects was waived.

Baseline attitudes survey

Prior to intervention implementation, baseline surveys were distributed on each ward on self-estimated HH compliance levels, perceived barriers and motivators to HH compliance, as well as the perceived link between HH and HAIs. Responses to questions utilized the Likert Scale, ranging from 5 = strongly agree to 1 = strongly disagree. A total number of 12 questions of the above described subjects were asked.

Multimodal intervention

This study set out to implement a stakeholder-driven, multi-modal HH promotion strategy to improve HH practices among healthcare workers. Meetings were held with the hospital infection control head nurse, infection control lead nurses of each ward, lead physicians of each ward and the pediatric infectious diseases team. All were asked about potential interventions to use that would be culturally suitable, acceptable, and most likely to make an impact to their staff and wards. A mascot was designed and used across all HH promotional items. Slogans on posters with various designs were shown to staff on the work floor, and the most popular designs chosen for use.

An existing HH promotional video produced by the PICU nurses which was awarded first prize in a recent hospital HH promotion competition was used. These were sent to the nurses, doctors and medical students via mobile phone at both wards at intervals during the intervention period. Other HH promotional interventions were: HH reminder posters at the bedside, distribution of in-house produced portable alcohol hand gel bottles, feedback of observed HH compliance levels during the intervention period, leadership of HH and establishment of safety climate by senior members of staff at both wards, and a staff-led vote of nursing, medical students, and medical staff to receive fob watch prizes awarding good HH compliance.

Hand hygiene assessment

Direct HH observation was carried out using the WHO's 5-moments for hand hygiene framework by identifying opportunities for hand hygiene and observing their compliance rate.⁽³⁾ Direct observation was performed by two research nurses during routine pediatric infectious disease team ward rounds. The nurses were trained in the observation method and their practices standardized to maximize inter-rater reliability. Observation was based on real time events occurring on the ward, rather than active selection of any professional groups. All staff members were informed of the months data collection would be conducted, however they were not informed specifically of timing of HH compliance observation. After identification of the profession being observed, the number of opportunities in accordance to the WHO's 5 moments for HH was observed, namely, before patient contact, before aseptic tasks, after body fluid exposure risk, after patient contact, and after contact with patient surroundings. Actual performed actions were recorded and divided by opportunities. Compliance (%) was calculated by then multiplying this figure with 100. Personal identities were not recorded, and it was possible for an individual to be observed and recorded more than once if several HH opportunities occurred during observation if they did not occur consecutively. At least 100 observations were done in each ward during two separate ward rounds in the month pre-intervention.

During the 6 intervention months, direct observation, using the exact same methods conducted in the pre-intervention data collection round were used, with at least 100 observations on each ward collected at three separate observation sessions. This value was based on the WHO's recommendations

on observing a minimum of 200 opportunities during each measurement period to allow for meaningful comparison before and after HH improvement interventions.⁽⁹⁾

Hospital acquired infection rates

Hospital acquired infection rates in accordance with Centers for Disease control (CDC) 2015 definitions, namely catheter associated urinary tract infections (CA-UTIs), catheter-related blood stream infections (CRBSIs) and ventilator associated pneumonia (VAPs) are routinely collected at KCMH for infection control surveillance purposes and reported to the infection control department on a monthly basis. These figures were obtained and used in this study for the purposes of analysis in relation to HH compliance data. Figures collected by hospital infection control are as rates per 1,000 patient days. The mean HAI rates from July to December 2015 and January to June 2016 represented the pre-intervention and post-intervention periods respectively.

Statistical analysis

As for the baseline attitudes survey, results were expressed as numbers and percentages. We analyzed HH compliance (%) by professional category, moments of HH in accordance to the WHO's 5-moments for HH and ward observed. The intervention period and non-intervention period figures were compared. Two-sided *P* - values and 95% confidence intervals were calculated comparing the two observation periods using the chi-squared test. Statistical significance was defined as *P* < 0.05. As identities of individuals were not recorded before and after interventions were performed, the two datasets were analyzed as independent datasets labelled as 'intervention' and 'non-intervention'.

Results

Baseline attitudes survey

A baseline HH attitudes survey was conducted in December, 2015. A total of 47 from 60 surveys distributed were returned (78.0%). The largest percentage of respondents to this survey were nurses (46.0%) followed by doctors (30.0%) and healthcare assistants (19.0%). Self-assessment of HH compliance was reported as 51.0% always (80.0 – 100.0%), 47.0% usually (60.0 – 80.0%) and 2.0% sometimes (40.0 – 60.0%); 38/47 (81.0%) of respondents responded 'strongly agree' to the concept of HH practices being linked to HAIs.

The most frequently stated barriers to HH compliance rated as agree (scored 4) or strongly agree (scored 5) was HH washing stations being located in inconvenient locations (36.0%), being too busy (30.0%) and inconvenient location of alcohol gel bottle placement (10.0%). The strongest motivators for good HH rated as strongly agree (rated score 5) was seeing the actual benefits of HH (79.0%), followed by leaders providing a good example (43.0%) and importance to HH given by leaders (36.0%). In response to this, handwashing stations and availability of alcohol gels both in the wards and their availability in portable hand gel form were ensured. HH reminders were placed at the bedside, and nursing and medical leads were asked to encourage their teams by leading by example for HH compliance.

Hand hygiene compliance

A total of 841 HH opportunities were observed, 223 of those being pre-intervention and 618 of those post-interventional. In the directly observed population overall, 41.0% were doctors, 25.0% nurses, 13.0% medical students, 12.0% healthcare assistants, and the remaining 10.0% a mix of other allied healthcare professionals. In total, HH compliance across all professional groups was 51.0% prior to intervention and increased to 70.0% 6 months post-intervention ($P < 0.001$). Table 1 and Figure 1 display the breakdown of HH compliance overall according to the WHO's 5-moments for HH at non-intervention and intervention time points of this study.

There was a statistically significant improvement in HH compliance the moment before touching a patient comparing intervention and non-intervention ($P < 0.001$) periods, however, there were no statistically significant differences for the four other moments. HH was lowest after touching patient surroundings with compliance at between only 37.0% and 31.0% with non-intervention and intervention groups respectively ($P = 0.39$).

The breakdown of HH compliance overall according to health care profession is shown in Table 2. The HH compliance of doctors and nurses were the two professions where HH compliance statistically significantly improved with HH interventions (both $P < 0.001$).

Hospital associated infection rates during non-intervention and intervention time points of this study are shown in Table 3. Catheter associated urinary tract infections, ventilator associated pneumonia and catheter associated urinary tract infections were not

found to have any association with HH compliance rates in this study.

Discussion

Our findings showed that multimodal HH compliance interventions were effective in significantly improving HH compliance overall by 19.0%, surpassing our initial hypothesis of 15.0%. HAI rates were unaffected by this improvement in HH compliance.

This study found the baseline HH compliance rates without intervention to be 51.0%, slightly higher than previous studies, approximately 22.0%.^(2, 4 - 6) Post intervention overall HH compliance rates increased to 70.0% post-intervention, considered to be a good HH compliance rate as previously discussed. Interestingly, the self-assessment baseline questionnaires, 98.0% of health care workers reported of HH compliance $> 60.0\%$. These figures in comparison to the actual observed HH compliance in this suggests that healthcare workers tended to overestimate their HH compliance. This finding highlights the ongoing need for feedback to staff to encourage long-term HH compliance.⁽⁹⁾ The pediatric intensive care unit and immunocompromised wards were selected to perform in this study in effort for equal representation of both regular level care wards and intensive care wards. This is based on established knowledge that work in intensive care settings is a risk factor for poor HH compliance, in attempt to control for this potential confounding factor.⁽¹⁾ Additionally, both wards were open plan wards so logistically practical for direct observers to collect direct observation data discreetly and unobtrusively during routine infectious diseases ward rounds. Vulnerability and high impact of HAIs on patient populations of these wards also played a role in their selection for this study.

The baseline attitudes survey provided a valuable insight on what staff felt hindered HH compliance, guiding production of tailored interventions to the needs our local population. The success of the interventions performed emphasizes the importance of involving the local population in production of interventions to encourage cooperation in HH compliance. Although some perceived barriers and needs, such as ready availability of HH facilities were straightforward to address, other issues such as being too busy or ensuring all leaders led by example were less so. It is encouraging from this study that despite these limitations it showed that interventions done where possible can still improve the level of HH compliance.

Table 1. Comparison of non-intervention compared with intervention on HH compliance in accordance with the WHO's 5- moments for hand hygiene compliance.

	Non-intervention period			Intervention period			P -value
	n (%)	n complied HH	% (95CI)	n (%)	n complied HH	% (95CI)	
Before touching patient	68 (30.0)	30	44 (32 - 57)	184 (30.0)	160	87 (81 - 92)	<0.001
Before clean/aseptic procedures	16 (7.0)	14	88 (62 - 98)	54 (9.0)	48	89 (77 - 96)	0.88
After body fluid exposure/risks	14 (6.0)	12	86 (57 - 98)	69 (11.0)	62	90 (80 - 96)	0.65
After touching patients	38 (17.0)	26	68 (51 - 83)	161 (26.0)	118	73 (66 - 80)	0.55
After touching patient surroundings	87 (39.0)	32	37 (27 - 48)	150 (24.0)	47	31 (24 - 40)	0.39
Total	223 (100.0)	114	51 (44 - 58)	618 (100.0)	435	70 (67 - 74)	<0.001

HH – Hand Hygiene, n – Number of cases, CI – Confidence Interval

Table 2. Comparison of HH compliance in intervention and non-intervention groups in accordance with profession.

	Non-intervention			Intervention			P -value
	n (%)	n complied HH	% (95CI)	n (%)	n complied HH	% (95CI)	
Doctors	107 (53.0)	58	54 (44 - 64)	251 (43.0)	203	81 (76 - 86)	<0.001
Nurses	59 (29.0)	33	56 (42 - 69)	160 (27.0)	133	83 (7 - 89)	<0.001
Medical Students	27 (13.0)	12	44 (26 - 65)	87 (15.0)	39	45 (34 - 56)	0.97
Healthcare Assistants	10 (5.0)	7	70 (35 - 94)	92 (16.0)	64	70 (59 - 79)	0.98

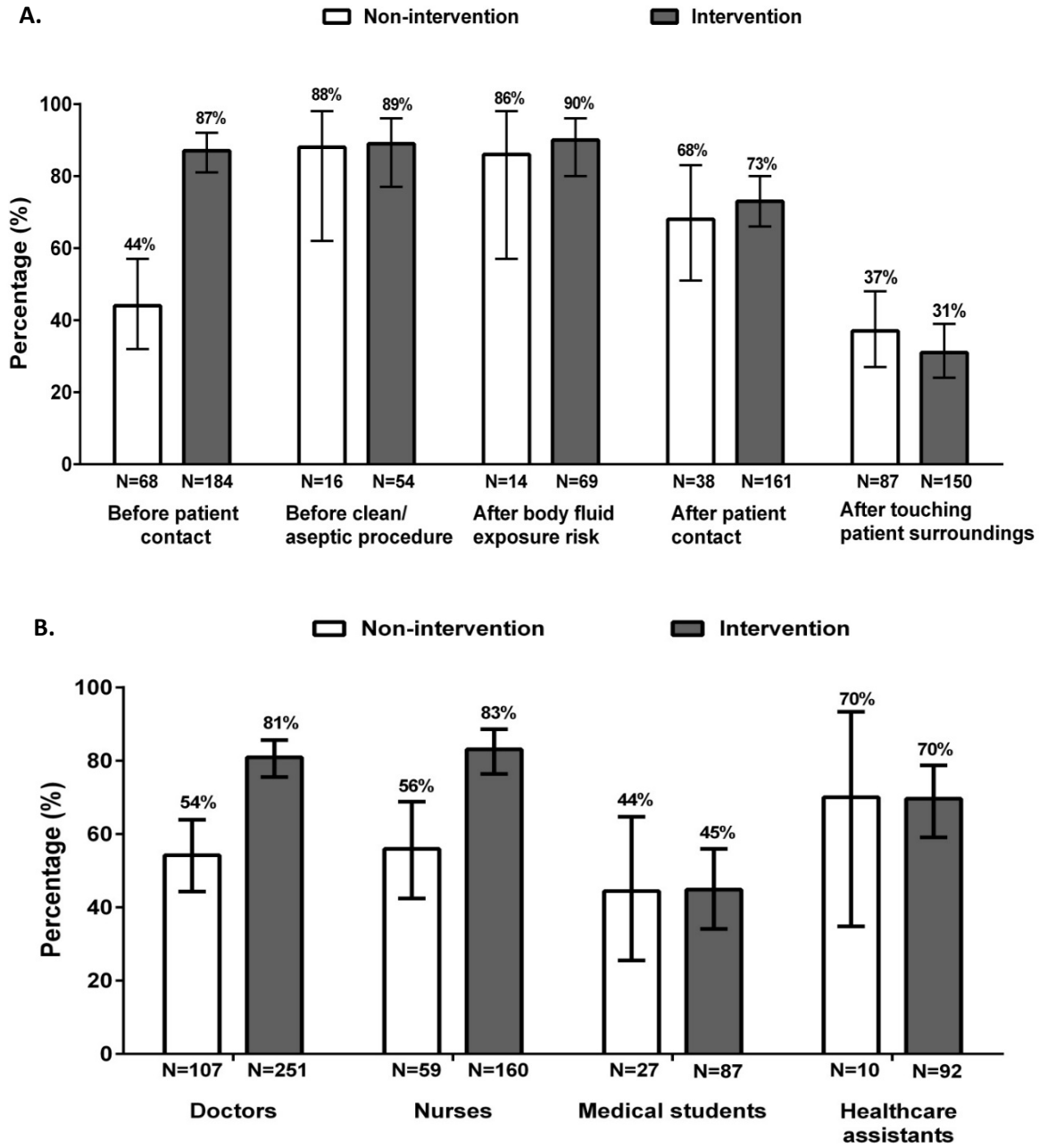


Figure 1. Percentage of hand hygiene compliance with and without intervention (A). In accordance with the WHO's 5-moments for HH compliance (B). In accordance with profession

Table 3. Hospital acquired infection rates comparing non-intervention and intervention groups in accordance with wards observed.

	Non-intervention period Mean (95%CI) per 1,000 patient day	Intervention period Mean (95%CI) per 1,000 patient day	P-value
Pediatric Intensive Care Unit			
CA-UTI	14.8 (7.4 - 26.4)	5.8 (1.6 - 14.7)	0.12
CRBSI	2.7 (0.5 - 7.7)	6.4 (2.6 - 13.1)	0.22
VAP	9.6 (4.8 - 17.2)	12.7 (6.8 - 21.7)	0.49
Immunocompromised Ward			
CA-UTI	0 (0 - 148.2)	0 (0 - 74)	NA
CRBSI	2.4 (0.1 - 13.3)	2.2 (0.1 - 12.2)	0.99
VAP	27.8 (0.7 - 145.3)	0*	NA
Total			
CA-UTI	14.4 (7.2 - 25.6)	5.3 (1.5 - 13.6)	0.08
CRBSI	2.6 (0.7 - 6.6)	5.1 (2.2 - 10.1)	0.25
VAP	10.2 (5.3 - 17.8)	12.7 (6.8 - 21.7)	0.58

CA-UTI Catheter associated urinary tract infections; CRBSI - Catheter related bloodstream infections; VAP - Ventilator associated pneumonia. *No data

When looking at the breakdown of HH compliance at pre-intervention according to profession, the highest HH levels was among the health care assistants, with rates at 70.0%, followed by the nursing staff (56.0%) and doctors (54.0%). These figures in the nursing staff and doctors are in accordance with findings reported in systematic review of 48.0% and 32.0% respectively. ⁽¹¹⁾ After the intervention, HH compliance significantly improved in the nursing and medical staff, but did not improve in medical students with intervention. This may have been due to a shorter cumulative ‘dose’ of exposure compared to other professions as students who only rotate through each ward for two weeks and were only exposed to interventions during their time on their pediatrics rotations, a maximum of 12 weeks. Nurses, doctors, and healthcare assistants, however, remained in the Department of Pediatrics throughout the study period so they were exposed to more interventions cumulatively. Thus, they are more likely to be affected by the interventions. One possible solution to this issue is to increase the prominence of HH training in the curriculum of these population groups.

Regarding HH compliance in relation to the WHO5HH, HH compliance at baseline was higher than 85.0% prior to clean/aseptic procedures and after body fluid exposure risk, which may imply that staff had high levels of awareness, compared to a previous Thai study where figures for these moments were

16.3% and 19.2%, respectively. ⁽⁶⁾ Such differences between our study and these figures may have been due to the fact that recent hospital wide HH interventional program had taken place prior to the commencement of this study. After intervention, the most significant improvement was seen in the moment before touching patients from 44.0% to 87.0%. It is possible this was influenced by the effect of HH reminder posters at bedside. HH compliance was lowest after touching patient surroundings, 37.0%, similar to previous study estimates of approximately 30.0%. ⁽¹⁴⁾ As this moment is perceived by healthcare workers to be low risk, it is associated with lower levels of compliance and it has been emphasized that environmental cues to remind healthcare workers where such opportunities are likely to arise should be performed to perturb this problem. ^(11, 14) Although efforts were made at the data collection methodology design at the outset for this to be otherwise, it is still possible that the moment after touching a patient in an open ward such as a bedrail is actually the continuing workflow of a healthcare worker prior to touching a patient in the next bed. Thus, for patients who have medical indications for contact isolation such as multidrug resistance bacterial infection, this emphasizes the importance of placing such patients in isolation rooms if they are initially on an open ward, as HH compliance following contact with the surroundings is low.

Despite studies stating that good HH compliance can reduce HAI rates by as much as 40.0%, the rates in this study have remained unchanged.⁽¹⁵⁾ The cause of this was presumed to be due to the multifactorial nature of the occurrence of HAIs, with poor HH being one of the many facets leading to them. Some of these facets could have included lack of interventions taken with medical equipment and environmental cleaning in patient wards such as at handwashing basins, ward water hygiene quality itself, and use of various infection prevention bundles. Sickbert-Bennett EE, *et al.* found in a longitudinal study that HH compliance led to substantial hospital wide HAI rate reduction.⁽¹⁶⁾ It is possible that because this study was conducted for two years rather than the 6 months of our study, the effects of increased HH compliance manifested. Contrary to this a Thai study by Picheansathian and colleagues did not find a reduction of HAI rates despite achieving significant HH compliance improvement following a multimodal HH promotional program, citing HAIs being multifactorial in their incidence and also methodology limitations in their study such as inter-rater reliability as reasons for this finding.⁽⁵⁾ This study was conducted over one year. Salemi C, *et al.* similarly found in a multimodal HH interventional program that despite improved HH rates, HAI rates for ventilator associated pneumonia remained unchanged in the 2-year study period. Additionally, a noted reduction in CRSBI rates from 3.0 to 1.4 per 1,000 central line post-intervention could not be attributed to HH compliance alone due to the multifactorial nature of this infection.⁽¹⁷⁾

The strengths of this study were that its interventions were tailor made according to the organizational culture and needs of staff, and in the process of its implementation, raised overall awareness of the importance of HH. It highlighted the importance of all team members in the effort to improve HH compliance by involving all team members at all stages of the development and interventional program. In accordance with the literature, it also instituted a multimodal interventional program which was repeated at regular intervals, which has been shown to be more effective than just single mode and or time promotional strategies.⁽²⁾

Its limitations were that despite direct observation being considered the 'gold standard' method of data collection for HH compliance in healthcare settings, it still had the obvious disadvantage of the Hawthorne

effect.⁽⁹⁾ Attempt to limit this effect was by the discreet performance of data collection during routine ward rounds and no specific announcement of timings of data collection in advance of scheduled sessions. Due to the nature in which this intervention program was conducted, it was also not possible to ensure that the pre-intervention and post-intervention groups were the same. Lastly, the distribution of 5 moments of HH being observed at pre-intervention and post-intervention was somewhat different, after touching of patient surroundings was 39.0% of number of observations and only 24.0% after intervention, this may have affected overall higher rate of HH. However, with the direct observation method it was not possible to control percentage of opportunities in advance.

Overall, we believe that this study complied with the most important essence of the rationale of implementing effective interventions in 'real-life' settings that can be used in the field. The results of this study highlight the need for further interventions to improve HH compliance following touching of patient surroundings, and overall in the promotion of HH amongst medical students. It would also be interesting to study further HH compliance levels after interventions are no longer running and what impact this has.

Hand hygiene practices are highly cost effective in minimizing HAIs in healthcare settings.^(1, 2) HH compliance in low to middle income countries is low.^(1, 2) As the reasons for non-adherence to HH are multifactorial, multimodal HH program have been found to be the most effective approach to increase compliance.⁽³⁾

This study was an example of the effectiveness that a population tailored multimodal HH promotion program had on HH compliance. Promotion of HH compliance in the medical student population is an important aspect of HH promotion program in improving overall HH compliance rates.

Conclusions

A multifaceted HH promotion program focusing on behavioral aspects that is ongoing is important in maintaining good HH compliance. Further investigation is however needed to be done on effective interventions to improve medical student HH compliance as well as HH compliance following contact with patient surroundings.

Acknowledgements

The researchers would like to thank Mr. Patomchai Ratanapaichit for his help in the design of the interventions as well as many of the logistical and administrative work necessary to have made this project possible. We also would thank to offer our thanks to Ms. Sunaree Losanthea for her help with data collection. Special thanks are also pass to Suriya Chomsavas for his help in the production of the HH promotion videos used in this study, and Rachaneekorn Nadsasarn for her assistance with data analysis, presentation and editing of this manuscript.

This study was funded by the Ratchadapisek-sompotch Endowment Fund of Chulalongkorn University (No. RA 59/002) and the Thai Research Fund (IRG 5780015). Both sponsors had no role in the study design, data collection, data analysis, data interpretation or writing of the report. The corresponding author had full access to all data in the study and final responsibility for the decision to submit for publication.

Conflict of interest

The authors, hereby, declare no conflict of interest.

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