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Assessment of hand hygiene compliance after hand hygiene education among health care workers in Cambodia

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ABSTRACT

Health care-associated infection (HCAI) is the most frequent adverse event for hospitalized patients. Hand hygiene is a simple and effective solution to protect patients from HCAI. This study aimed to introduce hand hygiene to health care workers based on the World Health Organization guideline for reducing HCAI in Cambodia and to assess their behavioral patterns on hand hygiene. All health care workers at Kampong Cham provincial hospital had lectures and practice on hand hygiene in January 2012. The surveys for hand hygiene compliance (HHC) were performed after 6 months, 1 year and 2 years, respectively. The number of surgical site infections (SSI) was counted in 2011 and 2014. Our analysis used the data of 58 workers, who were observed at all three points, although 139 workers were observed during the study period. The average of HHC at 6 months, 1 year and 2 years were 62.37%, 85.76% and 80.36%, respectively. The improved group (HHC 2 years/1 year≧1) had 32 workers, whereas the worsened group (HHC 2 years/1 year<1) had 26. There was a significant difference in departments of the two groups (P=0.011) but not in sex, age or occupations. The improved group had more workers of General (31.2% vs. 19.2%), Surgical (25.0% vs. 11.5%) and Infection (21.9% vs. 11.5%) categories compared to the worsened group. The incidence of SSI was improved from 32.26% in 2011 to 0.97% in 2014. Our results suggest that the education and the survey on hand hygiene are effective for reducing HCAI in Cambodia.

Key Words: alcohol-based hand rub, Cambodia, hand hygiene, hand hygiene compliance, health care-associated infection

INTRODUCTION

Health care-associated infections (HCAI) are those that patients acquire while receiving treatment for medical or surgical conditions.[1)] HCAI is the most frequent adverse event for hospitalized patients and is a major global issue for patient's safety.[2, 3)] The most frequent HCAI is urinary catheter-related urinary tract infection (CR-UTI),[1)] and the second is surgical site infection (SSI). Although catheter-related bloodstream infection (CR-BSI) and ventilator-associated pneumonia (VAP) are less common, these infections are associated with higher mortality and

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costs.[2] The greatest risk factor for CA-UTI is prolonged catheterization, beyond 6 days. Other risk factors for CA-UTI are female, patients with other active sites of infection, a major preexisting chronic condition, inserting the catheter outside the operating room, presence of a ureteral stent, or using the catheter to measure urine output, and so on.[4] A systematic review reported that risk factors for SSI were advanced age, patient frailty, surgery complexity, and co-morbidities such as diabetes or heart diseases.[5] Patient frailty means independence and activities of daily living such as admission from a long-term health facility or requiring assistance with three or more activities of daily living. About 30% patients of intensive care units (ICUs) are affected by at least one episode of HCAI even in high-income countries.[6, 7] In developing countries, malnutrition, age < 1 year, low birth weight, parenteral nutrition, or two or more underlying diseases are added to the risk factors because of poverty, a lack of basic hygiene and limited resources.[7-10]

The incidence of HCAI is reported to range from 1.7 to 23.6 per 100 patients by a worldwide systematic review[11] and WHO report based on large studies shows that HCAI incidence density ranges from 13.0 to 20.3 episodes per 1000 patient-days.[7] More than seven and 10 per 100 hospitalized patients acquire HCAI in developed and developing countries, respectively.[7] HCAI causes longer hospitalization and unnecessary death of patients as well as a massive additional financial burden to patients, their family and the government. In the United States, approximately 80,000 deaths occur per year due to HCAI, and hospital costs directly related to HCAI were from 28.4 to 33.8 billion US dollars in 2007.[11, 12] Meta-analysis using 220 articles related to HCAI in developing countries showed that the prevalence of HCAI was 15.5 per 100 patients (range 5.4-19.1), and it was much higher than proportions in Europe and the USA.[3] The analysis also reported that SSI was the leading infection in hospitals and that pooled cumulative incidence was 6.6 per 100 surgical procedures in developing countries, which was significantly higher than developed countries.

Patients are exposed to a variety of microorganisms during hospitalization, and many different bacteria, viruses, fungi and parasites may cause HCAI. Hand hygiene is a simple and effective solution to reduce the spread of infection and to protect patients from HCAI. The World Health Organization (WHO) released guidelines on "Hand Hygiene in Health Care"[13] and the "Clean Care is Safer Care" program is aimed at reducing HCAI globally.[14] WHO suggests that the main solutions for improvement are identifying local determinations of the HCAI burden, improving reporting and surveillance systems at the national level and improving staff education and accountability.[15] Cambodia is one of the developing countries and resources for promoting hand hygiene are limited by inadequate environmental hygienic conditions and waste disposal, poor infrastructure, insufficient equipment, understaffing, overcrowding, poor knowledge and application of basic infection control measures, lack of procedure, lack of knowledge of injection and blood transfusion safety, and absence of local and national guidelines and policies. Therefore, we conducted hand hygiene education based on WHO Guidelines on Hand Hygiene in Health Care[13] and the survey of hand hygiene compliance among health care workers in Kampong Cham (KgC) provincial hospital as a model for other health facilities in Cambodia.

MATERIALS AND METHODS

Study design

This is an observational study. In order to reduce HCAI in Cambodia, the Cambodian Ministry of Health (MoH) conducted hand hygiene education and surveys on hand washing action in KgC provincial hospital between 2012 and 2014. KgC provincial hospital is located 120 km from Phnom Penh and the complementary package of activities is level 3, which is the highest

level. It has 312 beds, 20 departments, and 240 health care workers who were 48 doctors, 120 nurses, 23 midwives and 49 others. The bed occupancy rate was 125% in 2013. The department of hospital service of MoH organized the education in collaboration with WHO and performed the survey with the infection control committee of the hospital.

Hand hygiene education of health care workers

We conducted the education program on hand hygiene for all health care workers in January 2012, which was based on the Infection Control Guideline published in July 2010 by the MoH.[16] We divided 240 workers into 8 groups and all groups had a lecture for 20 min and hand-washing practice for 40 min.

The lecture had three sessions and the first session was for learning the ways in which bacteria are spread by hands and the importance of hand hygiene. The second session was for understanding the WHO "Five Moments for Hand Hygiene"[14] and three kinds of hand hygiene which were recommended in "the Infection Control Guideline"[16] in order to choose an appropriate hand hygiene solution for different types of hand hygiene. The five moments are (1) before patient contact, (2) before aseptic task, (3) after handling specimens or exposure to bodily fluids, (4) after patient contact or examination, and (5) after touching patient surroundings. The three kinds of hand hygiene are (1) hand wash with soap and water, (2) surgical hand scrub, and (3) alcohol-based hand rub (ABHR). ABHR should be the standard of care if hands are not visibly dirty. Surgical hand scrub removes transient organisms and soil, and kills or inhibits the growth of resident micro-organisms. This type of hand washing is appropriate before surgical procedures and should take 3–5 min. The third session was for counting materials necessary for performing hand hygiene and demonstrating 6 steps of hand washing correctly. The 6 steps are as follows: rubbing hands palm to palm (step 1), right palm over left dorsum with interlaced fingers and vice versa (step 2), palm to palm with fingers interlaced (step 3), backs of fingers to opposing palms with fingers inter locked (step 4), rotational rubbing of left thumb clasped in right palm and vice versa (step 5), and rotational rubbing backwards and forwards with clasped fingers of right hand in left palm and vice versa (step 6). During the practice, all participants washed their hands with the 6 steps. The trainers from the MoH checked if the workers washed their hands appropriately. All worker's hands were checked by a UV light box or torch after washing to identify the quality of hand washing.

To promote hand washing actions after the education program, we provided the poster on hand hygiene, five moments, soap and alcohol hand rub in Cambodian language and put them up around the washing places. We also provided alcohol gel at the sinks of each ward.

Survey for hand hygiene compliance

To assess what proportion of health care workers follow the standard principles of hand hygiene practice, we performed surveys on alcohol based hand washing behavior 6 months, 1 year and 2 years after the education. We appointed 15 experienced workers from the ward chiefs as surveyors and trained them on the survey method. We used the checklist of hand hygiene compliance (HHC). The formula of HHC was as follows: HHC (%) = (hand hygiene action of alcohol hand rub/hand hygiene opportunity) × 100. The hand hygiene opportunity meant moments when alcohol-based hand hygiene was necessary during health care activities according to "The WHO Five Moments." Hand hygiene action had three categories, hand washing with soap and water, alcohol hand rub (with alcohol liquid, rinse, gel or foam) and a missed opportunity. The surveyors went to all wards and observed health care workers for 20 min, but did not inform them about the survey. Medical professionals including doctors, nurses, midwives, pharmacists, dentists, laboratory technicians and medical assistants (MAs) were observed in this survey. The

surveyors counted hand hygiene opportunities and checked his/her hand hygiene action in each opportunity. The director and the surveyors calculated HHC for each worker in each survey point.

Survey for surgical site infection

To examine the efficacy of hand hygiene promotion on reducing HCAI, we collected data from patient's medical records about the number of SSI from October to December 2011 and September to December 2014. SSIs were clinically diagnosed by surgeons according to the criteria defined as infections (1) occurring within 30 days after surgery, (2) involving only skin or subcutaneous tissues of the incision, (3) with local inflammatory signs such as pain, tenderness, localized swelling, redness, or heat. The members of the infection control committee confirmed that the collected SSIs were within the criteria.

Statistical analysis

Statistical analysis was performed using a χ^2 test for categorical variables, or a Student's *t* test for continuous variables. IBM SPSS Statistics for Windows, Version 22.0 software (IBM Corp, Armonk, New York) was used for statistical analyses, and a P-value of <0.05 was considered significant.

RESULTS

One hundred and thirty-nine health care workers were observed during the study period. The range in age was from 24 to 63 years old, and we observed 72 male and 67 female health care workers. Among 139 health care workers, 58 were observed at all three points (6 months+1 year+2 years), four and 38 at two points (6 months+1 year and 1 year+2 years), and 39 at only one point. To assess the effectiveness of the education by comparing HHC at three points, we used the data of 58 workers who were observed at three points. Among 58 people, females (55.2%) outnumbered males (44.8%) and the age was 42.4 ± 10.6 (average ± SD) (Table 1). The proportions of doctor, nurse, midwife and MA were 13.8%, 72.4%, 12.1% and 1.7%, respectively, and nurses made up the largest professional group to be observed. The departments to which 58 workers belonged were 20 and we divided 20 departments into six groups according to their characteristics (Table 2).

Figure 1 shows the HHC of all workers at three points, and we found that HHC at 1 year was higher than at 6 months in most workers. However, the difference between HHC at 2 years and 1 year was different between workers.

Next, we analyzed the correlation among HHC at three points and characteristics (gender, age, occupation and department) of 58 health care workers (Table 3). The average HHC of all 58 workers at 6 months, 1 year and 2 years were 62.37%, 85.76% and 80.36%, respectively. We found that the average HHC increased from 6 months to 1 year but decreased at 2 years. The higher HHC at 1 year than 6 months was found in all groups of each category. HHC at 2 years was lower than HHC at 1 year in most groups of each category. In gender or age, all groups showed a lower HHC at 2 years than 1 year. However, the older age group had less decrease of HHC at 2 years compared to 1 year. In occupation groups, midwife and MA had higher HHC at 2 years compared to HHC at 1 year, although there were seven midwives and one MA. There were three groups (Examination, Surgical and General) whose HHC at 2 years was higher than 1 year in the department category. HHC of the outpatient department (OPD) was lowest among all the departments at 6 months and 2 years.

We also studied HHC based on the improvement at 2 years compared to 1 year (Table 4). The

Table 1 Background of 58 health care workers

Variable		N	
Gender			
	Male	26	(44.8%)
	Female	32	(55.2%)
Age			
	Average ± SD (range)	42.4±10.6	(25–63)
	≦30	13	(22.4%)
	31–40	8	(13.8%)
	41–50	24	(41.4%)
	51	13	(22.4%)
Occupation			
	Doctor	8	(13.8%)
	Nurse	42	(72.4%)
	Midwife	7	(12.1%)
	Medical assistant	1	(1.7%)

Table 2 Group departments by category

Group category	Departments	N of workers
Outpatient department (OPD)	OPD	5
Emergency	Emergency ward	
	Intensive care unit (ICU)	10
	Operation room	
Examination	Ultrasound unit	
	Laboratory unit	7
	X-ray unit	
	Blood bank	
Surgical	Surgical ward I and II	11
	Maternity ward	
General	Medical ward	
	Pediatric ward	
	Psychiatric ward	15
	Ophthalmology ward	
	Otolaryngology ward	
Infection	Infectious disease ward	
	Stoma ward	10
	Tuberculosis ward	
	Infectious disease and HIV ward	

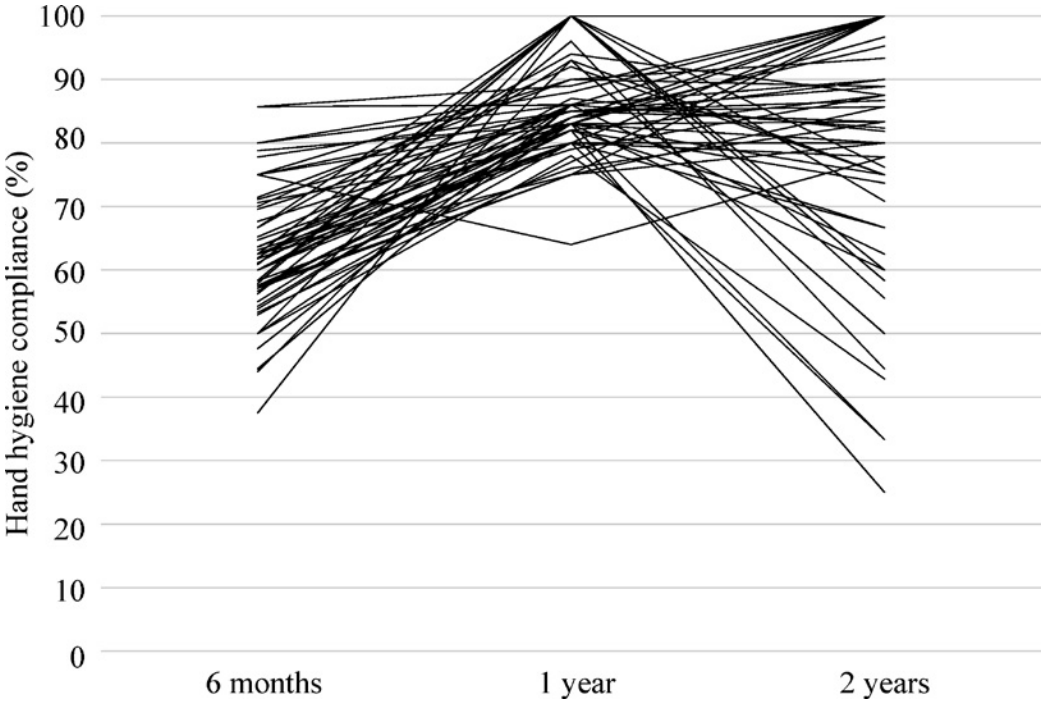

Fig. 1 Hand hygiene compliance (HHC) of 58 health care workers in 6 months, 1 year and 2 years after the training. HHC of most workers was clearly more improved at 1 year compared to 6 months. However, no improvement of HHC from 1 year to 2 years was observed in 44.8% of workers.

improved group had 32 workers whose HHC at 2 years was the same or higher than HHC at 1 year, whereas the worsened group had 26 workers whose HHC at 2 years were lower than HHC at 1 year. Both groups had more females than males. The average age was 42.8 and 41.9 years in the improved group and the worsened group, respectively. We found no significant difference in age between the two groups, although Table 4 indicated that older workers had higher HHC at 2 years. In terms of occupation, there were fewer doctors in the improved group than in the worsened group (9.4% vs. 19.2%). However, there was no significant difference in occupation between the two groups (P=0.462). Our results showed a significant difference between departments in the two groups (P=0.011). The improved group had more workers of General (31.2% vs. 19.2%), Surgical (25.0% vs. 11.5%) and Infection (21.9% vs. 11.5%) categories.

Table 5 shows the number of SSI in 2011 and 2014. We found that the number of SSI decreased in 2014 compared to 2011. The incidence of SSI was highest in December 2011 (34.10%) among all surveyed months. The average SSI incidence in four months of 2014 was lower than that in three months of 2011 (0.97% vs. 32.26%).

Table 3 Correlation between hand hygiene compliance and characteristics of health care workers

			HHC (95% CI)					
		N	6 months		1 year		2 years	
All		58	62.37	(59.67–65.07)	85.76	(83.71–87.80)	80.36	(75.26–85.35)
Sex	Male	26	64.62	(60.46–68.79)	86.66	(83.47–89.86)	76.03	(68.03–84.03)
	Female	32	60.53	(56.93–64.15)	85.02	(82.24–87.80)	83.77	(77.18–90.37)
Age	<30	13	63.85	(58.19–69.52)	83.76	(80.45–87.06)	76.55	(65.56–87.56)
	31–40	8	57.23	(50.50–63.97)	82.19	(77.51–86.86)	79.17	(63.52–94.84)
	41–50	24	63.34	(58.99–73.58)	88.45	(85.22–91.67)	80.19	(70.38–90.00)
	51–	13	62.23	(59.86–69.61)	84.98	(78.95–91.01)	84.95	(77.69–92.20)
Occupation	Doctor	8	64.78	(55.98–73.58)	92.92	(86.20–99.65)	72.97	(51.40–94.53)
	Nurse	42	62.33	(59.02–65.63)	84.13	(82.02–86.24)	79.61	(73.85–85.38)
	Midwife	7	60.47	(52.85–67.44)	85.29	(79.51–94.75)	90.00	(81.63–100.87)
	MA	1	58		100		100	
Department	OPD	5	53.97	(40.68–67.27)	87.29	(74.70–99.87)	40.79	(25.20–56.38)
	Emergency	10	64.14	(58.83–69.44)	89.74	(83.27–96.21)	69.17	(56.09–82.25)
	Examination	7	54.88	(48.78–60.99)	83.86	(79.13–88.59)	87.07	(78.92–95.22)
	Surgical	11	60.47	(53.20–67.73)	86.60	(81.51–91.69)	92.37	(85.96–98.78)
	General	15	62.54	(62.87–74.63)	82.45	(81.71–88.40)	87.88	(77.12–90.53)
	Infection	10	62.37	(56.65–68.42)	85.76	(75.96–88.93)	80.30	(76.59–99.18)

Table 4 Analysis of factors for keeping improved hand hygiene compliance in 2 years

			Improved group (HHC 2 years/1 year ≧1)	Worsened group (HHC 2 years/1 year <1)	P-value
		N	N=32	N=26	
Sex	Male	26	11 (34.4%)	11 (42.3%)	0.076
	Female	32	21 (65.6%)	15 (57.7%)	
Age	average ± SD	58	42.8 ± 10.3	41.9 ± 11.2	0.734
Occupation	Doctor	8	3 (9.4%)	5 (19.2%)	
	Nurse	42	23 (71.9%)	19 (73.1%)	0.462
	Other	8	6 (15.6%)	2 (7.7%)	
Department	OPD	5	0 (0%)	5 (19.2%)	
	Emergency	10	2 (6.2%)	8 (30.8%)	
	Examination	7	5 (15.6%)	2 (7.7%)	0.011
	Surgical	11	8 (25%)	3 (11.5%)	
	General	15	10 (31.2%)	5 (19.2%)	
	Infection	10	7 (21.9%)	3 (11.5%)	

Table 5 The numbers of operation and surgical site infection in 2011 and 2014

Month, Year	No. of operations	No. of C-sections	No. of SSI	Incidence of SSI (%)
Oct 2011	248	81	108	32.83
Nov 2011	250	80	99	30.00
Dec 2011	227	78	104	34.10
Sep 2014	233	55	2	0.69
Oct 2014	247	54	3	0.99
Nov 2014	258	107	7	1.91
Dec 2014	292	99	1	0.25

C-section, caesarean section; No, number; SSI, surgical site infection. Incidence of SSI was calculated by (No. of SSI) / (No. of operations + No. of C-sections).

DISCUSSION

This study showed the first trial of the education and the survey on hand hygiene for reducing HCAI in Cambodia which was conducted by MoH and the infection control committee of KgC provincial hospital. Hand hygiene plays a key role in the prevention of HCAI. When hands are visibly dirty or visibly soiled with blood or other body fluids, they should be washed with soap and water. However, ABHR should be used for routine decontamination in all other clinical situations if hands are not visibly dirty. In this study, hygiene practice of ABHR was introduced to all health care workers in the hospital, and HHC and the incidence of SSI were reduced after the education program. Our results suggest that “Five Moments for Hand Hygiene” and ABHR are acceptable for health care workers in their clinical practice in developing countries where resources are limited.

Our results showed that the average HHC at 6 months was 62.37% and then increased at 1 year (85.76%) followed by a decrease at 2 years (80.36%) (Table 3). HHC at 2 years was worse than 1 year in almost half of the workers observed in the survey (26 workers). These results indicate that the lectures and the practice for hand hygiene might be effective for only the first year, although the education of health care workers was shown to be a critical success factor in improving HHC. We performed the education and the survey at KgC provincial hospital as a pilot project, and our results suggest that the education program should be recommended once a year or more to maintain high HHC in health care workers in all health facilities in Cambodia.

The analysis of the worsened group compared to the improved group showed that HHC was higher in workers of department groups of the General, Surgical and Infection categories (Table 4). In our study, significant difference was not observed among occupations or genders although some studies showed that doctor status and male sex were risk factors. There are patients after operations, deliveries and caesarean sections in the surgical wards and the maternal ward of the Surgical department group, and these patients are easy to have infections because of their wound. It is reasonable to require health care workers of the department groups of Surgical and Infection to understand well the importance of hand hygiene to prevent HCAI in their wards. The General department group includes a pediatric ward, and health care workers must know that children tend to be easily infected. On the other hand, the Outpatient department and the Emergency department group (emergency ward, ICU and operation room) had more workers of the worsened group. The reason may be that workers in these departments were too busy to wash

their hands by the proper methods. Although doctors and nurses must do a surgical hand scrub before operations, they might not pay attention to hand hygiene when their hands are not visibly dirty. Our results were consistent with previous studies which showed that working in intensive care unit,[17, 18] anesthesiology and emergency care,[17] and often too busy or insufficient time were risk factors for low compliance.[13, 19, 20] Short duration of contact with patient,[19] interruption in patient-care activities,[21] and overcrowding[22] were also reported as risk factors for low hand hygiene compliance, and these factors are related to the Emergency and Outpatient department groups in our study. Dedrick *et al.* suggested that opportunities for hand contamination occurred during all brief patient encounters (i.e., < 2 minutes).[19] These results suggest that health care workers in these busy wards should have hand hygiene training more often than other wards to improve adherence to hand hygiene recommendation after brief encounters and to increase motivation. MoH should plan special education for them such as training with longer practice.

The incidence of SSI was reduced from 32.26% in 2011 to 0.97% in 2014, and the improvement of HHC might be one of the factors which lowered it. The training course was provided based on the guidelines of infection and prevention control that recommend using personal protective equipment and appropriate handling of patient care equipment, as well as hand washing. Using personal protective equipment such as gloves, gowns, eyewear and head caps, can protect patients and medical health care workers from infections. In terms of handling of patient care equipment, the guidelines divide patient care equipment into three categories (critical, semi-critical and non-critical) and shows the appropriate method of sterilization for each category. Providing the education course to teach health care workers about these recommendations through the guidelines might also reduce the incidence of SSI. We would like to perform the next survey to investigate that the training course, using personal protective equipment and appropriate sterilization could improve the incidence of SSI. HHC in the Surgical department group improved from 64.47% at 6 months to 92.37% at 2 years, and HHC at 2 years in this group was the best in all departments (Table 3). We collected the number of SSIs during hospitalization but did not study other types of HCAI. The surveillance of SSI after caesarean sections was conducted at the same hospital in Cambodia between October 2010 and February 2011.[23] Of 176 patients who were monitored for 30 days, 11 patients (6.25%) were diagnosed with SSI and four of the 11 cases were detected after hospital discharge. The incidence of SSI in our study cannot be compared to the incidence in the previous study because our SSI survey method was different from the previous study. However, these results suggest that SSI might occur more often after surgeries except caesarean sections. HHC of OPD and the Emergency department groups were not improved so much at 2 years compared to 6 months (Table 4). These results suggest that other types of HCAI might not be decreased as much as SSI. Although the survey and reporting system on the main four types of HCAI are needed to estimate the effectiveness of hand hygiene education on reducing HCAI, human resources and financial budgets are insufficient in Cambodia and these problems should be solved in the future.

There are four limitations in our study. First, the health care workers whose data could be used for our analysis to compare HHC at three points were few in number. However, these 58 workers were distributed to all wards and all age groups, and included four occupations such as doctors, nurses, midwives and medical assistants. We used the data of workers who were checked at 6 months, 1 year and 2 years, and we could understand how the HHC for each worker changed at three points (Figure 1). Therefore, the results of the analysis for comparing HHC at three points were reliable. The second limitation is that the HHC survey was not conducted before hand hygiene education. The initial survey before the education is needed to assure a more effective program of lectures and practice for workers. However, our results showed that HHC at 1 year was improved compared to 6 months. This suggests that HHC before the education

might be lower than at 6 months. When the same project is conducted in other health facilities in Cambodia, the initial survey on HHC should be performed before the training. The third limitation is that we analyzed the factors for improving or keeping HHC using only four factors. Many factors should be involved for improving HHC among health care workers, because it is very difficult and complicated to improve HHC. The fourth limitation is that our study collected the data of only superficial incisional SSI, but not deep incisional SSI or organ/space SSI. The Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System classifies the criteria of SSIs into three.[24] However, superficial incisional SSI is easy to diagnose by only observation, whereas CT scans or biopsy are needed to diagnose the other two SSIs. There are no CT scans in KgC provincial hospital and we only collected the data of superficial incisional SSIs. The fourth limitation is that we did not study bacterial culture to estimate the improvement of HCAI. Antimicrobial resistance is a growing concern in Cambodia which has already reported some bacteria including *Staphylococcus aureus* (*S. aureus*).[25-28] Only 6 pus samples were collected in the study of SSI after caesarean sections, but one was positive on culture for methicillin resistant *S. aureus* (MRSA).[23] Another study at the same hospital showed that nearly 45% of the 20 *S. aureus* strains isolated by the hospital laboratory were community-acquired MRSA (Somary N., Personal communication, 2011).[23] Cooper *et al.* predicted that improving HHC from very low levels to 20% or 40% significantly reduced transmission, but that improving compliance to levels above 40% would have relatively little impact on the prevalence of *S. aureus*.[29] Sebille *et al.* found that increasing HHC rates had only a modest effect on the prevalence of MRSA colonization.[30] These results suggest that HHC improvement may not lead to effectively reducing HCAI caused by *S. aureus* or antibiotic-resistant bacteria. Bacterial study is needed for surveillance of HCAI, however, it is difficult in Cambodia because of the limited financial budget and laboratory capacity.

In conclusion, this is the first report of the education and the survey on hand hygiene for reducing HCAI in Cambodia. Our results showed that HHC was improved during the first year after the education program but the average HHC at 2 years was decreased compared to 1 year. The improvement of HHC at 2 years from 1 year was significantly different between the department groups health care workers belonged to. The incidence of SSI was reduced from 32.26% to 0.97% in 3 years and it might be due to the improvement of HHC. These results suggest that the education and the survey conducted by MoH and the infection committee of the hospital may be effective for reducing HCAI in a developing country with limited budget and resources.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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