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# Handwashing practice and the use of personal protective equipment among medical students after the SARS epidemic in Hong Kong

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**Background:** Hand hygiene is an important element of infection control. We conducted 2 surveys on hand hygiene practices and use of personal protective equipment among medical students during and after the outbreak of severe acute respiratory syndrome (SARS) to study its impact on their personal hygiene practice when they contacted patients.

**Methods:** Two cross-sectional surveys were conducted among medical students in their clinical training years (years 3-5) in a teaching hospital (at which the first and major SARS outbreak occurred) in March 2003 and August 2004, respectively.

**Results:** Prior to the recognition of the SARS outbreak in March 2003, 35.2% of the students washed their hands before and 72.5% after they physically examined patients in the wards. None of the students wore masks during history taking and physical examination. In the 2004 survey, the corresponding proportions were 60.3% and 100%, respectively, and 86.1% and 93.8% of students wore masks during history taking and physical examination, respectively. Attitudes to handwashing and perception of infection risk were not significantly associated with handwashing practice, whereas peer behavior might be a significant influencing factor.

**Conclusion:** A significant improvement in compliance with hand hygiene practice was found after the SARS outbreak. (Am J Infect Control 2005;33:580-6.)

Handwashing is recognized as one of the most important and effective means of infection control. Nevertheless, the compliance of handwashing remains low among health care workers<sup>1-3</sup> and medical students.<sup>4,5</sup> Reasons for poor hand hygiene practices include the lack of scientific knowledge, unawareness of risk, misconceptions, unavailability of hand hygiene facilities, and lack of a role model among colleagues or superiors.<sup>6</sup> Although promotion of hand hygiene behavior is a complex issue,<sup>7,8</sup> education and administrative support from the hospital seems to be an effective measure.<sup>9</sup> Physicians in certain specialties have been shown to have poor compliance with hand hygiene guidelines.<sup>7</sup> Because physicians' behavior is influenced by education, we focused on handwashing and other personal hygiene practices of medical students.

The first major outbreak of severe acute respiratory syndrome (SARS) in Hong Kong occurred in the Prince of Wales Hospital (PWH) in March 2003. During this

outbreak, we conducted an epidemiologic study (the 2003 survey) on the risk of infection among medical students who had entered the ward in which the outbreak started and their practice of personal hygiene.<sup>10</sup> The epidemiology of SARS has since been better understood, and the major mode of transmission is believed to be the inhalation of droplets via the respiratory route or through direct contact of fomites contaminated with the SARS coronavirus.<sup>11</sup> Handwashing was a major health advice given to the public by the health authorities in Hong Kong.<sup>12</sup> The medical school has since stepped up the teaching on infection control among medical students, and the hospital has implemented stringent personal hygiene practices. To assess the impact of this reinforcement on handwashing and personal hygiene practices in the light of the SARS epidemic, we surveyed the practice of handwashing and other personal hygiene measures among medical students 1 year after the epidemic ended and compared their current practice with what their peers did 1 year ago.

## METHODS

### 2003 Survey

The target population was all year 3 to year 5 medical students who received their clinical training in PWH and who visited the medical ward when the SARS outbreak first occurred. A questionnaire was sent by e-mail to all year 3 to year 5 medical students in March 2003 that sought information on their history

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**Table 1.** Summary statistics of 169 medical students, 2004 survey

	N	Percentage
Sex		
Male	54	32.0
Female	115	68.0
Year of medical school		
3	50	29.6
4	66	39.1
5	52	30.8
Missing	1	0.6
Age, yr		
Below 20	4	2.4
20-24	155	91.7
25 or above	9	5.3
Missing	1	0.6
Visited any ward during August 2 to August 14, 2004		
Yes	144	85.2
No	25	14.8
Contacted any patients		
Yes	144	85.2
No	0	0.0
Not applicable	25	14.8

of activities in the ward, including their usual practice of handwashing and the use of gloves and masks during their contact with patients in the ward. Among these students, 16 contracted SARS and were interviewed by telephone during their recovery stage.

## 2004 Survey

The target population was all (currently) year 3 to year 5 medical students who underwent clinical training in the same hospital and who had contact with patients in the wards between August 2 and August 14, 2004. The questionnaire was designed to seek detailed information on the students' handwashing and personal hygiene practices, knowledge of handwashing guidelines, training on handwashing and use of personal protective equipment, and perceptions and attitudes on handwashing practices.

We asked whether the students washed their hands before and after they performed physical examinations on every patient. We also sought information on the use of soap, alcohol rub, and antibacterial handwashing liquids for those who complied and, for those who did not wash their hands, reasons for their noncompliance. Questions regarding handwashing practice before and after the students performed procedures that involved contact with body fluid, blood, or an open wound were asked. Information on use of masks during their history taking; their physical examination; and when they performed procedures that involved contact with body fluid, blood, or an open wound was sought.

**Table 2.** Distribution of medical students by year of medical school and specialty

Specialty	Year of medical school			Total
	3	4	5	
Geriatrics	1 (50.0%)	0 (0.0%)	1 (50.0%)	2
Medicine	25 (48.1%)	1 (1.9%)	26 (50.0%)	52
Orthopedics	4 (57.1%)	0 (0.0%)	3 (42.9%)	7
Obstetrics and gynecology	0 (0.0%)	17 (100.0%)	0 (0.0%)	17
Pediatrics	0 (0.0%)	12 (100.0%)	0 (0.0%)	12
Psychiatry	2 (13.3%)	13 (86.7%)	0 (0.0%)	15
Surgery	14 (48.3%)	0 (0.0%)	15 (51.7%)	29
Others	4 (36.4%)	0 (0.0%)	7 (63.6%)	11
Not applicable	1 (4.2%)	23 (95.8%)	0 (0.0%)	24
Total	50 (29.8%)	66 (39.3%)	52 (31.0%)	169

Information on use of gloves and the type of gloves used was also sought in the latter procedure. Knowledge and perception of the usefulness of the World Health Organization (WHO) guidelines<sup>13</sup> on handwashing, attitudes toward these guidelines, and perceived risks of cross infection because of noncompliance with hand hygiene practice were sought by a 10-point Likert scale, with 1 indicating total disagreement and 10 indicating maximal agreement to the statement. Information was also sought on whether their colleagues washed their hands according to the guidelines, whether they thought their own practice of handwashing would be taken as an example by their colleagues, whether the guidelines were too difficult to comply with, and whether they thought they could improve on their compliance with hand hygiene.

The questionnaires (in Microsoft Excel format; Redmond, WA) were sent to the students by e-mail, and weekly reminders were sent 3 times to improve the response rate. All the returned questionnaires were checked for completeness of response, and supplementary information or missing data were requested when necessary.

## Statistical analyses

Frequencies and percentages were computed for all the questions in the questionnaire and tabulated in Tables 1 to 5. Chi-square tests were used to compare the handwashing compliance by SARS patients and healthy students in the 2003 survey. The Fisher exact test was used to compare the difference between the handwashing compliance in April 2003 during the SARS outbreak and August 2004. All the computation and analyses were performed using SPSS 11.5 for Windows (SPSS Inc. SPSS Base 11.5 user's guide, 2002, SPSS Inc, Chicago, IL).

**Table 3.** Hand hygiene of 144 medical students who visited the wards

Procedures	Yes, n (%)	No, n (%)	Missing, n (%)	Not applicable, n*
History taking				
Wore mask	124 (86.1)	20 (13.9)	0 (0.0)	0
Physical examination				
Wore mask	122 (93.8)	8 (6.2)	1 (0.8)	13
Washed hands before	79 (60.3)	52 (39.7)	0 (0.0)	13
Washed hands after	131 (100.0)	0 (0.0)	0 (0.0)	13
Washed hands before examining next patient	91 (69.5)	40 (30.5)	0 (0.0)	13
Other procedures that involved contact with body fluid/blood/open wound				
Wore mask	75 (100.0)	0 (0.0)	0 (0.0)	69
Wore gloves	71 (94.7)	1 (1.3)	3 (4.0)	69
Washed hands before	49 (65.3)	26 (34.7)	0 (0.0)	69
Washed hand after	74 (98.7)	1 (1.3)	0 (0.0)	69

\*Not applicable: The student did not perform such procedures.

## RESULTS

### 2003 Survey

Of the 474 medical students, 334 (70.5%) responded to the survey, and 66 of them had visited the ward in which the index patient stayed during the beginning of the SARS outbreak. Fifty-one (77.3%) of the 66 students answered the questions about their usual handwashing practice, and 10 of them contracted SARS. Eighteen students (35.2%) replied that they would wash their hands before examining a patient, and 3 of them were SARS patients. No significant difference was observed between healthy students and those who contracted SARS ( $\chi^2 = 0.15$ ,  $P = .70$ ). Thirty-seven students (72.5%) replied that they would wash their hands after examining a patient, and 6 of them were SARS patients. There was no significant difference between the 2 groups of students in their handwashing practice ( $\chi^2 = 0.98$ ;  $P = .32$ ). None of the students wore masks while examining patients.

### 2004 Survey

A total of 169 (35.7%) students responded to our questionnaire survey. Summary statistics of the students are shown in Table 1. There were 54 males and 115 females; 91.7% were aged between 20 and 24 years. Among them, 144 students (85.2%) visited the hospital wards between August 2 and August 14, 2004, and all of those had direct contact with patients.

Table 2 shows the distribution of the students' year of study by the specialty of the wards they visited. Approximately half of year 3 and year 5 students visited the

**Table 4.** Frequency of use of personal protective measures and handwashing practice

	N	Percentage
Masks (n = 124)		
Paper	11	8.9
Surgical	112	90.3
N-95 respirator	1	0.8
Washing hands		
Water and liquid soap	14	10.7
Water and Hibiscrub (or other antibacterial liquid)	111	84.7
Alcohol rub	5	3.8
Water only	1	0.8
Gloves (n = 71)		
Latex	65	91.5
Polythene	6	8.5

**Table 5.** Knowledge about guidelines of infection control

	Yes, (%)	No, n (%)	Missing, n (%)
Have you ever been taught the guidelines? (n = 169)	145 (85.8)	22 (13.0)	2 (1.2)
Were the following taught? (n = 145)			
The importance of hand hygiene	143 (98.6)	2 (1.4)	0 (0.0)
The steps in handwashing	141 (97.2)	4 (2.8)	0 (0.0)
The use of personal protective equipment (eg, mask, gloves, aprons, and others)	142 (97.9)	3 (2.1)	0 (0.0)
The steps in putting on and removing the equipment	140 (96.6)	4 (2.8)	1 (0.7)

medical wards, and approximately one quarter visited surgical wards. Approximately one third of year 4 students did not visit any ward. Twenty-six percent visited obstetrics and gynecology wards; 20% visited psychiatric wards, and 18% visited pediatric wards. This pattern was related to the time schedule of their curriculum.

Compliance with infection control measures is shown in Table 3. Of the students, 86.1% replied they wore masks when they performed history taking, and 93.8% wore masks when they conducted physical examinations on patients. As to hand hygiene, 79 of 131 (60.3%) students replied that they washed their hands *before* performing physical examination on every patient, whereas 91 (69.5%) reported that they washed hands *before* examining the next patient when they examine several patients consecutively. (Some students explained that they did not wash their hands *before* examining each patient because they were examining a number of patients consecutively and had just washed their hands *after* examining the previous patient. This accounted for the difference in the 2 proportions.) Six students who replied they did not wash hands before examining patients cited "forgetfulness" as their

**Table 6.** Attitudes to hand hygiene practice

1. Did you know about the guidelines from WHO for handwashing? (n = 169)	Yes	87 (51.5%)
	No	79 (46.7%)
	Missing	3 (1.8%)
2. Will you follow the guidelines? (10-point scale: 1, very unlikely to 10, very likely)	Mean	7.7
	SD	1.5
3. Is hand hygiene a useful measure to prevent cross infection? (10-point scale: 1-total useless to 10-extremely useful)	Mean	9.0
	SD	1.0
4. Do your colleagues perform proper handwashing?	Yes	121 (71.6%)
	No	44 (26.0%)
	Missing	4 (2.4%)
5. Do you think your behavior toward handwashing is taken as an example by your colleagues?	Yes	24 (14.2%)
	No	24 (14.2%)
	Not sure	118 (69.8%)
6. Is it difficult to perform proper hand hygiene practice?	Missing	3 (1.8%)
	Yes	47 (27.8%)
	No	119 (70.4%)
7. Does noncompliance with proper hand hygiene increase the risk of cross infection in patients and students? (10-point scale: 1, totally disagree to 10, fully agree)	Missing	3 (1.8%)
	Mean	8.3
	SD	1.8
8. Do you think you can improve your compliance with hand hygiene?	Yes	128 (75.7%)
	No	10 (5.9%)
	Not sure	26 (15.4%)
	Missing	5 (3.0%)

excuse. All students washed their hands *after* their physical examination. In performing procedures that might involve contact with the body fluid/blood/open wound, 100% and 94.7% wore mask and gloves, respectively, and 65.3% and 98.7% washed their hands *before* and *after* the procedures, respectively.

Table 4 shows the frequency of use of personal protective equipment and handwashing as part of the infection control procedures. Surgical masks and paper masks were used by 90.3% and 8.9% of the respondents, respectively. For handwashing, 84.7% of the students used Hibiscrub (Astra Zeneca) (or other antibacterial liquid); 10% used liquid soap; 3.8% used alcohol rub, and 0.8% used water only. Of students, 91.5% of students wore latex gloves, and 8.5% wore polythene gloves while performing procedures that might involve contact with the body fluid/blood/open wound.

Table 5 summarized the knowledge about the guidelines of infection control among the students. One hundred forty-five (85.8%) students replied that they had

**Table 7.** Prevalence of handwashing in 2003 and 2004

Procedure	Year		P value*
	2003 (n = 51)	2004 (n = 131)	
Washed hands before examining the patient, n (%)	17 (33.3%)	79 (60.3%)	.001
Washed hands after examining the patient, n (%)	37 (72.5%)	131 (100.0%)	<.001

\*P value from Fisher exact test.

been taught these guidelines before their clinical teaching started. Over 96% of the students replied that they had been taught in each of the following 4 areas: (1) the importance of hand hygiene, (2) the steps in handwashing, (3) the use of personal protective equipment, and (4) the steps in putting on and removing the equipment.

The knowledge of the WHO handwashing guidelines and the attitudes of the students toward hand hygiene are shown in Table 6. Eighty-seven (51.5%) students were aware of the guidelines issued by the WHO<sup>13</sup> for handwashing. The average score that indicated the students' willingness to follow the guidelines was 7.7 (SD = 1.5) in a 10-point scale. The average score on the perceived usefulness of hand hygiene to prevent cross infection was 9.0 (SD = 1.0). On average, students strongly agreed that noncompliance with proper hand hygiene increased the risk of cross infection, with an average score of 8.3 out of 10. Most students (71.6%) thought that their colleagues performed proper handwashing, but a substantial proportion (27.8%) found it difficult to comply with the hand hygiene guidelines. Of students, 75.7% thought that they could improve their compliance with hand hygiene.

The attitudes of the students who washed their hands before they physically examined patients were compared with those who did not. The former group had higher mean scores for the following: (1) intention to follow handwashing guidelines taught by their teachers or as advised by WHO; (2) perceived usefulness of handwashing to prevent cross infection; and (3) perceived risk of cross infection to patients and themselves in the event of noncompliance. However, the differences in these mean scores were small (ranging from 0.2 to 0.3) and statistically insignificant. A significantly higher proportion of the former (handwashing) group reported that their colleagues performed proper handwashing compared with the latter (noncompliant) group. A significantly higher proportion of the latter group considered that proper handwashing practice was difficult and troublesome. However, 72% of this group felt that they could improve their compliance with handwashing.



Similar comparisons were made between students who washed their hands before performing procedures on patients that might involve contact with body fluid, blood, or open wound and those who did not. The results were broadly similar to those for physical examinations as described above, with insignificant but uniformly higher mean scores in the students' intention to follow handwashing guidelines, the perceived usefulness of handwashing, and the perceived risk of cross infection for not doing so. Compared with the former (compliant) group, a significantly higher proportion of the latter (noncompliant) group considered that it was difficult to comply with handwashing guidelines. Sixty-two percent of the noncompliant group thought that they could improve their practice of handwashing.

Table 7 shows the comparison of handwashing compliance between 2003 and 2004. In 2003, 18 out of 51 (35.2%) students replied that they washed their hands *before* performing physical examination on the patients. This proportion was almost doubled in 2004 (79 of 131, or 60.3%). The difference was highly significant ( $P = .001$ , Fisher exact test). Likewise, a significantly higher proportion of students surveyed in 2004 washed their hands *after* performing physical examination on patients, compared with findings in 2003: 37 of 51 students (72.5%) in 2003 and all (100%) in 2004 replied in the affirmative ( $P < .0001$ , Fisher exact test).

## DISCUSSION

We have conducted 2 surveys on handwashing and the use of personal protective equipment among medical students during their contact with patients in the hospital wards. The 2003 survey, conducted during the investigation of the SARS outbreak among medical students and other health care workers in mid-March, sought information on their usual personal hygiene practice in the wards before the outbreak was recognized. The 2004 survey partly reflected the impact of SARS on the practice of infection control measures. Good hand hygiene practice involves cleansing hands before and after examining different patients and is a useful measure to avoid the spread of infections. However, studies in several countries showed that the compliance of handwashing was low. Compliance with hand hygiene practice was 16.5% in Rosenthal et al's study<sup>9</sup> in Argentina, whereas a range between 4% to 52% have been reported elsewhere.<sup>14-23</sup> The prevalence of good hand hygiene practice among our students in 2003 (33.3%) was low but within this range. The 2004 survey, conducted a year after the SARS outbreak, revealed a significantly higher compliance with handwashing. Several explanations can be given. First,

teaching on infection control has been reinforced in the teaching curriculum after the SARS outbreak. Second, health care workers have been issued strict guidelines for infection control and personal hygiene. There was a generally heightened awareness of personal hygiene practices among all levels of health care workers in the hospital and possibly a greater perceived threat to health from a serious disease. All these factors could have influenced handwashing and other personal hygiene practices. However, if the changes in handwashing practice were mainly due to the threat caused by SARS, a retrogression to the pre-SARS practice might occur as the perceived threat wanes.

Proper handwashing practice is associated with a generally positive attitude toward handwashing, as shown by higher (though statistically insignificant) mean scores of intended handwashing behavior (following the guidelines), perceived usefulness of handwashing, and risk of cross infection resulting from noncompliance among those who practiced proper handwashing compared with those who did not. Overall, there were major discrepancies between the students' practice and their knowledge and attitude. Most remembered that they had learned the practice of handwashing and considered it highly useful (9 out of a score of 10) in prevention of cross infection. However, a significant proportion failed to practice proper hand hygiene. Although a change of the students' attitudes toward handwashing and other personal hygiene practice might contribute to better compliance, the underlying reasons for their noncompliance needs to be elucidated. Factors that might have discouraged proper handwashing practice must be identified and addressed. Various suggestions for further improvement in hand hygiene compliance have been made in previous studies on hand hygiene. These include factors at the personal, group, and institutional levels. Handwashing policies, education, and performance feedback on handwashing have been shown to be effective strategies in improving compliance.<sup>9</sup> Alcohol-based handrub has been promoted in Europe.<sup>7,24</sup> The Evidence-based Practice in Infection Control (EPIC) study showed that an alcohol-based handrub provides the most effective decontamination for a wide variety of bacteria and viruses.<sup>25</sup> Its use among our students was low (3.8%) compared with using water and antibacterial liquid (84.7%) and water and soap (10.7%), and its use should be widely promoted. Innovative methods such as the use of electronic monitoring and voice prompts have been shown to be useful to enhance the compliance. Swoboda et al<sup>26</sup> showed that compliance was also affected by the availability of the reminder signs near the washing facility. In our 2 surveys, we have not investigated the specific factors affecting handwashing practices such as the adequacy

of handwashing facilities and the effects of reminder signs in the wards. Recognizing the complexities of handwashing behavior, Pittet<sup>8</sup> concluded that "easy access, availability of hand lotion, alcohol handrub, and solo intervention often fails" and emphasized that "multimodal, multidisciplinary strategies are necessary."

Students who washed their hands before examining patients reported a significantly higher proportion of their peers who practiced proper handwashing, compared with the corresponding proportion reported by students who did not. This finding suggests that the practice of handwashing is influenced by peer behavior. One student, in his response to our open-ended question on the reason for noncompliance with handwashing guidelines, stated that he was following what his clinical teacher did. Despite this solitary response, the clinical teacher as a role model might well have influenced the behavior of many more students, a factor not necessarily quoted by students as the most important reason for noncompliance with handwashing practice. The importance of the role model in proper personal hygiene practice has been reported previously.<sup>7</sup>

The prevalence of handwashing was much higher after examining patients than before examining: 72.5% versus 35.2%, respectively, in 2003 and 100% versus 60.3%, respectively, in 2004. This implied that students were much more concerned about being infected by the patients whom they examined than spreading the infection to patients, with themselves as carriers. This self-centred behavior needs to be addressed, and hand hygiene practice that protects both the patient and the health care worker must be observed. By contrast, the proportions of students using personal protective equipment such as masks in history taking and physical examination of patients and wearing both masks and gloves when performing procedures involving body fluid contact were much higher (ranging from 86% to 100%) than that performing proper handwashing. In the 2003 survey, none of the students wore masks when they performed physical examinations on patients.

The teaching of hand hygiene has been considered rightfully as an educational priority.<sup>4</sup> However, our students' practice lagged behind, even though the topic was taught to all students before their clinical training. The frequency and method of teaching, as well as other measures aimed to enhance compliance, must be reexamined.

**Limitations:** The response rate of 70.5% in the 2003 survey was fairly high, in contrast to the low rate of 35.7% in the 2004 survey. One major reason for the discrepancy was that the 2003 survey was part of our effort in the investigation of the SARS outbreak in the hospital,

which raised a high level of concern among medical students, many of whom were victims of SARS. This might have accounted for a high response rate in that survey. By contrast, the 2004 survey, specifically designed to ascertain the students' handwashing and personal hygiene practice, might have been perceived as less important than the previous survey. If we assume that the proportion of nonresponding students in 2004 who practiced proper handwashing to be the same as that by respondents in 2003, the overall proportion of students who practiced proper handwashing in the 2004 survey would be 42.7%, still higher than in the 2003 survey (32.5%). If nonresponse was associated with poor handwashing and other personal hygiene practices, our observed difference in the results between the 2 surveys (60.3% vs 32.5%, respectively) could be explained by selection bias. Assuming that *all* nonrespondents in 2004 did not practice proper handwashing (an unlikely scenario), the true prevalence of proper handwashing practice would have been much lower, at 18%. This would imply a gross failure in the teaching of proper infection control in the hospital.

Another probable source of bias may be due to the difference between the reported behavior and the actual practice of the students, especially in view of the nonanonymity of the respondents. To measure the actual behavior, it is necessary to monitor the students' hand hygiene practice and their use of personal protective equipment in the wards. This would necessitate a major change in the study methods from a questionnaire survey approach and is outside the scope of our study. If the true handwashing practice is short of the reported "expected behavior," the problem of poor hand hygiene in both surveys would have been even greater. Assuming the same extent of underreporting of true (undesirable) behavior in both surveys, the comparison of the 2 survey results is still meaningful. When we compared the change in handwashing practice among those students who participated in both surveys, there was a substantial improvement in their behavior (20% and 40% improvement in handwashing prevalence before and after examining patients, respectively). However, the sample size was too small to be meaningful. (The 2003 study was targeted at a limited number of students who visited the ward in which the SARS outbreak occurred, whereas the 2004 survey was conducted in August, after the years 4 and 5 students had finished their studies and could not be contacted. Hence, only a few students participated in both the 2003 and 2004 surveys.)

We used electronic mail in conducting both surveys. The pros and cons of using electronic mail, or the World Wide Web (www), for conducting questionnaires/surveys have been widely discussed.<sup>27,28</sup> This method provides an efficient and convenient form of data

collection at low cost and offers participants a more comfortable interview environment.<sup>27,28</sup> The major criticisms are the possibility of coverage error because of nonuniversal usage of e-mail and unavailability of a full contact list and of submitting duplicate questionnaires.<sup>27</sup> In our surveys, nevertheless, these problems were unlikely because our target subjects were medical students who have been using e-mail for communication with their teachers routinely. Furthermore, a full list of their e-mail addresses was available. Duplicate returns were checked and deleted.

In conclusion, we surveyed medical students on their handwashing practice and use of personal protective equipment in 2003 and 2004. A significant improvement in compliance with hand hygiene practice was found after the SARS outbreak. Despite the improvement, there were discrepancies between knowledge and practice. To improve their hand hygiene practice, further investigation into the factors that might promote hand hygiene, including a review of the current teaching program on handwashing, is recommended.

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