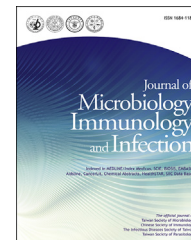




Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

ScienceDirect

journal homepage: [www.e-jmii.com](http://www.e-jmii.com)



Original Article

# Implementation of a national quality improvement program to enhance hand hygiene in nursing homes in Taiwan



Chih-Cheng Lai <sup>a</sup>, Min-Chi Lu <sup>b</sup>, Hung-Jen Tang <sup>c,d,e</sup>,  
Yen-Hsu Chen <sup>f</sup>, Yi-Hui Wu <sup>g</sup>, Hsiu-Tzy Chiang <sup>h</sup>, Li-Hung Wu <sup>i</sup>,  
Wen-Chien Ko <sup>g,j</sup>, Po-Ren Hsueh <sup>k,l</sup>, Yu-Hui Chen <sup>d,m,\*</sup>, for  
Infection Control Society of Taiwan

<sup>a</sup> Department of Intensive Care Medicine, Chi Mei Medical Center, Liouying, Tainan, Taiwan

<sup>b</sup> Department of Internal Medicine, Chung Shan Medical University, Taichung, Taiwan

<sup>c</sup> Department of Medicine, Chi-Mei Medical Center, Tainan, Taiwan

<sup>d</sup> Infection Control Center, Chi-Mei Medical Center, Tainan, Taiwan

<sup>e</sup> Department of Health and Nutrition, Chia Nan University of Pharmacy and Science, Tainan, Taiwan

<sup>f</sup> Division of Infectious Diseases, Department of Internal Medicine, Kaohsiung Medical University Hospital, School of Medicine, Graduate Institute of Medicine, Sepsis Research Center, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

<sup>g</sup> Center for Infection Control, College of Medicine, National Cheng Kung University Hospital, Tainan, Taiwan

<sup>h</sup> Infection Control Center, Mackay Memorial Hospital, Taipei, Taiwan

<sup>i</sup> Department of Infection Control, Show Chwan Memorial Hospital, Changhua, Taiwan

<sup>j</sup> Department of Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan

<sup>k</sup> Department of Internal Medicine, National Taiwan University Hospital, National Taiwan University College of Medicine, Taipei, Taiwan

<sup>l</sup> Department of Laboratory Medicine, National Taiwan University Hospital, National Taiwan University College of Medicine, Taipei, Taiwan

<sup>m</sup> Department of Nursing, College of Medicine and Life Science, Chung Hwa University of Medical Technology, Tainan, Taiwan

Received 3 April 2018; received in revised form 9 September 2018; accepted 11 September 2018

Available online 28 September 2018

## KEYWORDS

Quality improvement program;

**Abstract** *Background/purpose:* This study investigated the cause of hand hygiene deficit, and further implemented a quality improvement program using WHO's hand-hygiene strategy to enhance the compliance of hand hygiene in the nursing home in Taiwan.

\* Corresponding author. Infection Control Center, Chi Mei Medical Center, No.901, Zhonghua Rd., Yongkang Dist., Tainan City, 710, Taiwan. E-mail address: [yuyu711chen@gmail.com](mailto:yuyu711chen@gmail.com) (Y.-H. Chen).

<https://doi.org/10.1016/j.jmii.2018.09.007>

1684-1182/Copyright © 2018, Taiwan Society of Microbiology. Published by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Hand hygiene;  
Nursing homes;  
Taiwan

**Methods:** This prospective study was conducted in eleven nursing homes in Taiwan from January 2015 to December 2016. After intervention, we monitor the compliance, and accuracy of hand hygiene. In addition, we also calculated the number of episodes of infection per 1000 resident-days in each nursing home in the intervention period (July–December 2015) and post-intervention period (January–October 2016).

**Results:** Overall, the consumption of alcohol-based handrubs increased from 10.1 ml per resident-day in intervention period to 12.2 ml per resident-day in post intervention period. The compliance of hand hygiene increased from 74% in intervention period to 79% in post-intervention period and the rate of correct hand hygiene increased from 81% in intervention period to 87% in post-intervention period. Most importantly, the infection density decreased from 2.39 per 1000 resident-day in intervention period to 1.89 per 1000 resident-day.

**Conclusions:** A national quality-improvement program using WHO's hand-hygiene strategy to enhance hand hygiene and reduce healthcare associated infection is effective in nursing homes in Taiwan.

Copyright © 2018, Taiwan Society of Microbiology. Published by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Nursing home provides most of the post-acute care and long-term care in this era of aging. Within this environment, approximately 2 million infections can occur each year and more than one-third of residents can colonize multidrug-resistant organisms (MDRO).<sup>1</sup> In Taiwan, two recent surveillance investigations showed that MDROs, especially methicillin-resistant *Staphylococcus aureus* are prevalent in both of the residents and the environments in long term care facility.<sup>2,3</sup> To prevent and control the infection in nursing home, several measures including surveillance, hand hygiene, isolation precautions, education, and antibiotic stewardship are developed. Among these intervention, hand hygiene is the essential and the most important infection control measure in nursing homes.<sup>1,4</sup>

In a France study,<sup>5</sup> the implementation a bundle of hand hygiene-related measures in nursing home over one years was associated with significantly lower mortality (2.10 vs 2.65 per 100 residents per month, respectively;  $P = 0.003$ ) and antibiotic prescriptions (5.0 vs 5.8 defined daily doses per 100 resident days, respectively;  $P < 0.001$ ). Another randomized, matched pair pilot study in 10 Colorado nursing homes found that a multifaceted hand-washing/surface cleaning intervention was significantly associated with reduction in surface bacterial counts and nonsignificant reductions in total infections and lower respiratory tract infections.<sup>6</sup> Moreover, Assab et al.<sup>7</sup> found increasing hand hygiene compliance can help control the spread of norovirus in nursing home. However, the compliance of hand hygiene in nursing homes is very low in Taiwan. Previous study<sup>8</sup> observed 722 opportunities for hand hygiene in two nursing homes and found the overall hand hygiene compliance among nursing staff was only 11.3%. Thus, this prospective study was conducted to find out the cause of hand hygiene deficit, and further implement a quality improvement program to enhance the compliance of hand hygiene in the nursing home in Taiwan.

## Methods

### Setting

This quality improve program was prospectively conducted from January 2015 to December 2016. This program was based on WHO multimodal strategy for improvement of hand hygiene, and included the five major components - (i) system change, including access to alcohol-based handrubs; (ii) healthcare workers' training and education; (iii) monitoring and feedback on practices; (iv) visual reminders in the workplace; and (v) institutional patient-safety climate.<sup>9</sup> After obtaining the approval of the Institutional Review Boards, 31 nursing homes applied for joining this program initially, and only 11 nursing homes was approved for be enrolled into study. Three of them located in northern Taiwan, four in middle Taiwan, and four in southern Taiwan (Fig. 1). After the selection of 11 nursing homes, the questionnaires regarding the knowledge of hand hygiene and infection control measures were delivered to the healthcare worker for investigation. In addition, the infection control experts including infection specialist and infection control nurse visited each nursing home to realize what the deficits are, and find the way to improve.

### Multidisciplinary interventions

During the initial study period (January 2015 to June 2015, pre-intervention period), we instituted an education program regarding hand hygiene for healthcare workers and then periodically evaluated the effectiveness of the program. Monitoring hand hygiene compliance and accuracy were also conducted. Compliance was defined as the frequency of the number of performed action to the number of hand hygiene opportunity. We defined an opportunity as the occurrence of any indication during the observed care sequences including before touching a patient, before clean/aseptic procedure, after body fluid exposure risk, after touching a patient, and after touching patient

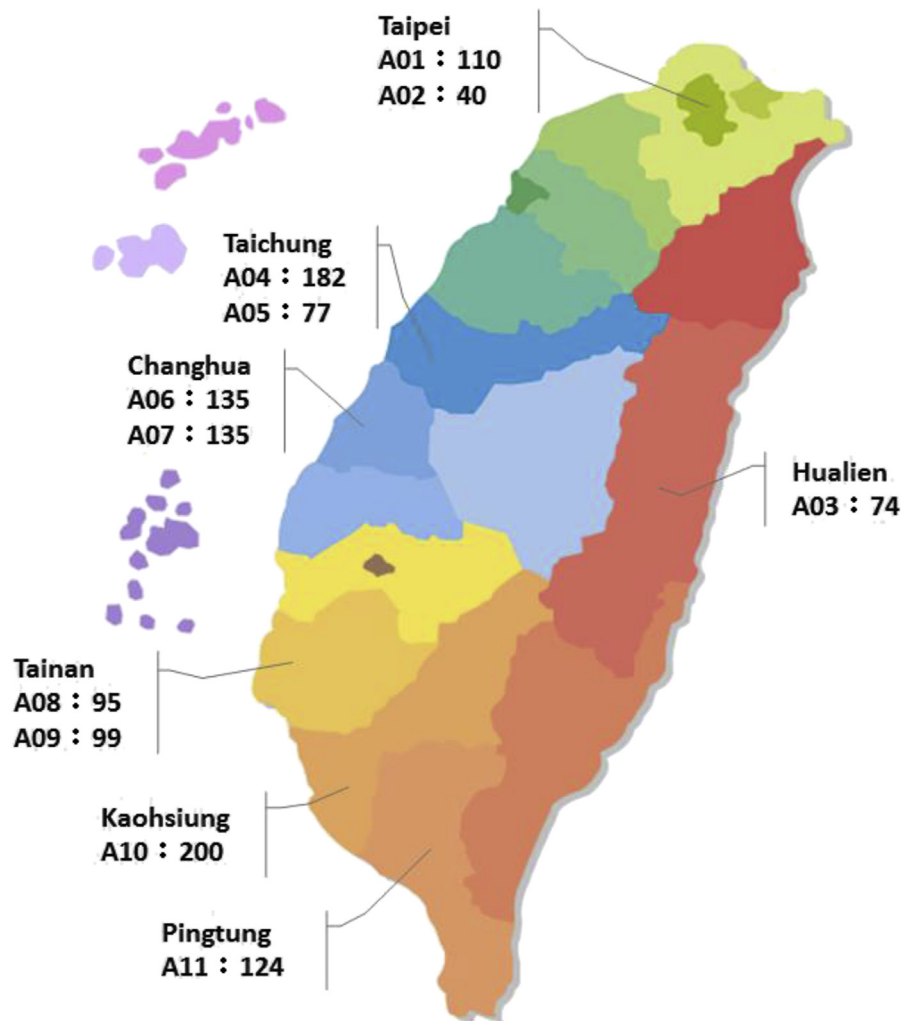


Figure 1. The location and bed number of 11 nursing homes, designated A01-A11, in Taiwan.

surroundings. An action with correct hand hygiene techniques must satisfy the following criteria: (1) rub hands with 6-step hand hygiene techniques; and (2) duration of the rub procedure lasts for 15 s at least.<sup>10</sup> Regular meetings between infection control experts and representatives of the 11 nursing homes were conducted every three months to monitor the progress of the intervention programs. We also calculated the number of episodes of infection per 1000 resident-days in each nursing home in the intervention period (July–December 2015) and post-intervention period (January–October 2016).

### Statistical analysis

Differences in compliance of hand hygiene, rate of correct hand hygiene, and consumption of alcohol-based handrubs, and infection density in each nursing home between the intervention and post-intervention periods were evaluated using the Pearson chi-square test. A  $P$  value  $< 0.05$  was considered to represent statistical significance. All statistical analyses were conducted using the statistical package SPSS for Windows (Version 11.0, SPSS, Chicago, IL, USA).

## Results

### Study subjects

A total of 11 nursing homes were enrolled in this study (table). The beds of these nursing homes ranged from 50 to 200 beds, and all of them can provide daily care for the residents with indwelling nasogastric tube, tracheostomy and Foley catheter. Based on the finding of questionnaires investigation from 211 healthcare workers, 6.2% did not know exactly the five movements of hand hygiene, 3.3% believed the ring on the hand would not affect hand hygiene, about 30% thought that alcohol-based handrubs remained effective against *Clostridium difficile*, enterovirus and norovirus, and 10.4% felt that hand hygiene was not required before contacting residents. Regarding knowledge about the duration of the entire procedure, 85.5% and 84.8% had the correct answer for handwash and handrub, respectively. The causes of lack of hand hygiene were reportedly including too busy, far away from hand hygiene apparatus, having gloves, and discomfort after using hand sanitizer. After well education, the overall knowledge level significantly increased from 77% to 97%

( $p < 0.001$ ). To report specifically, the knowledge about five movements of hand hygiene, environmental surveillance, infection control measure for multi-drug resistant organism, quality-improvement concept had improvement after education (Table 1).

Initially, the infection control experts found three main deficits of hand hygiene in nursing homes including the hand hygiene apparatus was not enough, the knowledge and the behavior were not adequate, and lack of management of equipment for hand hygiene. Based on the finding of on-site visits, we found that 71.2% of beds met the standard requirements of hand hygiene in healthcare setting; however, most of the hand sanitizers were located outside of the rooms. Despite 97% of public spaces, such as restaurants and visiting areas have handwashing facilities, only 48% of clinical care units, including rehabilitation units and treatment unit had these facilities. After introducing this program, the shortage of hand hygiene apparatus decreased from 18% (intervention period) to 8% (post-intervention period), the effective management of hand hygiene equipment increased from 2% to 22%, and the lack of adequate knowledge and appropriate behavior decreased from 9% to 4%. Additionally, 87.5% have improved their handwashing facilities.

The resident-day was 2753 and 2771 in the intervention period and post-intervention period, respectively. Overall, the consumption of alcohol-based handrubs increased from per resident-day in intervention period to per resident-day in post intervention period. Despite we observed the increasing consumption of alcohol-based handrubs in nine nursing homes, two nursing home showed the decreasing use of alcohol-based handrubs after intervention. Moreover, the amount of alcohol-based handrubs per resident-day varied in each nursing home, ranged from less five ml to

more than 30 ml (Fig. 2). Overall, the use of alcohol-based handrubs among these nursing homes increased from 10.1 ml in the intervention period to 12.2 ml in the post-interventional period ( $p < 0.05$ ).

Although the compliance rate of hand hygiene for all nursing home increased from 74% in intervention period to 79% in post-intervention period ( $p < 0.05$ ) (Fig. 3), the rate of correct hand hygiene increased from 81% in intervention period to 87% in post-intervention period ( $p < 0.05$ ) (Fig. 4). Most importantly, the overall infection density among eleven nursing homes decreased from 2.39 per 10,000 resident-day in intervention period to 1.89 per 10,000 resident-day ( $p < 0.05$ ).

## Discussion

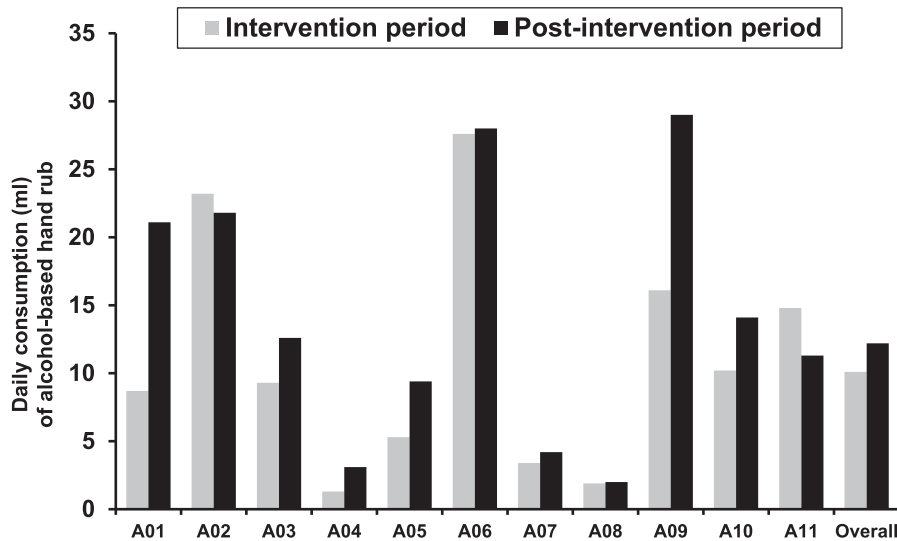
After introduction a multifaceted quality-improvement program in 11 nursing homes in Taiwan, several improvement regarding infection control have been achieved. Through the education program and improve the associated equipment, the compliance of hand hygiene increased from 74% in intervention period to 79% in post-intervention period. In addition, the rate of correct hand hygiene increased from 81.2% in intervention period to 87% in post-intervention period, and the consumption of alcohol-based handrubs increased from per resident-day in intervention period to per resident-day in post intervention period. All of these findings indicate that the behavior of hand hygiene is definitely enhanced in terms of compliance, correction, and utilization. These findings are consistent with previous studies<sup>11–20</sup> in different settings, including intensive care units, emergency departments, and acute hospitals that hand hygiene can be significantly improved after multidimensional interventions. Based on our study, a multimodal hand hygiene improvement program is feasible and effective for the promotion of had hygiene compliance in nursing home.

Improvement in hand hygiene has been reportedly associated with reducing nosocomial infections. In this study, the infection density decreased from 2.39 per 10,000 resident-day in intervention period to 1.89 per 10,000 resident-day. A similar decrease in healthcare associated infection (HAI) rate was reported in a tertiary hospital in Taiwan wherein the implementation of the WHO multimodal strategy resulted in significantly increasing hand hygiene compliance increased from 62.3% to 73.3%, and decreasing overall HAI decreased from 3.7% to 3.1%, urinary tract infection rate decreased from 1.5% to 1.2%, and respiratory tract infection rate decreased from 0.53% to 0.35%, respectively.<sup>16</sup> The results of another three-year study with multiple sequential interventions showed significant hospital-wide improvement in hand hygiene compliance from 41% to 87% and infection control from 4.8 to 3.3 per 1000 inpatient days.<sup>21</sup> Therefore, hand hygiene plays a critical role of infection control, and its improvement can help prevent nosocomial infections, thereby ensuring patient safety.

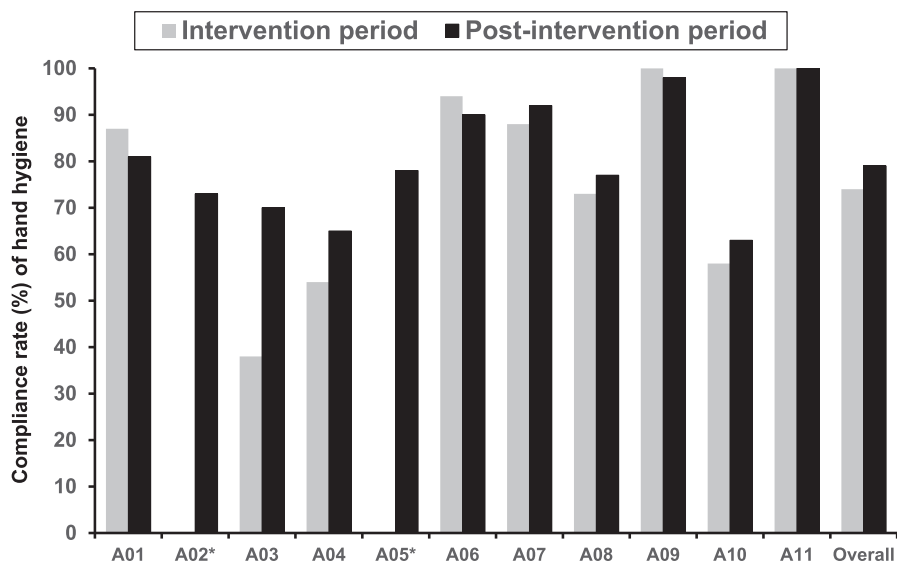
In this program, we used the method based on WHO multimodal strategy for improvement of hand hygiene. Initially, we did a questionnaire survey and on-site investigation to find what the deficits are. Most of nursing homes

**Table 1** The knowledge level of hand hygiene among 211 healthcare workers during intervention period and post-intervention period.

Knowledge aspects	Correct percentages		P values
	Intervention period	Post-intervention period	
Five movements of hand hygiene	74%	92%	<0.05
Environment surveillance and cleaning process	77%	99%	<0.05
Multidrug-resistant bacteria and infection control measures	92%	96%	0.127
Concepts of quality improvement process	63%	88%	<0.05
Overall	77%	97%	<0.05



**Figure 2.** The daily consumption of alcohol-based handrubs in each and all nursing homes before and after intervention. Though the consumption of alcohol-based handrubs varied in nursing homes, their average usage increased from 10.1 ml in the intervention period to 12.2 ml in the post-interventional period ( $p < 0.05$ ).

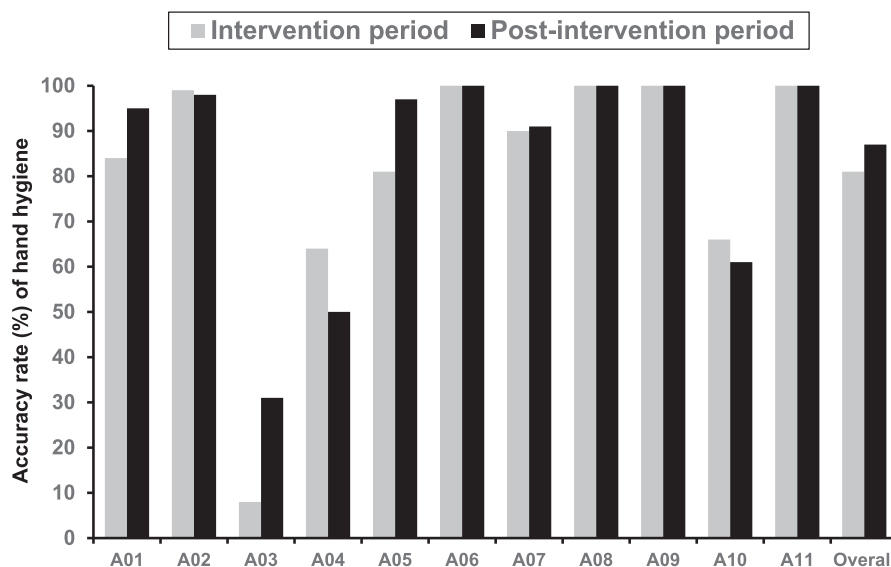


**Figure 3.** The compliance rate of hand hygiene in each and all nursing homes before and after intervention. The average compliance rate increased from 74% in intervention period to 79% in post-intervention period ( $p < 0.05$ ).

did not have enough hand hygiene apparatus, and the knowledge level and the behavior of hand hygiene among healthcare workers were not adequate. Then, recommendations to improve the equipment and environment of hand hygiene were made by the experts, and training and education courses for the promoters of hand hygiene program in the institutions were provided. Finally, regular performance assessment and feedback persisted. In the end, we observed this program is effective for enhancing hand hygiene. Based on the present report, our findings indicate that both software and hardware of hand hygiene are not

enough in the nursing home in Taiwan. It further suggests that the government should provide persistent education to enhance the knowledge and economic support to improve the hand hygiene program. This finding is in line with a global study<sup>9</sup> that compliance increased from 51.0% (95% CI: 45.1%–56.9%) of 21,884 hand-hygiene opportunities before the intervention to 67.2% (61.8%–72.2%) of 23,746 opportunities after implementation of WHO's hand-hygiene strategy.

In this study, the interventions applied in different institutes varied and were at the discretion of their



**Figure 4.** The accuracy rate of correct hand hygiene in each and all nursing homes before and after intervention. The average accuracy rate increased from 81% in intervention period to 87% in post-intervention period ( $p < 0.05$ ).

institutional director. Though the up-take rate of alcohol consumption in individual institution is not directly related to the infection density, which may be influenced by many factors, such as the variations of inhabitant numbers, performance quality of hand hygiene programs, and weighting of prevalent influenza or air-borne respiratory infections, the overall infection density among participating nursing homes declined significantly after this program.

Although the results of this study add value to the available literature on the link between hand hygiene practices and infection control in nursing home, there were several limitations. First, only 11 nursing homes were enrolled in this surveillance, so our findings may not be generalized to other nursing homes. However, these 11 nursing homes were located in different parts of Taiwan and had different sizes. Thus, our findings should be representative. Second, we did not record the causes of poor compliance and incorrect hand hygiene, so we cannot analysis which is the weak point. Finally, we cannot totally exclude the Hawthorne effect in this investigation. Further studies are warranted to elucidate these causes and find the resolution to improve.

In conclusion, a national quality-improvement program using WHO's hand-hygiene strategy to enhance hand hygiene and reduce healthcare associated infection is effective in nursing homes in Taiwan.

## Conflicts of interest

There is no conflict of interest.

## Acknowledgments

We appreciate for the support of Jing-Ru Wang, Ya-Fang Chen, Ya-Fen Yang, Tu-Wen Chen, Pei-Chun Yu, Meei-Hwa

Chen, Weh-Yuh Shieh, Chih-Hua Chang, Li-Chuan Shen, Chien-Hui Cheng, Chiu-Yen Yu, and Shu-Hui Tseng in 11 nursing homes.

This study was supported by the grants from Ministry of Health and Welfare, Taiwan (MOWH105-CDC-C-114-112106 and MOWH106-CDC-C-114-122112).

## References

1. Montoya A, Cassone M, Mody L. Infections in nursing homes: epidemiology and prevention programs. *Clin Geriatr Med* 2016; 32:585–607.
2. Lee CM, Lai CC, Chiang HT, Lu MC, Wang LF, Tsai TL, et al. Presence of multidrug-resistant organisms in the residents and environments of long-term care facilities in Taiwan. *J Microbiol Immunol Infect* 2017;50:133–44.
3. Lai CC, Lee CM, Chiang HT, Lu MC, Wnag LF, Tsai TL, et al. Methicillin-resistant *Staphylococcus aureus* sequence type 45 with high rates of ciprofloxacin and tetracycline resistance in the residents and environments of long-term care facilities in Taiwan. *J Infect* 2018;76:305–7.
4. Hocine MN, Temime L. Impact of hand hygiene on the infectious risk in nursing home residents: a systematic review. *Am J Infect Contr* 2015;43:e47–52.
5. Temime L, Cohen N, Ait-Bouziad K, Denormandie P, Dab W, Hocine MN. Impact of a multicomponent hand hygiene-related intervention on the infectious risk in nursing homes: a cluster randomized trial. *Am J Infect Contr* 2018;46:173–9.
6. McConeghy KW, Baier R, McGrath KP, Baer CJ, Mor V. Implementing a pilot trial of an infection control program in nursing homes: results of a matched cluster randomized trial. *J Am Med Dir Assoc* 2017;18:707–12.
7. Assab R, Temime L. The role of hand hygiene in controlling norovirus spread in nursing homes. *BMC Infect Dis* 2016;16:395.
8. Liu WI, Liang SY, Wu SF, Chuang YH. Hand hygiene compliance among the nursing staff in freestanding nursing homes in Taiwan: a preliminary study. *Int J Nurs Pract* 2014;20:46–52.
9. Allegranzi B, Gayet-Ageron A, Damani N, Bengaly L, McLaws ML, Moro ML, et al. Global implementation of WHO's

- multimodal strategy for improvement of hand hygiene: a quasi-experimental study. *Lancet Infect Dis* 2013;**13**:843–51.
10. Shen L, Wang X. Implementation of WHO multimodal strategy for improvement of hand hygiene: a quasi-experimental study in a Traditional Chinese Medicine Hospital in Xi'an, China. *Antimicrob Resist Infect Contr* 2017;**6**:98.
  11. Phan HT, Tran HTT, Tran HTM, Dinh APP, Ngo HT, Theorell-Haglow J, et al. An educational intervention to improve hand hygiene compliance in Vietnam. *BMC Infect Dis* 2018;**18**:116.
  12. Sadeghi-Moghaddam P, Arjmandnia M, Shokrollahi M, Aghaali M. Does training improve compliance with hand hygiene and decrease infections in the neonatal intensive care unit? A prospective study. *J Neonatal Perinat Med* 2015;**8**: 221–5.
  13. Arntz PR, Hopman J, Nillesen M, Yalcin E, Bleeker-Rovers CP, Voss A, et al. Effectiveness of a multimodal hand hygiene improvement strategy in the emergency department. *Am J Infect Contr* 2016;**44**:1203–7.
  14. Chun JY, Seo HK, Kim MK, Shin MJ, Kim SY, Kim M, et al. Impact of a hand hygiene campaign in a tertiary hospital in South Korea on the rate of hospital-onset methicillin-resistant *Staphylococcus aureus* bacteremia and economic evaluation of the campaign. *Am J Infect Contr* 2016;**44**:1486–91.
  15. Mu X, Xu Y, Yang T, Zhang J, Wang C, Liu W, et al. Improving hand hygiene compliance among healthcare workers: an intervention study in a hospital in Guizhou Province, China. *Braz J Infect Dis* 2016;**20**:413–8.
  16. Chen JK, Wu KS, Lee SS, Lin HS, Tsai HC, Li CH, et al. Impact of implementation of the World Health Organization multimodal hand hygiene improvement strategy in a teaching hospital in Taiwan. *Am J Infect Contr* 2016;**44**:222–7.
  17. Chen P, Yuan T, Sun Q, Jiang L, Jiang H, Zhu Z, et al. Role of quality control circle in sustained improvement of hand hygiene compliance: an observational study in a stomatology hospital in Shandong, China. *Antimicrob Resist Infect Contr* 2016;**5**:54.
  18. Lai CC, Lee CM, Chiang HT, Hung CT, Chen YC, Su LH, et al. Implementation of a national bundle care program to reduce catheter-associated urinary tract infection in high-risk units of hospitals in Taiwan. *J Microbiol Immunol Infect* 2017;**50**: 464–70.
  19. Lai CC, Cia CT, Chiang HT, Kung YC, Shi ZY, Chuang YC, et al. Implementation of a national bundle care program to reduce central line-associated bloodstream infections in intensive care units in Taiwan. *J Microbiol Immunol Infect* 2018;**51**:666–71.
  20. Lin WP, Chang YC, Wu UI, Hung MC, Chuang PY, Wang JT, et al. Multimodal interventions for bundle implementation to decrease central line-associated bloodstream infections in adult intensive care units in a teaching hospital in Taiwan, 2009-2013. *J Microbiol Immunol Infect* 2018;**51**:644–51.
  21. Kirkland KB, Homa KA, Lasky RA, Ptak JA, Taylor EA, Splaine ME. Impact of a hospital-wide hand hygiene initiative on healthcare-associated infections: results of an interrupted time series. *BMJ Qual Saf* 2012;**21**:1019–26.