Original Article

JHSMR Journal of Health Science and Medical Research

Comparison of Hand Hygiene Behaviors among Primary Care Unit Outpatients and Visitors before and after Installation of Behavioral Nudges during the COVID-19 Situation: A Quasi-Experimental Study

Supakorn Sripaew, M.D.[1], Wit Wichaidit, Ph.D.[2], Chanya Angsuwaree[3], Chawit Thitasomkun[3], Inthon Lailamad[3], Natchapon Kliangchuai[3], Natchatchanan Phuttipong[3], Pongsakorn Lertchaiwatpanya[3], Saranya Kumlungroob[3]

[1]Department of Family Medicine and Preventive Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

[2]Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

[3]Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

Received 12 January 2022 ● Revised 12 April 2022 ● Accepted 12 May 2022 ● Published online 10 August 2022

Abstract:

Objective: To describe the probability of appropriate hand hygiene behaviors among outpatients and visitors at a primary care unit before and after installation of additionally strategically placed hand rub dispensers and empirically-designed behavioral nudges.

Material and Methods: We conducted a quasi-experimental study at a suburban primary care unit in southern Thailand. The intervention consisted of included installation of hand rub dispensers and attachment of behavioral nudges. We designed the behavioral nudges using qualitative data from a focus-group discussion with local residents, who identified disgust and normative expectations from children as the main behavioral drivers for following appropriate hand hygiene behaviors. We then conducted surreptitious observations of hand hygiene behaviors among outpatients and visitors before intervention delivery during Wave 1 and Wave 2 of the pandemic (Phase 1 and Phase 2, respectively), after installation of the hand gel dispensers alone (Phase 3), and after attaching behavioral nudge signs to the dispensers (Phase 4).

Results: The probability of appropriate hand hygiene behavior increased from 0.6 percent in Phase 1 to 13.5 percent in Phase 4. However, the increase was statistically significant only from Phase 2 to Phase 3 in the zones where the dispensers were located (adjusted odds ratio 10.58; 95% confidence interval 1.95, 57.24).

Contact: Supakorn Sripaew, M.D.
Department of Family and Preventive Medicine, Faculty of Medicine,
Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.
E-mail: supakorn.s@email.psu.ac.th

J Health Sci Med Res .....
doi: 10.31584/jhsmr.2022888
www.jhsmr.org

Conclusion: The probability of appropriate hand hygiene behavior after installation of the dispensers was significantly higher than at pre-intervention, but the difference in appropriate hand hygiene before and after attachment of the nudges to the dispensers was not statistically significant. The study findings could nonetheless contribute empirical evidence on observed changes in hand hygiene behaviors in a primary care setting.

Keywords: hand hygiene, primary health care, quasi-experimental study

Introduction

The corona virus disease 2019 (COVID-19) was declared a pandemic in March 2020 by the World Health Organization (WHO) and has caused more than 6 million deaths worldwide as of March 2022.[1] Proper hand hygiene is one of the public health measures recommended by many health organizations to reduce various community infections and the spread of COVID-19 When this study was being conducted, good hand hygiene was a way to help control disease while the vaccines were being developed, and even though the vaccines are now being widely administered are still recommended to help control COVID-19.[2-5] In community settings, primary care units (PCUs) have an important role in health promotion and disease prevention, and medical consultation for many health problems.[6] Primary care professionals provide a comprehensive range of services for all ages and many health problems, including outpatient services, home health care, and emergency medical services.[7] During the COVID-19 pandemic, community residents who might normally seek care at a larger hospital for various ailments may decide to first visit their PCU, which may increase the chance of transmitting COVID-19 in the primary health care setting from both visitors to health care workers and patients to visitors.[8]

Appropriate hand hygiene includes applying soap or an alcohol-based hand rub following touching other people or surfaces or contact with bodily fluids, mucous membranes, or non-intact skin.[2] Previous observational studies have found that proper hand hygiene was frequently not performed by visitors while visiting health care facilities (by only 4.3 to 36.3%)[9,10] while compliance by health care workers was generally much better (22.0 to 95.6%).[10,11]

Nudging is a branch of behavioral psychology based on the concept that a human's rapid judgement is intuitive (i.e. automatic thinking) and sometimes cognitively biased. A nudge is "any aspect of choice architecture" that alters a person's decision-making and steers an individual's behavior towards desired outcomes without significant change in incentives.[12] The application of behavioral nudges has proven efficacious in increasing desired hand hygiene behaviors in various settings.[13-16] Previous studies in the hospital context found that installing alcohol-based hand hygiene product dispensers together with behavioral nudges improved hand hygiene behaviors. In a hospital setting, Caris et al., designed posters based on a literature review and cross-sectional survey examining health care providers' responses to the posters, then installed them next to the study dispensers, and found that the proposed nudges increased the use of alcohol-based hand rub next to the dispensers.[13] Additionally, other proposed nudges, including infrastructure improvements and altering a school environment by painting guiding footprints, were also found to be efficacious in increasing handwashing in children.[14]

At the time that the current study was conducted (December 2020), health authorities in Thailand were paying considerable attention to promotion of non-

mandatory preventive measures such as wearing masks and performing appropriate hand hygiene.[6] However, information on compliance with hand hygiene recommendations and findings from experimental studies on the use of nudges to improve hand hygiene was limited. Thus there were questions on the extent that the probability of desired hand hygiene behaviors differed with and without hand rub dispensers and behavioral nudges. Such information can contribute empirical evidence for the improvement of hand hygiene behaviors for relevant stakeholders. The objective of this study was to describe the probability of appropriate hand hygiene behaviors among outpatients and visitors at a primary care unit: 1) before intervention delivery during Wave 1 of the COVID-19 pandemic; 2) before intervention delivery during Wave 2; 3) after installation of alcohol-based hand rub dispensers during Wave 2, and; 4) after attaching empirically-designed behavioral nudges to the dispensers.

Material and Methods

Study design and setting

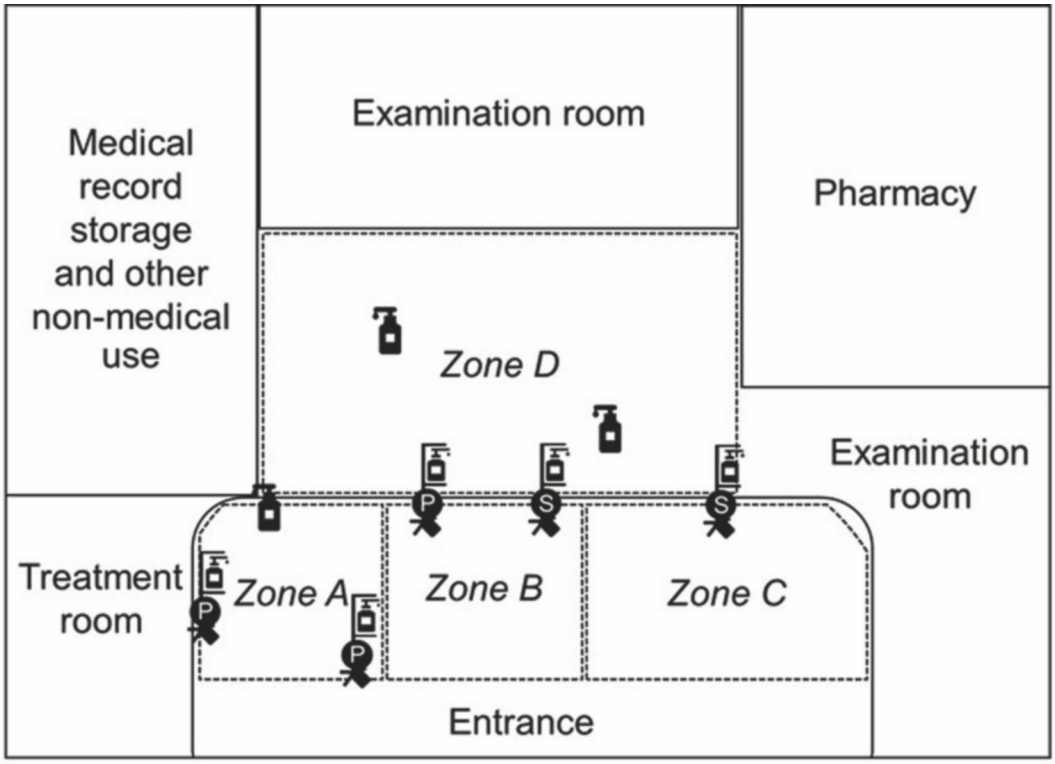
We conducted a quasi-experimental study at a primary care unit (PCU) in the suburban area of Hat Yai City, Songkhla Province, southern Thailand. Our interventions included installation of alcohol-based hand rub dispensers, and attachment of behavioral nudge signs to the dispensers. The design of the behavioral nudges was empirically-informed based on data from a semi-structured focus group discussion (FGD) with local residents and health volunteers in the service area of a different nearby PCU in December 2020. Both the study site PCU and the FGD PCU were public facilities that received funding from their local administrative organizations and the Thai National Health Security System, each serving approximately 10,000 patients per year with outpatient-only services. For our research purposes the study site was divided into 4 functional zones: treatment room waiting area (Zone A), medical examination waiting area- external (Zone B), payment and prescription waiting area (Zone C), and medical examination waiting area - internal (Zone D) Figure 1. The patient started from zone A, then proceeded to either Zone B or D per medical indication, and ended at Zone C before the patient exited the study site. Normally, an outpatient would spend 30-90 minutes per visit. The distance between the distal side of Zone A and the distal side of Zone C was approximately 20-25 meters.

Intervention: installation of hand rub dispensers

Our hand hygiene promotion intervention was based on the EAST (easy, attractive, social, and timely) framework.[17] Before intervention delivery, the study site had 3 foot-pedal alcohol hand rub dispensers (denoted with 'P' in Figure 1) and 3 free-standing hand rub bottles. Our intervention included initial installation of 2 additional hand rub dispensers without behavior nudge signs, with subsequent installation of nudge signs on these 2 dispensers (denoted with 'S' in Figure 1). The local Provincial Administrative Organization supplied us with Thai-FDA-certified alcohol-based hand rub (ethyl alcohol 70% V/V mixed with glycerin).

Intervention: behavioral nudge signs design and attachment

To design a nudge intervention that could motivate the study population, we conducted a focus group discussion (FGD) with visitors and health volunteers who attended another PCU approximately 5 kilometers from the study site. The aim of the FGD was to identify the determinants of appropriate hand hygiene behavior in a similar population to the visitors and clients at our study site. The inclusion criteria for the FGD participants were: 1) age 18 years or older, and 2) being able to communicate in the Thai language. We screened the participants for risk of



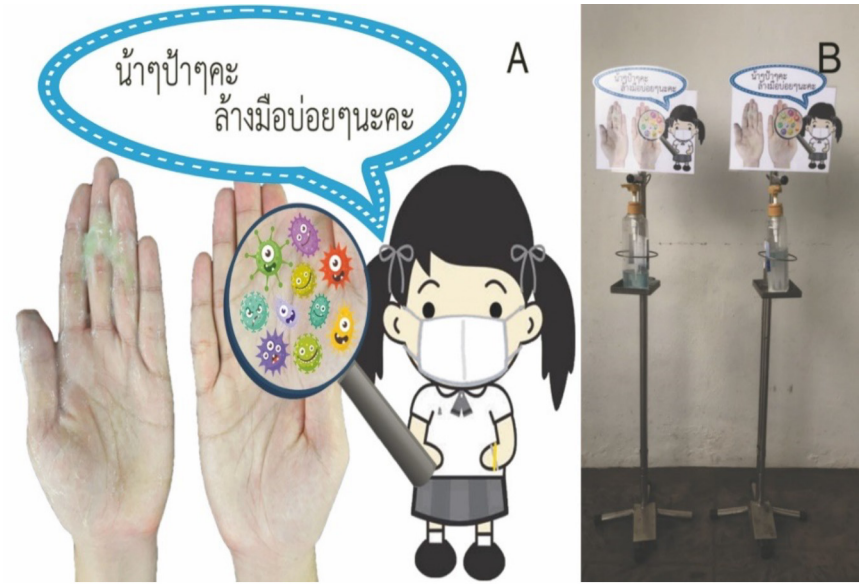
Remark: The bottle icons indicate the locations of the free-standing hand rub bottles in the study PCU. The three dispenser icons with 'P' indicate the PCU's dispensers, while the two dispenser icons with 'S' indicate the locations of the study intervention's additional dispensers.

Figure 1 Diagram of the study primary care unit and locations where alcohol-based hand rub dispensers with/without nudges were located

COVID-19 infection and excluded those who were deemed to be at high risk according to the Thai national guidelines.

We trained one interviewer, three note takers, and two electronic voice recorder operators in one role-playing session prior to the actual interviews. The actual focus group discussion session lasted 90 minutes and was supervised by the lead investigator who had experience in FGD. Two investigators independently transcribed the audio records and field notes from the FGD session, and other investigators identified and resolved discrepancies in the transcript. Qualitative data from the session were analyzed using content analysis based on the Focus-Opportunity-Attribute-Motivation (FOAM) theoretical framework.[18]

Of the 28 persons who were invited, 14 persons agreed to participate in the FGD, but only 9 actually came to the session (1 man and 8 women; 4 village health volunteers and 5 local residents). The most common reason for non-participation was being too busy with an upcoming local election. The mean age of the focus group participants was 48.9 years. Two themes emerged from the focus group discussion session: incentives for appropriate hand hygiene and barriers to appropriate hand hygiene



Remark: translation of the word balloon: "*Aunties, uncles, please wash your hands often!*")

Figure 2 The details of the nudge sign (A) and foot-delivery alcohol-based hand rub dispensers with the nudge sign (B)

Supplementary Table 1. Following internal discussions, two sub-themes were deemed to be most applicable to the design of behavioral nudge signs: 1) a person's feeling of disgust at germs, and 2) perceived social norms of hand hygiene (as encouraged by children in the household of the participant). We then drafted the nudge signs, and consulted the staff of the study site PCU to finalize the design. The final design included a cartoon image of a young girl in a school uniform (to represent children in the target population's households) with a word balloon containing a sentence to remind adult community members to perform hand hygiene. The cartoon image also included a drawing of a magnifying glass held over an image of hands with some pale-green colored mucus on some fingers and cartoon images of 'germs' inside the mucus (designed to induce disgust and remind the viewer of the presence of invisible organisms on unwashed hands) Figure 2A. The image was printed on sheets of laminated paper which were then attached to the top of newly installed alcohol hand rub dispensers Figure 2B. The height above the floor of the alcohol-based hand rub dispensers including the nudge images was approximately 125 cm.

Sample size calculation

We calculated the required sample size by assuming a 10.6% probability of appropriate hand hygiene behaviors at pre-intervention and 63.7% probability of appropriate hand hygiene behaviors at post-intervention based on the results of a previous study.[19] Using the sample size calculation formula for comparison of two independent proportions[20] at 95% level of confidence and 80% power, we obtained a sample size of 24 potential pathogen transmission events at pre-intervention and at least 24 events at post-intervention.

Measurement of hand hygiene behavior

Our outcome of interest was probability of appropriate hand hygiene behavior at potential pathogen transmission events, using surreptitious structured observations. We observed all visitors to the PCU on data collection dates, excluding infants and individuals with observable physical or mental limitations. Our enumerators observed all potential pathogen transmission events (i.e. coughing, sneezing, touching any parts of face, touching mask, and drinking water) that occurred within the study area based on convenience sampling. With this approach, a single observer could observe multiple events from a single visitor.

Our data collection instrument was a KoboToolbox online structured observation form based on an instrument used in previous studies.[15,21] The final version of the study instrument included the date and time of the event, sex and age group of the observed person, the location ("Zone") of the observed person, observed hand hygiene behavior (yes/ no/ uncertain), the types of hand hygiene (i.e. using alcohol-based hand rub provided by the PCU or using a personal hand rub product portable hand rub products), and the type of potential pathogen transmission event (or "triggering event").

We trained a team of enumerators on how to conduct surreptitious structural observation using a series of table-top exercises. The enumerators then conducted a 2-hour field exercise and pilot study at the study site 2 days prior to the actual data collection date to pilot-test the observation protocol. We informed the PCU staff about the study, and that a number of enumerators (who were medical students, scheduled to work at the PCU) would be seen 'doing paperwork' inside the PCU as a pretense for surreptitious observation. We also informed the PCU staff that additional investigation team members would perform structured observation of hand hygiene behaviors from hidden locations.

Based on the number of events observed during the pilot study, we then planned to conduct a 3-hour structured observation in the morning of the data collection date to obtain the required number of events according to the calculated sample size. In addition, the survey team also agreed on the optimal observation areas, and that the enumerators would be allowed to move to alternative locations as deemed appropriate in case of reactivity on the part of the outpatients and/or visitors.

The primary observation posts were an empty reception desk in the Treatment Room (overlooking Zone A), the hallway inside the PCU (overlooking Zone B), in an empty area next to the pharmacy (overlooking Zone C), and behind the door inside the examination room (overlooking Zone D). The enumerators observed the hand hygiene behaviors that occurred in connection with each triggering event. We instructed the enumerators to record whether they observed hand hygiene 'almost immediately' before the triggering event (e.g., before touching eye) and after the triggering event (e.g., after sneezing or touching mask). In case any hand hygiene practices could not be clearly observed (e.g., the person at the dispenser had their back turned to the enumerator so their hand washing motions were not observable), the enumerator then classified the hand hygiene event as 'uncertain' in connection with the potential transmission event and carried on with other 'events' until 24 or more events were recorded.

The structured observations were conducted on 3 days: 1) Day 1 (COVID-19 Wave-1 pre-intervention, 18 December 2020); 2) Day 2 (COVID-19 Wave-2 pre-intervention, 22 December 2020), and; 3) Day 3 (post-intervention, 23 December 2020). The investigators initially planned to collect data only on Day 1 and Day 3. However, the Royal Thai Government announced a new COVID-19 outbreak wave (Wave 2) on 20 December 2020. The investigators deemed this development to have potential

influence on the behaviors of the target population and decided to add Day 2 to collect pre-intervention data in the post-announcement context. To describe the probability of appropriate hand hygiene behavior after installation of the alcohol-based hand rub dispensers with and without the behavioral nudge signs, we decided to first install the alcohol hand rub dispensers without the nudge and observe them for 90 minutes on day 3, from 8:30 am to 10:00 am. Then the next day we attached the behavioral nudge signs to the dispensers followed by another 90 minutes of observation (day 3, from 10:00 am to 11:30 am). We instructed the enumerators to observe as many events as they could until the end of the time period.

Data analysis

We defined the probability of appropriate hand hygiene behavior as the ratio between observed potential pathogen transmission events with hand hygiene behavior divided by all observed potential pathogen transmission events. We performed data cleaning by defining events with observed hand hygiene behavior categorized as "uncertain" and either made corrections (to "Yes" or "No") or excluded the event from data analysis. We did not include handwashing with soap and water because there were no sinks with water and soap in the observation areas at the time of the study. The demographic information and the events in this study were based on a unit of person-event (one person could have multiple observed events, therefore multiple person-events).

We compared the probability of hand hygiene behavior at potential pathogen transmission events during the 4 phases of our study: 1) Phase 1 (day 1, pre-intervention, COVID-19 Wave-1); 2) Phase 2 (day 2, pre-intervention, COVID-19 Wave-2); 3) Phase 3 (day 3, post-intervention, dispensers without nudges), and 4) Phase 4 (day 3, post-intervention, dispensers with nudges). We performed bivariate analyses using frequency and percentage with the chi-square test of independence, and performed multivariate analyses to assess the differences without and with adjustment for event location, age group, and sex of each observed person and reported the findings as crude and adjusted odds ratios with 95% confidence intervals. We further stratified the probability of appropriate hand hygiene behavior among the 4 study phases into 2 zone effects: Zones A and D (neither dispensers nor nudges were present), Zones B and C (dispensers and/or nudges were installed) and use the Breslow-Day test of homogeneity to identify potential interactions from zone effects on hand hygiene behaviors.

Ethical considerations

The study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC. 63-324-9-1). We informed the FGD participants and obtained written informed consent prior to starting the session. Hand hygiene behaviors at the study sites were deemed to be public behaviors and structured observations of such behaviors were deemed not to be a violation of privacy and confidentiality, thus the IRB allowed an exemption from obtaining informed consent for the structured observations.

Results

Our enumerators observed a total of 1,402 events in all 4 phases of the study, 46 (3.3%) of which involved hand hygiene behavior. The age group and sex of the observed persons, event locations, and triggering (potential pathogen transmission) events significantly differed between phases Table 1. Most of the observed triggering events happened in Zone C (waiting area for payment and prescriptions), touching the mask was the most common triggering event, while although 34 (73.9%) of the observed hand hygiene events had no observed triggering event.

Table 1 Demographic characteristics of the observed potential pathogen transmission events in the pre- and post-intervention phases

	Pre-intervention		Post-intervention		
	Phase 1* (n=681 events)%	Phase 2* (n=366 events)%	Phase 3* (n=155 events)%	Phase 4* (n=200 events)%	p-value#
Location of observed event°					
Zone A	14.1	23.5	23.1	18.5	<0.001
Zone B	32.2	21.0	29.5	11.5	
Zone C	39.5	37.7	38.5	55.5	
Zone D	14.2	17.8	9.0	14.5	
Age group of observed person					
Pre-school (<5 years)	0.3	5.7	0.0	11.0	<0.001
Primary school (6-12 years)	0.9	19.7	1.9	7.0	
Secondary school (13-17 years)	0.0	0.8	0.6	2.5	
Adult (18-59 years)	70.0	54.1	59.6	53.0	
Elderly (≥60 years)	28.0	19.1	37.8	25.5	
Sex of observed person					
Male	27.5	20.8	31.4	42.0	<0.001
Female	70.8	79.0	59.0	53.0	
Other	0.3	0.0	9.6	5.0	
Unspecified	1.5	0.3	0.0	0.0	
Triggering (potential pathogen transmission) event					
Coughing	0.1	0.0	0.0	0.0	<0.001
Sneezing	0.6	0.3	0.6	0.0	
Touching mask	56.5	54.4	48.1	61.0	
Touching other respiratory fluids	0.0	0.8	0.0	0.5	
Touching eye	8.4	8.2	6.4	6.5	
Touching nose	8.5	3.8	3.8	5.0	
Touching lips	2.1	2.2	0.0	3.0	
Touching other parts of face	23.1	28.1	24.4	14.0	
Eating	0.0	0.0	8.3	0.0	
Drinking water	0.1	0.3	1.9	1.0	
Hand hygiene with no trigger	0.6	1.6	5.1	8.0	
Unsure	0.0	0.0	1.3	1.0	

*Phase 1: Day 1, pre-intervention, Wave 1 of pandemic; Phase 2: Day 2, pre-intervention, Wave 2 of pandemic; Phase 3: Day 3, post-intervention, dispensers without nudges; Phase 4: Day 3, post-intervention, dispensers with nudges

°Zone A: treatment room waiting area; Zone B: medical examination waiting area-external; Zone C: payment and prescription waiting area; Zone D: medical examination waiting area-internal.

#From Chi-square test of independence

Table 2 Hand hygiene behavior by sex, age, and area of observation (zone)

Characteristic	No hand hygiene (%)	Hand hygiene (%)	p-value*
Sex of observed person			
Male	345 (94.7)	21 (5.3)	0.081
Female	943 (97.4)	25 (2.6)	
Other	27 (100.0)	0 (0.0)	
Unspecified	11 (100.0)	0 (0.0)	
Age group of observed person			
Pre-school (<5 years)	40 (88.9)	5 (11.1)	0.019
Primary school (6-12 years)	95 (100.0)	0 (0.0)	
Secondary school (13-17 years)	9 (100.0)	0 (0.0)	
Adult (18-59 year)	847 (97.0)	26 (3.0)	
Elderly (≥60 years)	356 (96.0)	15 (4.0)	
Location of observed event°			
Zone A	242 (94.9)	13 (5.1)	0.002
Zone B	348 (95.6)	16 (4.4)	
Zone C	561 (97.1)	17 (2.9)	
Zone D	205 (100.0)	0 (0.0)	

*Fisher exact test

Table 3 Probability of appropriate hand hygiene behavior at the pre-intervention phases (phase 1 and phase 2), and after installation of the gel-dispensers (phase 3) and attachment of behavioral nudge signs to the dispensers (phase 4)

Event	Phase 1 (%)	Phase 2 (%)	Phase 3 (%)	Phase 4 (%)	Phase 2 VS Phase 1		Phase 3 VS Phase 2		Phase 4 VS Phase 3	
					Crude OR (95% CI)	Adj OR* (95% CI)	Crude OR (95% CI)	Adj OR* (95% CI)	Crude OR (95% CI)	Adj OR* (95% CI)
No hand hygiene, n (%)	677 (99.4)	360 (98.4)	146 (94.2)	173 (86.5)	N/A	N/A	N/A	N/A	N/A	N/A
Hand hygiene, n (%)	4 (0.6)	6 (1.6)	9 (5.8)	27 (13.5)	2.82 (0.79, 10.06)	3.87 (1.07, 13.98)	3.70 (1.29, 10.58)	2.75 (0.92, 8.19)	2.53 (1.15, 5.56)	2.66 (1.17, 6.07)

*Adjusted for age group and sex of the observed individuals
N/A=not applicable, OR=odds ratio, 95% CI=95% confidence interval

We found that the probability of appropriate hand hygiene behaviors varied among sexes, age groups, and locations of the observed person Table 2. While female adult was the most common demographic, the probability of appropriate hand hygiene behavior was higher among men and among pre-school children. In addition, the probability of appropriate hand hygiene behavior in the treatment room waiting area (Zone A) was higher than at other locations.

The probability of appropriate hand hygiene behavior increased from 0.6 percent in Phase 1 to 13.5 percent in Phase 4. In pairwise comparisons Table 3, the odds of appropriate hand hygiene significantly increased in Phase 2 compared with Phase 1 (adjusted OR=3.87; 95% CI 1.07, 13.98) and Phase 4 compared with Phase 3 (adjusted OR=2.66; 95% CI 1.17–6.07).

When we assessed differences in probability of appropriate hand hygiene behavior between phases, stratified by nudge zones (Zones B and C) vs. non-nudge zones (Zones A and D) Table 4, we found that the probability of appropriate hand hygiene behavior increased from Phases 1 thru 4 in both areas. However, the only increase that was statistically significant was the difference between Phase 3 (compared to Phase 2) in Zones B and C (adjusted OR=10.58; 95% CI 1.95–57.24). The differences in probability of appropriate hand hygiene behavior between Phases 4 and 3 in both nudge and non-nudge zones were not statistically significant. The Breslow-Day test of heterogeneity also suggested that all differences between zones in the increases in probability of appropriate hand hygiene behavior were statistically non-significant.

Discussion

In this quasi-experimental study, we installed additional alcohol hand rub dispensers at a primary care unit, and subsequently attached behavioral nudge signs (designed based on empirical data on drivers of hand hygiene from a focus-group discussions) and observed differences between before installation of the dispensers, after installation of the dispensers without the signs, and after attachment of the signs to the installed dispensers. We found that the probability of appropriate hand hygiene behavior differed significantly at each phase of observation, and that there were extreme differences by type of event and location where the behavior occurred. The findings of this study, including qualitative data findings from the focus group discussions, should be of interest to relevant stakeholders in infectious disease control and water, sanitation and hygiene promotion.

The findings from the focus group discussion on drivers of hand hygiene behavior can be considered as a small-scale qualitative study conducted among adult community members in the study area. Similar to a previous study,[22] we found that disgust with germs was identified as the main determinant of appropriate hand hygiene behavior. However, unlike another previous study which used an image of the eyes of an elderly male person as a nudge for improving desired hand hygiene behavior[23], our focus group discussion identified social norms on hand hygiene being reinforced by a sense of shame when being challenged by a child in one's household. The focus group discussion findings suggested that populations may have similar intrapersonal drivers (i.e., disgust), while interpersonal drivers may vary between populations (i.e., normative expectation of child instead of more senior adults). These differences should be further assessed in other settings and demographic groups.

Unlike hand hygiene intervention studies which delivered the alcohol hand rub dispensers simultaneously with nudge signs[15] or other behavioral interventions[24], our study design allowed a separate assessment of probability of appropriate hand hygiene behavior with dispensers from assessment of probability of hand hygiene behavior with

Table 4 Probability of appropriate hand hygiene behavior at pre-intervention phases (phase 1 and phase 2), after installation of gel dispensers (phase 3), and attachment of behavioral nudge signs to the dispensers (phase 4), in zones without nudges (Zones A and D) and with nudges (Zones B and C)

Events	Phase 1 (%)	Phase 2 (%)	Phase 3 (%)	Phase 4 (%)	Phase 2 VS Phase 1**		Phase 3 VS Phase 2***		Phase 4 VS Phase 3****	
					Crude OR (95% CI)	Adj OR* (95% CI)	Crude OR (95% CI)	Adj OR* (95% CI)	Crude OR (95% CI)	Adj OR* (95% CI)
Zone A and D (zones without nudges)										
No hand hygiene, n (%)	193 (100.0)	147 (97.4)	48 (96.0)	59 (89.4)	N/A	N/A	N/A	N/A	N/A	N/A
Hand hygiene, n (%)	0 (0.0)	4 (2.6)	2 (4.0)	7 (10.6)	N/A	N/A	1.5 (0.10, 11.00)	0.9 (0.11, 7.55)	2.8 (0.50, 29.1)	4.36 (0.57, 33.19)
Zone B and C (zones with nudges)										
No hand hygiene, n (%)	484 (99.2)	213 (99.1)	98 (93.3)	114 (85.1)	N/A	N/A	N/A	N/A	N/A	N/A
Hand hygiene, n (%)	4 (0.8)	2 (0.9)	7 (6.7)	20 (14.9)	1.1 (0.10, 7.90)	1.67 (0.30, 9.27)	7.60 (1.40, 75.70)	10.58 (1.95, 57.24)	2.50 (0.90, 7.20)	2.24 (0.87, 5.77)

* Adjusted for age group, sex of the observed individuals, and zone effect

** Breslow-Day test of heterogeneity could not be calculated.

*** Breslow-Day test of heterogeneity p-value=0.18. The differences in changes in odds of appropriate hand hygiene behavior from phase 2 to phase 3 in both areas (Zones A and D vs. Zones B and C) were not statistically significant.

**** Breslow-Day test of heterogeneity p-value=0.88. The differences in changes in odds of appropriate hand hygiene behavior from phase 3 to phase 4 in both areas (Zones A and D vs. Zones B and C) were not statistically significant.

N/A=not applicable, OR=odds ratio, 95% CI=95% confidence interval

dispensers with nudges. Considering that the enumerators conducted Phase 3 and 4 observations consecutively on the same day with no change in the study area environment, any differences between the two phases could be attributed primarily to the nudges. The findings of this study thus contribute empirical evidence to this ongoing research area of behavioral economics.

We found that the probability of hand hygiene behavior significantly increased only from phase 2 to phase 3 in the nudge zones, whereas changes in hand hygiene behavior probability (Phase 4 compared to Phase 3) were not statistically significant. There was also no statistical evidence for effect modification (heterogeneity in changes between phases) by zones, despite a pattern in stratified analyses that suggested otherwise, which was likely attributable to the small sample size. The context of the study setting should be taken into consideration in the interpretation of these study findings. Considering that the distance from the far end of Zone A to the far end of Zone C is only approximately 20-25 meters, clients are generally

not isolated within their location or zone. For example, clients in Zone A could see the behaviors of clients in other zones, including Zones B and C. If clients in Zone A observed clients in Zones B and C getting up to perform hand hygiene, these observed behaviors could also motivate clients in Zone A to also perform hand hygiene despite the lack of gel dispensers or nudges. In other words, clients in Zones A and D could have been motivated by seeing the clients in either Zone B or C perform hand hygiene, prompting them to imitate others' behaviors.[25] Furthermore, the installation of the dispensers themselves could have functioned as 'salient nudges'[26], further contributing to possible spill-over effects.

Our enumerators were instructed to observe hand hygiene behaviors within a very short window period prior to or after the potential pathogen transmission event. We gave this instruction in order to be certain that each hand hygiene event (or lack thereof) was related to a specific triggering event, and not a previous or subsequent event. Hand hygiene behaviors that occurred among the observed persons who had a triggering event but with delayed hand hygiene would be misclassified as "No hand hygiene", and this could have introduced information bias due to misclassification into our study findings. Furthermore, more than half of all observed events were mask-touching, and the findings regarding probability of appropriate hand hygiene behavior should be interpreted in this context.

The strengths of our quasi-experimental study were the use of primary qualitative data to design a behavioral nudge that suited the local context, and the gradual delivery of the intervention components at separate times which allowed us to make more detailed assessments of changes in hand hygiene behaviors. However, a number of limitations should also be considered in the interpretation of the study findings. Firstly, the post-intervention data collection activity in Phases 3 and 4 were conducted for only 90 minutes each, which limited the statistical power of the study due to the small amount for data and did not allow us to assess sustainability or possible waning of hand hygiene behaviors over a longer period of time. Secondly, we did not assess the extent that the observed individuals noticed or were reactive to the structured observation, thus the potential influence of a Hawthorne effect could not be excluded from the study results. Thirdly, the study was conducted only at one primary care unit in southern Thailand based on three days of data collection, which might limit the generalizability of the study findings.

Conclusion

We found a significant increase in probability of appropriate hand hygiene behavior before and after the installation of the dispensers in the zone where they were placed, and additional statistically insignificant increments in probability of appropriate hand hygiene behavior after attaching the behavioral nudge signs to the dispensers. Nonetheless, the interventions might have helped to motivate and create opportunities for appropriate hand hygiene behavior among the clients of the primary care unit in general. We suggest that caveats regarding lack of data on sustainability of the effect, and lack of generalizability should be considered in the interpretation of the study findings.

Acknowledgements

We would like to thank the staff of Ban Phru Municipality and Ban Plak Thong PCU for their assistance and cooperation, and thank the local government office and primary care unit staff who donated alcohol-based hand rub to the project. We also thank Mr. David L. Patterson of the International Affairs Office, Faculty of Medicine, Prince of Songkla University, for English editing and suggestions. Last but not least, we would like to acknowledge the Faculty of Medicine, Prince of Songkla University for funding support.

Funding sources

The research was financially supported by the Faculty of Medicine, Prince of Songkla University (reference number 63-008-1).

Conflict of interest

The authors have no conflicts of interest associated with the material presented in this paper.

References

1. Coronavirus Update (Live) – Worldometer [homepage on the Internet]. Kansas: Worldometer; 2021 [cited 2022 Mar 7]. Available from: https://www.worldometers.info/coronavirus.
2. WHO guidelines on hand hygiene in health care: a summary. World Health Organization [monograph on the Internet]. Geneva: World Health Organization (WHO); 2009 [cited 2021 Jan 19]. Available from: https://www.who.int/gpsc/5may/tools/who_guidelines-handhygiene_summary.pdf.
3. Kratzel A, Todt D, V'kovski P, Steiner S, Gultom M, Thao TTN, et al. Inactivation of severe acute respiratory syndrome Coronavirus 2 by WHO-recommended hand rub formulations and alcohols. Emerg Infect Dis 2020;26:1592-5.
4. Hand Hygiene for All [monograph on the Internet]. New York: World Health Organization and United Nations International Children's Emergency Fund; 2020 [cited 2021 April 4]. Available from: https://www.unicef.org/sites/default/files/2020-06/Hand-hygiene-for-all-2020_0.pdf.
5. Aiello AE, Coulborn RM, Perez V, Larson EL. Effect of hand hygiene on infectious disease risk in the community setting: a meta-analysis. Am J Public Health 2008;98:1372-81.
6. Tuicharoen J, Wongprakhob N, Munsraket K, Nimkratoke T. Management of the COVID -19 in primary health care settings. J Health Sci BCNSP 2020;4:1-20.
7. Green LA, Fryer GE, Yawn BP, Lanier D, Dovey SM. The ecology of medical care revisited. N Engl J Med 2001;344:2021-5.
8. Healthcare Workers [homepage on the Internet]. Georgia : Centers for Disease Control and Prevention; 2020 [cited 2021 April 30]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/hcf-visitors.html.
9. Birnbach DJ, Rosen LF, Fitzpatrick M, Arheart KL, Munoz-Price LS. An evaluation of hand hygiene in an intensive care unit: Are visitors a potential vector for pathogens?. J Infect Public Health 2015;8:570-4.
10. Savage J, Fuller C, Besser S, Stone S. Use of alcohol hand rub (AHR) at ward entrances and use of soap and AHR by patients and visitors: a study in 27 wards in nine acute NHS trusts. J Infect Prev 2011;12:54-8.
11. Randle J, Firth J, Vaughan N. An observational study of hand hygiene compliance in paediatric wards: Hand hygiene compliance in paediatric wards. J Clin Nurs 2013;22:2586-92.
12. Thaler RH, Sunstein CR. Nudge: improving decisions about health, wealth, and happiness. New Haven: Yale University Press; 2008.
13. Caris MG, Labuschagne HA, Dekker M, Kramer MHH, van Agtmael MA, Vandenbroucke-Grauls CMJE. Nudging to improve hand hygiene. J Hos Infect 2018;98:352-8.
14. Dreibelbis R, Kroeger A, Hossain K, Venkatesh M, Ram PK. Behavior change without behavior change communication: nudging handwashing among primary school students in bangladesh. Int J Environ Res Public Health 2016;13:129.
15. Wichaidit W, Naknual S, Kleangkert N, Liabsuetrakul T. Installation of pedal-operated alcohol gel dispensers with behavioral nudges and changes in hand hygiene behaviors during the COVID-19 pandemic: a hospital-based quasi-experimental study. J Public Health Res 2020;9:1863.
16. Aarestrup SC, Moesgaard F. Nudging hospital visitors' hand hygiene compliance [monograph on the internet]. Copenhagen: iNudgeyou; 2016 [cited 2021 Jan 20]. Available from: http://rgdoi.net/10.13140/RG.2.2.25911.52641.
17. Service O, Michael H, Halpern D, Algate F, Gallagher R, Nguyen S, et al. EAST: Four simple ways to apply behavioural insights [monograph on the internet]. London: Behavioral Insight Team (BI); 2014 [cited 2021 Jan 20]. Available from: https://www.behaviouralinsights.co.uk/wp-content/uploads/2015/07/BIT-Publication-EAST_FA_WEB.pdf.
18. Coombes Y, Devine J. Introducing FOAM : a framework to analyze handwashing behaviors to design handwashing programs [monograph from the internet]. Washington: World Bank; 2010 [cited 2020 June 18]. Available from: https://openknowledge.worldbank.org/handle/10986/27924.

19. Fakhry M, Hanna GB, Anderson O, Holmes A, Nathwani D. Effectiveness of an audible reminder on hand hygiene adherence. Am J Infect Control 2012;40:320–3.
20. Rosner B. Fundamentals of biostatistics. 8th edition. Boston: Cengage Learning; 2016.
21. About KoBoToolbox [homepage on the internet]. Cambridge: Harvard Humanitarian Initiative [cited 2021 Jan 18]. Available from: https://www.kobotoolbox.org.
22. Rahman MJ, Nizame FA, Unicomb L, Luby SP, Winch PJ. Behavioral antecedents for handwashing in a low-income urban setting in Bangladesh: an exploratory study. BMC Public Health 2017;17:392.
23. King D, Vlaev I, Everett-Thomas R, Fitzpatrick M, Darzi A, Birnbach DJ. "Priming" hand hygiene compliance in clinical environments. Health Psychol 2016;35:96–101.
24. Wichaidit W, Steinacher R, Okal JA, Whinnery J, Null C, Kordas K, et al. Effect of an equipment-behavior change intervention on handwashing behavior among primary school children in Kenya: the Povu Poa school pilot study. BMC Public Health 2019;19:647.
25. Bandura A. Social learning theory. Englewood Cliffs: Prentice-Hall; 1997.
26. Weijers RJ, de Koning BB. Nudging to increase hand hygiene during the COVID-19 pandemic: a field experiment. Can J Behav Sci 2021;53:353–7.