The Effect of Hand Hygiene on Illness Rate Among Students in University Residence Halls

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Background: Several studies have indicated a connection between hand sanitization and infection control in numerous settings such as extended care facilities, schools, and hospitals. The purpose of this study was to assess the effectiveness of both a hand hygiene message campaign and the use of an alcohol gel hand sanitizer in decreasing the incidence of upper respiratory illness (URI) among students living in university residence halls.

Methods: This study involved a total of 430 students recruited from four residence halls during the Fall Semester at the University of Colorado at the Boulder campus. Dormitories were paired into control and product groups. In the product groups, alcohol gel hand sanitizer dispensers were installed in every room and bathroom and in dining halls. The data were statistically analyzed for the differences between product and control groups in reported symptoms, illness rates, and absenteeism from classes.

Results: The overall increase in hand hygiene behavior and reduction in symptoms, illness rates, and absenteeism between the product group and control group was statistically significant. Reductions in URI symptoms ranged from 14.8 % to 39.9%. Total improvement in illness rate was 20.0%. The product group had 43% less missed school/work days.

Conclusion: Hand hygiene practices were improved through increased frequency of handwashing through increasing awareness of the importance of hand hygiene, and the use of alcohol gel hand sanitizer in university dormitories. This resulted in fewer URI symptoms, lower illness rates, and lower absenteeism.

Absenteeism due to illness from transmissible infections is a major problem in educational institutions. Among kindergarten through twelfth-grade public school students, the transmission of communicable diseases such as viral and bacterial infections is responsible for more than 164 million lost school days per school year.[1] At the elementary school level, the major contributor to absenteeism is illness caused by the spread of microorganisms.[1, 2, 3] On college campuses, upper-respiratory illness is an important concern because upper respiratory illness occurs frequently among young adults.[4] Such illnesses may interfere with class attendance which may in turn affect academic performance. Additionally, college health centers may have to devote significant resources to assisting students who have upper-respiratory illness. For instance, at the university where this study was conducted, the health center saw 3,121 students for upper-respiratory illness in the fall semester of 2001; however, many of the students who were seen

were suffering from viral infections that did not require medical intervention and would abate by themselves. Reducing the occurrence of upper-respiratory illness has the potential to benefit students and to help health centers better utilize their resources.

Hands are the primary mode of transmission of many infectious diseases, particularly among those living and working in close proximity to one another such as in military barracks, college dormitories, and summer camps. As with hospitals and extended care facilities, dormitories and schools have significant predisposing factors for microbial cross-contamination and transmission. Close environments, doorknobs and other inanimate objects serving as resting grounds for microbes, and contaminated hands serving as vehicles of transmission all contribute to increased infection rates among these groups. According to the US Centers for Disease Control and Prevention and the Association for Professionals in Infection Control and Epidemiology, simple hand washing is the single most important and effective method of preventing the spread of transmissible diseases.[5,6] Teaching appropriate hand hygiene practices can promote wellness and have numerous benefits in a wide variety of settings such as learning institutions including child care centers, elementary and high schools, and universities. Appropriate hand hygiene practices such as hand washing and hand sanitization can potentially result in the reduction of the spread of infection and the resulting lost days due to absenteeism. Education combined with a convenient hand hygiene regimen was found to significantly increase the frequency of hand washing among elementary school students.[7] Several studies have demonstrated that appropriate handwashing can reduce upper-respiratory illness and diarrhea rates among children in day care settings.[8-11]The efficacy of handwashing in reducing upper respiratory illness has also been demonstrated in a study of navy recruits during basic training.[12]

Conventional handwashing with soap and water is an excellent component of a hand hygiene program to reduce the risk of infection through hand contact; however, the complexity of behavior and the difficulty of maintaining compliance to basic handwashing practices are challenges to overcome, especially in the school environment.[13,14] Hand hygiene practices are difficult to perform due to factors such as time constraints and the lack of sinks in most classroom environments. In these situations, an alternative to the conventional hand hygiene practice of hand washing with soap and water is the use of a waterless alcohol gel hand sanitizer. Waterless hand sanitizers, such as alcohol gels, offer quick, easy, and effective hand hygiene. Hammond *et*

al demonstrated that elementary school absenteeism due to illness was significantly reduced when students practiced good hand hygiene by using an alcohol gel sanitizer.[15] In another study, Fendler *et al* showed that alcohol gel hand sanitizers also reduced the infection rate in an extended care facility where propinquity and direct contact between residents and care givers provide ideal situations for microbial transfer and cross contamination.[16]

Group living environments, such as residence halls, make the spread of transmissible diseases and upper respiratory illness more likely. As in classroom situations, students in residence halls may be less likely to regularly wash their hands due to the absence of sinks in their rooms and the inconvenience of walking to the washrooms to do so. Alcohol hand sanitizers have been shown to offer an effective alternative to conventional hand washing in elementary schools.[15] The objective of this study was to determine the effectiveness of hand hygiene education and of the use of an alcohol gel hand sanitizer in university residence halls as a hand hygiene methodology to decrease the incidence of URI's and absenteeism. A waterless alcohol gel hand sanitizer was used in this study as a supplement to existing handwashing with soap and water.

METHODS

Subjects

A total of 430 students living in four residence halls were recruited during Fall semester on the University of Colorado at Boulder campus. This sample size was selected because a sample of approximately 400 participants (200 in each group) was sufficiently large enough to detect moderate effect size differences in illness rates comparing across groups.[17] The four resident halls that participated in this study were selected because the hall directors were willing to assist with the study and because the student populations in the halls were typical of students living in resident halls on the campus. We did make an attempt to "match" halls on one key factor: academic emphasis. Two of the residence halls included academic programs as part of their learning environment, so we assigned one of these halls to the product group and one to the control group. The other two halls, one of which was assigned to product group and one to control group, included no special emphasis.

With the exception of age and gender, the profile of students in the study roughly matched that of the student population on campus. This is presented in Table 1. The gender breakdown of the study was 61.9% female and 38.1% male. This differs from the student population on campus (52% male; 48% female). The participation in the study was voluntary and the slightly larger proportion of females in the study reflects the tendency of women to be aware of and interested in health issues.

Overall, there were no significant differences in demographics between product and control groups except in the reported number of roommates. The average number of roommates for students living in the product halls was 1.00 while the students living in the control halls had an average of 0.87 roommates ($p<0.05$). Although this difference is statistically significant, it is not likely to reflect an important difference in the living arrangement of most students in the study. Residence halls at the University of Colorado are co-educational, with each floor having separate male and female sections and gender-specific washrooms.

Prevalence of allergies was not significantly different between the groups (19.5 % of all participants experienced allergies during the Fall.) Students who suffered from asthma composed 9.2% of the subject pool. There was no significant difference between product and control groups in terms of number of participants who smoked (17.4% of the sample smoked). Seasonal variations in illness rates were not considered for this investigation. However, product as well as control dormitories were selected in close proximity to each other.

Table 1. Demographics of the Student Participants

Average Age (years):	18.29 (± 0.69)
Freshmen	85.6%
Ethnicity	
Caucasian	88.0%
African-American	1.7%
Hispanic/Latino	4.2%
Asian/Pacific Islander	2.8%
American Indian/Alaskan Native	0.3%
Other	3.1%

Gender	
Male	38.1%
Female	61.9%
Out-of State	45.0%

Out of the 430 students recruited, 188 participants from the product group and 203 participants from the control group completed at least three weekly reports for the study. Participation in the study was rewarded with cash incentives totaling a maximum of $65 and weekly non-monetary incentives.

Materials

Purell® Instant Hand Sanitizer (GOJO Industries, Inc., Akron, Ohio) was used as the alcohol gel hand sanitizer. Both *in vitro* and *in vivo* antibacterial efficacy of the sanitizer were determined by Bioscience Laboratories, Inc., in Bozeman, MT, by using 15-second timed exposure kill tests and the Healthcare Personnel Handwash protocol (a modification of the American Society for Testing and Materials Standard Method E 1174-87), respectively. Independent Test Laboratory, Minneapolis, MN, similarly evaluated the product for antiviral efficacy by using 30-second timed exposure kill evaluations for viruses. Additionally, the irritation potential of the product was measured over the course of 15 additional product application cycles. The results can be found in the Provon Technical Guide published by GOJO Industries, Inc.[18]

Approximately one to two weeks prior to the beginning of the study, alcohol gel dispensers were installed in every room, washroom and dining hall in the product group residence halls to be used as an adjunct to handwashing. Additionally, one week before the start of the study, a handwashing message campaign consisting of bulletin boards and weekly messages was implemented in the product group residence halls. The messages were designed to encourage regular handwashing and sanitizer use in order to prevent colds and flu. Students in the control group were informed that they were participating in a wellness study, but they neither received

hand hygiene messages nor alcohol gel hand sanitizers. However, they completed the same surveys as the product group.

Protocol

Informed consent was completed by the participants at the time they agreed to participate in the study. The study involved pre- and post-study assessments of participants' health knowledge, attitudes, and behaviors and social support for health practices, and weekly assessments of URI symptoms, some health practices, and absenteeism across eight weeks. The health attitude, knowledge and behavior survey assessed handwashing practices, smoking frequency, and exercise behaviors as well as their diet, water consumption, and sleeping practices. The social support survey addressed social support structures for health practices within the college environment. These pre/post surveys allowed for examination of the relationship between wellness and general health behavior. Knowledge items regarding the relationship between handwashing and illness included true/false items such as "You cannot get a cold or flu from touching faucets and door handles;" "Washing your hands with soap and water can remove up to 99% of the germs from your hands." Attitude items asked about the extent to which pariticipants felt is was easy and good to wash or use a sanitizer and included items such as ""Washing my hands before eating a meal is inconvenient" and "It is convenient to carry gel sanitizer with me" (rated on a 5-point scale from strongly disagree to strongly agree). Behavior items asked participants to indicate whether they engaged in a behavior all the time, most of the time, some times, rarely or never; these items asked about things such as washing hands after using the bathroom or washing hands before preparing food. The measures for hand health attitudes and hand health behaviors achieved adequate reliability (Cronbach's alpha above .70); the knowledge measure was not assessed for reliability. Results regarding knowledge, attitudes and specific behaviors are reported elsewhere[19] It is important to remember that knowledge, attitudes and behaviors were also assessed for smoking, exercise, and eating habits. This means that although participants knew the study examined hand health, these other items should have reduced the likelihood that the pre-survey changed behavior or made participants self-conscious in reporting hand health behavior and illness later in the study.

The weekly survey included eight items regarding URI symptoms, three items regarding frequency/timing of handwashing and sanitizer use, two items about smoking frequency/timing, and one item about the frequency of exercise. Weekly reports were collected for eight weeks because of the academic calendar. The study began approximately two weeks into the fifteen week semester. The eight week window of data collection reflected the majority of the remaining time in the semester prior to exam periods. A previous pilot study had indicated that completion of weekly reports declined sharply as exams approached because students were concerned with other responsibilities. Thus, data collection ended just before the end of the semester.

Data analysis

Analyses of the data involved examining the differences between the product and control groups in several categories: reported hand washings and hand sanitizer uses; reported symptoms; and illness rate as determined by the researchers based on symptom reports; and absenteeism. Chi-squared analysis using a continuity correction were conducted.

Frequency of hand washing and hand sanitizer use was determined using the following equations:

(1) $$\frac{\text{Number of reported handwashings for the day}}{\text{Reported number of hours awake for the day}}$$

(2) $$\frac{\text{Number of reported hand sanitizer uses for the day}}{\text{Reported number of hours awake for the day}}$$

Analysis of reported symptoms for the product and control groups examined total participant reports of the presence or absence of eight symptoms typical of URI's across the duration of the study. Chi-square analyses using a continuity correction were conducted for each emerged symptom. The differences in reports of symptoms between product and control groups were compared.

Analysis of illness rates of the product and control groups was based on symptom reports. A participant was classified as having an illness if they reported at least two symptoms, and one of

the symptoms lasted at least 2 –3 days. This classification criteria was determined in consultation with the University Wellness Program staff and reflects one diagnostic standard for suspecting URI's. Again, a chi-square analysis using continuity correction was employed. Illness data were also analyzed for each week of the study. Lastly, the number of reported days absent was compared between product and control group.

RESULTS

Hand Hygiene Practices

Results of the frequency of hand washing and hand sanitizer use are presented in Table 4. Results are given as an average number of handwashing sessions per hour and average number of hand sanitizer uses per hour. The difference was statistically significant as determined by chi-square analysis. Over the course of the study, the product group washed their hands 10.4% more often than the control group. As expected, the frequency of hand sanitizer use was also significantly greater in the product group as well (0.26 uses/hour vs. 0.03 uses per hour).

Table 4. Frequency of handwashing and hand sanitizer use in product and control groups

	Average frequency of hand washing ($p < 0.02$)	**Average frequency of hand sanitizer use** ($p < 0.0001$)
Product group	0.48 times/ hour	0.26 uses/ hour
Control group	0.43 times/ hour	0.03 uses/hour

Illness Data

Significant results between the product group and control group emerged for each reported symptom. Percentages for the presence of each reported symptom are shown in Table 5. Chi-squared values are also included.

Table 5. Reported symptoms.

Symptom	Product Group	Control Group	Improvement over Control	Chi-squared value
Sore throat	21.9%	25.7%	14.8%	5.19
	n = 290	n = 359		(p=0.02)
Stuffy Nose	43.7%	51.3%	14.8%	15.27
	n = 561	n = 702		(p = 0.0001)
Ear Pain	5.4%	8.2%	34.1%	7.76
	n = 72	n = 115		(p=0.004)
Painful/Swollen	9.8%	16.3%	39.9%	24.18
Neck	n = 131	n = 228		(p = 0.0001)
Cough	14.6%	21.0%	30.5%	18.82
	n = 194	n = 293		(p=0.0001)
Chest	10.5%	15.4%	31.8%	14.28
Congestion	n = 139	n 214		(p=0.0001)
Sinus Pain	11.2%	16.4%	31.7%	15.05
	n = 148	n = 229		(p = 0.0001)
Fever	11.1%	16.3%	31.9%	15.56
	n = 147	n = 228		(p = 0.0001)

The illness data for product and control groups for each week of the study were analyzed. Results are shown in Table 6. Significant differences in illness rates emerged for only three of the eight weeks although illness rates were higher in the control group each week. Overall, there was a statistically significant difference between the product and control groups. The product group had a 20% improvement in illness rate over the control group.

Table 6. Weekly illness rates*.

Week	Product Group	Control Group	Improvement over control	Chi-squared value
1[a]	50.0%	63.8%	21.6%	5.98
	n = 87	n = 104		
2[a]	45.0%	56.5%	20.4%	3.58
	n = 67	n = 87		
3	40.9%	45.0%	9.1%	0.48
	n = 74	n = 85		
4	37.5%	45.3%	17.2%	2.00
	n = 66	n = 87		
5	32.6%	41.1%	20.7%	2.41
	n = 56	n = 74		
6[b]	30.4%	44.0%	30.9%	6.44
	n = 52	n = 81		
7	29.4%	38.5%	23.6%	2.81
	n = 50	n = 70		
8	32.3%	40.8%	20.8%	2.22
	n = 50	n = 71		
Total[c]	37.2%	46.5%	20.0%	23.81
	n = 502	n = 659		

[a] Statistical significance ($p < 0.05$)
[b] Statistical significance ($p < 0.06$)
[c] Statistical significance ($p < 0.0001$)
* A variety of definitions of illness have been offered identifying URIs. Carabin et. al [25] define URTI as two or more upper-respiratory symptoms, both of which must last at least two-three days. We also analyzed the data using this more stringent definition of URI. Results revealed a significant different in illness rate for the product group versus the control group ($X2 = 19.97$, $p<.0001$), with lower rates of illness for the product group (20.2%) than for the control group (27.5%). Results for the weekly analyses showed significantly less illness for the product group on weeks 2 and 4 only.

Lastly, absenteeism or missed school/work data were collected and analyzed. The results are shown in Table 7. Chi-squared analysis confirmed a statistical difference between the product and control group. With $p<0.01$, there was 43.0% improvement absenteeism for the product group.

Table 7. Absenteeism data shown as missed school and/or work days.

	Product Group	**Control Group**	**Improvement over Control**
Missed School/Work Days[a]	5.7% n = 76	9.5% n = 134	40.0%

[a] Statistical significance ($p < 0.01$)

DISCUSSION

The results of this study clearly show a statistically significant increase in hand washing and hand sanitizer use among students who were provided with messages on hand hygiene and had an alcohol gel hand sanitizer available to them. Interestingly, there was some hand sanitizer use among students in the control group. This is attributed to the growing popularity of instant hand sanitizers. Some students most likely had their own personal bottles either in their room or in their purses or pockets. The product group, however, used the hand sanitizer more often and had statistically significant decreases in the incidence of URI symptoms. The illness rate in the hand hygiene group was also significantly lower. It should be mentioned that illness incidents were based on self-reporting by students and that no clinical confirmation of these illnesses were obtained for both product and control groups.

The increase in hand hygiene episodes is illustrated in Figure 1. In improvement in illness rates and absenteeism rates in the Product group is shown in Figure 2.

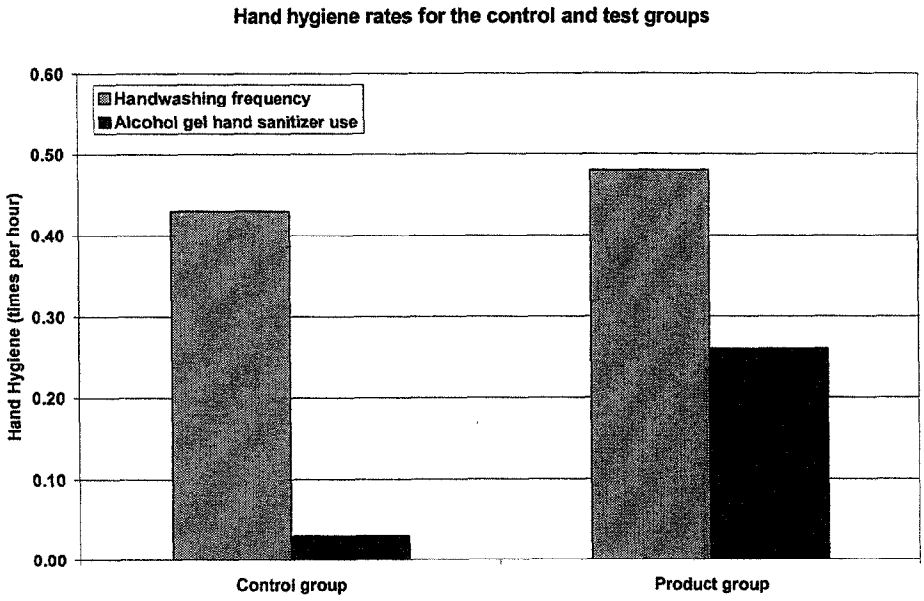

Figure 1. Hand hygiene practices among the Control and Product groups.

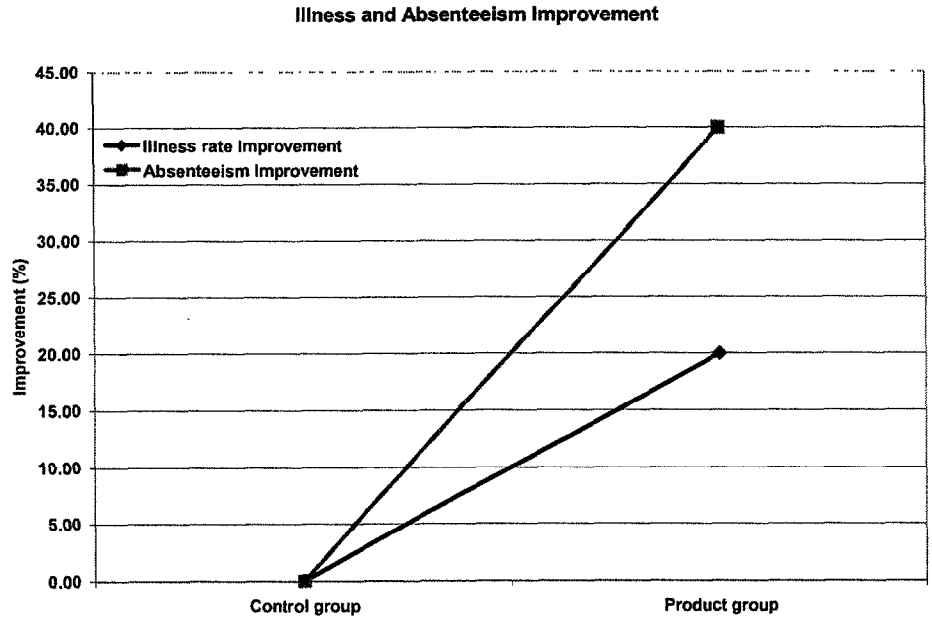

Figure 2. The improvement in illness and absenteeism rates in the Product Group.

A relationship between hand hygiene, illness rate, and missed school days is shown in the results. Although limited and generally pertaining to preschool and elementary school environments, the current literature substantiates the positive effect of various hand hygiene programs on illness-related absenteeism in school populations.[13-15, 20-22] Studies by the Buckeye Institute indicate attendance is a key prognostic factor of academic success for elementary school children.[23,24] This finding can also be extended to the higher education environment. The current study suggests that both handwashing and the use of hand sanitizers have a positive effect on the wellness of university hall residents. It should also be noted that while the average number of roommates was higher in the product group (which would tend to increase the likelihood of microbial transmission), the product group still had fewer URI symptoms, lower illness rates and fewer missed school days.

The outcomes of improved hand hygiene habits have far reaching implications. For the student, reduced absenteeism due to an improvement and increase in hand hygiene behavior can result in improved academic performance. This potentially helps the student succeed in college and improves the likelihood that the student will have a positive college experience. For the University, this behavior can result in reduced healthcare costs since fewer students may need to utilize health center resources. Since increased attendance results in better academic performance, the university could boast higher average student grades and better retention of students. However, a number of other factors have the potential to influence the occurrence of upper-respiratory illness and should be kept in mind when considering the results of this study. Smokers in this study experienced higher rates of URI than non-smokers. Exercise, sleep and eating habits also influence illness rates. Thus, the impact of improved hand hygiene should be considered within the context of general health behaviors. And, universities should think about hand hygiene promotion as one aspect of general wellness promotion.

CONCLUSION

Through hand hygiene education and availability of an alcohol gel hand sanitizer product, hand hygiene behavior was improved among residents of university housing. This resulted in

fewer symptoms of URI, lower illness rates, and fewer missed school days. This outcome has benefits for both students and the University.

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