

Every Drop Counts: Positive Reinforcement in Increasing Hand Hygiene

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Abstract

Hand hygiene compliance has shown to be low in both the healthcare and public setting. This study evaluates the rates of hand hygiene compliance of a regular hand sanitizer dispenser to one with a positive reinforcement visual usage count. Each machine was individually observed for cafeteria visitor's hand hygiene usage or refusal. Observation found that 7.4% accepted hand sanitizer from the regular dispenser, while 16.0% accepted hand sanitizer from the positive reinforcement dispenser. The hand sanitizer dispenser with a positive reinforcement visual count received significantly higher usage ($p < 0.001$). Findings were discussed in light of healthcare-associated infections and infectious disease spread.

Keywords: hand hygiene, positive reinforcement, infection control, compliance, hand sanitizer

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Background

Hand hygiene is an action done by many every single day. The Centers for Disease Control and Prevention (CDC) defines hand hygiene as "cleaning one's hands" to reduce pathogens that may be present on the hands (2016). Various hand hygiene methods include washing hands with soap and water, using hand sanitizer, or wiping hands down with sanitary wipes. Hand hygiene may be routine after bathroom use, before eating, or whenever one's hands may feel dirty. Although it may be an action without thought, hand hygiene is vital to our health. The CDC states that hand hygiene is the primary way to prevent the spread of infection (CDC, 2016). The importance of hand hygiene in preventing infectious spread has been reported on as well. One study compared dormitories at different colleges to see if providing greater access to hand sanitizer and messaging through educational hand hygiene fliers made a difference in hand hygiene compliance. When compared to the control group, who received no experimental implementations, the experimental group increased their hand hygiene use & knowledge and had lower reported cases of influenza and colds (White, Kolble, Carlson, & Lipson, 2005).

Although the importance and impact of hand hygiene are remarkable, hand hygiene compliance rates remain low. Compliance by healthcare workers, who are in constant contact with hospital patients, is imperative to decreasing infectious spread. However, one study of various intensive care units found hand hygiene compliance rates for healthcare workers ranging from 100% down to 3% (Musu et al., 2017). The CDC also states that some healthcare workers miss over 50% of hand hygiene opportunities that emerge while providing care (2019b).

Different hand hygiene compliance rates in hospitals, as shown in the research provided, may potentially increase infection rates.

Infections have a substantial impact on the healthcare system. Healthcare-Associated Infections (HAI) are infections that a patient contracts during their hospital admission (ODPHP, 2020). According to the World Health Organization (WHO), HAIs are grossly prominent with an estimated "1.4 million cases at any given time" (2020). Both patients and hospitals are negatively affected by HAI's. It is estimated that 75,000 patients, in hospitals in the United States alone, die from HAIs every year (NCDHHS, 2019). HAIs are also very costly, with hospitals spending an overall 28-33 billion extra every year towards patient care and treatments (NCDHHS, 2019). The impact that infections have on patients and hospitals alone is tremendous.

Infection spread often occurs in the general public as well. One example of infectious spread that occurs annually is the Influenza virus, which has tens of millions of reported cases every year (CDC, 2020a). Another example is the common cold, which affects millions every year as well (CDC, 2019a). Hand hygiene compliance in the general public is seen to be at a low rate as well. One study observed hand hygiene compliance at four separate public bathrooms. It was found that out of the 3,749 people observed, only 66.9% washed their hands with soap (Borchgrevink, JaeMin, & SeungHyun, 2013). Out of all observed people, only 5.3% washed their hands for CDC's recommended amount of handwashing time (Borchgrevink, JaeMin, & SeungHyun, 2013). Both hospitals and the general public could potentially benefit from increased hand hygiene to decrease the spread of infection. Finding a method to encourage hand hygiene practice is of great need.

Project Thesis

Multiple Elkay bottle filling stations are located across the Point Loma Nazarene University campus. The Elkay stations include a "Green Ticker" that counts the number of plastic bottles saved by using a reusable bottle at the water station (Elkay, n.d.a). The counter increases by 1 number whenever 20 ounces of water is dispensed to represent a "plastic bottle saved" (Elkay, n.d.a). The "Greek Ticker" is an environmental benefits calculator, which informs people of their impact on the environment (HSS, n.d.). Through active informing, the goal is to increase awareness and action on environmental preservation measures (HSS, n.d.).

The goal of the environmental benefits calculator, encouraging eco-friendly behavior by actively seeing user impact, appears to be based on positive psychology. Psychologist B.F. Skinner studied positive reinforcement with rats and witnessed how the rats were more likely to complete an action (press a lever) when they were rewarded for it (given food pellets) (McLeod, 2018). Positive reinforcement is the theory that a particular behavior will reoccur more often if it is followed by a pleasant stimulus (Ackerman, 2020). The theory of positive psychology can be applied to human behavior. Examples include cheering on a team when they are winning or giving a child a prize when they have been excellent in class. Although positive reinforcement is seen and used daily as a method of encouragement for more productive and beneficial behavior, positive reinforcement has sparsely been used as a method to increase hand hygiene compliance.

This study was designed to examine the degree to which an environmental benefits calculator-type counter would increase hand hygiene compliance. The counter was attached to an automatic hand sanitizer dispenser and increased by one number with each use. The number on the counter maintained a count, showing how many people completed hand hygiene. The

positive reinforcement factor in this project was understood to be the increasing number on the counter, which would represent an overall contribution to decreasing infectious spread when hand hygiene is completed. It was hypothesized that there would be an increase in hand hygiene compliance with the hand sanitizer dispenser with counter versus a standard hand sanitizer dispenser with no counter.

Literature Review

The following is a review of previous research conducted. The literature review will focus on both positive reinforcement studies on increasing hand hygiene compliance and the environmental benefits calculators.

Positive Reinforcement

In 2011, The largest and longest study on the promotion of alcohol sanitizer implemented positive reinforcement through a quasi-experimental cohort study and time-series design over five years (Mayer et al., 2011). The study demonstrated that rewards, such as chocolate bars, gift cards, and unit trophies, encouraged the use of hand hygiene. All four groups tested significantly increased their hand hygiene compliance over five years, speaking to the consistency and longevity that positive reinforcement can provide to healthcare.

Another study used both positive and negative reinforcement to encourage hand hygiene. Results showed that the positive reinforcement, which in the study was giving healthcare workers candy for completing hand hygiene, created a more long-standing behavior change, as compared to the change induced by negative reinforcement (Cumbler et al., 2013). Results on the unit were significant, with hand hygiene on the unit changing from 78% to 97.2% and no healthcare-acquired infection on that unit during the two years the study was being conducted

(Cumbler et al., 2013). Positive reinforcement appears to have a more significant impact on wanted behavior.

Positive reinforcement with a non-monetary reward for hospital staff was proven to be very successful as well. It was found that hand hygiene compliance significantly increased when those who had the highest compliance got priority choice for choosing their work schedules (Brazzell, 2014). Radiofrequency was used to find compliance data on each of their staff members. Compliance tracking proved to be a great data collector for the study conductors, while the non-monetary reward also proved successful in increased hand hygiene compliance.

Many studies demonstrated positive reinforcement as being a sustainable method for keeping compliance rates up, but not every study found this. One study compared positive reinforcement of hand hygiene through the reward of stickers, gift cards, unit pizza parties, and acknowledgment to further education on hand hygiene and no intervention (control group) (Harne-Britner, Allen, & Fowler, 2011). Although the results showed that the positive reinforcement group was the only group to have a statistically significant increase (from 60.8% baseline to 82.5% after six months) in hand hygiene compliance, the compliance rate wavered throughout the six months (Harne-Britner et al., 2011). The length of time of the experiment and interventions should be taken into account.

Although mentioned as a promising intervention by almost every study done with positive reinforcement and hand hygiene paired, there is still a lack of studies with this type of intervention. Most studies that implement positive reinforcement in the healthcare system also seem to focus on the same rewards, such as food items (chocolate bars, pizza, candies) or gift

cards. Positive reinforcement should continue to be studied with the change to the types of rewards given to staff.

Environmental Benefits Calculator

Environmental calculators are beneficial tools that have been used to promote increasing environmental impact awareness and decreasing the carbon footprint. The "Green Ticker" on Elkay's bottle filling stations is one example of an environmental benefits calculator. A case study was conducted at New Mexico State University, reviewing how successful the implementation of Elkay water dispensers with the "Green Ticker" was (Elkay, n.d.b). After three years, New Mexico State University had 34 Elkay bottle filling stations on their campus and an estimated total of over 520,000 plastic bottles saved (Elkay, n.d.b). The case study documents the success the college had with saving plastic bottles, which was tracked by the counter. It should be noted that the case study only reviewed New Mexico State University, which may narrow the applicability of the population.

One study looked at how providing information on environmental impact in tomato horticulture created more awareness in environmental choices (Torrellas, Anton, & Montero, 2013). Results showed areas to work on with environmental conservation along with values to track baseline and progress of changes. Through the environmental calculator, crop producers were able to see the impact fertilizers and energy had on the environment, making them more cognizant and aware (Torrellas, Anton, & Montero, 2013). Although this study is focused on environmental impact, its success on crop producer's awareness can be seen as promising.

The carbon footprint calculator is another environmental calculator that analyzes people's carbon emissions. One study reviewed community responses in the United Kingdom

and Sweden to an interactive carbon footprint calculator. The carbon footprint calculator, called the "REAP Petit" in the study, had community members input their daily use of power sources, travel, and food along with other activities (West, Owen, Axelsson, & West, 2015). Results from the United Kingdom community showed a significant decrease in power use compared to the general United Kingdom population.

When looking at this study in comparison to the proposed project, a difference to be noted is the length of time one spends using the feedback system. For the "REAP Petit" calculator, users enter their lifestyle information and choose to take action to decrease carbon emissions based on their results (West, Owen, Axelsson, & West, 2015). For the proposed project, accepting hand hygiene would take a few seconds. One main point that the study made, though, was the moral drive that the carbon footprint calculator brings. "REAP Petit" users could see their results compared to their neighborhood's results, encouraging them to take moral-based action to become more self-aware of their carbon footprint (West, Owen, Axelsson, & West, 2015). The proposed project in this study has a moral-based drive proponent as well through its visual count of hand sanitizer usage of others who have passed by the dispenser.

Journals discussing the impact of environmental benefits calculators were sparse. As expected, journals found focused on environmental impacts. However, the success of impact-awareness through the environmental calculators appeared prominent. Environmental calculator user responses can speak to the hypothesis of an increased hand hygiene compliance response with a hand sanitizer user counter.

The purpose of this literature review is to provide a broader insight into the past research done on both positive reinforcement initiatives on hand hygiene and a positive reinforcement

method used with environmental calculators. This research will compare the success of past positive reinforcement methods with increasing hand hygiene compliance and the success of the environmental calculators.

Research Methods

The experimental prototype was a Purell automatic hand sanitizer dispenser (Appendix A). The dispenser was attached to a stand to make the prototype more mobile. Attached to the front of the dispenser was a counter display. The counter was programmed to increase by one number whenever someone used the hand sanitizer dispenser. When the counter display was not in use, the counter would be hidden behind the hand sanitizer dispenser.

Messaging was deliberated to ensure that the most concise yet impactful message was advertised. Two messages were attached to the hand sanitizer dispenser: one educating the public on hand hygiene importance and one explaining the meaning of the counter. Messages that were considered for educating the public on hand hygiene importance included "Its flu season: Prevent the spread of germs with clean hands," "Let's stop the spread of germs," "What it comes to germs, every drop counts!", and "Germs don't stand a chance against hand sanitizer." The message "The #1 way to prevent spreading germs lies in your hands" was chosen (Appendix B). Messages that were considered for explaining the counter number displayed included "Another disease prevented," "Every drop counts!", "Hands cleaned," and "Number of hands preventing the spread of germs." The message "Clean hands" was chosen (Appendix C).

The location chosen for the observation was on the Point Loma Nazarene University campus. The CDC states that one of the critical times to complete hand hygiene is before eating (CDC, 2020b). Based on the CDC recommendation, the hand sanitizer dispenser was placed at

the cafeteria entrance. The dispenser was placed at the center of the entrance, several feet away from the main entrance door (Appendix A). Central placement would ensure that all subjects had to walk past the hand sanitizer dispenser, allowing all subjects to partake in hand hygiene.

A comparison of a hand sanitizer machine with no positive reinforcement and one with positive reinforcement was conducted on different weeks. The same days and times of the week were used to prevent any variables in data collection. Observation of hand hygiene use without positive reinforcement was conducted on week one. Days and times of observation and data collection are as follows: February 13 & 14, 2020, from 1700-1900 and February 15, 2020, from 1630-1830. Observation of hand hygiene use with positive reinforcement was conducted on week two. Days and times of observation and data collection are as follows: February 20 & 21, 2020, from 1700-1900 and February 22, 2020, from 1630-1830. The times chosen are Point Loma Nazarene University cafeteria's dinner time. The cafeteria experiences a high volume of customers during dinner time, which would aid in ensuring that as many subjects as possible are observed during the experiment times chosen.

Each subject was a customer of the PLNU cafeteria. Completing hand hygiene was optional for all subjects observed. There was no negative reinforcement for any subject who declined hand hygiene. Subject privacy was maintained during the entire data collection process. Data collectors were observing subjects from an open lounge across from the prototype location. Data collection included counting each cafeteria customer and marking if they accepted hand hygiene (used the hand sanitizer dispenser) or declined hand hygiene (did not use the hand sanitizer dispenser).

Research Results

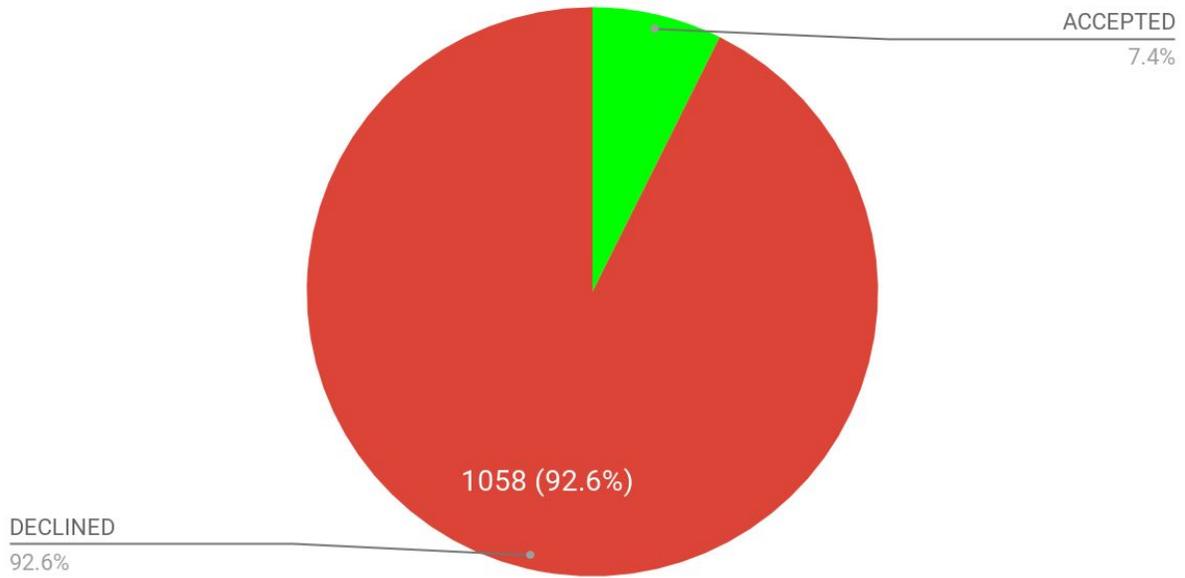
A total of 2375 cafeteria customers were observed during the entire experiment. Week one of the experiment, a hand sanitizer dispenser with no positive reinforcement, had a total of 1142 subjects observed. Of the 1142 subjects, 84 accepted the hand sanitizer, and 1058 declined the hand sanitizer. Of all week one subjects, 7.4% were observed accepting hand hygiene. Week two of the experiment, a hand sanitizer dispenser with positive reinforcement and messaging, had a total of 1233 subjects observed. Of the 1233 subjects, 197 accepted the hand sanitizer, and 1036 declined the hand sanitizer. Of all week two subjects, 16.0% were observed accepting hand hygiene.

Chi-Squared and P-value data were calculated from the data collected from observation. Chi-Squared calculation results were 42.25. Based on Chi-Squared results, the p-value was calculated at <0.001. There was a significant increase in the number of subjects who completed hand hygiene with the positive reinforcement counter and message compared to a hand sanitizer dispenser without any intervention.

Experiment Week	Date	Accepted	Declined
WEEK 1 No Intervention	February 13, 2020	50	561
	February 14, 2020	16	222
	February 15, 2020	18	275
WEEK 2 Positive Reinforcement & Message	February 20, 2020	100	542
	February 21, 2020	65	276
	February 22, 2020	32	218

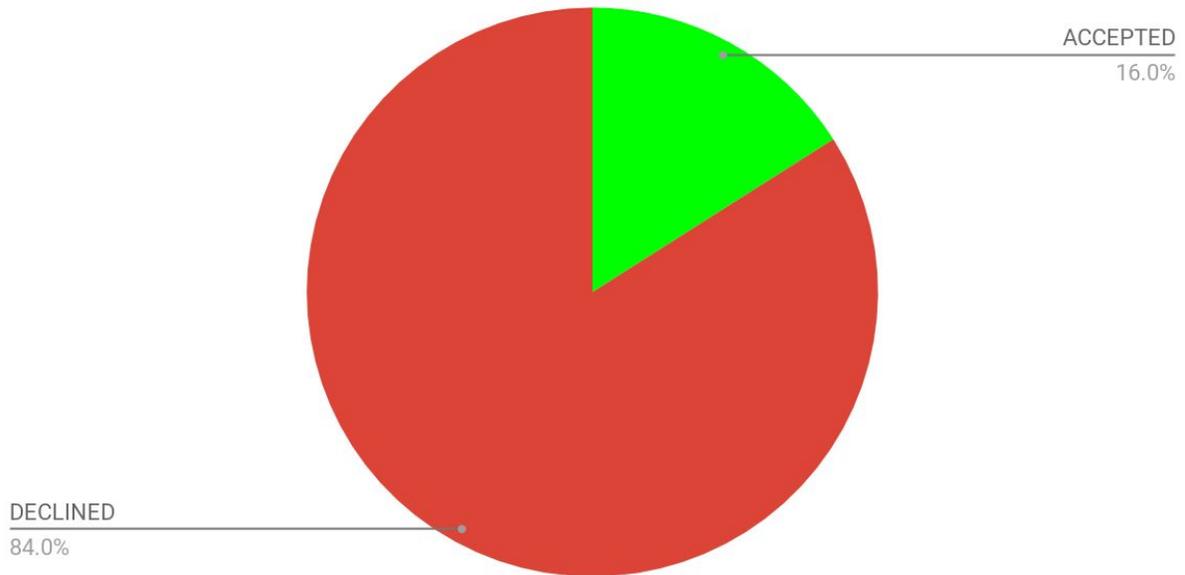
Week 1

No Intervention



WEEK 2

Positive Reinforcement + Message



Limitations

Limitations of the study should be considered when reviewing the results. During the experimental period, the Coronavirus Disease was spreading and gaining more awareness. The non-intervention dispenser was observed before the positive reinforcement dispenser. The confounding variable of history, a difference of subject awareness and knowledge on infection spread and hygiene precautions, may have contributed to higher hand hygiene compliance rates during week two of the experiment.

It was noted through observation that groups of two or more subjects might influence each other in their decision to participate in hand hygiene. Often when one member in the group completes hand hygiene, the other member or members in the group see this action. The other subjects in the group often completed hand hygiene directly after the first member did so. Group peer pressure may contribute to hand hygiene compliance rates in groups and should be looked into more.

Preferred methods of hand hygiene may differ from person to person. A bathroom was located before the entrance of the cafeteria. Subjects may have completed hand washing as a hand hygiene method before entering the cafeteria, and therefore declined the hand sanitizer. The cafeteria also requires college student customers to scan in using their school IDs. Many students were often looking for their IDs before walking into the cafeteria or were holding their study materials, making it harder for them to use the hand sanitizer machine.

Implications

The success of the positive reinforcement counter prototype may prove beneficial for high tactile places. Hospitals may place hand sanitizer dispensers with the counter at the entrance

to encourage visitors to complete hand hygiene. Healthcare workers can also see the impact they are making on their unit when they use hand sanitizer. The positive reinforcement counter hand sanitizer dispenser can be used in public places as well. Examples of highly tactile areas include grocery stores, gyms, and restaurants.

The prototype may also prove to be beneficial financially compared to other positive reinforcement methods in the past. In comparison to past studies, who have used prizes to encourage higher hand hygiene compliance rates, the electronic counter is a one-time cost. The counter can also be reset back to zero. For the model used in this study, turning the counter off and back on reset the number to zero. An optional counter reset can be beneficial for places that want a daily count or have a high flow of customers. The number of people who completed hand hygiene can also be recorded manually, making the prototype a tool for hand hygiene compliance data.

Conclusions

Hand hygiene compliance is essential for decreasing the spread of infection (CDC, 2016). With hospital-acquired infection rates high, seasonal colds and flu ever-present, and the Coronavirus causing concerns for the future, hand hygiene is more important than ever. With the success of environmental benefits calculators showing consumers their impact on the environment, a counter showing how many people engaged in hand hygiene was studied. The hand sanitizer dispenser with a counter and messaging was compared to a hand sanitizer dispenser with no intervention. The results were statistically significant, with the p-value being < 0.001. There was a significant increase in the number of people who completed hand hygiene with the electronic counter compared to the dispenser with no intervention.

To our knowledge, this is the first electronic counter intervention for hand hygiene of its kind. More research is needed to gain a better understanding of the electronic counter's influence on hand hygiene compliance. Suggestions include trying different counter set-ups, locations, messaging, and colors. Testing out a larger counter display may attract more users. Placing the prototype in different locations can potentially show different hand hygiene compliance rates or behaviors. Testing different messaging and coloring of signage may entice more people to use hand hygiene. In the future, the counter may be considered towards other methods of hand hygiene, such as hand washing. With all of the recommendations in mind, the project shows to have a future in rethinking hand hygiene. Whether it comes to hand sanitizer or soap, every drop counts.

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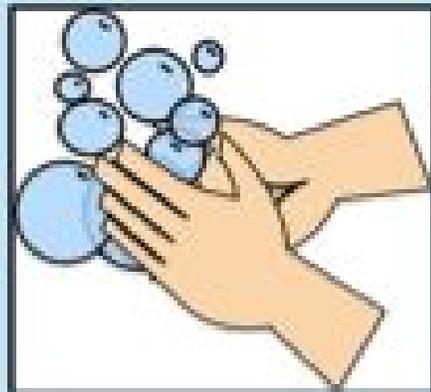
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Appendix A



Appendix B

**THE #1 WAY
TO PREVENT
SPREADING
GERMS LIES IN
YOUR HANDS**



Appendix C

