Increasing hand-hygiene compliance in clinical settings using a baby-eyes sticker: A field study

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Abstract
This double-blind field study tested the effectiveness of a baby-eyes image in promoting healthcare workers’ hand-hygiene compliance in a hospital setting. Adults are inclined to take care of babies and aspire to be their role models; therefore, they should wash their hands thoroughly when being watched by babies. Participants were healthcare workers from the obstetrical and neonatology units of a women’s hospital in Hangzhou. We recorded and coded 3,360 hours and 10,325 hand-hygiene events over a five-week period—from 16 October to 20 November 2018. Three types of stickers, depicting baby eyes, adult eyes, or flowers, were placed above handwashing basins to compare hand-hygiene behavior between the three conditions. Each condition continued for one week, and experimenters interchanged the stickers in each unit to control for the location and sequence effects. Participants in the baby-eyes condition (72.9%) were more likely to use sanitizer than those in the flowers condition (69.4%; \( \chi^2 = 9.74, p < .01, \phi_c = 0.034 \)). Moreover, participants in the baby-eyes condition were more likely to use sanitizer than those in the adult-eyes condition (70.8%); however, the difference only trended towards significance (\( \chi^2 = 2.38, p = .066, \phi_c = 0.023 \)). The mean handwashing time between the three conditions was significant (Welch’s \( F(2, 3488.436) = 3.50, p < .05, \eta^2 = 0.001 \)). Washing time in the baby-eyes condition (17.41 \pm 12.02) was significantly longer than in the adult-eyes condition (16.36 \pm 11.47; \( p < .05 \)). The presence of a baby-eyes image promoted hand-hygiene compliance in the hospital environment. This finding can be adopted to change public health behaviors. It also holds theoretical implications that enhance our understanding of how being monitored by children can enhance responsible behaviors.

Keywords
baby-eyes sticker, sanitizer usage, adult-eyes sticker, handwashing, handwashing duration, healthcare workers

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As the COVID-19 outbreak continues to evolve, enacting proper hand hygiene (e.g. sanitizer usage and extensive hand-rubbing; World Health Organization [WHO], 2009) is imperative. Timely hand hygiene can remove at least 98.36% of SARS-CoV-2 (Ma et al., 2020). A recent study estimated that, by increasing hand hygiene at airports, the risk of an outbreak turning into a pandemic could be reduced by 24–69% (Nicolaides et al., 2019). However, poor hand-hygiene compliance remains a serious issue undermining public health during the current COVID-19 pandemic.

Hand-hygiene practices among healthcare workers are particularly important since healthcare workers’

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hands are the foremost means of pathogen transmission (Lotfinejad et al., 2020). A low level of compliance with hand-hygiene guidelines contributes to hospital-acquired infections including gastrointestinal, respiratory, and skin infections (Bloomfield et al., 2007). Hospital-acquired infections lead to significant morbidity and mortality and increase the burden of cost on the patients and the healthcare system (Graves et al., 2007). Research has shown that the hands of healthcare workers are the primary means of transmitting pathogens and causing hospital-acquired infections (Ducel et al., 2002). Thus, effective hand hygiene among healthcare workers is a key step to reducing cross-infection in hospitals.

Hospital administrators have typically adopted education-based programs to promote hand hygiene through emphasizing its importance or demonstrating proper hand-hygiene procedures, including using sanitizer and rubbing hands together for some time (Gould et al., 2008; Naikoba & Hayward, 2001; Pittet et al., 1999). For example, to reduce hospital infections, many hospitals have introduced the WHO campaign, “My five moments of hand hygiene,” a promotional program based on the education, training, monitoring, and reporting of hand hygiene to improve hand-hygiene practice among healthcare workers (Sax et al., 2007). Unfortunately, despite several efforts directed at increasing hand hygiene, the rate of adherence to hand-hygiene regulations in hospitals has remained suboptimal with no more than 40% compliance (Blauuw et al., 2010). It is even more sobering that a study conducted in a hospital lobby found that the rate of hand-hygiene compliance was less than 12% (Sevdalis et al., 2012). Although the National Health Commission of the People’s Republic of China does not explicitly require the rate of adherence to hand hygiene for medical staff, it does require them to perform hand hygiene with soap (or sanitizer) and running water for at least 15 seconds.

Since the education-based interventions promoted by hospitals only produced transient and modest improvements in hand hygiene (Naikoba & Hayward, 2001; Pittet et al., 1999), researchers adopted a new strategy to promote hand hygiene; they decided to design a physical environment to stimulate effective hand hygiene (King et al., 2016; Schmidtke et al., 2017). In this study, a new visual design was introduced to promote hand-hygiene compliance. Building on a previous study that showed that a picture of adult eyes can enhance hand-hygiene compliance (King et al., 2016), we investigated whether a picture of baby eyes can induce hand-hygiene compliance to a greater extent.

Healthcare workers who do not clean their hands thoroughly do not necessarily intend to be careless. They have already been educated about the importance of hand hygiene and trained on how to properly clean their hands (Jackson et al., 2010). However, they fail to do so when their other duties take priority or when they are extremely busy and their minds are preoccupied. Therefore, introducing effective cues into their immediate environment may remind workers to clean their hands properly. Hospital administrators should aim to design the environment in such a way that proper hand-hygiene practices are rarely, if ever, forgotten. Based on the theories of behavioral science that emphasize the automatic processes of human behavior and judgement (Bartholomew & Mullen, 2011), it has been demonstrated that exposure to certain cues (e.g., words, smells, or images) in the environment activates certain behaviors. Previous studies used olfactory primes to increase hand-hygiene compliance (King et al., 2016; Schmidtke et al., 2017). A recent study that is more relevant to the present study used an image of adult eyes to promote hand hygiene. Researchers installed a picture of a pair of adult eyes above an alcohol sanitizer and found that this manipulation led to an increase in the number of people who used the sanitizer before entering the ward (King et al., 2016). Specifically, an image of adult male eyes boosted hand-hygiene compliance by 18% (King et al., 2016). The objective of the present study was to extend these findings using a different prime: an image of baby eyes. The baby-eyes prime used in this study provides a potentially powerful mechanism to achieve this important goal.

Eyes are a powerful perceptual signal for human beings. The mere presence of a picture of eyes can exert an influence on human behavior because the brain naturally reacts in specific ways to images of faces and eyes. It has been established by previous research that, when people feel they are being observed, they tend to cooperate and comply with social regulations (Bateson et al., 2006; Ernest-Jones et al., 2011; Nettle et al., 2012). People behave differently when they believe that they are being observed because they are anxious about others’ opinions of them. Indeed, researchers have discovered that merely presenting a picture of eyes appearing to watch people nearly tripled the amount of money put in a box (Bateson et al., 2006). In the lounge of a psychology department, when a picture of male eyes was placed on the price list, the staff paid 2.76 times more for their drinks than during the weeks with a picture of flowers on the list. The previous study examined the impact of both male and female eyes, but it did not include baby eyes (King et al., 2016). They found that an image of adult eyes placed above a hand sanitizer can promote handwashing. In this study, we introduced a novel intervention cue: a pair of baby eyes.
In this study, we hypothesized that a pair of baby eyes may be especially effective in promoting handwashing among healthcare workers. Adult eyes may promote hand hygiene by triggering feelings of being watched and monitored. However, we assumed that baby eyes would trigger not only feelings of being watched but also the urge to be a role model for others, especially children. Children observe and adopt others’ behaviors via unconscious mimicry in addition to consciously learning social norms (Bandura, 1977). Research suggests that adults tend to refrain from inappropriate behaviors in front of babies (Bandura & Walters, 1963) because they are afraid that their behaviors may be imitated by the babies. Therefore, a pair of baby eyes may trigger the urge to perform responsible behaviors, such as hand-hygiene compliance, since adults tend to set a good example for babies.

Moreover, baby eyes differ from adult eyes in that they may trigger caregiving-related thoughts in adults, which should lead to more responsible behaviors such as hand-hygiene compliance. Human babies are quite vulnerable and depend completely on adults for survival. Thus, it is essential for adults to have a natural tendency to respond to the needs of babies (Emlen, 1970; Trivers, 1974). Indeed, natural selection should favor babies who have the ability to elicit protection or other forms of care from adults. This ethological view has been supported by mounting evidence that infantile characteristics can elicit caregiving tendencies in adults (Bell & Harper, 1977; Harper & Varakis, 1970; Lewis & Rosenblum, 1974).

We examined the effectiveness of an image of baby eyes to promote hand-hygiene compliance in a clinical setting. To summarize, building on previous literature that a picture of adult eyes can promote cooperation regarding hand hygiene (Ernest-Jones et al., 2011; Pfatteicher & Keller, 2015; Powell et al., 2012), this study investigated whether a picture of baby eyes can produce the same result. Specifically, we manipulated the hand-hygiene environment by placing an image of a pair of baby eyes above four non-surgical washing sinks in a hospital.

Method

Public involvement

No patients were involved in this study. Our study included members of the medical staff (physicians, nurses, and ancillary staff) in the neonatal and obstetrical units of a women’s hospital. The hospital administration had installed cameras to monitor the handwashing sinks a few months before this study was conducted; all hospital workers were aware of these cameras. The participants were first involved in the study after the new cameras had been installed by the researchers, and the stickers had been pasted above each sink. The identity and privacy of the medical staff were protected during the recording of the video clips because they all wore surgical masks, the cameras could not record their faces clearly enough to enable recognition, and the coders only coded the washing events and not the participants’ identities. Since this study aimed to unconsciously influence people’s behavior, the medical staff were not informed of the study beforehand; however, they were debriefed about the entire procedure after the experiment was concluded.

Study setting

This study took place in the obstetrical and the neonatal units in a 950-bed women’s hospital in China. All of the participants came from the neonatal unit and the obstetrical unit. The obstetrical unit had 55 nurses and 11 nursing workers; however, the exact number of doctors could not be determined since they came from different wards. The number of obstetrical doctors did not affect the experiment since the profession of the handwashers was not the primary variable in our study. The neonatal unit had 30 doctors, 30 nurses, and 6 caregivers. Our participants comprised healthcare workers including physicians, nurses, and ancillary staff. The women’s hospitals generally implement higher standards for handwashing in the neonatal unit than in the obstetrical unit to protect newborns from hospital-acquired infections.

This particular hospital had installed cameras to monitor the handwashing sinks in the neonatal and obstetrical units from January 2012, and all workers were aware of this. The cameras allow clear views of the washing areas. Since the pixelation of images from the old cameras in the two units was too low to observe and record the hand movements of the washers, we updated four cameras (two per unit) and placed them on the oblique top of each sink under observation (Figure 1). The updated cameras had a high-resolution version (Hikvision DS-2CD3325D-1, with a lens diameter of 4 mm and a resolution of 2 MP). The diameter of the cameras was about 30 cm. This update was approved by the hospital ethics committee. We conducted the study over a five-week period from 16 October to 20 November 2018. During the observation period, we witnessed 10,325 handwashing events. Since it was an observational experiment, we could not be sure of the exact number of samples that would be adopted before the experiment was over.
This experiment lasted for five weeks and comprised three conditions: flower sticker, adult-eyes sticker, and baby-eyes sticker. The adult eyes and flower sign are from a published paper (Manesi et al., 2016). The picture of baby eyes is from www.quanjing.com. We obtained informed consent from the owners for publication of this photograph. These stickers were photoshopped black-and-white images and were pretested to ensure they had equal contrast and brightness (see Figure 2). The stickers, measuring 5.24 × 1.64 inches, were affixed to the wall right above the faucet to make them prominent to people washing their hands (Figure 3). Table 1 shows the timeline for each condition and the number of handwashing events. We adopted a cross-over design to control the confounding factors of order effect and unit effect. Each washing sink was observed under the three study conditions; in any given week during the five-week study period, one condition was active in each sink. The conditions were changed at 5:00 p.m. each Monday afternoon, when the washing area tended to be nearly empty, to ensure that no one noticed the replacement process.
Each eyes condition was placed between the flower conditions to neutralize the effect of the previous condition. A schematic layout of the schedule is presented in Table 1.

**Coding and variables**

Eight volunteers served as coders to code the video clips. They were openly recruited from undergraduate students in preventive medicine and were not aware of the experimental hypothesis at the time of coding. They were randomly divided into four pairs of coders. Each pair was responsible for one of the four cameras, and each coder coded the video clips independently. Each coder calculated the duration of every handwashing event in seconds and identified whether sanitizer was used (1 = used; 0 = not used). For each camera, two coders showed high consistency in washing duration (Table 2). In addition, identification of sanitizer usage was almost identical between the two coders with the exception of one handwashing event. The disagreement was resolved by consulting a third coder.

**Sanitizer usage.** This hospital requires staff to use sanitizers; therefore, the events in which hand sanitizer was used were coded as 1 and events without sanitizer were coded as 0. The number of people who used sanitizer was the primary outcome. This index was calculated by dividing the number of people who used sanitizer in a particular condition by the total number of people who washed their hands in that condition.

**Washing duration.** The duration of handwashing events was the secondary outcome. Washing duration was calculated as the time from using the hand sanitizer to turning off the faucet for the last time.
Results

Hand sanitizer usage

Overall, the four cameras recorded 3,360 hours and 10,325 hand-hygiene events, which were coded and analyzed. No hand-hygiene event was excluded. Among them, 70.5% (7,276/10,325) included the use of sanitizer and 29.5% (3,049/10,325) failed to do so. Washing events in the neonatal unit showed a higher percentage of sanitizer usage than did those in the obstetrical unit ([85.3% (5,490/6,433) and 45.9% (1,786/3,892), respectively]; $\chi^2 = 1813.71$, 95% CI [0.13, 0.16], $p = .000 < .01$, effect size $\phi_c = 0.419$).

Next, we compared sanitizer usage between the three conditions (flowers, baby eyes, and adult eyes). Consistent with our predictions, participants in the baby-eyes condition (72.9%, 1,737/2,384) were more likely to use sanitizer than those in the flower condition (69.4%, 4,111/5,924); however, the difference only trended towards significance ($\chi^2 = 2.38$, 95% CI [0.97, 1.17], $p = .125$). Moreover, participants in the baby-eyes condition were also more likely to use sanitizer than those in the adult-eyes condition (70.8%, 1,428/2,018); however, the difference only trended towards significance ($\chi^2 = 3.01$, 95% CI [0.94, 4.95], $p = .083$).

Table 1 Schedule of stickers on different sinks and video clips of hand hygiene.

| Week | Neonatology 1 | Neonatology 2 | Obstetrics 1 | Obstetrics 2 |
|------|---------------|---------------|--------------|--------------|
| 1    | sticker clips | sticker clips | sticker clips | sticker clips |
| 2    | flower 522    | flower 502    | baby eyes 422 | adult eyes 425 |
| 3    | baby eyes 594 | adult eyes 884 | flower 481    | flower 410   |
| 4    | flower 558    | flower 993    | adult eyes 373 | baby eyes 367 |
| 5    | adult eyes 434 | baby eyes 1001 | flower 201    | flower 315   |
| Total| 2458          | 3975          | 2048         | 1844         |

Table 2 Consistent levels of handwashing duration.

| Camera       | Spearman's $r$ |
|--------------|----------------|
| Neonatal 1   | .957**         |
| Neonatal 2   | .921**         |
| Obstetrics 1 | .950**         |
| Obstetrics 2 | .951**         |

Note: ** $p < .001$.

Figure 3 Stickers used in the units, as captured by cameras: (a) stickers used in the neonatal unit, as captured by camera a; (b) stickers used in the neonatal unit, as captured by camera b; (c) stickers used in the obstetrics unit, as captured by camera a; (d) stickers used in the obstetrics unit, as captured by camera b.
1.27], \( p = .066, \phi_v = 0.023 \). Finally, there was no significant difference between the rate of using hand sanitizer in the adult-eyes condition and the flower condition \( (\chi^2 = 1.31, 95\% \text{ CI } [0.96, 1.19], p = .262 > .05, \phi_v = 0.013) \). These statistics are depicted in Figure 4.

**Handwashing duration**

We then analyzed handwashing duration between the three conditions (flowers, baby eyes, and adult eyes). On average, handwashing lasted for a duration of 16.91 seconds among overall observations across all conditions. One-way analyses of variance showed that the intervention effect of stickers on the duration of handwashing was significant (Welch’s \( F(2, 3488.436) = 3.50, p = .03 < .05 \), effect size \( \eta^2 = 0.001 \)). The Games–Howell post-hoc test showed that the washing duration in the baby-eyes condition \( (M = 17.41 \text{ seconds}, SD = 12.02, 95\% \text{ CI } [16.88, 17.95]) \) was significantly higher than in the adult-eyes condition \( (M = 16.36 \text{ seconds}, SD = 11.47, 95\% \text{ CI } [15.79, 16.93], p = .02 < .05, \eta^2 = 0.002) \). However, there was no significant difference between the baby-eyes condition and the flower condition in duration \( (M = 16.88 \text{ seconds}, SD = 11.35, 95\% \text{ CI } [16.55, 17.23], p = .22 > .05, \eta^2 = 0.000; \) Figure 5).

Since the hospital administration instituted a higher standard for handwashing in the neonatal unit than in the obstetrical unit in this hospital, we analyzed handwashing duration in the two units separately. There was no significant effect induced by the change of stickers on the handwashing duration in the neonatal unit \( (\text{Welch’s } F(2, 2829.05) = 2.62, p = .07 > .05, \eta^2 = 0.02) \). However, the stickers had a significant effect on handwashing duration in the obstetrical unit \( (\text{Welch’s } F(2, 666.57) = 2.91, p = .04 < .05, \eta^2 = 0.04) \). In the obstetrical unit, the average handwashing duration in the baby-eyes condition was 19.82 seconds \( (SD = 12.24, 95\% \text{ CI } [18.60, 21.03]) \), which was significantly longer than in the adult-eyes condition \( (M = 18.48 \text{ seconds}, SD = 11.96, 95\% \text{ CI } [17.17, 19.79], p = .03 < .05, \eta^2 = 0.003) \). Although it was only trending towards significance, the eyes sticker condition had a longer handwashing duration than the flower sticker condition \( (M = 18.12 \text{ seconds}, SD = 10.83, 95\% \text{ CI } [17.47, 18.77], p = .26 > .05, \eta^2 = 0.01) \).

**Discussion**

In the ongoing pandemic, public health officials have advocated hand hygiene as one of the best ways to protect against COVID-19 (Choi & Ki, 2020; Lai et al., 2020). The current standard for hand hygiene to prevent SARS-CoV-2 infection involves scrubbing the hands thoroughly with hand sanitizer and clean water for at least 20 seconds. However, many people may still fail to comply with these instructions. Through the analysis of 10,325 hand-hygiene clips from the hospital sinks, this study demonstrated that a picture of baby eyes placed in the immediate environment can promote effective hand hygiene in clinical settings. Not only did the picture of baby eyes increase sanitizer usage by 3.5% and 2.1% compared to the flower and adult-eyes conditions, respectively, it also
led to people washing their hands for 1.05 and 1.34 seconds longer on average among total workers and among the obstetrical unit workers, respectively, compared to the picture of adult eyes. Our research suggests that people react more quickly and positively to baby eyes than to adult eyes.

**Strengths and limitations**

This study provides evidence that a picture of baby eyes promotes hand-hygiene compliance more effectively than either a picture of adult eyes or a picture of flowers. One possible explanation for this is that the baby-eyes setting may trigger thoughts related to caring as well as avoiding inappropriate behavior in the presence of babies, prompting the healthcare staff to behave more responsibly. The other possible explanation for this is that the adult eyes in the picture used in this study did not look stern enough. A previous study showed that a picture of stern-looking male eyes promoted handwashing compliance, whereas female eyes (gaze undescribed) failed to produce such an effect (Schmidtke et al., 2017). It has been argued that eyes with a stern expression can effectively promote hand-hygiene compliance through asserting authority and fear of punishment (Carli, 2001).

A picture of baby eyes did not influence washing duration among workers in the neonatal unit. A possible explanation is that the neonatal unit has a higher standard action (e.g. six steps) for handwashing; thus, there could be a ceiling effect in washing duration in this unit since workers in the neonatal unit regularly implement these handwashing steps; that is, they have formed a habit of it and can perform the action in less time. Indeed, the average washing duration in the neonatal unit was 16.43 seconds, whereas the average washing duration in the obstetrical unit was 18.56 seconds. Another reason may be that workers in the neonatal unit are exposed to babies often; thus, an image of baby eyes failed to exert much influence on them.

This study had several limitations. One of the primary limitations is that the cameras only captured clips of the people who washed their hands in the sink. It cannot be known how many people did not wash their hands. We could only gather data about those who came to the sink to wash their hands; those who did not intend to wash their hands were not considered. This limitation may create a selection bias in our sample. Moreover, the choice to observe handwashing at only four washing sinks is another major limitation because there are other washing sinks in the hospital used by the workers. Finally, we cannot guarantee that the workers noticed the image each time they came to wash their hands or in each condition.

Appropriate hand-hygiene compliance is an essential practice in clinical environments to prevent hospital-acquired infections. Despite its importance, low rates of hand-hygiene compliance have been regularly reported. In the flower condition of this study, only 69.4% of people used sanitizer and 32.3% exceeded 20 seconds of washing. Given the fact that we did not examine those people who did not come to the sinks, this figure is disappointingly low.

The findings of our study have important practical implications that can be adopted by hospital administrators to change public health behaviors using a low-cost intervention. The findings could be applied in initiatives to promote hand-hygiene compliance.
The results also hold theoretical implications that help to enhance our understanding of how being monitored by others can contribute to cooperative behaviors and compliance to regulations.

To the best of our knowledge, this study was the first to evaluate the effect of an image of baby eyes in a real-world clinical setting. Based on these preliminary findings, we believe that further research in examining the effectiveness of this stimulus should explore its effects in other settings and for other cooperative behaviors. It is possible that a pair of innocent baby eyes may be a powerful tool to encourage people to perform essential behaviors benefitting themselves as well as others.

**Conclusion**

Adults are more likely to respond positively when they perceive that they are receiving a baby’s attention, even if it is only an image of a baby’s eyes. This finding can be effectively used to increase hand-hygience compliance in the current COVID-19 pandemic. During a pandemic, hand-hygience compliance can lead to better resistance against the virus and reduce the risk of infection. This study provides a promising approach to improve hand-hygience compliance. The presence of an image of baby eyes leads to a sense of gaze, which activates the role model effect. In the current pandemic, it is a simple and economic measure to protect both healthcare workers and patients as well as the general public. The stickers cost very little; however, hand-hygience compliance induced by them will save lives.

**Declarations of interest**

The author(s) declare that there are no conflicts of interest.

**Ethical considerations**

The Women Hospital School of Medicine Zhejiang University approved this study, and the ethical review approval number is 20180048.

**Data sharing statement**

Upon completion of the study and after publication of the primary manuscript, data requests for academic purposes can be submitted to the lead author (QY) or chief investigator (XZ) of this manuscript with publishable contact details. The data are deidentified participant data.

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**Author contributions**

The manuscript was collaboratively developed by all the authors. QY and TS wrote the manuscript with coordinated input from all collaborators. XZ substantially contributed to the redrafting of the manuscript. TS, FW, HW, and FX largely wrote the sample-size section along with the method section. TS, RL, and ZW largely wrote the statistical analyses.

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