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## Major article

## A study of the efficacy of flashing lights to increase the salience of alcohol-gel dispensers for improving hand hygiene compliance



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## Key Words:

Infection control  
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**Background:** Many interventions have been implemented to improve hand hygiene compliance, each with varying effects and monetary costs. Although some previous studies have addressed the issue of conspicuousness, we found only 1 study that considered improving hand hygiene by using flashing lights.

**Method:** Our attention theory-based hypothesis tested whether a simple red light flashing at 2-3 Hz affixed to the alcohol gel dispensers, within the main hospital entrance, would increase hand hygiene compliance over the baseline rate. Baseline and intervention observations were completed over five 60-minute periods (Monday-Friday) from 7:30 to 8:30 AM using a covert observation method.

**Results:** Baseline hand hygiene compliance was 12.4%. Our intervention increased compliance to 23.5% during cold weather and 27.1% during warm weather. Overall, our pooled compliance rate increased to 25.3% ( $P < .0001$ ).

**Conclusions:** A simple, inexpensive flashing red light affixed to alcohol gel dispensers was sufficiently salient to approximately double overall hand hygiene compliance within the main hospital entrance. We hypothesize that our intervention drew attention to the dispensers, which then reminded employees and visitors alike to wash their hands. Compliance was worse during cold days, presumably related to more individuals wearing gloves.

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Attention is the ongoing cognitive process of acquiring information from one's environment. In some circumstances, the stimuli that we select to process are inappropriate, resulting in a failure of selective attention. Occasionally, we are unable to focus on one important source of information while ignoring others, resulting in a failure of focused attention. Divided attention is the cognitive process of concurrently distributing one's attention across multiple sources of information within an environment. Here, failure to perceive and process critical cues can be considered a failure of divided attention.<sup>1</sup>

The hospital environment is information-rich and attention-seeking, with many signs, colors, frequent alarms, and public address system announcements. Our hospital's main entrance has

flashing lights at the automated teller machine, auditory cues directing attention to parking payment machines, and many other directions, posters, and signs. In addition, individuals entering the hospital may be easily distracted and/or preoccupied by their cell phones, bags, and coffee mugs. Consequently, hand alcohol gel dispensers, which are inconspicuous objects within hospitals such as ours, are easily ignored.

Errors of omission (ie, omitting necessary tasks) are one of the most common types of human error.<sup>2</sup> In most situations, failure to disinfect hands can be considered an error of omission, consequent to a failure of divided attention. Certain circumstances increase the probability that a particular step or task will be omitted; for instance, tasks in which an item to be acted on is concealed or lacking in conspicuousness are liable to be omitted.<sup>2</sup>

Errors of omission often can be reduced by increasing a target's salience, thereby drawing attention to it. For example, visual attention will be drawn to items that are large, bright, colorful, and constantly changing (eg, blinking).<sup>1</sup> This general concept has been applied in previous hand hygiene studies. In one such study, hand

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hygiene compliance at the front entrance of a large tertiary care hospital at baseline was 0.52% and increased to nearly 12% simply after signage was placed near the existing hand hygiene dispenser.<sup>3</sup> Fakhry et al<sup>4</sup> used motion sensor-triggered audible hand hygiene reminders; compliance improved immediately from 10.6% to 63.7% and was sustained over a 6-month period. However, we found only 1 previous study that evaluated (in a simulated setting) the effect of a flashing light on compliance.<sup>5</sup> That intervention, in combination with improving the line of site of a dispenser, significantly improved preexamination compliance from 37% to 66%.

The purpose of the present study was to evaluate the effect on hand hygiene compliance of a simple, inexpensive, salient red flashing light affixed to hand alcohol gel dispensers at the front entrance of our hospital.

## METHODS

### Setting

The study setting was the main entrance of a large tertiary care academic hospital. We chose the main entrance for observing hand hygiene compliance because numerous observations could be recorded in a relatively short time compared with other locations. Formal approval from our local Research Ethics Board was obtained before study initiation.

Eight hand alcohol gel dispensers were located on 4 sides of 2 separate stands. The stands were located in the main foyer that leads to other halls.

### Properties of the intervention

Four red flashing lights were used. The lights were attached with high-grade organosiloxo polymer (total cost of C\$1.50) to 4 of the 8 alcohol dispensers. The lights were in the line of sight of the majority of pedestrian traffic and operated independent of one another.

Each light lasted up to 15 hours, was rechargeable via a USB cable, and cost \$9.75. In total, our system cost \$40.50 and was installed within minutes.

### Light color

A red light was selected because it conventionally directs individuals to stop or slow down. This would then draw attention to the signage requesting performance of hand hygiene.

### Light frequency

Flashing lights have been shown to be more conspicuous than constant lights.<sup>6,7</sup> The ideal frequency for the present study was deemed to be 2-5 Hz (flashes/second), to ensure greater conspicuousness while not exceeding the threshold of 5 Hz, beyond which epileptiform seizures may be triggered.<sup>8</sup> Our lights had a frequency of 3 Hz.

### Brightness

One potential problem with brightness is annoyance or discomfort. We hypothesized that a flashing red light used to identify bicyclists at night would be adequate for this study, bright enough to catch the attention of passers-by, but not blinding. The lights had a luminous flux of 23 lumens.

### Auditing method

All observers were trained to use the covert observation (ie, "secret shopper") method used at other institutions.<sup>9</sup> Any hand

**Table 1**

Compliance data: percentages during baseline and intervention periods in September 2012,\* January 2013, and April 2013

Period	Compliant	Noncompliant	Total	%
Baseline 1 (September 17-21, 2012)	396	2661	3057	13
Baseline 2 (January 7-11, 2013)	358	2476	2834	12.6
Intervention 1 (January 14-18, 2013)	730	2370	3100	23.5
Baseline 3 (April 15-19, 2013)	360	2699	3059	11.8
Intervention 2 (April 22-26, 2013)	835	2248	3083	27.1

\*No intervention during this period.

hygiene attempt at the moment of entering or exiting the entrance was considered a compliance event, regardless of the quality of the attempt. No identification of the subject as a visitor or an employee was recorded. Over the same time period, all persons entering the hospital were counted. Only children who were judged not capable of using the hand alcohol gel dispenser on their own accord were excluded from this count.

All observations were completed over five 60-minute periods on Monday through Friday, from 7:30 to 8:30 AM.

### Baseline compliance observations

Baseline hand hygiene compliance was determined during 3 separate Monday-Friday inclusive sessions. The initial baseline compliance was evaluated on September 17-21, 2012 (baseline 1) by the principal investigator, with the intention of determining the magnitude of hand hygiene compliance. Subsequent observations of baseline compliance were completed by trained observers (blinded to the study hypothesis and protocol) on January 7-11, 2013 (baseline 2) and April 15-19, 2013 (baseline 3).

### Intervention observations

The first intervention period (intervention 1) was January 14-18, 2013. Trained observers not involved during baseline 1 were used. Of note, a community outbreak of influenza occurred during this intervention period.

Another set of baseline and intervention assessments (intervention 2) was completed on April 22-26, 2013, immediately after baseline 3. This unplanned assessment was performed to determine the effect of cold weather, if any, on compliance during the January observation period.

### Statistical analysis

The percentage of observed subjects compliant with hand hygiene was determined by dividing the number of compliant subjects by the total number of subjects deemed eligible to be compliant because they walked past the dispenser stands.

Chi-square analysis was used to determine any statistically significant difference between baseline and postintervention compliance. Post hoc correlation analysis was used to identify any relationship between compliance and morning temperature. (The mean morning temperature for each observation day was calculated by taking the mean of the published values for the 7:00-8:00 and 8:00-9:00 AM time periods from the Environment Canada Web site.) A multivariable linear regression model was applied to determine the adjusted effect of intervention, temperature, and individual days of the week on each day's compliance.

## RESULTS

During this study, we directly observed 15,133 opportunities for hand hygiene. As shown in Table 1, mean hand hygiene compliance

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