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## Major Article

## Use patterns and frequency of hand hygiene in healthcare facilities: Analysis of electronic surveillance data

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## Key Words:

Hand hygiene  
Healthcare  
Monitoring  
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Occupational exposure**Background:** Healthcare workers perform hand hygiene much more frequently than workers in other fields. As a result, healthcare workers have a higher exposure to topical antiseptic products.**Methods:** Five tertiary care facilities were equipped with an electronic hand hygiene compliance monitoring system. Alcohol-based handrub (ABHR) and handwash use was recorded on a worker-specific basis for 6 months. Total hand hygiene product use and total hours worked were calculated for each worker to determine use frequency.**Results:** A detailed, descriptive analysis of hand hygiene practices was performed. All facilities demonstrated high hand hygiene compliance rates (>85%). ABHR use was more frequent (9.1 uses/hour, 95<sup>th</sup> percentile) than handwashing (2.1 uses/hour, 95<sup>th</sup> percentile). This study identified a relationship between hand hygiene frequency and job function. Nursing and nonclinical support staff demonstrated higher usage rates than other healthcare workers. For these workers with high hand hygiene frequency, 95<sup>th</sup> percentile usage rates for ABHR use and handwashing were 9.6 and 2.2 uses/hour, respectively.**Conclusions:** This extensive dataset, monitoring nearly 4000 healthcare workers and more than 6 million data points, provides a detailed description of current hand hygiene practices of hospital staff. ABHR was used more frequently than handwashing. Job function was found to affect hand hygiene frequency, with nonclinical staff and nursing staff demonstrating elevated rates of hand hygiene.© 2018 Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## BACKGROUND

Hand hygiene of healthcare personnel is recognized as a crucial factor in limiting healthcare-associated infections. The World Health Organization (WHO)<sup>1</sup> and the Centers for Disease Control and Prevention (CDC)<sup>2</sup> recommend that healthcare workers wash their hands with soap and water when visible soil is present. When hands are not visibly soiled, hand hygiene with an alcohol-based handrub (ABHR) is recommended. The use of ABHR is faster, more effective, and less damaging to the skin, and it is the hand hygiene modality most frequently used by healthcare workers in the United States.<sup>3</sup> WHO<sup>1</sup> introduced the concept of “My Five Moments for Hand

Hygiene,” which includes the following hygiene opportunities: 1) before touching a patient; 2) before a clean/aseptic procedure; 3) after body fluid exposure risk; 4) after touching a patient; and 5) after touching a patient’s surroundings. In complying with these clinical guidelines, healthcare workers often have a higher exposure to hand hygiene product ingredients than workers in most other fields. Furthermore, workers with more frequent patient contact require an even higher frequency of hand hygiene to comply with clinical guidelines. To demonstrate the safety of hand hygiene product ingredients, the U.S. Food and Drug Administration<sup>4</sup> has requested data from repeated-exposure safety studies using human subjects and representative usage patterns. To create an accurate exposure model, it is necessary to assess current hand antiseptics practices and frequency of use in actual healthcare facilities.

Several observational and self-reported studies have evaluated compliance with the recommendations from the WHO<sup>1</sup> report. Some studies reported that the average number of hand hygiene opportunities for nurses in an intensive care unit was as high as 30 events/hour.<sup>5,6</sup> Although such studies estimated the hypothetical

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number of hand hygiene events based on job responsibilities, the authors reported on hygiene opportunities, not on actual measured hand hygiene events. Limitations noted in observational studies of hand hygiene frequency have included inconsistent observational methods, small sample sizes, and potentially biased observers.<sup>7-11</sup> The Hawthorne effect has also been noted with observational studies, repeatedly showing that the presence of observers alters behavioral practices of the test population during the observation period. This effect results in a temporary upsurge of hand hygiene events during the direct surveillance period.<sup>12</sup> The net result is that this influence misrepresents long-term hand hygiene patterns. If healthcare facilities have an inaccurate understanding of actual hand hygiene practices, they may not devote the proper resources to continuous improvement of these essential intervention practices, potentially increasing the risk of costly hospital-acquired infections.

In contrast to observational studies, electronic data gathering has a major advantage in that it eliminates the bias and subject influence that is inherent in observational studies.<sup>13</sup> Electronic monitoring also allows 24-hour monitoring, which would be arduous at best with a direct observational study.<sup>14</sup>

The analysis reported in this article draws from extensive, highly accurate data—measurements of hand hygiene events gathered unobtrusively through electronic monitoring in 5 hospitals over 6 months, generating a dataset of more than 1.4 million person-hours from 4208 healthcare workers. This study used the Ecolab Hand Hygiene Compliance Monitoring System (HHCMS). In this system, each employee has a unique identification badge that communicates with the monitoring system. Monitoring is done without interruption, on a 24-hour basis, 7 days per week. The Ecolab HHCMS was developed to ensure hand hygiene compliance, but it is uniquely valuable for providing near real-time data on hand hygiene frequency that is highly relevant for understanding current hand hygiene practices and determining occupational exposure levels to hand hygiene products.

### Study objective

The objective of this study was to employ direct measurement data to perform a highly accurate descriptive analysis detailing how frequently healthcare workers use hand hygiene products in an occupational setting.

### METHODS

Data were gathered over a 6-month period spanning July 1, 2016, to December 31, 2016, in 5 medium-sized healthcare facilities ranging from 200 to 500 beds per hospital. All 5 facilities had general medical-surgical units as well as multiple specialty services, which varied by hospital. Examples of specialty services included orthopedics, maternity care, and cardiac care. Each facility was equipped with the Ecolab HHCMS, which employs monitoring beacons that communicate with each dispenser and with the badge of each employee. Therefore, each recorded or logged product dispense is associated with an individual, the individual's job description, the dispensing location, and a time and date record of the specific product being dispensed. When a hand hygiene product is dispensed (ie, either an ABHR or a handwash product), the event is communicated to a central database by wireless connection. During the 6-month surveillance period considered in this study, more than 6.65 million (6,652,474) dispensing events were recorded, and a total of approximately 1.4 million person-hours were tracked for product use. All healthcare workers employed directly by the hospitals were monitored.

Hand hygiene product usage data were collected from locations where workers would have a high frequency of patient contact. The Ecolab HHCMS does not include hand hygiene dispensers in public restrooms, and dispensers in surgical scrub sink areas were also not included in this analysis. Further excluded were products such as hand-conditioning lotions and creams, which were available to the staff in the facilities but are not used for hand hygiene.

A few healthcare workers at these 5 hospitals were employed on a contractor or consultant basis. Individuals not employed directly by the hospital were not monitored and were not included in the analyses. Across all of the hospitals, many medical specialists worked on a consulting physician basis and were not employed directly by the facility. Physicians have repeatedly been shown to have significantly lower hand hygiene product use and compliance rates than other healthcare workers,<sup>2,9,15</sup> so the effect of having this group underrepresented in the dataset in this analysis would overestimate hand hygiene frequency for healthcare workers as a whole. Other positions were staffed by contractors on an ad-hoc basis at individual facilities. This factor was not expected to have any significant effect on the analysis.

The 5 healthcare facilities selected for this evaluation were identified as having a high degree of compliance with hand hygiene clinical guidelines. Specifically, their compliance rates were higher than 85%, whereas the average compliance rate for most hospitals is lower than 50%,<sup>16</sup> and mean baseline rates as low as 5% have been reported by WHO.<sup>1</sup> For this reason, the individuals monitored for this analysis would be expected to provide an accurate and representative dataset for estimating occupational exposure for healthcare workers. Moreover, the study population, which comprised 3927 individuals, would be expected to be representative of hand hygiene practices in diverse settings where these products are used.

### Data preparation

The dataset analyzed included all dispensing data for ABHR and a nonmedicated handwash product used in 5 hospitals. The data collection period was July 1, 2016, to December 31, 2016, for 4 of the hospitals and July 4, 2016, to December 31, 2016, for the fifth. The initial overall dataset consisted of 6,652,474 dispensing events, representing 4208 hospital workers.

Since the unprocessed data did not have a shift designation for a given dispensing event, time between dispenses for each individual was used to parse the data into separate shifts and calculate the length of each shift. Specifically, if more than 6 hours passed between dispensing events for a given worker, these events were assumed to occur in 2 different shifts. The time between the first dispense on a shift and the last dispense on a shift was used as a proxy for shift length.

All workers who logged a total time of less than 1 hour at a given hospital over the entire 6-month period were excluded from the analysis. After this exclusion criterion was applied, there were 6,651,438 dispensing events from 3927 hospital workers. Thus, this evaluation was able to retain more than 99.9% of dispensing events and 93.3% of workers.

### Use by product

Usage rates for ABHR and handwash were evaluated separately to allow for a more detailed understanding of hand hygiene patterns and practices.

**Calculation of Hand Hygiene Frequency per Hour:** As mentioned previously, the goal of this study was to describe healthcare worker usage rates of the individual hand hygiene products. Exposure estimates were derived as applications per hour, for each

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