personal and programmatic insights to explain their proficiency and serve as models for their coworkers.

The primary limitation of our study is that we did not evaluate the impact of cleaning on surface contamination or healthcare-associated infections. Also, the study consisted of a small sample size of rooms and housekeepers, and the amount of time spent cleaning each room was not validated by direct observation. Although our findings relate to only a single setting, the thoroughness of cleaning that we documented is similar to that reported in many healthcare settings. If the efficiency of cleaning is similar in other settings, it is likely that substantial opportunities to improve both the thoroughness of cleaning and the overall efficiency of practice exist in many healthcare settings.

In conclusion, we documented a counter-intuitive observation that a greater amount of time spent cleaning a hospital room does not necessarily correlate with the effectiveness of cleaning high-touch surfaces. Our finding emphasizes that process improvement interventions should evaluate both the efficiency and thoroughness of hospital surface cleaning to optimize the cost effectiveness of cleaning practice in healthcare settings.

ACKNOWLEDGMENTS

We thank personnel in the Environmental Service Department for their dedicated service.

Potential conflicts of interest. M.E.R. reports receiving research support from 3M. P.C. reports serving as a consultant and on the speaker's bureau for Ecolab and Steris and having licensed patents to Ecolab. All other authors report no conflicts of interest relevant to this article. All authors submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and the conflicts that the editors consider relevant to this article are disclosed here.

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Received May 30, 2012; accepted September 5, 2012; electronically published November 20, 2012.

Presented in part: 5th Decennial International Conference on Healthcare Associated Infections 2010; Atlanta, Georgia; March 18–22, 2010.

Infect Control Hosp Epidemiol 2013;34(1):100-102

0899-823X/2013/3401-0017$15.00. DOI: 10.1086/668779

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Improving Hand Hygiene Compliance in Hospitals by Design

Essential in reducing hospital-acquired infections is adequate hand hygiene (HH) among healthcare workers (HCWs).[1] International studies show, however, that HH guidelines are adhered to in less than 50% of required times.[2] Research into HH behavior has shown that self-reported compliance is often higher than observed compliance, which seems to indicate that HCWs are unaware of their HH behavior.[2] In addition, because of its frequency, HH behavior could be considered an automatic (or subconscious) behavior.[3] Therefore, a (temporary) shift from the subconscious to the conscious could be a solution to change current HH behavior and create new habits. These insights formed the points of departure of the design project described here, which aimed to develop an alcohol-based hand rub (ABHR) dispenser to stimulate

HCWs to better adhere to the international guidelines of HH.[4,5] In order to increase the chance of success of the new dispenser, a participatory design approach was applied, meaning that all stakeholders of the dispenser (nurses, physicians, infection control practitioners, housekeeping) were actively involved in the different phases of the development process.[6,7]

The development process of the new dispenser consisted of 5 phases: analysis, idea finding (identifying promising design directions), and 3 idea iterations. Interim ideas were evaluated using functional 3-dimensional prototypes and the results applied to further develop the final concept. Methods of user research included observations and individual and focus group interviews.

The new ABHR dispenser that resulted from this project incorporates 3 distinctive features: (1) instant feedback, (2) a spray mechanism, and (3) an integrated drip tray (see Figure 1). First, the new dispenser provides instant feedback to the HCWs on their frequency of using the dispenser in order to increase their awareness about their HH behavior. By means of 5 light-emitting diodes (LEDs), the number of performed HH moments is displayed during a fixed period of time (15 minutes). The LED feedback refers symbolically to the 5 moments of HH as prescribed by the World Health Organization.[8] This feedback, which does not differentiate between multiple users, is expected to stimulate a higher frequency of use by acting as a mirror (see what your behavior is) and a mediator (see the behavior of your colleagues and discuss it). When more than 5 device activations occur within the specified 15 minutes, the LED circle starts again. Second, the dispenser uses a spray mechanism that sprays a fixed amount (3 mL) of ABHR on the back of both hands. This way, alcohol is applied directly between the fingers, an important part of the hand that is difficult to clean.[5] The dispenser contains 2 refills to ensure that the device is less likely to run empty. Third, the integrated drip tray allows for the possibility of universal placement (ie, not restricted to the sink area) without damage to floors or other surfaces.

Twenty nurses and 4 physicians working in the intensive care unit and surgical ward of a large university teaching hospital in the Netherlands tested the new dispenser. The test materials consisted of a functional prototype (Figure 1, right) and an evaluation questionnaire covering topics on access, performance feedback, stimulation of use, social control, professional look and feel of the product, and ranking of the 3 distinctive design features. The test took place in a 4-, 2-, or 1-patient room. HCWs were asked to use the prototype and report their experiences to the researcher and to complete the questionnaire. All user tests were audio-recorded and summarized. Questionnaires were analyzed in SPSS (v15). Each item was scored on a 7-point Likert scale, except for the most important feature of the dispenser, which was scored by ranking.

Most participants considered the spray functionality easy to use and appreciated that the correct amount of ABHR was dispensed automatically. The participants mentioned that the spray mechanism made the product appearance more luxurious. Sometimes it was ambiguous for users how their hands should be placed in the dispenser (palms up or down). Participants appreciated the way the concept provided performance feedback and considered it useful in combination

ments of HH as prescribed by the World Health Organiza-

Most participants considered the spray functionality easy