

TECHNOLOGY TO REDUCE INSTITUTIONAL CROSS-INFECTION RATES BY IMPROVING HAND HYGIENE OF CAREGIVERS

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BACKGROUND

As older people are admitted to hospitals and long term care facilities more frequently, they tend to be among the most vulnerable to nosocomial infections. In North America one in every 10 people admitted to a hospital acquires an infection and nearly 100,000 of these people die each year¹. It is estimated that approximately half of these deaths are preventable with improved hand hygiene^{2,3}. Complications of nosocomial infections, a secondary disorder associated with being treated in a hospital but unrelated to the patient's primary condition, include permanent disability or death and often increase the duration of hospitalization and costs of care⁴. Authors in Gerontechnology typically focus on the development of technology to increase the quality of life of older people and people with disabilities living at home. However, we have found the urgency of the growing problem of antibiotic-resistant hospital acquired infections to be compelling and have applied our bioengineering skills in an attempt to address this major concern to enhance quality of life for older people.

The current practice for caregivers is to wash their hands with water and soap at a sink or use a dispenser to apply a small volume of alcohol-based gel to disinfect his or her hands. In the Canadian Province of Ontario, the government requires this to be done on four occasions – when entering and leaving a patient zone, before performing an aseptic procedure and after possible contact with body fluids. Rates of hospital-acquired infections may be reduced by up to one-third if caregivers comply with these official hand washing guidelines⁵. Pittet et al.² provide evidence that hand hygiene is the primary means to reduce nosocomial infections and the transmission of antimicrobial-resistant pathogens. However, numerous international studies have found that compliance with hand washing guidelines rarely exceeds 45% and caregivers have revealed that “busyness”, lack of time, inaccessible equipment and skin irritation have contributed to these poor compliance rates⁶. Some hand wash interventions have raised this compliance level to higher levels (60%) but it is very difficult to sustain these levels⁶. We have recorded the number of occasions when caregivers should cleanse their hands if following official hand washing guidelines strictly (Ministry of Health and Long Term Care⁷) and found that it averages over 150 times in an 8-hour shift for a regulated nurse in a rehabilitation environment. With the many competing demands and high workload in the clinical setting, it is not surprising that compliance is difficult to achieve and a challenge to maintain⁸.

THE NEW TECHNOLOGY

To address some of these concerns, researchers at Toronto Rehabilitation Institute have developed a system that uses wireless technology to prompt caregivers to cleanse their hands and provides personalized feedback on performance. The system comprises four components:

- 1) The immediate environment around patient beds is marked using a grouping of low-powered infrared emitters that define a zone with a precise boundary, see figure 1.
- 2) The caregiver wears a miniature receiver attached to the identity lanyard to log the time of entry and exit of a patient zone and identities of each zone visited, see figure 2. The receiver has an infrared detector (eye) that is mounted on the end of a short stem so that it has a clear view of the emitters in the ceiling. The receiver issues audible prompts to remind the caregiver when a patient zone is entered or exited without performing the required hand hygiene.

- 3) Caregivers either cleanse their hands using a wearable alcohol gel dispensers or wall-mounted alcohol gel dispensers. These dispensers are equipped with low-powered radio transmitters which send a signal to the receiver each time they are operated causing the time of the hand hygiene event to be logged.
- 4) Data collected by the receiver can be downloaded to display the history of hand hygiene over periods of a day, a week or a month, for an individual or for a group, see figure 3. Hand hygiene activity including compliance can be calculated from the logged data.



Figure 1 Infrared 'beacons' define zones with precise boundaries around each of two patients



Figure 2 Nurse (author VB) wearing the receiver/prompter on the back of her identity lanyard and a personal alcohol gel dispenser clipped to her pocket

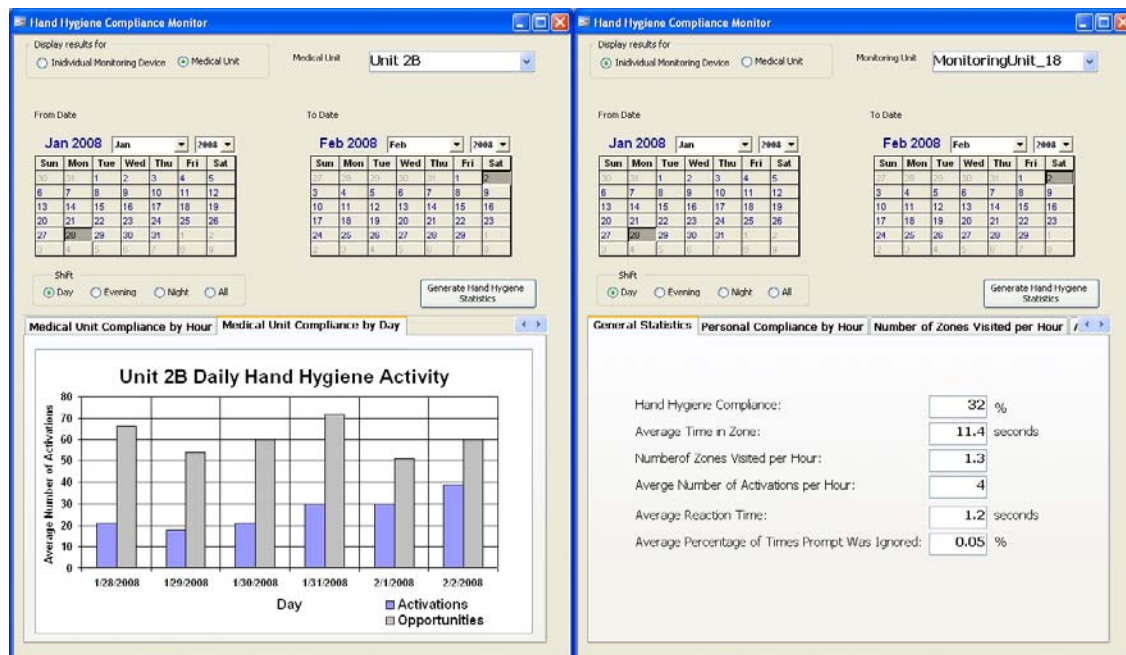


Figure 3 In the above example of feedback on the left, users of this system are able to view the combined daily hand hygiene activities of every staff member in a hospital unit. The right screen shot shows individual general statistics including compliance. No names or personal identification appear on individual data printouts.

DISCUSSION

Although the technology has the potential to radically increase the effectiveness of a wearable hand hygiene system, there are obvious privacy issues for the caregivers since this system can be used to determine how long the caregiver spends with a specific patient, not just whether they wash their hands. Therefore, we considered it important to involve caregivers in the design of the system. The system was designed so that it only records when caregivers enter or leave patient zones and is not capable of tracking the caregiver's movements outside these zones, avoiding the invasion of their privacy. The system can also be used with a degree of anonymity since the association between the identity of the receivers and the individuals wearing them can be kept discrete if desired.

Considerable effort has been expended to miniaturize the receiver and optimize the alcohol dispenser so that it is not a nuisance to wear. A series of workshops were held with caregivers during the design⁷. The participants welcomed the assistance that the technology will provide with the challenging task of remembering to perform hand hygiene every time when approaching and leaving a patient. They considered it helpful to maintaining professional standards. Two out of 14 subjects requested that their performance not be disclosed until they had had a period of a few weeks to become accustomed to the device by viewing their own performance privately.

There has been considerable national attention focused in Canada recently in the news media on the problem of hospital acquired infections. The reaction to news of our innovation was vast with mixed responses. For example, one major national newspaper stated in its opinion column that the problem should be solved through education and discipline rather than by our technology. Our response in a letter to the press and in media interviews was that busy caregivers must cleanse their hands between 100 and 150 times in a shift and that this rate can be as high as once per minute at busy times. Clearly it is not simple to remember to perform hand hygiene at every occasion when there are many other demands and tasks. It was also explained that no other interventions have resulted in sustained

increases in hand hygiene compliance. A weekly newsletter of the public relations industry reported that our response was the public relations 'touch-down' of the week and that the tone of articles and opinions in the media changed in response⁹.

Alpha trials are now underway with caregivers in one of our Toronto Rehabilitation Institute facilities. The objectives of these trials are to ensure the system meets the needs of the caregivers and to ascertain that the technology performs reliably and can be installed easily. Beta trials are planned using both control and experimental wards in an acute care hospital and a complex continuing care hospital in order to confirm that the frequency of hand hygiene is increased by using the system and that the increase is sustained.

CONCLUSION

A new technology has been prototyped in an effort to assist caregivers to increase and maintain their rates of hand hygiene compliance. The system uses a low-cost distributed architecture based on infrared beacons marking patient zones. Preliminary response to the new technology is positive and indicates that staff are comfortable using the system. Clinical trials are in progress.

References

1. Jarvis WR (1996). Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention. Infect Control Hosp Epidemiol, 17(8):552-557.
2. Pittet D, Hugonnet S, Harbarth S, et al. (2000). Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Infection Control Programme. Lancet, 356(9238):1307-12.
3. Larson EL, Early E, Cloonan P, Sugrue S, Parides M (2000). An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. Behavioral Medicine, 26(1):14-22.
4. Nyatanga & Holliman (2005). Integrated care pathways (ICPs) and infection control. Clinical Governance: An international journal, 10(2),106-117.
5. Creedon S (2006). Health care workers' hand decontamination practices: An Irish study. Clinical Nursing Research, 15(1), 6-26.
6. Cromer A, Hutsell S, Latham S, Bryant K, Wacker B, Smith S, Bendyk S, Valainis G, Carney M. (2004). Impact of implementing a method of feedback and accountability related to contact precautions compliance. Infection control Department, Spartanburg Hospital for Restorative Care, 32(8), 451-455.
7. Ministry of Health and Long Term Care, Ontario. *Just Clean Your Hands*. Retrieved on May 14, 2008, from <http://www.justcleanyourhands.ca/>
8. Boscart V, McGilton K, Levchenko A, Hufton G, Holliday P, Fernie G (2008). Acceptability of a wearable hand wash device with monitoring capabilities. Submitted to the Journal of Hospital Infection, February 2008.
9. Walker W. Communication plays of the week. Touchdowns & Fumbles, 7 March 2008.

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