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Automated Hand Hygiene Monitoring

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Hospital acquired infections (HAI) cause two million infections yearly, resulting in 88,000 deaths globally (Pittet et al. 2004). They are defined as infections occurring 48 hours after being admitted to a healthcare facility and are secondary to the patient's original condition (Larson 1999). Most HAI must be treated with antibiotics, resulting in increases in antibioticresistant organisms, lengthened hospital stays, massive inefficiency in hospital systems, disability and in some cases death. Annual costs of HAI in the United States range between five and 11 billion dollars (Ricks 2007; Kelvens et al. 2007). An estimated five percent to 19 percent of their patients are infected, with 30 percent in intensive care units. In Europe, reported numbers range from 6.7 percent to 14 percent, causing 15,000 deaths a year. Preventing HAI is therefore one of the most important goals of infection control research.

It is estimated that one third of HAI are preventable (Larson and Kretzer 1995). Hand washing is the single most important measure to reduce the risks. Hand washing is often neglected or performed incorrectly. Studies observing hygiene practices agree that 40 to 60 percent of doctors and nurses fail to wash hands between patients (Thompson et al.1997). Some of the reasons that have been listed include the lack of priority over other required procedures, insufficient time, inconvenient placement of hand wash facilities, allergy to hand hygiene solutions, and lack of leadership from senior staff (Thompson et al. 1997; Larson and Killien 1982; Gould 1994; Boyce 1999).

Consequently, different approaches have been suggested to improve compliance including education, surveillance and monitoring quantities of disinfection products consumed. Educational programmes have failed to produce sustained improvements (Pittet et al. 2004; Boyce 1999). Observational methods are extremely expensive and have shown to be poor predictors of actual compliance (Mortel and Murgo 2006). Keeping track of disinfection product consumption does not provide reliable and accurate data on the number of hand wash opportunities (JCAHO 2004).

In recent years, commercialisation of wearable hand hygiene products opened the possibility for more efficient hand hygiene activities by allowing staff to disinfect while moving from place to place. The potential advantages are significant since the convenience and availability of the dispenser enables a stronger habit of hand hygiene. Pilot testing of wearable dispensers found that participants increased the frequency of hand hygiene between patient contact from an average of 37 percent to 49 percent (p=.006) (Moore et al. 2006). This level of improvement is in the range anticipated but still unacceptably low. Sustained compliance greater than 60 percent seems unlikely unless a radically new technology can be developed. This paper reports on a novel electronic hand hygiene system with monitoring and reminding properties.

A New Technology

Toronto Rehabilitation Institute, Canada, developed a hand hygiene monitoring system to enhance and record hand wash frequency. The new technology consists of three main components: (1) small wearable electronic monitors, (2) protected zones installed to define individual patient environments, and (3) personal wearable alcohol gel dispensers.

The monitors identify when staff enter and leave a patient environment by using infrared communication with controllers installed in the patient zones. The zones are defined by infrared emitters with regulated intensity, mounted inside direction elements that are adhered to the ceiling and

arranged in groups to precisely cover the patient areas. The monitors work in combination with the dispensers and perform monitoring, data logging and hand hygiene prompting functions, according to programmable logic rules. Each monitor records in real-time the events of the user entering and leaving patient areas and hand hygiene actions. These records are later downloaded and performance printouts are generated. Patient zone controllers are configured to transmit zone identifiers and additional specific information (e.g. risk level), so the wearable monitor can provide different prompting options if specific hand hygiene procedures are required. Although the above described system has the potential to radically increase the frequency of hand washing, there are obvious privacy issues since the system can be used to determine how much time staff spend with a patient, not just whether hands are washed. Therefore, the first phase of the larger study focused on exploring the acceptability and usability of the system.

The Study

An exploratory study was conducted at a large teaching facility in Toronto, Canada. The study consisted of a field test in which participants tested the device, and focus groups to explore the acceptability of being monitored and the usefulness of the system (Boscart et al. 2008). Staff felt this technology was a convenient and secure approach to remind them of the hand wash act. Staff also liked the consistency of the system when it provided reminders to disinfect hands before approaching and leaving patients. Overall, staff felt comfortable with receiving individual performance data and indicated that the system has capabilities to increase compliance and improve sustainability of hand hygiene.

Perspectives for Healthcare Staff, Management, and Infection Control Specialists

The data collected have important potential to healthcare staff using the system, management, infection control specialists, and policy makers. The system is able to provide the time of entering and leaving identified patient zones, and also indicates the time hands were disinfected. Subsequently, individual compliance can be calculated. This information can be compared with anonymised unit, facility, or job category performance to provide the individual with a reliable framework of his or her own hand wash behaviour. From the management's perspective, these detailed data are valuable for several reasons. First, a manager can easily identify and compare performance at an individual, unit and facility level. The system can also present frequencies of hand disinfections registered per location and records if this disinfection took place before entering the zone or as a response to a reminder from the system. Different levels of access and anonymous data can be built in. The system will also allow identification of specific situations (e.g. mealtimes, physician rounds), locations, or times (e.g. night shifts) of hand hygiene. Specific trends can be monitored and subsequently addressed with tailored interventions. The individual data collected automatically can then serve as an evaluation of any given intervention, thereby avoiding expensive and time-limited observations of hand wash compliance.

Another advantage of this system is not directly related to hand hygiene, nevertheless it is one that has potential to improve care and efficiency. The data collected will provide reliable information on the specific healthcare provider's time spent with an individual patient. The duration of specific procedures or therapy can be calculated per patient. These data might be particularly helpful to calculate staffing on a timely basis, taking into account the fluctuating patient conditions, treatments and available staff.

Currently, compliance is calculated based on limited observations of some staff in specific areas within the facility. Not only does the Hawthorne effect interfere with the data collection, the reliability of the data collected is questionable (Mortel and Murgo 2006). This novel system will be able to provide accurate and timely data for managers and infection control specialists on hand hygiene compliance when entering or leaving a patient zone.

Discussion

In developing a technology to monitor staff's hand washing activities, the need arose to explore concerns about being continuously aware of hand hygiene. The research team built a prototype version and collected data from staff. Participants were very excited about the new technology. They responded positively because the opportunity to obtain help to improve their performance appealed to their professionalism. The ability to be able to select whether the data is anonymous or is attributed was welcomed. Staff expressed a desire that the data be maintained anonymously for an introductory period until they had thoroughly familiarised themselves with the technology and had had an opportunity to adjust their practices to achieve optimal performance.

When a patient suffers or dies from a HAI, there are financial ramifications in addition to the human costs. Based on research endorsed by the World Health Organization, improvements in hand hygiene could reduce infections and costs substantially. Implementation of the new hand hygiene monitoring and reminding system in all hospitals in Ontario, Canada, would cost approximately 12 million Canadian dollars annually. Given the 77,395 HAI a year in Ontario (Zoutman et al. 2003; Canadian Institute for Health Information 2003- 2004 and 2004-2005), with an extra cost of an HAI of 6000 Canadian dollars, the total annual cost of HAIs in Ontario could be over 460 million Canadian dollars. If this system could increase hand hygiene by only 10 percent, 3,870 of these HAI could be avoided yearly, resulting in 19 Canadian dollars million in cost savings (Wodchis et al. 2008).

Conclusions

A new hygiene compliance monitoring system has been developed that has the potential to reduce transmission of infections and associated costs. The new solution can provide managers, staff and infection control specialists with hand hygiene performance data collected automatically. The feedback from early testing has given the research team confidence to expedite the completion of the technology and its commercialisation in an effort to increase hand hygiene compliance and reduce transmission of infections with consequent reductions in costs, morbidity, and mortality.

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