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Major Article

Pilot study of digital tools to support multimodal hand hygiene in a clinical setting

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Background: Digital tools for hand hygiene do not share data, limiting their potential to support multimodal programs. The Christie NHS Foundation Trust, United Kingdom, worked with GOJO (in the United States), MEG (in Ireland), and SureWash (in Ireland) to integrate their systems and pilot their combined use in a clinical setting.

Methods: A 28-bed medical oncology unit piloted the system for 5 weeks. Live data from the tools were combined to create a novel combined risk status metric that was displayed publicly and via a management Web site.

Results: The combined risk status reduced over the pilot period. However, larger and longer duration studies are required to reach statistical significance. Staff and especially patient reaction was positive in that 70% of the hand hygiene training events were by patients. The digital tools did not negatively impact clinical workflow and received positive engagement from staff and patients. The combined risk status did not change significantly over the short pilot period because there was also no specific hand hygiene improvement campaign underway at the time of the pilot study.

Conclusions: The results indicate that integrated digital tools can provide both rich data and novel tools that both measure impact and provide feedback to support the implementation of multimodal hand hygiene campaigns, reducing the need for significant additional personnel resources.

BACKGROUND

Health care–associated infections (HAIs) are a major focus of patient safety, and some studies place the annual burden of HAIs in the United States at 2 million infections and 100,000 related deaths.[1] Targeted hand hygiene initiatives have had a significant impact on reducing HAIs.[2] However, such hand hygiene initiatives can cost from $225-$4,669 per 1,000 bed days.[3]

Hand hygiene improvement interventions range from wide participation of staff as auditors[4,5] to the use of remote video observation and feedback.[6] The subjectivity of human assessments of hand hygiene is frequently reported,[7] and different strategies aim to control for the Hawthorne effect.[8] Culture and social dynamics on a unit can be a major factor in intervention success,[9] and Pincock et al[10] note the importance of a multimodal strategy that involves a range of a wide set of stakeholders and a coordinated set of intervention types, such as education, audits, visual reminders, multidisciplinary teams, and an explicit process improvement strategy. Conway[11] discusses the challenge of implementation and recommends that for maximum impact, feedback should be delivered directly to health care workers (HCWs), and prior to implementation a plan for using the data to drive improvement should be considered.

Banfield and Kerr[12] raised patient hand hygiene as an important link in the chain of infection prevention, and Srigley et al[13] reviewed a number of studies that aimed to improve patient hand

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hygiene. Studies have reported that dedicated education resources have a significant impact on rates of patient hand hygiene[14,15] and showed that specific education encouraged patients to perform hand hygiene when approached by a HCW,[16] resulting in a positive impact on compliance.

The Christie NHS Foundation Trust, United Kingdom, examined the feasibility of implementing a multimodal hand hygiene intervention. However, the cost of implementation using additional infection prevention and control (IPC) staff was prohibitive; therefore, digital tools were examined. There are a range of digital tools available, such as tablet-based audit tools, smart dispensers, and hand hygiene training kiosks for both staff and patients, but no integrated solution existed. As a result, we challenged a number of vendors, GOJO (in the United States), MEG (in Ireland), and SureWash (in Ireland), to work together to develop an integrated digital framework for hand hygiene and support a pilot evaluation in a clinical setting.

Aims of the study

Our aims were to evaluate, in a live clinical setting, the ability of integrated digital tools to support a multimodal hand hygiene program, assess the reaction of staff and patients to real-time feedback of a combined risk status (CRS), and identify the design considerations for a larger-scale rollout.

METHODS

The intervention described in this article combined data from observational and electronic audits with live feedback and high availability training for staff and patients. The main technical work of the study was the integration of 3 core tools via a Web service, the development of the novel risk measure and the reporting and feedback system. Both subjective and objective measures were developed to understand the context and the impact of the intervention.

Core tools to be integrated

The 3 core systems are subsequently discussed.

Tool 1: MEG: tablet-based clinical support tools

MEG clinical support tools provide a range of software for frontline HCWs on mobile and tablet devices and provide real-time results and alerts for auditors and managers. This study used the hand hygiene auditing tool throughout the unit for recording direct observation of practice compliance scores.

Tool 2: SureWash: hand hygiene training and competence validation system

SureWash is an interactive kiosk that can be moved around the hospital to train and assess staff and patients in hand hygiene. The system uses camera-based augmented reality and gamified learning to ensure that the muscle memory of hand hygiene is learned correctly. In this study, a SureWash system was placed in the day room where it was visible and accessible to all.

Tool 3: GOJO: SMARTLINK activity monitoring system

The system captures soap and sanitizer dispenses (events) and room entries and exits (opportunities), and can be configured to monitor and measure hand hygiene performance by facility, floor, unit, or room. The data captured are not role specific and include health care personnel, doctors, patients, and visitors. In this study, 3 people counters were used, 1 4-bed bay and 2 in single rooms. There were 5 SMARTLINK dispensers (GOJO, Akron, OH) used, one for each of the side rooms and 3, 1 soap and 2 Purell (GOJO), associated with the 4-bed bay.

Novel technologies developed for the pilot study

Data integration and display via the cloud

All 3 systems used a Web database, and a new set of protocols were developed to allow them to share data. Data were gathered from the core tools into a common database at 15-minute intervals, and the analytics and dashboards were updated accordingly.

Signal processing and constructing time series data

To construct a time series dataset from asynchronous data sources, a number of algorithms were developed to be consistent with clinical practice. The tool 1 observational compliance score and tool 2 hand hygiene technique performance score were updated at each observation using a 24-hour moving average. The tool 3 people counter data were adjusted using a standard signal processing technique to mitigate false-positives because of staff hovering in doorways or quick entries or exits where actual hand hygiene was not required. The tool 3 activity metric score (total dispenser activations/people counting events) was updated every 15 minutes based on a cumulative count from midnight each day.

Calculating the CRS

One aim of the pilot study was to develop a novel CRS to indicate overall performance in hand hygiene and provide an easy to understand display. The CRS was calculated based on a combination of live data from each of the digital systems. To develop the algorithm, a couple of weeks of baseline data were gathered and used by the IPC team to develop the rules for the red-amber-green status for each of the tools. These rules were encoded into a set of finite state machines according to the rules in Table 1.

The CRS also used a red-amber-green rating scheme that was set based on a logical combination of the values from the data sources. Through consultation with the IPC team, the CRS was set to be green only if at most one of the data streams was in the amber zone but all others were green. It was determined to be red if ≥2 data streams were in the red zone; all other states were regarded as amber.

Risk management feedback system

It was important that the CRS be easily understood by staff and patients. The team favored a strong graphical format with a clear meaning and readable from a distance. The final design used an emoji-type icon on a germ-filled background to indicate risk status. The CRS was followed immediately by a screen indicating actions needed to improve the score; both the CRS states and the action screens are shown in Figure 1. The CRS and action screens were rotated every 4 seconds on the .53 m display of the tool 2 unit that was positioned in the day room as shown in Figure 2.

The CRS along with a detailed data visualization dashboard was provided on a Web site which could be accessed on a computer or on a mobile device as shown in Figure 3.

Table 1
Algorithm to set the RAG status for each data source

RAG status	Tool 1: DOP compliance	Tool 2: Performance	Tool 3: Activity metric
Green	$x \geq 80\%$	$x > 70\%$	$x > 30\%$
Amber	$80\% > x \geq 50\%$	$70\% > x \geq 40\%$	$30\% > x \geq 15\%$
Red	$x < 50\%$	$x < 40\%$	$x < 15\%$

DOP, direct observation of practice; *RAG*, red-amber-green.