RESEARCH ARTICLE

Good to Great: Quality-Improvement Initiative Increases and Sustains Pediatric Health Care Worker Hand Hygiene Compliance

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ABSTRACT

OBJECTIVE: The Joint Commission, the Centers for Disease Control and Prevention, and the World Health Organization challenge hospitals to achieve and sustain compliance with effective hand hygiene (HH) practice; however, many inpatient units fail to achieve a high level of reliability. The aim of the project was to increase and sustain health care worker (HCW) compliance with HH protocols from 87% (level of reliability [LOR] 1) to ≥95% (LOR 2) within 9 months on 2 pediatric inpatient units in an academic children's hospital.

METHODS: This study was a time-series, quality-improvement project. Interventions were tested through multiple plan-do-study-act cycles on 2 pediatric inpatient units. HH compliance audits of HCWs on these units were performed randomly each week by the hospital infection prevention program. Control charts of percentages of HCW HH compliance were constructed with 3-σ (data within 3 SDs from a mean) control limits. These control limits were adjusted after achieving significant improvements in performance over time. Charts were annotated with interventions including (1) increasing awareness, (2) providing timely feedback, (3) empowering patients and families to participate in mitigation, (4) providing focused education, and (5) developing interdisciplinary HH champions.

RESULTS: HH compliance rates improved from an average of 87% (LOR 1) to ≥95% (LOR 2) within 9 months, and this improvement has been sustained for >2 years on both pediatric inpatient units.

CONCLUSIONS: Significant and sustained gains in HH compliance rates of ≥95% (LOR 2) can be achieved by applying high-reliability human-factor interventions.

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According to the World Health Organization, 7 out of every 100 hospitalized patients will acquire health care–associated infections (HAIs). Infection-control measures such as effective hand hygiene (HH) can reduce the frequency of HAIs by >50%.[1–3] The Centers for Disease Control and Prevention and the World Health Organization have supported improvements by providing recommendations and best-practice and implementation guides designed to improve HH compliance, with limited success. Nevertheless, health care worker (HCW) compliance with HH guidelines remains below benchmarks previously set by The Joint Commission.[4]

Despite widespread availability of evidence-based HH implementation tools, physicians and other HCWs do not reliably follow guidelines.[5–7] Common barriers to guideline adherence include lack of awareness, familiarity, agreement, self-efficacy, outcome expectancy, and inability to overcome inertia of previous practice.[8] Building on a general understanding of these barriers and using known improvement methods to develop a targeted approach is key to achieving the project aim.[9]

Principles of reliability science can be used to understand complex health care processes, measure performance, and design interventions to achieve desired results. The Institute for Healthcare Improvement has a 3-step model (prevent, identify-and-mitigate, redesign) that health care organizations can use to achieve levels of reliability (LORs) of compliance ≥95% (LOR 2) to improve patient safety.[10] Targeting safety culture and using champions are examples of successful LOR 2 interventions for improving processes or outcomes for patients.[11–13] We used these concepts in the design of the project to improve and sustain HH compliance rates of ≥95% (LOR 2).[14,15]

Despite previous attempts to improve HH performance on the 2 pediatric inpatient units, compliance remained below the hospital goal of 95% and lagged behind all other areas in the children's hospital. Posted signs and intermittent educational programs for staff were in place to achieve LOR 1 performance. However, specific interventions aimed at the desired compliance rate of ≥95% were needed to improve rates from "good" (LOR 1) to "great" (LOR 2). With this in mind, we designed our project to include high-reliability concepts. The Specific, Measureable, Achievable, Relevant, and Time-bound (SMART) aim[16] of the study was to increase HCW compliance with HH protocols from 87% (LOR 1) to ≥95% (LOR 2) within 9 months in the 2 pediatric inpatient units.

METHODS

Setting

Duke Children's Hospital is a 190-bed tertiary care children's hospital, within a large academic medical center, that has ~7500 admissions per year in Durham, North Carolina. The project focused on the 2 pediatric medical surgical units with 31 rooms each; 1 unit had more hematology/oncology patients, whereas the other had more solid-organ transplant, pulmonary, and cardiology patients. These units were chosen as the study location because of the mixed patient population and the desire of nursing and physician unit leaders to improve HH compliance rates.

Before the project began, both units had sinks with antimicrobial soap and paper towel dispensers, hospital-approved alcohol-based hand sanitizer near the patient door entrance, and signs reminding HCWs to clean their hands. HCWs were required to complete the hospital's annual online infection prevention (IP) educational module. In addition, periodic education was provided to HCWs from the hospital's IP program in response to low compliance rates. Performance was measured weekly by using a validated directly observed HH audit (DOHA) program. HH compliance was reported monthly as a percentage on unit scorecards.

Human Subjects Protection

The Duke University Health System Institutional Review Board determined that this study did not meet the definition of research and satisfied the Privacy Rule because the study was considered part of hospital quality-improvement efforts.

Study Design

We used a time-series, quality-improvement design to evaluate the effectiveness of interventions to improve HCW HH compliance on 2 inpatient pediatric units. Testing of the interventions occurred on 1 unit and was expanded to the other. Because of the diverse patient population, we hypothesized that other centers could successfully replicate interventions in other similar inpatient units.

Planning the Intervention

In the fall of 2013, a multidisciplinary project team was assembled that included 2 nurse managers, an IP nurse, and a pediatric hospitalist, who was also the medical director of the inpatient units. Ad hoc membership on the improvement team included a pediatric chief resident, bedside nurse, nursing assistant, and HH auditor. The team mapped the process,[17] conducted a modified failure mode and effects analysis, examined key drivers, and prioritized interventions in a key driver diagram (Fig 1).[14]

First, the team observed noncompliant encounters and categorized them by HCW type in a Pareto chart (Fig 2). We found that although nurses were the most frequent noncompliant HCW type, many noncompliant encounters were from nursing students and hospital volunteers who are less familiar with HH protocols. Understanding the frequency and distribution of noncompliant HH encounters allowed us to target our interventions accordingly.

Data for both units were aggregated and displayed together because the sample size for many of the weeks was too small to measure the effect of changes. Interventions were prioritized on the basis of common reasons for noncompliance as observed by members of the improvement team, available evidence,[3,9,13,18] and desire to implement high-level-reliability design concepts. To achieve compliance rates of ≥95%, we tested and implemented the following 3 LOR 2 change concepts[19]: (1) development of a redundant HH supply system, (2) implementation of an HH champion program to provide real-time

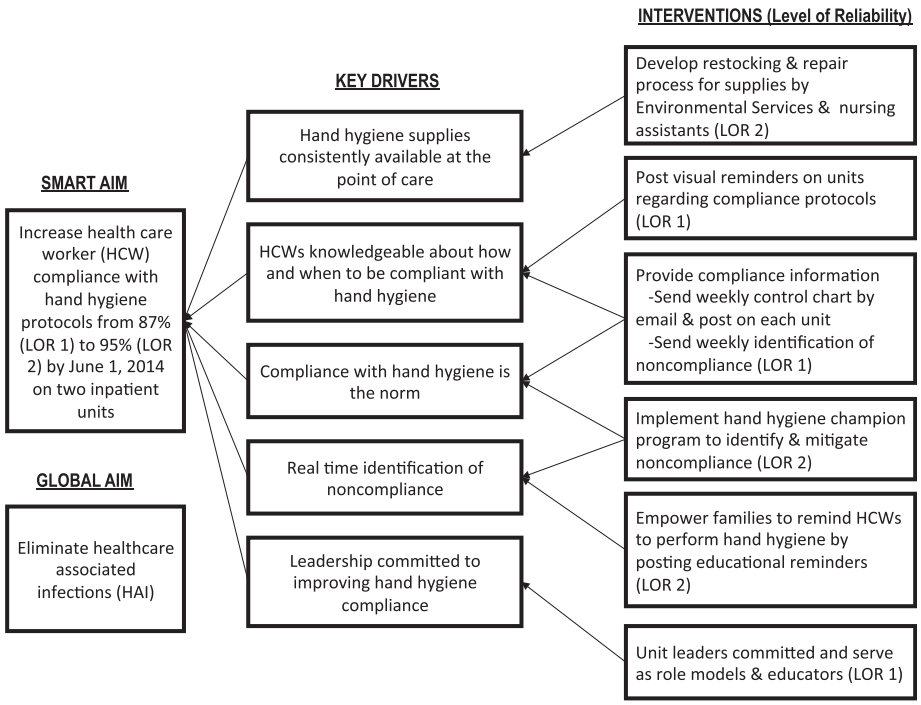

FIGURE 1 Key driver diagram summarizing the project aims, drivers, and interventions.

mitigation, and (3) empowering families and patients to remind HCWs to perform HH.

Improvement Activities

Interventions focused on the following 5 key drivers: (1) HH supplies consistently available at the point of care, (2) HCWs knowledgeable about how and when to be compliant with HH, (3) compliance with HH is the norm, (4) real-time identification of noncompliance, and (5) leadership committed to improving HH compliance. Interventions were developed and tested by using multiple plan-do-study-act (PDSA) cycles.[14] On the basis of our observations of noncompliant encounters, we performed several PDSA cycles targeting these drivers as shown in Fig 1. PDSA cycles are summarized in Table 1 and are described below as they relate to the drivers.

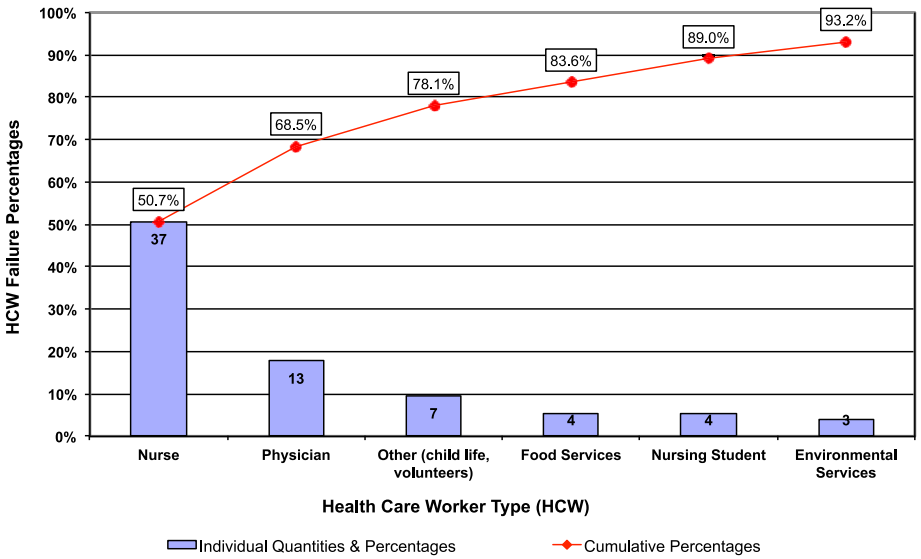

FIGURE 2 Pareto chart categorizing HH compliance failures by HCW type on 2 pediatric units from August 1, 2013, through December 30, 2013.

TABLE 1 Summary and Timeline of Interventions

Tests of Change	Intervention Start Dates	Lessons Learned	Interventions
Visual reminders	10/7/2013 (screensaver) 2/2/2013 (door signs)	–Important to use multiple types such as screensavers, door signs –Make the image simple and visually appealing –Rotate types of signs if able to keep reminders "fresh"	–Placed "Wash Your Dukes" screensaver on all patient and staff computers –Created and posted bright, laminated "Wash Your Dukes" signs on all patient doors
Feedback of performance	10/21/2013	–Provide feedback frequently to target audience –To reach all HCWs, used e-mail, posting annotated control charts, discussed during staff meetings –Important to include information about specific types of noncompliance (who, when, why)	–Provided weekly feedback to all HCWs by e-mail, posted in work rooms, discussed during monthly unit safety meeting
Standardizing the hand sanitizer supply system	12/29/2013	– Discovered a lack of protocol or ownership for who would resupply and maintain stock of hand sanitizer	–Developed standardized checklist for supply system –Developed redundant supply system for nursing care assistants and janitorial staff
Isolation protocol reminder signs	1/19/2013	–Learned that HCWs did not understand proper protocol and wanted posted information	–Created and posted signs with the isolation carts showing how to perform isolation protocol
Use of safety champions	4/13/2014	–Role clarification of champions is needed for consistency –Adaptation of hospital nursing "champion" role and reporting structure to unit leadership –Multidisciplinary teams should include nurses, attending physicians, case managers, nursing care assistants –Use of hospital medicine attending physicians for leadership, educational, and continuity purposes	–Recruited champions, adapted "champion" nursing role, created expectations, and implemented role
Empowering patients and families using signs	5/4/2014	–Testing signage with target audience was important –Some staff considered language asking them if they washed their hands to be offensive –Some families did not notice whether staff were compliant with HH –Families on oncology service more likely to support importance of good HH compliance	–Developed and posted signs in each patient room inviting families to speak up if they did not see staff cleaning hands

HH Supplies Consistently Available at the Point of Care

During observations of HH practice on the units, the project team found that hand sanitizer available in and outside of each patient room was not replaced consistently. PDSA cycles resulted in the development of a standardized checklist and a redundant supply process for nursing assistants and environmental services workers. Implementation of this LOR 2 intervention created a reliable hand sanitizer supply system that supported the HH practice of HCWs on both units.

HCWs Knowledgeable About How and When To Be Compliant With HH

The project team learned that HCWs knew how to clean their hands but did not always do so with each room entry and exit and when using contact and droplet isolation materials. We also learned about a behavior we called "popping in." HCWs would enter and exit a patient's room without performing HH to quickly speak with the patient or family. HCWs were unaware that this practice was noncompliant, because his or her intent was to avoid touching the patient or room contents. Education and awareness interventions targeted different HCW groups on the basis of their common reason for noncompliance. For example, visual reminders were found to be most helpful for nursing students, volunteers, and other less common HCW types who do not regularly work in these units, whereas nurses were given education to mitigate "popping in." We observed a qualitative improvement in HCW HH practice knowledge during staff meetings and other informal discussions.

Compliance With HH Is the Norm

We learned that HCWs responded well to receiving weekly feedback by e-mail and posting annotated control charts with detailed narrative information about noncompliance. Project team members discussed performance during staff meetings, in the weekly resident e-mail newsletter, at monthly pediatric hospital medicine faculty meetings, and at multidisciplinary unit safety meetings. These efforts helped improve the transparency of data by providing frequent, detailed feedback and showed that complying with HH was the norm by reinforcing good practice.

An HH champion program was tested and implemented on the basis of the formal

nursing champion role used for other purposes. We theorized that identifying, training, and empowering nurses, nursing care assistants, hospitalists, and case managers to become HH experts and provide peer-to-peer reinforcement of correct practice would influence unit culture. These HCWs were chosen because of their impact on the largest HCW types, frequency of contact with new employees, visibility on the units, and leadership characteristics. As a result of these changes, we observed a qualitative change in the culture of the units that performing correct HH every time was the norm.

Real-Time Identification of Noncompliance

Although delivering regular feedback of performance resulted in improved compliance with HH protocols, creating a program to provide real-time identification of noncompliance and mitigation resulted in a higher level of reliability. Testing this theory resulted in implementation of a multidisciplinary HH champion program and posting signs inviting families to enforce HH practice. During this test of change, we observed that some families were not aware of HH compliance and seemed uninterested in reinforcing this practice with HCWs. However, families and patients with medical complexity, central lines, or a compromised immune system were, in general, enthusiastic about participating in the mitigation of noncompliance.

Leadership Committed To Improving HH Compliance

Unit nursing and physician leaders were motivated to improve HH performance on their units, acting as champions, role models, and educators. Testing of these roles focused on how and when unit leaders should show their commitment and communicate expectations to HCWs. As mentioned previously, incorporating communication of HH performance into existing safety and operational meetings showed the commitment of unit nursing and medical director leadership. In addition, unit leaders discovered the value of unofficial leadership of a staff member by empowering a motivated nursing assistant to serve as a unit champion to provide real-time mitigation and feedback.

Measurement

Data were collected from August 2013 through March 2016 and tests of change occurred between September 2013 and May 2014. DOHA auditors collected HH performance data in accordance with the Centers for Disease Control and Prevention guidelines[2,20] on the 2 pediatric inpatient units. They used random, covert audits to collect and enter data into a database with the use of Web-enabled handheld devices.

A compliant HH encounter was defined as cleaning ungloved hands with soap and water or hospital-approved hand sanitizer immediately before and after the HCW enters a patient room or care area. For patients with isolation precautions, compliance was defined as first donning gown and/or surgical mask, followed by proper cleaning by rubbing hands and wrists with sanitizer or using soap and water, and then the application of clean gloves before room entry. Upon departure from the room, a compliant encounter included first removal of isolation equipment followed by proper HH.

Data for all HCW types, by clinical service area and time and date of observation by the DOHA auditors, were available to the project team on a secure Web site for the calculation of the project measure. The HH performance measure was defined as the ratio of compliant observations divided by the total number of observations, which was reported as a percentage continuously over time in a percentage control chart (p-chart) (Fig 2). In addition, central line–associated bloodstream infections (CLABSIs) were measured for each unit as CLABSI rate per 1000 line-days during the project period.

Analysis

This study used a time-series, quality-improvement project design. Analysis of HH compliance measures was performed by using a statistical process control (SPC) chart p-chart.[18,21] During the baseline and intervention phases of the project, weekly percentages of HH compliance for HCWs on both units were plotted on an SPC chart (Fig 3). Starting June 2014, HH compliance was plotted monthly rather than weekly once the project entered the control phase. Monitoring performance with the use of an SPC chart allowed for differentiation between normal and special-cause variation. Special-cause variation was defined as $\geq$8 points above or below the mean, according to standard SPC rules.[22] The upper and lower control limits of the SPC chart defined the region in which 99% of the data will be located. The SPC chart was annotated with the start date of each intervention so its impact could be correlated with HH compliance rates. Microsoft Excel (Microsoft Corporation, Redmond, WA) with customized macros was used to perform the analysis and construct the p-chart. Interventions impacting HH compliance for each unit were compared with baseline performance over time.

RESULTS

Baseline HH compliance rates were variable, ranging from 61% to 99% with an average of 87% (LOR 1). The relationship of various interventions to HCW HH compliance is shown in the annotated SPC chart (Fig 3). The first 3 interventions (visual reminders on all computer monitors and patient doors, unit leaders serving as role models and educators, and weekly feedback of data) resulted in special-cause variation and performance of $\geq$95% (LOR 2). Additional interventions, including standardizing the supply system, displaying isolation precaution information and patient door sign reminders, and development of an HH safety champion, resulted in special-cause variation and a second upward shift of the mean line. HH protocol compliance was sustained at $\geq$95% (LOR 2) for $>$2 years. Furthermore, the decrease in variability shown by the narrowing of the control limits from the baseline period, August 2013, through the end of interventions in June of 2014 suggested that the process became more stable over time. CLABSI rates per 1000 line-days remained unchanged on each unit, with averages of 1.35 and 1.08 from August 2013 through March 2016, despite improvements in HH compliance.

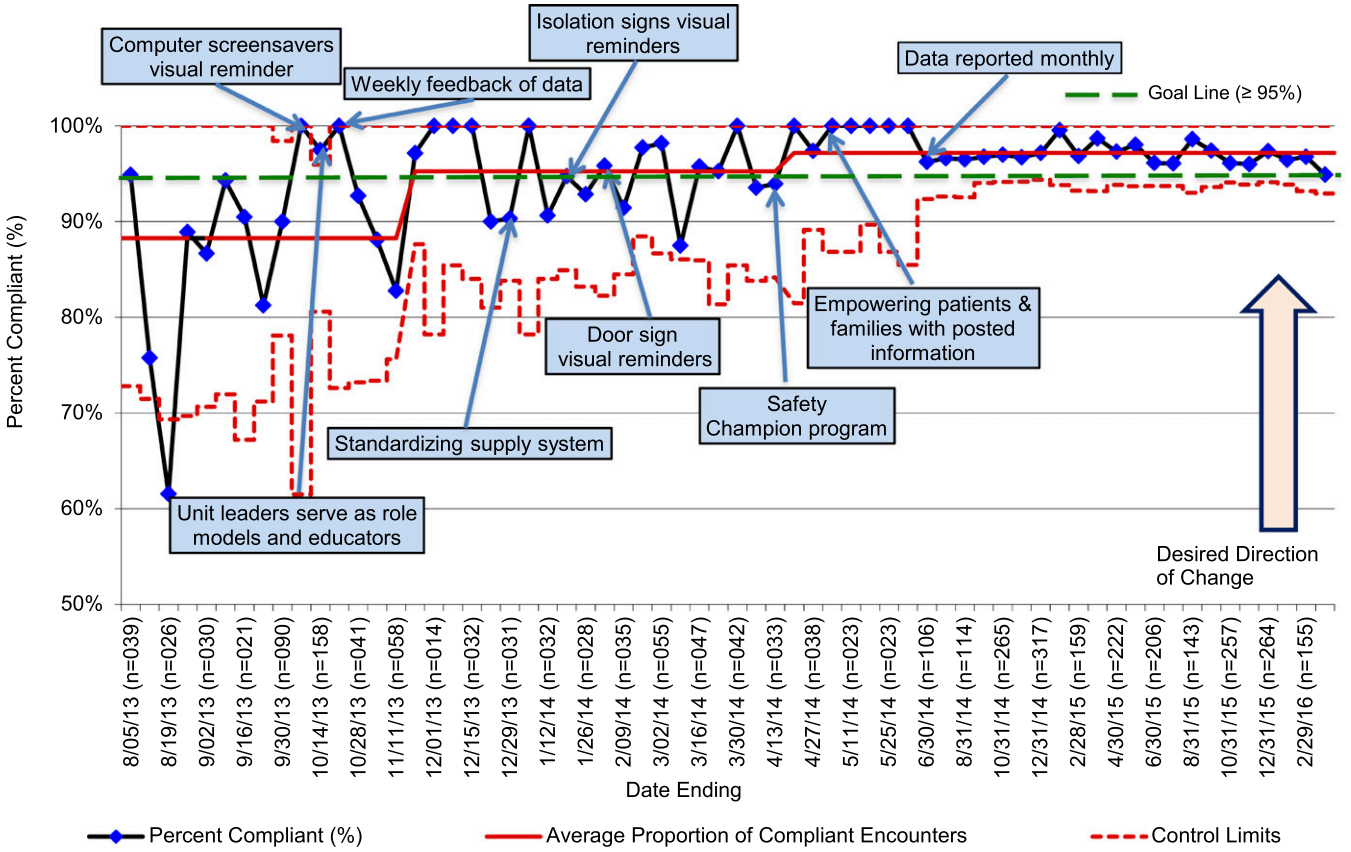

FIGURE 3 Percentage of compliant HH encounters on 2 inpatient units: p-chart shows the primary outcome measure with annotations of test of change. The *x* axis is labeled with every other week or month, and data points are weekly until June 2014 when they were measured monthly.

DISCUSSION

The implementation of evidence-based interventions improved HH practice reliability from a compliance rate of 87% (LOR 1) to ≥95% (LOR 2) on 2 pediatric inpatient units, and these results were sustained for >2 years. The inclusion of all types of HCWs working on units with a mixed population of pediatric patients makes this work generalizable to other hospitals.

Effective, reliable completion of HH with each patient encounter is a deceptively complex task and is influenced by many factors in the real world of hospital care. This study, like previous initiatives,[3,9,13,18] successfully implemented multiple interventions targeting education, increased awareness, data feedback, and strong leadership support to improve HH. However, previous studies either targeted a specific type of HCW[13] or failed to achieve sustained performance as high as ≥95% (LOR 2).[3] The work required to design a system to achieve LOR 2 that targets all HCWs is more difficult and, as shown by this project, required several LOR 2 interventions. This project was unique in that it used high-reliability change concepts to improve performance from LOR 1 to LOR 2 on 2 pediatric units and also sustained the LOR 2 performance level for >2 years.

Previous interventions in our hospital achieved LOR 1 performance by improving awareness, monthly feedback of performance, and providing education resulting in HH compliance rates in the mid-80% on both units with a variability of 61% to 99%. Our project successfully improved and sustained compliance at ≥95% by implementing LOR 2 interventions, including creating a culture in which HH compliance is the norm, implementing interdisciplinary HH safety champions to provide real-time feedback and mitigation, and creating redundancy in the hand sanitizer supply system. Although it is difficult to determine which intervention caused the largest effect, we believe that weekly feedback of performance data that included specific, narrative feedback displayed with an annotated SPC, rather than as a percentage on dashboards, was critical to our success. The timely, accurate measurement by HCW type made it possible to change unit culture and to sustain it by creating a system of interdisciplinary HH champions. These HH safety champions identified noncompliance and provided reminders to the HCW to comply with protocols immediately at the time of the event. As a result, HCWs became more aware of their own behavior, contributing to an overall improvement in unit culture.[23] HCWs were empowered to speak up and establish a social norm for behavior on these units.

In addition, the Hawthorne effect, which is a social phenomenon described as behavior change due to an awareness of being observed,[24] was likely a major contributor to our project improvements. Although medical researchers are careful to minimize this effect, individuals who want to change… health care systems can use the Hawthorne effect to their advantage.[25,26] Previous studies have measured the positive effect that auditors alone[27] or coupled with attention to improvement can have on HH compliance.[28,29] Our project combines the influence of performance auditing, leadership commitment, HH champions, informational signage, reminders, and empowering patients and families to speak up to create a powerful Hawthorne effect. Furthermore, these interventions have been incorporated into the operation of the units contributing to sustained HH performance.

Our study had several limitations. This was a single-center study, and our results may not be generalizable to other settings. We did not measure the cost-effectiveness of this improvement project or other balancing measures, such as staff satisfaction. We also did not quantify how often patients and families or HH champions reminded HCWs to comply with HH protocols, nor did we measure HH knowledge. Finally, we were unable to link improvements in HH compliance to HAIs such as CLABSIs.

The Duke Program for Infection Prevention and pediatric unit leadership continue to monitor HH compliance to ensure sustained performance on these units. At the time of this publication, HH performance has remained at ≥95% for >2 years. Efforts to improve HH compliance in other areas of the hospital were occurring in parallel during this project. Some of the interventions developed in this project, including the screensaver reminders, were expanded across the hospital. Compliance rates in all areas of the hospital have remained between 90% and 95%.

CONCLUSIONS

The use of proven improvement methods, including high-reliability concepts, created a Hawthorne effect, which was key to improving and sustaining HCW compliance with HH protocols at ≥95% (LOR 2). Next steps include the continued control of practice in these well-performing units and across the hospital.

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