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Sustaining and Spreading Improvement in Hand Hygiene Compliance

Features

Department

"If other quality and safety problems exhibit the same characteristics as hand hygiene noncompliance, attempting to address them everywhere with exactly the same set of interventions is likely to fail because the key causes of the problem will differ from place to place."

— Beyond the Collaborative: Spreading Effective Improvement in Hand Hygiene Compliance (p. 24)

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Infection Prevention and Control

Editorial: Toward More Reliable Processes in Health Care

Peter Pronovost, MD, PhD

Walk into most manufacturing plants that are performing well, perhaps winning the Malcolm Baldrige Award,[1] and you will find robust leadership and management systems focused on customer needs. Good leaders establish a bedrock of values, a clear moral compass, and a compelling vision and inspire others to embrace that vision. Good managers declare goals and measures and ensure that both of these cascade through each level of the organization, with designated processes and persons accountable for them. Workers know the behaviors needed to achieve the goals, and management is visible in their work area and posts performance on key behaviors.

Health care has not yet widely embraced these management practices. Despite considerable clinical research to identify essential behaviors and practices, health care processes are unreliable, for which there are several reasons. First, we are still heavily practicing the "art" of medicine, reflecting a failure to determine when art is needed and when more disciplined science should be practiced. Second, at most organizations, clinicians are not trained in the tools and methods of Lean, Six Sigma, and change management—which Chassin and colleagues, in their two articles in this issue of *The Joint Commission Journal on Quality and Patient Safety*,[2,3] refer to collectively as Robust Process Improvement® (RPI®). Third, our accountability systems are grossly underdeveloped, and low compliance with evidence-based practices is too often tolerated.

Thanks to The Joint Commission Center for Transforming Healthcare, all of this seems to be changing in health care. Its first project addressed hand hygiene, one of the most effective behaviors to prevent health care–associated infections, for which compliance lies at less than 50% at most hospitals. The first article describes how eight hospitals used RPI to achieve a 70.5% relative improvement in the units that implemented a five-step Six Sigma project (Define, Measure, Analyze, Improve, Control).[2] A notable component of the project was the Center's approach to identifying barriers to hand washing. Too often we assume that knowledge is the only barrier and education the sole intervention. Yet other common barriers are agreement (clinicians do not agree with the evidence), ambiguity (what we are asking is unclear), and ability (systems make it impossible). This project identified local barriers, unique to each unit, and then sought local solutions.

The intervention then spread, as reported in the second article.[3] In the first three years, data were collected from 174 organizations, which implemented 769 projects, with each unit serving as a project. The average hand hygiene compliance improved from 57.9% to 83.5% in a diverse sample of units. Despite the use of RPI, the study design could have been more robust. For example, control units were not selected.

Yet the important message is that RPI can improve patient care and should be applied broadly in health care. Lean and Six Sigma, for example, are too often considered a work process tool rather than as a management system. Yet the Toyota production system was based on two key principles: respect for people and continued improvement.[4] When Toyota encountered quality problems in the last decade, its leaders learned that they needed to add a key value—humility.[5]

Health care would benefit from refocusing on the following principles: I am humble and curious; I respect, appreciate and help others; and I am accountable to continuously improve myself, my organization, and my community.[6] The Joint Commission Center for Transforming Healthcare has provided the tools and has pushed us further toward becoming high reliability organizations.[7]

These two articles offer hope that health care can benefit from more disciplined use of RPI—Lean, Six Sigma, and change management. To make it stick and spread, we will need managers and leaders to champion this approach as the way to manage and lead their organizations. In the struggle to find the balance between art and science, patients would be better served if more emphasis was placed on management science. **J**

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Infection Prevention and Control

Improving Hand Hygiene at Eight Hospitals in the United States by Targeting Specific Causes of Noncompliance

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In the 1840s, Semmelweis demonstrated the efficacy of hand hygiene in dramatically reducing maternal deaths in hospitals from puerperal fever.[1] Ever since, the goal of achieving and sustaining high rates of compliance with hand hygiene protocols has generally eluded hospitals. For example, in a systematic review of 96 studies from around the world, Erasmus et al. reported a median hand hygiene compliance rate of 40% in hospital units of all kinds.[2] In 2005 the World Health Organization announced the launch of its first Global Patient Safety Challenge, which was focused on improving hand hygiene.[3]

The Joint Commission Center for Transforming Healthcare (the Center) was created in 2008 to apply the tools and methods of Lean, Six Sigma, and change management to address the most difficult safety and quality problems facing health care. These tools, to which we refer collectively as Robust Process Improvement® (RPI®), have long been effectively employed in business[4,5] and, more recently, in health care. Two reviews document the extent to which the use of Lean and Six Sigma tools are spreading in health care.[6,7] Although rigorous evaluations of these tools' impact are few, there are good reasons to believe that they can be more effective than standard approaches to health care quality improvement (QI).[8,9]

RPI differs from long-standing efforts that emphasize evidence-based guidelines, checklists, and toolkits, all of which are typically not customized to the setting.[10,11] RPI provides new ways of examining complicated problems and discovering highly effective, targeted interventions.[12] In keeping with its objective to transform health care into a high reliability industry, the Center convenes teams from hospitals and health systems from across the United States that have mastered the RPI tools with RPI experts from the Center.[13] Much like the practice in other QI collaboratives,[14,15] teams from the Center's participants in a given project discuss their work and any barriers to accomplishing their goals in face-to-face sessions, with technical support and clinical guidance offered through teleconference calls. Improving and sustaining hand hygiene compliance was selected

Article-at-a-Glance

Background: Hospitals and infection prevention specialists have attempted to achieve high levels of compliance with hand hygiene protocols for many decades. Despite these efforts, measured performance is disappointingly low.

Methods: The Joint Commission Center for Transforming Healthcare convened teams of experts in performance improvement and infectious disease from eight hospitals for its hand hygiene quality improvement project, which was conducted from December 2008 through September 2010. Together, they used Lean, Six Sigma, and change management methods to measure the magnitude of hand hygiene noncompliance, assess specific causes of hand hygiene failures, develop and test interventions targeted to specific causes, and sustain improved levels of performance.

Results: At baseline, hand hygiene compliance averaged 47.5% across all eight hospitals. Initial data revealed 41 different causes of hand hygiene noncompliance, which were condensed into 24 groups of causes. Key causes varied greatly among the hospitals. Each hospital developed and implemented specific interventions targeted to its most important causes of hand hygiene noncompliance. The improvements were associated with a 70.5% increase in compliance across the eight hospitals from 47.5% to 81.0% ($p < .001$), a level of performance that was sustained for 11 months through the end of the project period.

Conclusion: Lean, Six Sigma, and change management tools were used to identify specific causes of hand hygiene noncompliance at individual hospitals and target specific interventions to remedy the most important causes. This approach allowed each hospital to customize its improvement efforts by focusing on the causes most prevalent at its own facility. Such a targeted approach may be more effective, efficient, and sustainable than "one-size-fits-all" strategies.

Table 1. Characteristics and Project Details of the Hospitals

Hospital	Location	Teaching Hospital	No. of Beds	Pilot Sites		
				Med/Surg	ICU	Other
Cedars-Sinai Medical Center	Los Angeles	Yes	950	X	X	
Exempla Lutheran Medical Center	Wheat Ridge, Colorado	No	400			X*
Froedtert Hospital	Milwaukee	Yes	486	X		
The Johns Hopkins Hospital	Baltimore	Yes	1,041	X	X	
Memorial Hermann The Woodlands Hospital	Houston	No	252	X	X	
Trinity Health-Saint Joseph Mercy Hospital	Ann Arbor, Michigan	Yes	537	X		
Virtua Memorial Hospital	Mount Holly, New Jersey	No	270	X	X	X
Wake Forest Baptist Medical Center	Winston-Salem, North Carolina	Yes	872	X	X	

Med/Surg, medical/surgical.
* Implemented throughout hospital.

by the Center for its inaugural project in 2008.[16] In this article, we describe the eight participating hospitals' identification of the most important specific causes of hand hygiene noncompliance at their respective settings and subsequent targeting of specific interventions to remedy them.

Methods

Project Design

The Hand Hygiene Project was a 22-month QI project (December 2008–September 2010) designed to improve hand hygiene compliance at the eight participating hospitals. Data on hand hygiene compliance were collected monthly from February 2009 through September 2010. Because this project involved increasing compliance with already existing hospital policies and because all staff were expected to comply, Institutional Review Board approval was not required.

Hospital Participation

The eight hospitals that volunteered to participate in the project were Cedars-Sinai Medical Center, Exempla Lutheran Medical Center, Froedtert Hospital, The Johns Hopkins Hospital, Memorial Hermann The Woodlands Hospital, Saint Joseph Mercy (a member of Trinity Health), Virtua Memorial Hospital, and Wake Forest Baptist Medical Center.[16] Table 1 (above) shows the location, size, and teaching status of these hospitals, together with the types of inpatient units that they engaged in the project. These eight hospitals were selected for the project from a larger group of 16 Center-participating hospitals with RPI expertise. The selection process was based primarily on a ranking, conducted in fall 2008, regarding which quality and safety problems that the hospitals considered as most important to solve for their own institutions. The eight hospitals had ranked hand hygiene as first or second on their list of important quality and safety problems.

Project Planning and Implementation

As shown in the project's time line (Table 2, page 6), the Center convened teams from the eight participating hospitals to plan and then implement the project. The teams from each hospital most commonly consisted of an RPI expert and a physician specialist in infectious diseases or an infection control professional. The teams met a total of seven times at The Joint Commission and participating hospitals. Between meetings, Center staff monitored progress in conference calls. The project followed the general outline of a typical, five-step Six Sigma project (Define, Measure, Analyze, Improve, Control)—Define the problem precisely, Measure its magnitude reliably, Analyze the causes of hand hygiene failure, Implement interventions targeted to specific causes, and Control (sustain) the improvements over time.[17] The teams paid close attention to change management throughout the project. Specific tools were used to engage all relevant stakeholders in the project, identify particular sources of resistance to change to facilitate overcoming them, maintain support for the interventions, and hand over oversight of the improvements to frontline staff to facilitate their sustainability.

***Reaching Consensus on the Project's Focus* (December 2008–April 2009).** The teams reached consensus that the focus of the project would be to increase hand hygiene compliance on caregivers' entering or exiting a patient's room. Each hospital chose one or more inpatient units (typically, an adult medical/surgical unit and/or an ICU) in which to conduct the project. Center staff and teams reviewed the various approaches to measuring compliance that were commonly used in 2008.[18] As op-

Table 2. Time Line of the Hand Hygiene Project

December 2008–January 2009 Prework and Kickoff Meeting
- Eight Participating Hospitals (*see* Table 1)
- Provided Robust Process Improvement® (including Lean, Six Sigma, and change management) overview and structure
- Meeting held with project Sponsors, Champions, and Black Belts
- Project charter being developed

February 2009 Define Report Out
- Project charter was approved.
- Problem statement: Health care personnel hand hygiene is insufficient in the health care delivery process resulting in transmission of pathogens and potential hospital-acquired infections.
- Project scope: The eight participating organizations all chose a medical/surgical unit as the pilot unit. Five of the eight organizations chose an additional unit: intensive care unit. One organization chose its entire hospital (*see* Table 1).
- Project goal: At least a 50% improvement in hand hygiene compliance

April 2009 Measure Report Out
- Measurement system defined: Hand hygiene compliance was based on wash in and was out (two separate opportunities)
- Data collectors (secret observers) trained on data collection
- Data collection for baseline period (February 2009–July 2009, varied start and end dates of data collection for each organization)

June 2009 Analyze Report Out
- Baseline data collection period being completed
- Just-in-time coaches used for feedback and to identify nonobservable causes of hand hygiene noncompliance
- Root causes being identified and validated through graphical and statistical analysis by each of the participating organizations

August 2009 Improve Report Out
- Baseline data collection period completed, average compliance at 47.5% (*see* Figure 1)
- Completed analysis, identified 24 different causes for hand hygiene compliance *see* Table 3)
- Set of root causes differed from one hospital to another (*see* Table 4).
- Solutions targeted to the root causes identified were developed, implemented, and started to be validated (*see* Table 5).

October 2009 Improve/Control Report Out
- Solutions being validated, compliance through September 2009 up to 76.1% (*see* Figure 1)
- Control plans for sustainment of improvements being developed
- Control data for sustainability will start to be collected November 2009.

February 2010 Control/Celebrate Report Out
- Improve phase completed October 2009, average compliance at 76.1% (*see* Figure 1)
- Control plan implemented November 2009
- Control data will be collected through September 2010. Teams celebrated success of project to date.

posed to surveys of workers and measures of product consumption, "direct observation of the hand hygiene behavior of health care workers is considered the 'gold standard' of measurement methods."[18(p. xviii)] "Because no automated measurement method (for example, video surveillance, RFID [radio frequency identification] tags and proximity sensors on hand rub dispensers) was in use at all sites, the hospitals chose the gold standard in the form of "secret" observers. The hospitals developed training programs and a certifying test to increase the reliability with which all "secret" observers at all sites were observing and assessing compliance. They were free to choose whom they recruited as secret observers, but they all observed similar protocols for training and certifying observers and for replacing any individuals whose role became known to the unit staff. The teams also agreed on a plan to collect compliance data on a sample of observations that included every working shift during a 24-hour day and all 7 days of the week. Although the hospitals did not use an identical, standardized sampling plan, each hospital's monthly sample had to include observations from all shifts and all days of the week. Hospitals, using their own observation forms, recorded compliance data separately for each entry and exit of any caregiver into or out of a patient's room. Activities inside a patient's room that might require additional hand hygiene were not included because of the difficulty of secret observers' assessment of compliance in this setting while simultaneously remaining unidentified. Visitors and emergency situations were excluded from measurement.

***Identifying Causes of Hand Hygiene Noncompliance* (June–August 2009).** Causes of hand hygiene noncompliance were discovered in two ways. At first, causes were to be directly observed by the secret observers (for example, if there was no sink or hand rub dispenser near the door of a patient room). However, in the Analyze phase of the project it became evident that the secret observers could not identify all the important reasons why people failed to clean their hands. Therefore, a second method of identifying causes of failure was developed. Several individuals on each of the inpatient units participating in the project were designated and trained as "just-in-time coaches." The role of these coaches was to observe instances of noncompliance and, immediately on making the observation, ask the caregivers why they had not cleaned their hands. The hospitals collected qualitative data from these coaches, convened to review and categorize the qualitative data, and developed a standardized set of definitions that was used across all sites throughout the project to assign specific causes to particular episodes of noncompliance. These standardized definitions were used to collect data on the frequency of occurrence of each cause of

noncompliance.

Center staff compiled the standardized data from the secret observers and the just-in-time coaches across all sites to produce aggregate project data. Although coaches often identified instances of hand hygiene compliance that were not seen by the secret observers, only data collected by the secret observers were used to calculate rates of hand hygiene compliance.

***Assessing the Most Important Causes of Hand Hygiene Failure in Each Participating Inpatient Unit, Deploying Specific Interventions to Eliminate Them, and Sustaining Improvement* (August 2009–September 2010).** Each hospital used RPI tools to assess the most important causes of hand hygiene failure in its participating inpatient unit(s) and to develop and test specific interventions to eliminate them. Hospitals were not constrained in any way in their choice of interventions, but many of the interventions were developed collaboratively during project meetings. Experiences with particular approaches were shared widely among participating hospitals.

Hand hygiene compliance data were collected during 3 months of development and testing of interventions (Improve phase) and for 11 months following the full deployment of all the interventions selected by participating hospitals (Control phase). The hospitals used specific RPI tools to addresses the problem of sustaining improvement. Their Control phase plans entailed continued measurement of hand hygiene compliance by using the same secret observer method (with a reduced sample size) so that they would know if and when compliance began to decrease. At that time, the plans called for reassessment of specific causes of hand hygiene failure and renewed attention to the specific interventions previously employed to manage those causes or the deployment of new interventions if a new cause appeared.

Analysis of Compliance Data

As specific data on numerators and denominators that were used to calculate the proportions of monthly sampled observations were not available, the proportions were analyzed as separate observations. Because the range of the proportions was between zero and one, an arcsine transformation was applied to the data before analysis to stabilize the variance, and the transformed data were used in the analysis. There were 3 monthly data points per hospital in the Improve phase and 11 data points in the Control phase. In a preliminary analysis, the data were analyzed within each of these phases using a linear mixed model to determine if there was a systematic difference in the mean rates over month. The month effect for the analysis of each phase was shown to be not significant ($p > .05$), so the data were averaged over each phase within each hospital, and a linear mixed model was fit to these mean phase values. The data were averaged over month in the baseline phase, as there were an unequal number of baseline data points collected from hospitals in this phase of the study. The study hypothesized that the major improvement would occur in the Improve phase and that this improvement would be sustained in the Control phase. All pairwise differences in phase means were then tested at the .05 level of significance using a Bonferroni correction to control for multiple comparisons.

Results

Descriptive Statistics

Five of the eight participating hospitals engaged both an ICU and an adult medical/surgical inpatient unit in the project (Table 1). Two of the hospitals included only adult medical/surgical inpatient units, and the remaining hospital implemented the project in all inpatient units throughout the organization.

Hand Hygiene Compliance and Causes of Noncompliance

Hospitals collected baseline data on compliance and causes from February through July 2009. Baseline compliance across all participating hospitals and units was 47.5%. Initial data from the eight hospitals revealed 41 different causes of hand hygiene noncompliance. We categorized the raw data on causes into 24 groups, as shown in Table 3 (page 8), to best indicate the specific interventions that would be needed to remedy them. For example, several problems with preexisting data on hand hygiene compliance were combined into a single cause (Table 3, no. 18). In one instance, this analysis led to a refinement in the measurement protocol—emergency situations were then excluded from compliance rate calculations. Table 3 lists the 24 causes of hand hygiene failure.

One of the project's earliest and most consistent findings was the realization that almost all the specific causes of hand hygiene failure would require separate and distinct interventions to remediate. For example, inconvenient location of hand rub dispensers required purchasing and placing dispensers in close proximity to the entrance to patient rooms. Ensuring that dispensers are always full required the development and implementation of an effective maintenance program. Specific gaps in the knowledge and training of particular disciplines of caregivers, such as housekeepers or food service workers, required the modification of the hospitals' education and training programs for them. Changing the culture of a hospital unit so that all staff at every level of seniority and job type would feel not

only comfortable but obligated to stop another individual from entering a patient room without washing hands required a solution entirely different from all the others.

Another important finding that had major implications for the project participants and the Center was the fact that not all 24 causes were found for each of the eight hospitals. To the contrary, each hospital had a small set of key causes that explained the large majority of its hand hygiene failures. Further, those key causes differed from one hospital to another, as shown in Table 4 (page 9). Key causes were identified and validated in two ways. First, for causes that were observed by the secret observers during their measurement activities, chi-square tests were conducted to determine which of them were significantly ($p < .05$) associated with noncompliance. Second, causes identified by the just-in-time coaches were arrayed in a Pareto chart displaying their frequency. Hospitals typically selected the top one to three of these causes to include in their list of key causes. The number of key causes varied substantially, from a low of two (hospital F) to a high of nine (hospital D), with the remaining six hospitals exhibiting between five and eight key causes.

Table 3. Causes of Hand Hygiene Noncompliance in the Eight Hospitals*

1. Health care worker forgot
2. Ineffective or inconvenient placement of hand rub dispenser or sink
3. Dispenser or sink broken
4. No hand rub in dispenser, no soap at sink
5. Health care worker was distracted
6. Perception that wearing gloves negated need for hand hygiene
7. Proper use of gloves (for example, changing between rooms) slows down work process
8. Ineffective or incomplete education
9. Inadequate safety culture that does not stress importance of hand hygiene for all caregivers regardless of role
10. Caregiver's hands were full (holding medications, supplies, linens, food trays); no convenient place to put supplies to facilitate hand hygiene
11. Lack of accountability: staff do not remind each other to clean hands
12. Isolation area: special circumstances related to gowning and gloving
13. Skin irritation from hand cleaning product
14. Lotion dispenser used instead of soap
15. Following another person into or out of a patient room
16. Equipment sharing between rooms requires frequent entry and exit from room
17. Bedside procedure or treatment requires frequent entry to and exit from patient room
18. Hand hygiene compliance data are not collected, are inaccurate, or reported infrequently
19. Admitting or discharging patients requires frequent entry and exit from patient room
20. Perception that excessive hand cleaning is required
21. Hand cleaning product perceived as feeling unpleasant
22. Health care worker was too busy
23. Emergency situation
24. Work flow not conducive to consistent hand hygiene

* Not in order of frequency or importance.

Compliance During Testing and Deployment of Interventions

Each hospital collected baseline (preintervention) compliance data for several months, but the calendar time periods varied among them. Therefore, we averaged the hospitals' baseline data; that is, we calculated a single percentage compliance figure to represent each hospital's entire experience during its particular baseline period. To arrive at the baseline compliance figure for the project, we summed the eight individual hospital percentages and divided by 8.

The hospitals tested and deployed interventions from August through October 2009 (Improve phase). Table 5 (page 10) displays many of the specific interventions and how they were targeted to each of the 10 key causes of hand hygiene noncompliance shown in Table 4. During the testing phase, hospitals with the same causes of noncompliance shared their experiences in developing specific, targeted interventions and learned from one another, often arriving at similar approaches to those common causes. For example, six of the eight hospitals found that various caregivers had the mistaken opinion that hand hygiene was not necessary if they were wearing gloves (Table 4). This discovery led those hospitals to revise their training programs to focus on the proper relationship between hand hygiene and gloves for food service workers, housekeepers, and other specific groups of caregivers. From November 2009 through September 2010, the hospitals collected additional compliance data to assess the sustainability of the improvements they achieved.

Figure 1 (page 11) displays the time trend of the compliance data, showing box plots for each of the time periods. The mean monthly hand hygiene compliance rates were not significantly different over month within the Improve phase ($p = .4905$) or within the Control phase ($p = .7428$), justifying the averaging of rates over each month within each phase for further analysis. The average compliance rate for the baseline, Improve, and Control phases was 47.5%, 76.1%, and 81.0% respectively, with a standard error of 4.8%. Compared to the baseline, compliance for both the Improve and Control phases was sig-

Table 4. Variability of Key Causes of Hand Hygiene Noncompliance Across the Eight Hospitals

	Individual Hospitals							
Key Causes of Hand Hygiene Noncompliance	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Ineffective placement of dispensers or sinks		X		X	X		X	X
Hand hygiene compliance data are not collected or reported accurately or frequently	X	X		X	X			X
Lack of accountability and just-in-time coaching		X	X	X	X		X	X
Safety culture does not stress hand hygiene at all levels			X	X	X	X		X
Ineffective or insufficient education		X	X	X	X		X	
Hands full	X	X	X	X	X		X	
Wearing gloves interferes with the process	X	X	X	X			X	
Perception that hand hygiene is not needed if wearing gloves	X		X	X	X		X	X
Health care worker forgot	X	X		X			X	
Distractions	X	X				X	X	

nificantly higher ($p < .0001$ for both comparisons). Control phase compliance was higher than that of the Improve phase, although not significantly ($p = .1096$), indicating that the improvement in compliance in the Improve phase was sustained in the Control phase.

Discussion

Using varied methods and definitions, studies repeatedly show that improving hand hygiene compliance in hospitals reduces rates of infection.[19–23] However, efforts to improve rates of hand hygiene compliance have proved difficult to spread and sustain.[24,25] A number of factors have been identified as barriers to such efforts.[26–28] Studies of whether and how barriers vary among hospitals are lacking.

We employed Lean, Six Sigma, and change management tools to systematically assess causes of hand hygiene noncompliance and to drive improvement at eight hospitals in the United States. Together, these hospitals improved their hand hygiene compliance in selected inpatient units by 70.5% and sustained the improved levels for 11 months. Our findings suggest that several factors were associated with this success and may be important considerations in the design and implementation of such programs. First, we found 24 different causes of hand hygiene failures across the inpatient units of the eight hospitals that participated in this project. Each one of these different causes pointed toward very different remedial measures. For example, when hospitals found that housekeepers were using the same gloves when they went into different patient rooms, they revised their training programs for those caregivers to emphasize the proper use of gloves. If nurses approached the door of patient rooms with their hands full of supplies to perform a particular patient care activity (for example, to change a surgical dressing) and there was no place to temporarily put those supplies, an opportunity to clean hands was often lost. The installation of shelves or the use of rolling carts was employed to remedy this cause.

The second important finding was that the 24 causes were not evenly distributed across all eight hospitals. To the contrary, as the data in Table 4 show, a smaller number of key causes—ranging from 2 to 9—was identified that explained the large majority of hand hygiene failures at each hospital. Perhaps the most impactful finding, however, was the discovery that those key causes differed from one hospital to another. Each hospital designed and implemented a different set of interventions, each intervention targeted to one of the most important causes of hand hygiene failure in its facility. Taken together, the implication of this pattern of findings is potentially profound. It suggests that a single, "one-size-fits-all" approach to improving hand hygiene in hospitals will not succeed. If one does not know exactly why hand hygiene is failing and which specific causes are most prevalent in a particular hospital, it will not be possible to devise an effective set of interventions. Furthermore, following a prespecified laundry list of interventions in a particular hospital is likely to result in a significant amount of wasted effort because some items on the list are likely to focus on specific causes that are not among the key ones in that facility. For example, if hospital A did not know what its key causes were and deployed interventions to remedy all 10 of the causes (Table 4), it would waste a lot of time in attempting to address the 4 causes that were not important in the organization. Thus, targeting interventions to specific causes may be more efficient than a one-size-fits-all best practice because it permits hospitals to avoid wasting resources on problems that they do not have.

Table 5. Solutions Targeted to the Main Causes of Hand Hygiene Failures

Main Causes	Solutions
Ineffective placement of dispensers or sinks	• Provide easy access to hand hygiene equipment and dispensers.
Hand hygiene compliance data are not collected or reported accurately or frequently	• Data provide a framework for a systematic approach for improvement. • Utilize a sound measurement system to determine the real score in real time. • Scrutinize and question the data. • Measure the specific, high-impact causes of hand hygiene failures in your facility and target solutions to those causes.
Lack of accountability and just-in-time coaching	• Leadership commits to hand hygiene as an organizational priority and demonstrates support by role modeling consistent hand hygiene compliance. • Train leaders as just-in-time coaches to reinforce compliance. • Through just-in-time coaches, intervene to remind health care workers to wash their hands. • Implement employee contracts to be signed by all health care workers to reinforce their commitment to hand hygiene. • Apply progressive disciplinary action against repeat offenders. Expectations should be applied equally to all health care workers.
Safety culture does not stress hand hygiene at all levels	• Make hand hygiene a habit—as automatic as looking both ways when you cross the street or fastening your seat belt when you get in your car. • Ensure commitment of leadership to achieve hand hygiene compliance of 90+% • Serve as a role model by practicing proper hand hygiene. • Hold everyone accountable and responsible—physicians, nurses, food service staff, housekeepers, chaplains, technicians, therapists.
Ineffective or insufficient education	• Provide general education on hand hygiene expectations. Include information on infection prevention, and stress the organizationwide commitment to hand hygiene, highlighting strategies deployed to reinforce compliance, such as posters and visual cues. Some organizations make this part of annual training provided to new and existing employees. • Provide discipline-specific education that puts hand hygiene within the context of an employee's daily work and processes. • Reinforce education with just-in-time coaching.
Hands full	• Create a place for everything; for example, a health care worker with full hands needs a dedicated space where he or she can place items while performing hand hygiene.
Wearing gloves interferes with the process	• Locate glove dispensers near hand-rub dispensers and sinks to facilitate the proper use of gloves. • Provide training on glove use that incorporates hand cleansing and glove use within a specific work flow. • Use visual cues to reinforce and remind.
Perception that hand hygiene is not needed if wearing gloves	• Provide discipline-specific education that puts hand hygiene within the context of an employee's daily work and processes. • Standardize the work processes that involve entry into a patient's room, and specify when and why hand hygiene is required; for example, standard processes for food tray delivery and room cleanings. • Provide discipline-specific education and training on glove use.
Health care workers forget or distractions	• Use a code word to be used among health care workers to signal to a peer that they missed an opportunity and need to wash. • Identify new technologies to make it easy for health care workers to remember to clean their hands, such as RFID, automatic reminders, and warning systems. • Train and deploy just-in-time coaches to provide real-time reinforcement and feedback to health care workers. Just-in-time coaches are critical in creating a change in culture and behavior. • Visual cues reinforce hand hygiene messages and training. These include stickers, colors, and posters. Visual cues need to be changed periodically so that they continue to be effective. • Apply progressive disciplinary action against repeat offenders. Expectations should be applied equally to all health care workers.

RFID, radio frequency identification.

Box Plot of Percentage of Monthly Sampled Observations That Were Compliant with Hand Hygiene, February 2009–September 2010

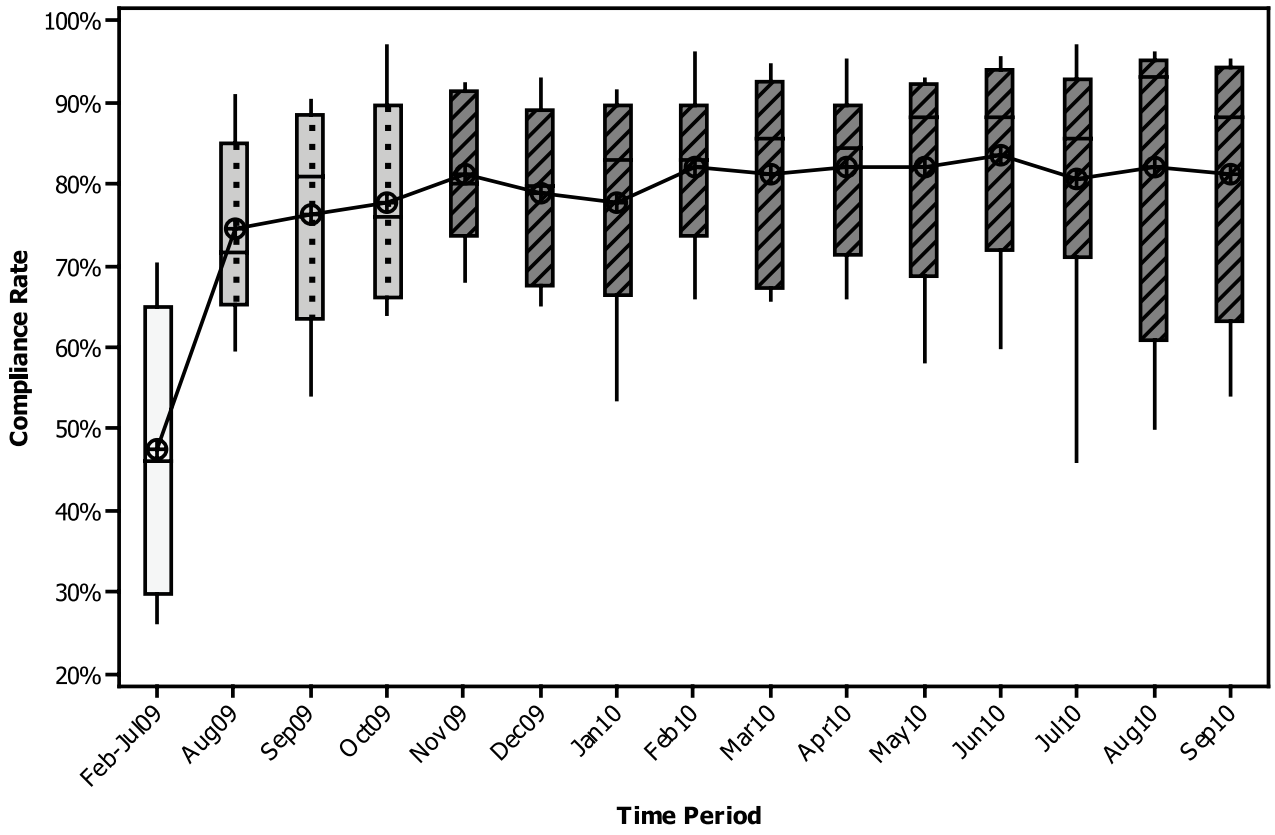

Figure 1. *The monthly data were calculated by summing the eight individual hospitals' monthly percentage compliance and dividing by 8. The mean compliance rates are shown for the baseline (February 2009–July 2009), Improve (August 2009–October 2009), and Control (November 2009–September 2010) phases. Compared to the baseline phase, compliance for both the Improve and Control phases was significantly higher (*$p < .0001$ *for both comparisons).*

Limitations

This study has several limitations. Because the evaluation design compared baseline with postintervention rates of compliance, we cannot be certain that the interventions developed by project participants were solely responsible for the improvements in hand hygiene compliance. For example, we cannot exclude the possibility that influences external to this project, such as other programs or activities to reduce the frequency of health care–associated infections, played a role in influencing rates of hand hygiene compliance. On the other hand, each of these hospitals had previous efforts in place to improve hand hygiene. Given the mean baseline performance of 47.5%, it seems reasonable to conclude that those prior efforts had been at best only modestly successful. Furthermore, each of these hospitals had considerable expertise in applying the strategies and tools of RPI. We do not know whether hospitals that have no such process improvement expertise can benefit from the knowledge gained in this project. Despite the sustained improvement throughout the 11-month Control phase, we do not know how hand hygiene compliance changed following the end of the project. Nor can we assess which of the specific interventions had the greatest effect on improving hand hygiene because multiple interventions were deployed at the same time during the Improve phase and different sets of interventions were used at different hospitals. Finally, although we have documented substantial improvements in hand hygiene compliance, we do not have data to demonstrate that health care–associated infection outcomes concomitantly improved for these hospitals.

Conclusion

In this study, eight hospitals used Lean, Six Sigma, and change management tools to improve their hand hygiene compliance

from 47.5% to 81.0% and sustained that high level of improved performance for 11 months. Each hospital had a different set of key causes of hand hygiene failure and implemented a set of interventions customized to target its most important key causes. Such a targeted approach may be more effective and more efficient than a one-size-fits-all improvement strategy. J

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Infection Prevention and Control

Beyond the Collaborative: Spreading Effective Improvement in Hand Hygiene Compliance

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Teams from different health care organizations have engaged with each other in structured efforts to improve quality of care under various auspices for nearly two decades. Data assessing the effectiveness of quality improvement (QI) collaboratives are mixed, but participants uniformly praise the benefits their individual organizations received.[1–9] Much less is known about whether organizations that did not participate in the collaborative are able to effectively employ interventions developed and/or implemented by those organizations that did participate.

The Joint Commission Center for Transforming Healthcare (the Center) was created in 2008 to engage hospitals in collaborative QI using the tools and methods of Lean, Six Sigma, and change management. Collectively, we refer to these three sets of tools as Robust Process Improvement® (RPI®).[10] Improving hand hygiene compliance was selected by the Center as the focus of its inaugural project.[11] As previously described, the Center convened teams from eight hospitals to improve hand hygiene compliance by using RPI tools and methods.[12] The eight hospitals, all of which had considerable RPI expertise, improved their hand hygiene compliance over the course of this 22-month project by 70.5%—from 47.5% to 81.0% ($p < .001$).

Following the conclusion of the collaborative project, the Center engaged another group of organizations, most of which had little or no RPI expertise, to evaluate and pilot test the knowledge and improvement tools created by the project and to adapt them for hospitals and other health care organizations that did not participate in the original project to use to improve their hand hygiene compliance. That pilot test resulted in the creation of a set of web-based tools that were made available to all Joint Commission–accredited health care organizations. In this article, we describe the work undertaken to assess the generalizability of the findings of the original project and to pilot test the Web-based improvement tools with 19 health care organizations. We also report the subsequent results of the first 289

Article-at-a-Glance

Background: Data assessing the effectiveness of quality improvement (QI) collaboratives are mixed; spreading improvement beyond the original collaborative group has proved difficult. Little is known about whether organizations that did not participate in the collaborative are able to effectively employ interventions developed or implemented by those organizations that did participate.

Methods: The Joint Commission Center for Transforming Healthcare conducted a collaborative QI project with eight hospitals, using Lean, Six Sigma, and change management methods to improve hand hygiene compliance. Participating hospitals achieved a 70.5% relative improvement (47.5% to 81.0%; $p < .001$). Following this project, working with an additional 19 hospitals, the Center created Web-based tools to enable health care organizations to use the same methods employed by the original eight hospitals without needing any knowledge or experience with Lean, Six Sigma, or change management. This Targeted Solutions Tool® (TST)® allowed organizations to discover the most important, specific causes of hand hygiene noncompliance in their facilities and to target interventions at those causes.

Results: In the first three years, 289 health care organizations used the TST to initiate 1,495 projects to improve hand hygiene compliance. Of the 769 projects at 174 organizations for which baseline and improvement data were available, average compliance improved from 57.9% to 83.5% ($p < .0001$). Similar improvement was observed in many clinical care settings, including ambulatory, long term care, inpatient pediatrics, critical care, and adult medical/surgical units.

Conclusion: Hospitals and other health care organizations using the TST achieved levels of hand hygiene compliance comparable to those experienced by the participants in the original collaborative.

organizations that used the Web-based tools to try to improve their hand hygiene compliance.

Methods

How the Center Conducts Multihospital Quality Improvement Projects

The Center uses RPI tools together with hospitals and health systems that have mastered their use to address a wide variety of health care quality and safety problems. The Center was designed by The Joint Commission both to generate new knowledge about improvement by conducting projects and to spread that knowledge beyond the small group of hospitals and health systems that have the RPI capacity to participate in its projects. Therefore, the Center conducts its projects with particular attention to discovering how the findings may be generalized to the larger populations of hospitals lacking the same RPI expertise that characterizes the hospitals that participate in initial collaboratives. Using the RPI tools to address a complex problem systematically greatly facilitates this process. The Center uses the five steps of a typical Six Sigma project (Define, Measure, Analyze, Improve, and Control) as an overall guide in constructing its project plans.[10–13] This method leads participating hospitals to devise ways to measure the magnitude of the problem under study, assess the specific causes of the problem at their facilities, create and deploy effective interventions directed at the most prevalent causes, and implement plans to sustain improved performance.

Center staff ensure that all participating hospitals agree on the same measurement system and commit to collecting and analyzing data using the same methods so those data can be compiled across sites. Following the conclusion of the work with the participating hospitals, the Center pilot tests the project methods with a group of other health care organizations that have much less RPI expertise to learn how to translate the lessons learned in the original project. The results of that work are embedded in set of tools and software that are Web-based and devoid of any jargon referable to Lean, Six Sigma, or any specialized change management or process improvement methods. We call this product the Targeted Solutions Tool® (TST®),[14] an innovative online application that guides users through every step of the improvement project without the need for any specialized training. Importantly, in addition to providing specific, effective improvement interventions, the TST also guides users through all the supportive change management processes that are essential to achieving and sustaining higher levels of performance.* In the Center's hand hygiene compliance project, 24 different causes of hand hygiene failure were identified, and their frequency varied greatly among the eight participating hospitals.[11,12] In acknowledgement of this variability, the TST is designed so that users will identify the particular causes of hand hygiene failure that explain the majority of the problem at *their* organizations. After the key causes are identified, users select specific interventions, targeted to each key cause, that were proven effective by the original participating hospitals. The TST provides detailed implementation guides and instructions supporting the deployment of the specific interventions. TST users enter all data measuring hand hygiene compliance directly into the TST database at all phases of their projects. Those data are available to the Center for analysis and to identify opportunities to improve the effectiveness of the tools. An overview and illustrations of some of the features of the hand hygiene TST are provided in Sidebar 1 (pages 15–17).

* The TST is available to all Joint Commission–accredited health care organizations at no added cost and to others by arrangement on a case-by-case basis for a fee.

Developing and Pilot Testing the Hand Hygiene TST (November 2009–September 2010)

Pilot testing of the Hand Hygiene TST was conducted in two phases. In Phase 1, to develop the TST, Center staff identified 14 hospitals for initial pilot testing (November 2009–August 2010) of specific components of the effective hand hygiene improvement program developed during the course of the original project—namely, the measurement system, which uses trained secret observers; the methods of identifying causes of hand hygiene failure; and the targeted improvement interventions.[11] The hospitals were selected to represent a broader range of size, geography, and teaching status than the original 8 hospitals. Table 1 (page 18) lists these organizations and their characteristics.

As this pilot test was coming to a conclusion, the Center finalized the TST and tested it in Phase 2 of pilot testing with a second group of 5 hospitals before its wider release (May 2010–September 2010). Table 2 (page 18) lists these 5 hospitals and their characteristics. These hospitals represented a convenience sample of organizations that expressed their desire to work with the Center. They were selected to provide additional diversity of experience with the TST among hospitals with little or no RPI expertise and varying size, location, and teaching status

The TST was released to all Joint Commission–accredited health care organizations in September 2010. Following that release (February–June 2011), the Center worked with five nursing homes to assess whether the hand hygiene TST would be effective in such long term care settings. Not only are nursing home residents themselves vulnerable to health care–associated

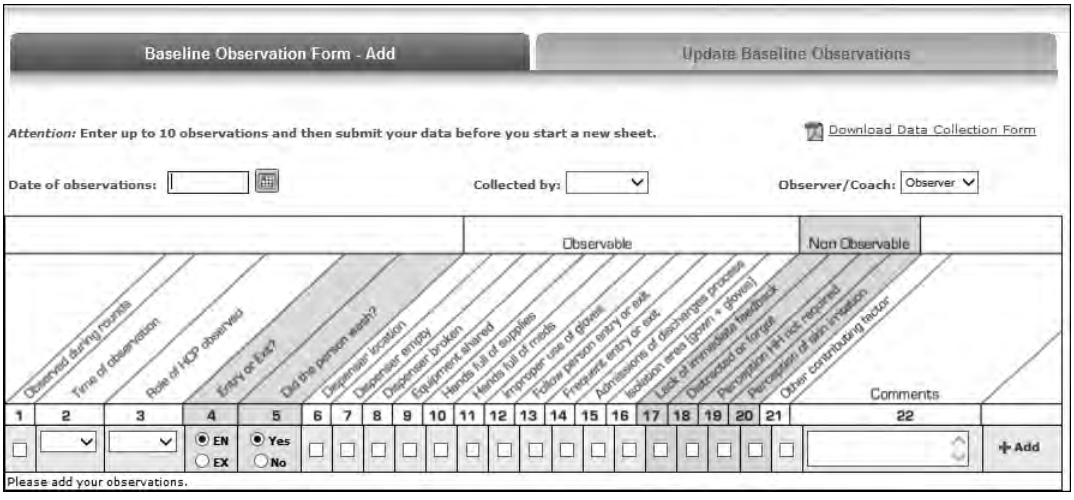
Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool

Targeted Solutions Tool® (TST®) is an innovative Web-based application that guides health care organizations through a step-by-step process to accurately measure their organization's actual hand hygiene compliance, identify their contributing factors to poor hand hygiene compliance, and direct them to proven solutions that are targeted and customized to address their particular identified contributing factors. The Hand Hygiene TST includes, for example, Downloadable Training Materials, Data Collection Tool, Data Analysis Tools, Targeted Solutions & Implementation Guides, and Tools for Sustaining Improvements. (Available in color in online article.)

Downloadable Training Materials

In the Training section of the tool, there are downloadable training materials, video scenarios, and practice exercises using the data collection form. At the end of the training session, there is a brief assessment that data collectors will take to ensure that they have learned the skills needed for accurate and consistent data collection.

Data Collection Tool

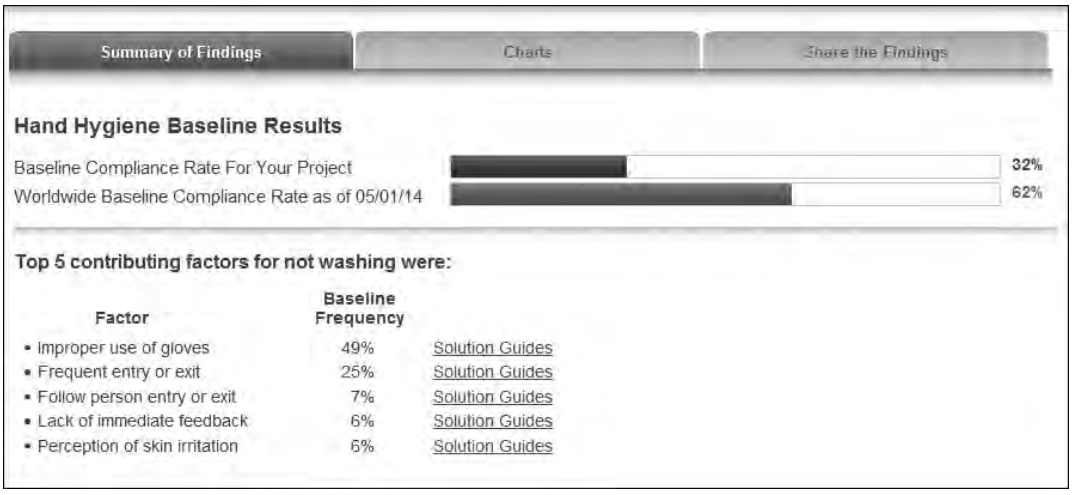


Using the data collection form, secret observers and just-in-time coaches record hand hygiene compliance and observable and nonobservable contributing factors of hand hygiene noncompliance.

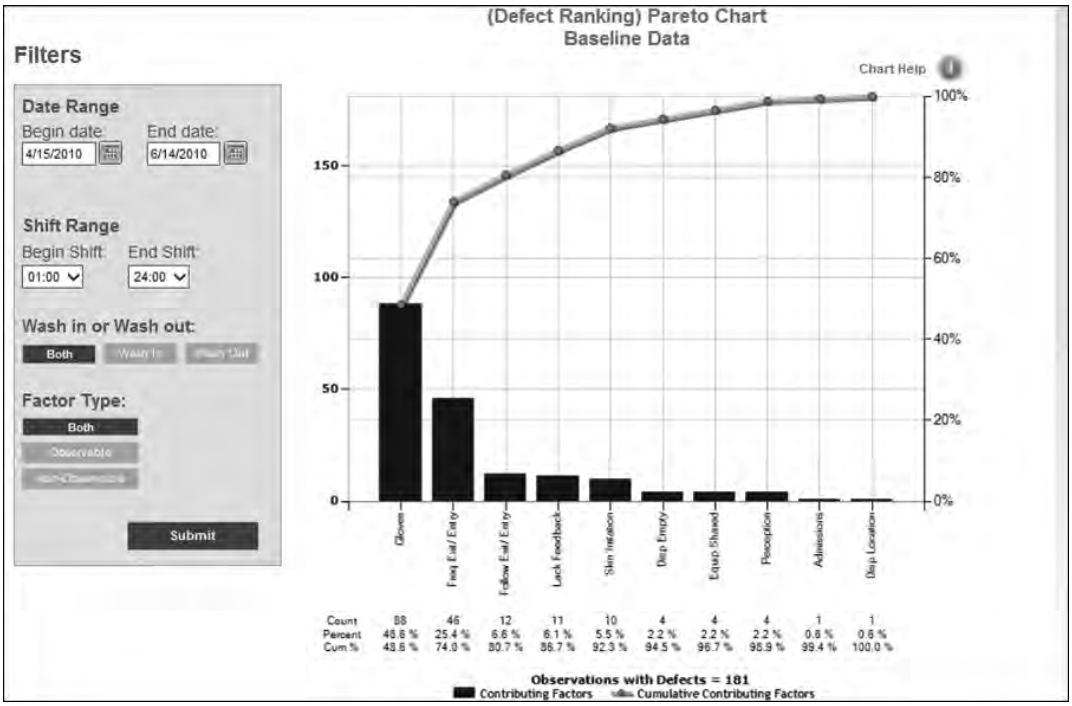
(continued on page 16)

Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool (continued)

Data Analysis Tools



The TST will show the baseline hand hygiene compliance rate for the project compared to the baseline rate for all projects in the TST at the time the data are entered. In April 2014, the hand hygiene TST was made available to international organizations accredited under the Joint Commission International accreditation program. Hence, the comparator for project baseline rates is the "worldwide" baseline from all TST users around the world. The TST also ranks the top five contributing factors of hand hygiene noncompliance from highest to lowest frequency based on the data collected. After solutions are implemented, the TST will show a comparison of your baseline and improve hand hygiene compliance rates.



The TST provides various charts having filtering capability to analyze the data collected by date, shift range, and role type. The charts are updated in real time as new data are collected and entered into the TST.

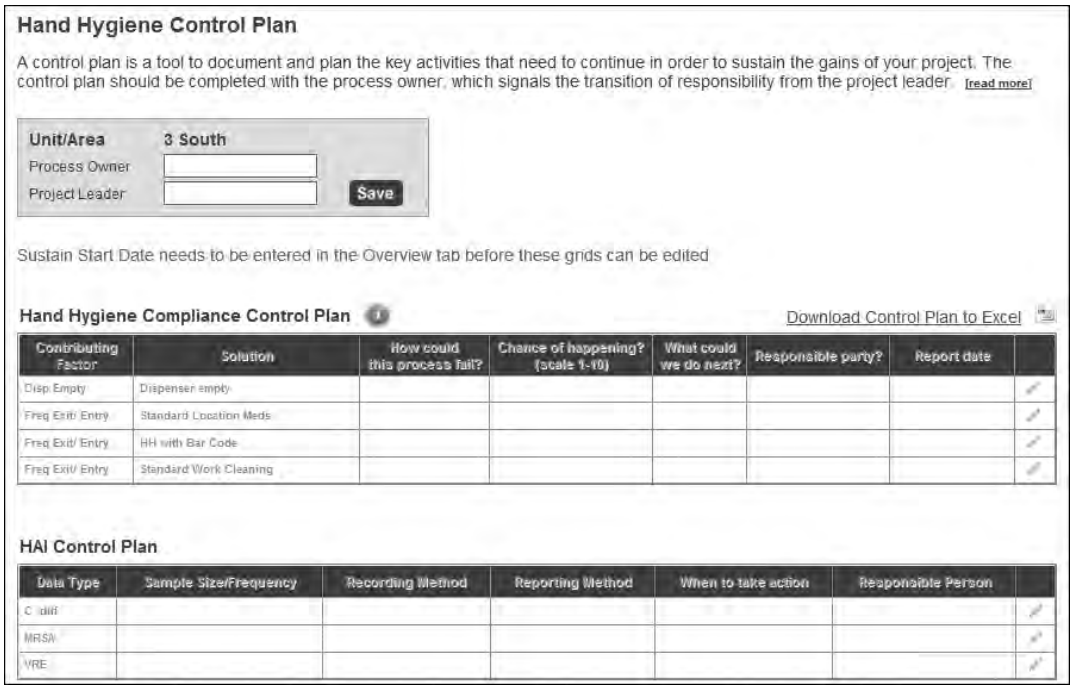
(continued on page 17)

Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool (continued)

Targeted Solutions & Implementation Guides

The TST provides specific Solutions and Implementation Guides that have been developed and validated and that are targeted to the contributing factors that have been identified through data collection.

Tools for Sustaining Improvements



The last section of the TST focuses on sustaining the improvements made in the project and replicating these results in other areas of the organization.

infections, but they are frequently transferred to hospitals when they contract serious infections, thus adding to the infection control challenges facing hospitals. Improved hand hygiene in nursing homes may, therefore, be doubly beneficial.

For the TST, we developed a standardized program for training secret observers that included video scenarios that present different circumstances for observing hand hygiene compliance, quizzes to determine whether candidates have mastered the rules for determining compliance, and a certifying examination that must be passed successfully with a score of ≥ 90% before an observer is permitted to begin data collection. To establish the baseline hand hygiene compliance rate, the TST recommends that the secret observers collect at least 240 observations. The TST urges users to go beyond this bare minimum, suggesting that two observers collect 10 to 20 observations per day for a two-to-three-week period. Importantly, data collectors are instructed to conduct observations during all three standard nursing shifts and on every day of the week. A similar number of observations are recommended during the Improve phase. In the Control phase, 80 observations per month are recommended so that the organization will know whether improvement is maintained or begins to fall off. We did not attempt to estimate or track the proportion of all opportunities to clean hands that is represented in the data collected by the secret observers.

Although secret observers can identify some causes of hand hygiene failure (for example, a hand rub dispenser that is broken or empty), other causes require direct interview of caregivers (for example, a perception that hand hygiene is not required prior to entering a patient's room). To preserve the anonymity of the secret observers and, thereby, the integrity of the

Table 1. Characteristics of the 14 Hospitals Participating in Phase 1 of Hand Hygiene Targeted Solutions Tool Pilot Testing

Hospital	Location	Teaching Status	No. of Beds
Adventist La Grange Memorial Hospital	Illinois	Yes	205
Jackson Purchase Medical Center	Kentucky	No	55
Kings County Hospital Center	New York	Yes	622
Memorial Hermann Northeast Hospital	Texas	No	255
Memorial Hermann Texas Medical Center	Texas	Yes	1,082
Metropolitan Hospital Center	New York	Yes	140
North Shore-LIJ: Forest Hills Hospital	New York	Yes	222
North Shore-LIJ: Plainview Hospital	New York	Yes	239
North Shore-LIJ: Southside Hospital	New York	Yes	371
North Shore-LIJ: Syosset Hospital	New York	No	103
Northwest Medical Center	Alabama	No	10
Stanford Health Care	California	Yes	613
The Charlotte Hungerford Hospital	Connecticut	No	109
UAB Highlands	Alabama	No	219

Table 2. Characteristics of the Five Hospitals Participating in Phase 2 of Hand Hygiene Targeted Solutions Tool Pilot Testing

Hospital	Location	Teaching Status	No. of Beds
Good Shepherd Rehabilitation Hospital	Pennsylvania	No	74
Higgins General Hospital	Georgia	No	25
Montefiore Health System	New York	Yes	1,491
Overlake Hospital Medical Center	Washington	No	337
UCSF Medical Center	California	Yes	580

measurement system, the TST uses different individuals, trained as "just-in-time coaches" to interview caregivers immediately following a missed hand hygiene opportunity and to ascertain the reasons why caregivers did not clean their hands (for example, a belief that wearing gloves obviated the need for hand hygiene). The TST provides guidance on the traits that characterize effective just-in-time coaches and contains a standardized program to train them. To ensure consistency in assessing hand hygiene opportunities, these coaches undergo the same training and are required to pass the same certifying examination as the secret observers. The coaches also receive specific advice and scripting on nonthreatening ways to ask staff about why hand hygiene was not performed. In addition, coaches are encouraged to recognize and reward staff by positively reinforcing instances of compliance with hand hygiene protocols. These individuals also often served as key components of the improvement interventions. The TST recommends that the coaches collect at least 20 to 30 observations of causes of noncompliance per day for about two weeks.

Each hospital that participated in pilot testing used the measurement system and just-in-time coaches to determine its rate of baseline hand hygiene compliance and its most important causes of noncompliance. Each then selected and implemented specific interventions to address its causes. The measurement system was used continuously to document any improvement in hand hygiene compliance and to monitor it on an ongoing basis. If a decrease in compliance is observed, the TST provides specific recommendations for understanding what caused the decline and how to reverse it. The just-in-time coaches should be reengaged to determine the causes of the decrease in compliance, and interventions appropriate to those causes should be implemented. We did not track how frequently organizations used any of the specific interventions contained in the TST.

Statistical Methods

For the analysis of the Phase 1 and Phase 2 pilots, paired *t*-tests were performed to assess the statistical significance of the difference in hand hygiene compliance rates from the baseline phase to the Improve phase. For users of the TST, we performed several analyses to evaluate the statistical significance of differ-

ences in hand hygiene compliance between the baseline and Improve phases. We used a paired *t*-test to evaluate changes in hand hygiene compliance rates for a group of nursing homes that used the TST.

For other TST users, we used a hierarchical logistic random effects model to control for observations of hand hygiene compliance that were nested within health care organizations. The binary dependent variable was hand hygiene performed ("yes" or "no"). We used clinical area (for example, ICU, medical/surgical inpatient, ambulatory), time of day (midnight to 7 A.M., 8 A.M. to 3 P.M., and 4 P.M. to 11 P.M.), and whether hand hygiene was observed on entering or exiting a patient's room as independent variables in the random effects model. The health care organization was the random effect. We used similar random effects models to evaluate the significance of changes in compliance between baseline and Improve phases for hand hygiene on entering and exiting a patient room, by time of day, and for each of nine different clinical areas in which health care organizations undertook projects. In addition, we used a logistic regression model with clinical area as the random effect, grouped by phase (baseline and Improve) to estimate the variance between areas at baseline and at Improve. We tested the statistical significance of the difference in variances with a chi-square test. We also examined a subset of all TST users, those that had entered at least 100 observations of hand hygiene compliance in each of the baseline and Improve phases. We used a paired *t*-test to assess the statistical significance of the difference in hand hygiene compliance between the two phases.

Results

We report results here for the following:

1. The two groups of hospitals involved in the development and pilot testing of the TST—the 14 hospitals participating in Phase 1 of pilot testing and the 5 hospitals participating in Phase 2 of pilot testing
2. The first 289 health care organizations to use the TST to improve hand hygiene
3. The 5 nursing homes that participated with Center staff in a special test of the TST in long term care

Pilot Testing the Hand Hygiene TST in the Two Groups of Hospitals

We first summarize the results of pilot testing the components of the TST. The measurement system, which used secret observers, worked well in all the pilot settings and required no changes. No new causes of hand hygiene failure were discovered during pilot testing, although the original list of 24 was somewhat modified to simplify the collection of those data. Pilot testing permitted the development of additional interventions adapted to circumstances pertaining to particular settings. For example, in one inpatient rehabilitation unit that was configured in a gym-like setting, the open floor plan made it difficult to place alcohol hand rub dispensers within easy access of health care workers. After much consideration and collaboration with the manufacturer of the hand rub used in this facility, it was determined that the best solution was to provide the workers with small bottles of hand rub affixed to a lanyard for easy access. Pilot testing also led to further development of the TST's guidance on how to implement specific improvement interventions because the pilot tests were conducted in a wide variety of hospitals of varying sizes and regions of the United States. For example, one intervention involved unit staff agreeing on the use of a "code word" or action for staff to remind each other to perform hand hygiene without fear of embarrassing a coworker. Pilot testing resulted in the inclusion of a wider variety of code words (for example, "Dude!") and gestures such as a hand clap.

Two of the causes identified in the original project were chosen for special attention because they were so frequently implicated and felt to be essential to the long-term success of the effort to improve hand hygiene compliance. Deficiencies in the culture of safety often led to health care workers being too intimidated to remind others (particularly those more senior, including physicians) to clean their hands when they were observed to fail to do so on entering or leaving a patient's room. Often accompanying these deficiencies was a failure to hold everyone accountable for adhering to the hand hygiene protocol. Because of the centrality of deficiencies in the culture of safety to sustaining improvement, the use of the TST ensures that all projects address these two causes effectively. Tools to support all phases of a hand hygiene improvement effort were pilot tested and assembled to produce the Center's hand hygiene TST.

Each of the two groups of hospitals that participated in the development and pilot testing demonstrated improved hand hygiene compliance. In aggregate, averaging compliance rates across hospitals, the 14 hospitals involved in Phase 1 of pilot testing improved their hand hygiene compliance from a baseline of 41.5% to 61.8% ($p < .001$). Phase 2 of pilot testing, in which the full TST suite of tools was used, verified that health care organizations without RPI expertise could use it to measure hand hygiene compliance, identify and prioritize the most important causes of noncompliance, and implement effective improvement interventions. Overall, the 5 hospitals involved in this final test of the TST improved their hand hygiene compliance from a baseline of 34.4% to 67.8% ($p = .002$)

The First Three Years of Hand Hygiene TST Use by 289 Health Care Organizations

In the three years between September 2010, when the hand hygiene TST was made available, and September 2013, 289 health care organizations initiated 1,495 projects, accounting for a total of 898,423 observations in different clinical areas, and entered compliance data using the hand hygiene TST (Figure 1, page 21). (An individual project typically involved a single unit within a hospital or other organization.) Although 79% of the projects were initiated by hospitals, 10% were undertaken by ambulatory care organizations, and 7% by home care organizations. The remainder were conducted by nursing homes (2%), behavioral health organizations (1%), and laboratories (0.4%). Of those projects, 849 from 194 separate organizations had completed baseline data collection by September 2013. Across all observations in all projects, average compliance at baseline was 57.9%, with 25% of projects showing compliance rates < 42.9%, and 25% > 75.0%. There were no differences in compliance rates by time of day: midnight to 7 A.M. (58.9%), 8 A.M. to 3 P.M. (57.9%), and 4 P.M. to 11 P.M. (57.0%). Hand hygiene was performed more often on leaving a patient's room (63.3%) than on entry (53.1%). These findings are consistent with others reported in the literature, as identified in a systematic review of studies of hand hygiene in hospitals.[15] Ten studies assessed the relationship of hand hygiene with time of day (day versus night); 6 found no association, 3 found a positive association, and 1 was negative.[15] For the 35 studies in which hand hygiene compliance was assessed before and after patient contact, the median compliance after patient contact was 47%, compared to 21% before patient contact.[15]

Table 3 (page 21) shows the overall frequency of the 14 causes of noncompliance across all projects at baseline. Improper use of gloves was the most frequently identified cause, being observed 6,591 (33.4%) times out of a total of 19,756 observations of causes of noncompliance. The data in Table 3, which represent all observations of hand hygiene compliance at baseline for which a cause of noncompliance was identified, are not weighted or adjusted for the fact that different numbers of observations were entered by different organizations. Separately, we examined the data on causes of noncompliance for the 139 hospitals that had completed baseline data collection. Hospitals represented 79.9% of all 174 such organizations. We found substantial variability in which cause of noncompliance was the most frequent in different hospitals. Improper use of gloves was the most frequent cause in 48.9% of the hospitals, followed by frequent entry or exit (in 20.0%), and hands full of supplies or medications in another 20.0%. Inconvenient location of hand rub dispenser was the most common cause in 3.7%, isolation area gowning and gloving problems in 3.0%, following a person into or out of a patient room in 2.2%, and broken hand rub dispensers in 0.7%.

We identified several different ways in which gloves were used improperly, including situations in which caregivers believed that as long as they did not intend to have direct contact with patients (for example, housekeepers emptying garbage cans), they could wear the same gloves when going from one patient room to another. In other situations, caregivers did not believe it was necessary to clean their hands before putting on or after removing gloves. Another group of causes related to circumstances in which caregivers were required to repeatedly enter and leave a patient's room to complete a particular care process (for example, conducting a bedside procedure or treatment [19.4%], sharing equipment between rooms [5.8%], or admitting or discharging a patient [2.6%]). Other common factors contributing to hand hygiene noncompliance were situations in which caregivers approached patient rooms with their hands full of supplies (17.0%) or medications (4.9%) and found no convenient place to put down what they were carrying so they could clean their hands. Finally, when a group of individuals (for example, physicians on rounds) approached a patient's room, if the first person to enter failed to exercise hand hygiene, the rest of the group was much less likely to do so than if he or she did clean his or her hands (6.0%).

When an organization enters its baseline compliance data and identifies the specific causes of noncompliance in the clinical area under study, the TST provides a frequency distribution (Pareto diagram) of the most important causes in that area (Sidebar 1). The organization selects as many interventions as it wishes to address these key causes of noncompliance. Postintervention data are entered into the TST, and the organization tracks changes in hand hygiene compliance rates.

By mid-September 2013, 769 projects from 174 organizations had implemented improvement interventions and entered at least some data from the Improve phase of their projects; 80 projects had entered baseline data but had not yet implemented interventions. The Improve data presented here represent a snapshot of one point in time (September 2013). Since then, more health care organizations have been initiating projects over time, and ongoing projects continue to mature by deploying additional interventions and further improving performance.

As of September 2013, average compliance for the "improve" projects was 83.5%, representing an absolute increase of 25.6 percentage points and a 44.2% relative increase over

Health Care Organizations Using the Hand Hygiene TST in the First Three Years (September 2010–September 2013)

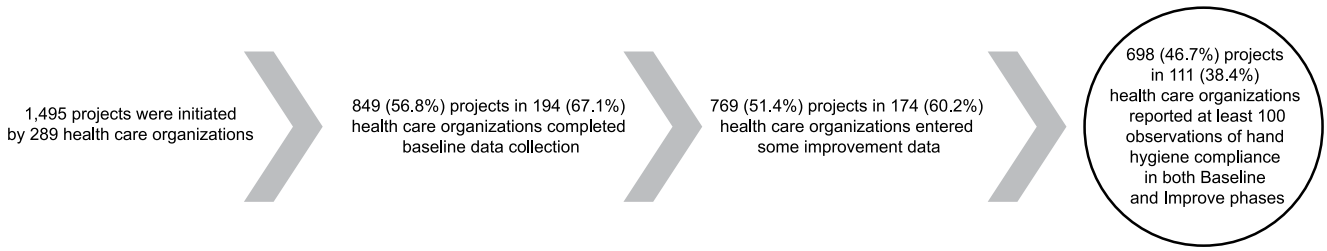


Figure 1. *This flowchart shows the way in which the projects and health care organizations used for the analysis were identified.*

Table 3. Frequency of Causes of Hand Hygiene Noncompliance at Baseline for 1,495 Projects at 289 Health Care Organizations (September 2010–September 2013)

Cause of Hand Hygiene Noncompliance	Frequency of Occurrence*	
	%	(*N*)
Improper use of gloves	33.4	(6,591)
Bedside procedure or treatment requires frequent entry to or exit from room	19.4	(3,828)
Hands full (supplies)	17.0	(3,359)
Isolation area (gowning and gloving)	6.1	(1,203)
Following a person into or out of a patient room	6.0	(1,190)
Shared equipment requires frequent entry or exit from room	5.8	(1,139)
Hands full (medications)	4.9	(968)
Inconvenient location of hand rub dispenser or sink	3.7	(730)
Admission or discharge of patient requires frequent entry to and exit from room	2.6	(518)
Hand rub dispenser empty	0.8	(165)
Hand rub dispenser broken	0.2	(49)
Health care worker distracted or forgot	0.04	(8)
Perception hand hygiene not required	0.04	(7)
Concerned about skin irritation	0.005	(1)

* Frequency is calculated on the basis of 19,756 total observations of causes of hand hygiene noncompliance.

the baseline compliance rate of 57.9%. The results of the hierarchical logistic random effects model showed that controlling for the nesting of hand hygiene observations within organizations, type of clinical area in which the project was conducted, washing on entry or exit, and time of day, the increase in compliance between baseline and Improve phases was statistically significant ($p < .0001$). Of the 769 projects, 25% had improved to a compliance rate of 65.1% or lower, while 25% improved to 79.8% or greater. Ten percent of projects achieved an improved compliance rate of 96.7% or greater. The gap between entry and exit compliance rates diminished: exit (85.4%), entry (81.8%). Improvement occurred at almost identical rates for hand hygiene opportunities at different times during the day, with each time period registering similarly improved compliance rates: midnight to 7 A.M. (84.8%), 8 A.M. to 3 P.M. (82.9%), 4 P.M. to 11 P.M. (84.6%). The logistic random effects models demonstrated that the improvements from baseline in hand hygiene compliance on entry and exit and for all three time periods were all statistically significant ($p < .0001$), controlling for the nesting of observations within organizations and the other independent variables. Table 4 (page 22) displays baseline and improve compliance rates by the different clinical areas in which projects were conducted. Although different clinical areas exhibited different compliance rates at baseline (range, 50.5% to 72.4%), all improved to roughly similar levels (range, 79.6% to 87.4%), and the variation among them diminished considerably. Logistic random effects modeling showed that the improvements in each clinical area from baseline to Improve phases were statis-

Table 4. Hand Hygiene Compliance Improvement by Clinical Area*

Clinical area (No. of projects)	Baseline (*N*)	Baseline Rate (%)	Improve (*N*)	Improve Rate (%)	Relative Improvement (%)†
Adult critical care (105)	19,897	62.5	63,483	79.6	27.3
Adult intermediate care (37)	5,177	56.6	42,089	82.6	46.0
Adult medical/surgical (310)	42,724	50.5	319,894	83.9	66.1
Ambulatory care (173)	12,649	72.4	56,793	86.9	20.0
Emergency department (47)	5,859	51.7	27,001	79.7	54.3
Long term care (33)	5,630	59.7	22,738	85.9	43.9
Pediatric critical care (27)	3,580	61.2	20,901	83.9	37.0
Pediatric intermediate care (12)	2,938	56.3	14,957	79.6	41.5
Pediatric medical/surgical (25)	4,656	69.8	16,169	87.4	25.2

* Data from 769 projects in 174 health care organizations with baseline and improve data; *N* = number of observations of hand hygiene compliance.
† $p < .0001$ for all improve versus baseline comparisons. *See* text for description of hierarchical logistic random effects model (page 19).

tically significant ($p < .0001$) and that the variance in hand hygiene compliance rates among clinical areas diminished significantly from baseline to Improve ($p = .0064$).

In a separate analysis, we examined the extent to which individual health care organizations improved their hand hygiene compliance. We included only the 111 organizations (63.7% of the original 174) that had at least 100 observations in each of the baseline and Improve phases. These 111 organizations conducted a total of 698 projects involving the same range of clinical areas displayed in Table 4. Forty-one percent of these organizations undertook a single project during this time period; another 15% carried out two projects, and 9% conducted 20 or more. Hand hygiene compliance at baseline across the 111 organizations averaged 52.1% and improved to an average of 70.8% in the Improve phase ($p < .001$). The distribution of compliance rates by organization in the baseline and Improve phases is displayed by deciles in Figure 2 (page 23). At baseline, 10.8% of organizations recorded hand hygiene compliance rates of ≥ 70%, which increased to 55.9% during the Improve phase. ($p < .001$)

Hand Hygiene TST Use by Five Nursing Homes (February 2011–June 2011)

Five nursing homes participated in our efforts to determine whether the hand hygiene TST, which, as we have described, was developed in our work with acute care hospitals, could also be effective in improving hand hygiene compliance in long term care organizations. These nursing homes constituted a convenience sample, having come to our attention by expressing a desire to deploy the hand hygiene TST. They used the final version of the TST after it was released for more general use in September 2010. No alterations were made in the TST to attempt to customize it for long term care. The five nursing homes found all components of the TST to be relevant and workable in their organizations. Averaging the baseline and Improve phase rates across the five nursing homes demonstrated that hand hygiene compliance improved from a baseline of 38.0% to 66.2% ($p = .006$).

Discussion

Spreading improvement in health care has proved frustratingly difficult. Morris et al. reviewed the literature behind the often-cited 17-year gap between the production of evidence of efficacy of a health care intervention and its adoption in clinical practice.[16] The general literature on diffusion of innovation typically focuses on the adoption of new practices in the absence of active efforts to spread them.[17,18] Evaluation of QI collaboratives, which has focused on their effectiveness in improving the specific aspect of health care quality addressed, suggests that when positive results are obtained they are neither uniform nor consistently impressive.[1–9] Lindenauer has suggested that traditional research methods may be inadequate to evaluate the impact of QI collaboratives.[19] We investigated a somewhat different aspect of the problem of spreading improvement. Specifically, we aimed to package the tools and methods by which eight hospitals successfully improved their hand hygiene compliance and to evaluate the extent to which health care organizations that had played no part in the original QI collaborative could adopt and use those tools and methods to effectively increase hand hygiene compliance.

Hand hygiene was selected by the Center for its inaugural project because of its vital importance in preventing health care–associated infection and because of its notorious resistance to improvement. A 2010 systematic review of 96 stud-

Distribution of Hand Hygiene Compliance Rates from Baseline to Improve Among 111 Health Care Organizations Using the Hand Hygiene TST, September 2010–September 2013

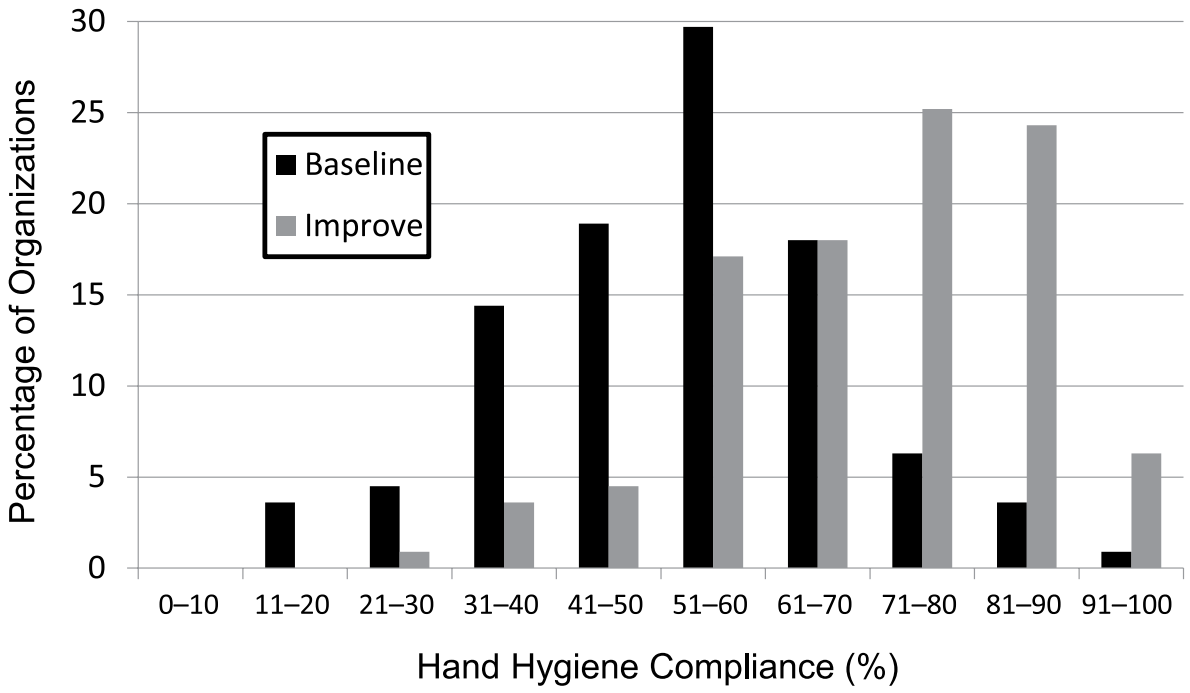


Figure 2. *Hand hygiene compliance at baseline across the 111 organizations averaged 52.1% and improved to an average of 70.8% in the Improve phase (*p < *.001).*

ies of hand hygiene compliance in hospitals around the world concluded that the median compliance rate was 40%.[15] In 2005 the World Health Organization (WHO) initiated its first Global Patient Safety Challenge, an ongoing initiative that is directed at improving hand hygiene compliance.[20] WHO, in reviewing numerous studies on interventions to improve hand hygiene compliance, concluded, in its *Guidelines on Hand Hygiene in Health Care*, that "sustainable improvement demonstrated by a follow-up evaluation of two years or more after implementation has rarely been documented."[21(p.93)] We believed that a collaborative approach to QI using RPI tools might enable the discovery of more effective ways to improve hand hygiene compliance, sustain improved performance, and spread effective interventions. The original Center collaborative achieved and sustained a hand hygiene compliance rate of 81.0%.[12] As we have demonstrated in this article, using the tools created from the original project—the TST—174 health care organizations of various kinds achieved a mean compliance rate of 83.5%, closely similar to that of the collaborative.

In addition to what we report here, we are not aware of any other formal assessment of an intentional, systematic attempt to spread the work of a QI collaborative from the original participants to a wider range of unrelated health care organizations. The adequacy of the assessment of the impact of one national effort in the United States to spread best practices has been debated, with particular concerns raised about the reliability of measures of impact and the questionable attribution of what impact there was to the mechanism of spread.[22–24] The Institute for Healthcare Improvement has developed a framework to guide efforts to spread improvement.[25] There are examples of effective spread of QI interventions within particular hospitals or health care systems.[26–30] Perhaps the closest example to the present report is the effective spread of successful interventions to reduce ICU central line–associated bloodstream infections from a single hospital to wider groups of intensive care units in many hospitals.[31,32]

There are also notable failures of spread that provide some insight into factors that are vital to success. Urbach et al. describe the failure of the adoption of surgical safety checklists to affect outcomes in Ontario, Canada.[33] Leape suggested several possible explanations, including the likelihood that the processes described in the checklist were not fully implemented and

that "the team building needed for local adaptation did not occur."[34(p. 1064)] Sparks et al., who evaluated implementation of another surgical safety checklist, found that the average checklist was 84.5% complete. Measuring the completeness of the checklist document, however, proved to be a poor reflection of whether the interventions noted on the checklist were actually implemented. When these authors examined medical records to verify whether items on the checklist were actually carried out in clinical care, they found that the average checklist accurately reflected care processes only 54.1% of the time.[35] Those results strongly suggest that the measurement system used to detect change in any improvement intervention (within the same or between different organizations) must be carefully designed and implemented. Measures that accurately and reliably assess whether the intended process change has actually occurred are critical to successful improvement.

Vos et al. reported the results of a 17-project team collaborative that attempted to reduce hospital outpatient waiting times and inpatient lengths of stay.[36] Their teams found that they needed interventions that were customized to their specific local circumstances and that the collaborative method was unable to assist in providing such solutions. Øvretveit has recognized this problem, citing the work of the Center, and emphasized an important challenge for those who would spread improvement interventions: how to determine when to implement "an exact copy" of a proven intervention and when it is necessary to adapt it to local circumstances.[37]

We believe that several factors were important contributors to the effectiveness of the spread of the Center's hand hygiene interventions from the original collaborative to the group of health care organizations which then used the TST. First, the systematic and rigorous application of RPI tools in the original project produced a reliable and generalizable measurement system for hand hygiene compliance that can be used by a wide variety of health care organizations, large and small. Second, we discovered that, although there are many causes of hand hygiene noncompliance, the smaller number of specific key causes that explain the large majority of noncompliance vary considerably from one hospital to another or from one patient care area to another. This phenomenon required us to design a set of tools that enable organizations to discover what their key causes are and to deploy a set of customized interventions that are targeted to their key causes. Third, we paid careful attention to translating the original collaborative's work to ensure that the TST could be used by other organizations without any specific knowledge of RPI tools.

If they are replicated, the findings from this study could have important implications for the way in which QI efforts are spread across health care organizations. Our approach to improvement is quite different from the more typical, "one-size-fits-all" best-practice method.[12] If other quality and safety problems exhibit the same characteristics as hand hygiene noncompliance, attempting to address them everywhere with exactly the same set of interventions is likely to fail because the key causes of the problem will differ from place to place. Future improvement work should focus on examining the variability of the underlying causes of quality problems from one health care organization to another.

This study has important limitations. We report here the initial results of the use of the TST. Further research will be required to determine how long the improvements reported here may be sustained. We did not conduct an evaluation with randomly selected controls. Factors other than the use of the TST may explain some of the improvement in hand hygiene compliance reported here. The health care organizations that used the TST were self-selected and therefore perhaps more motivated to improve hand hygiene compliance than those who have not chosen to use the TST. We do not know whether other organizations would achieve comparable levels of improvement. As shown in Figure 1, the data on improvement reported here derive from a subset of all the organizations that initiated any projects in the TST, namely from the 60.2% (n = 174) of organizations that had progressed sufficiently through their projects to have entered some improvement data by September 2013. We do not know whether organizations continuing to use the TST will achieve similar results. Nor do we know whether organizations that obtained improvement in one or more of their units would experience similar results in different parts of their organizations. Finally, we did not assess the extent to which improvements in hand hygiene compliance were associated with changes in the rates of health care–associated infections.

Conclusion

We developed and deployed a set of Web-based tools—the TST—derived from the results of an eight-hospital collaborative QI project that achieved substantial increases in hand hygiene compliance. The TST was designed to facilitate the spread of effective QI interventions beyond the collaborative that created them. It has been used by a variety of health care organizations, primarily hospitals, to achieve levels of improved hand hygiene compliance comparable to those achieved in the original collaborative, across a wide variety of different clinical settings. We believe that the success of an effort to spread effective QI interventions may depend on the recognition that the key

causes of the quality problem under study vary from one place to another. The degree to which the attempt to spread improvement is able to customize the specific interventions any single organization employs so that they target that organization's key causes may be the most important determinant of its success or failure. J

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See the online version of this article for
Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool (color version)

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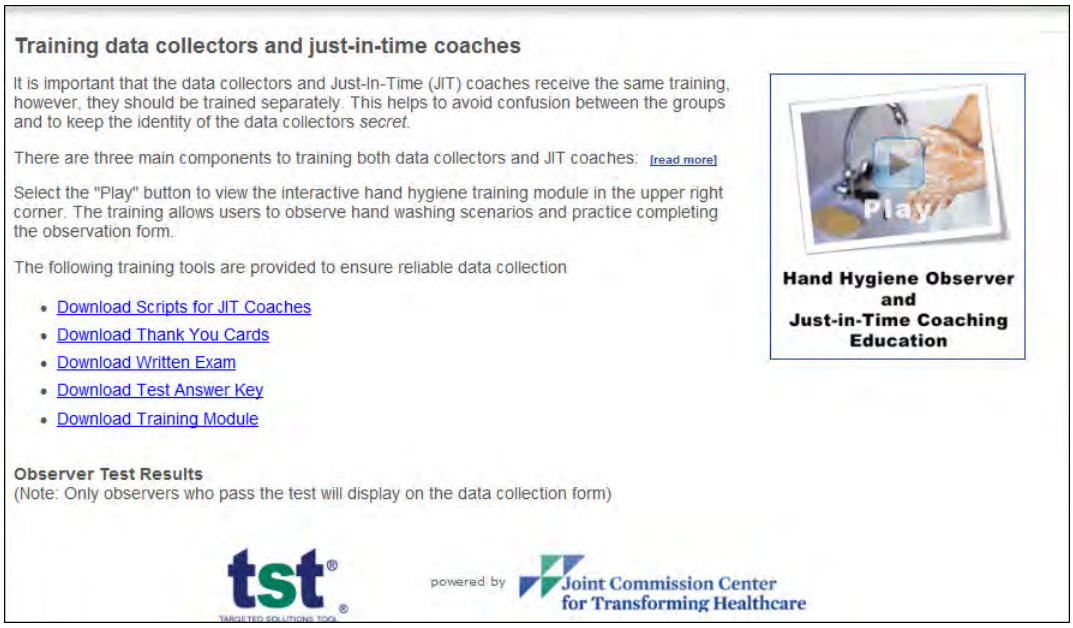
Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool

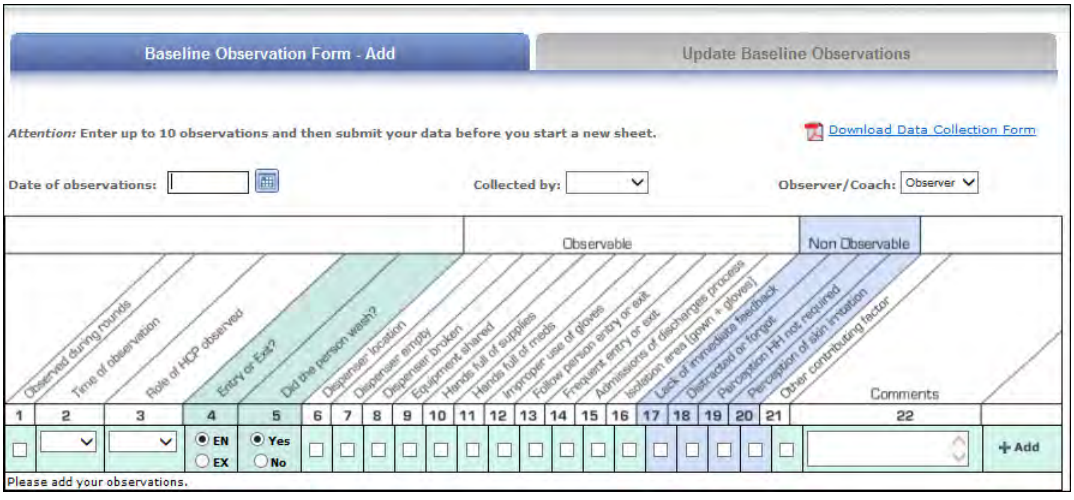
Targeted Solutions Tool® (TST®) is an innovative Web-based application that guides health care organizations through a step-by-step process to accurately measure their organization's actual hand hygiene compliance, identify their contributing factors to poor hand hygiene compliance, and direct them to proven solutions that are targeted and customized to address their particular identified contributing factors. The Hand Hygiene TST includes, for example, Downloadable Training Materials, Data Collection Tool, Data Analysis Tools, Targeted Solutions & Implementation Guides, and Tools for Sustaining Improvements.

Downloadable Training Materials



In the Training section of the tool, there are downloadable training materials, video scenarios, and practice exercises using the data collection form. At the end of the training session, there is a brief assessment that data collectors will take to ensure that they have learned the skills needed for accurate and consistent data collection.

Data Collection Tool

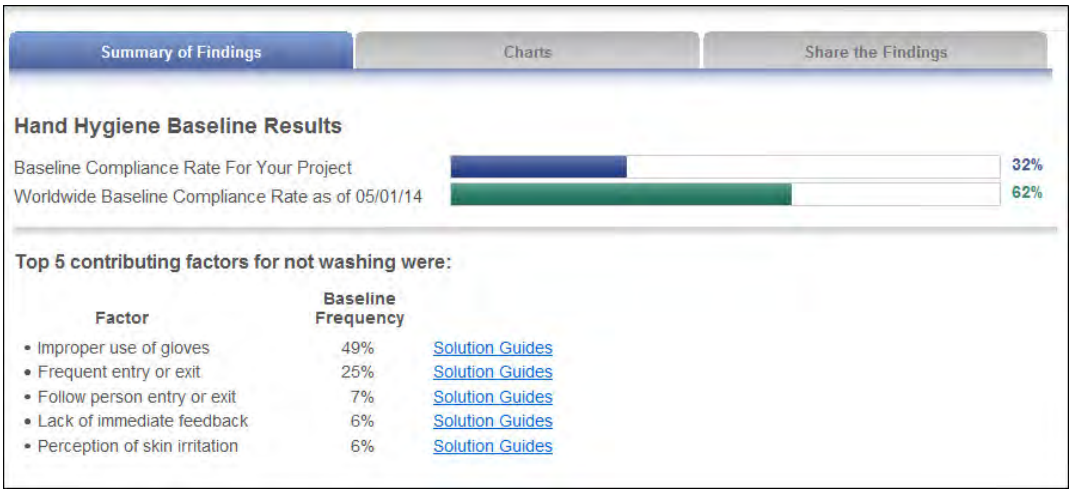


Using the data collection form, secret observers and just-in-time coaches record hand hygiene compliance and observable and nonobservable contributing factors of hand hygiene noncompliance.

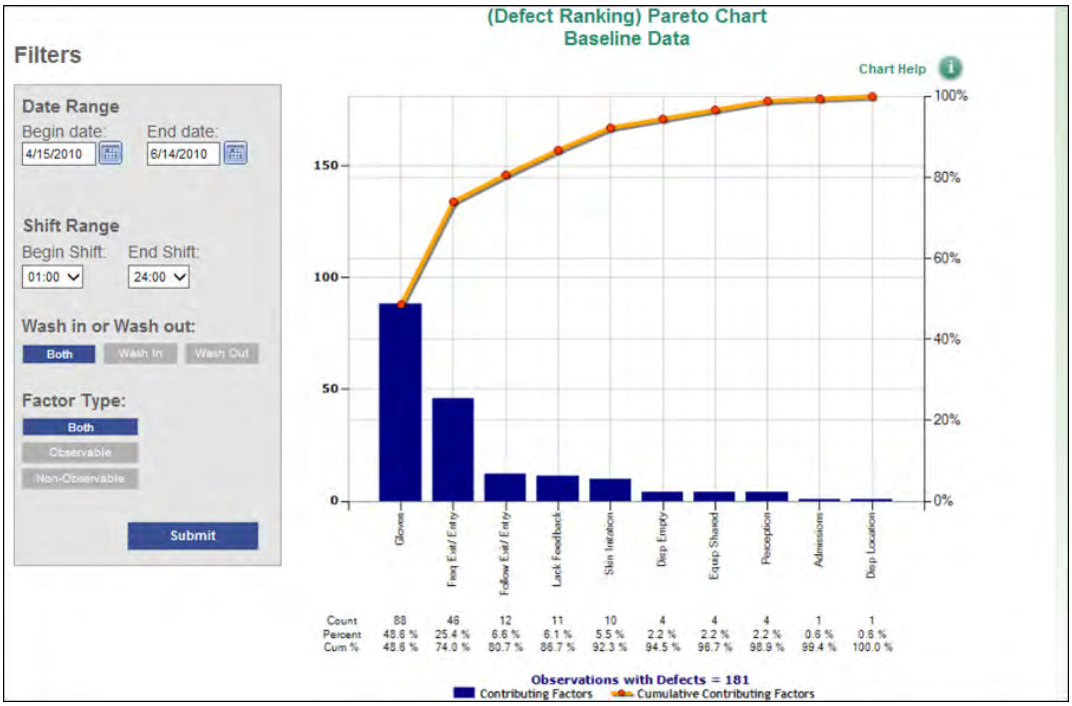
(continued on page AP2)

Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool (continued)

Data Analysis Tools



The TST will show the baseline hand hygiene compliance rate for the project compared to the baseline rate for all projects in the TST at the time the data are entered. In April 2014, the hand hygiene TST was made available to international organizations accredited under the Joint Commission International accreditation program. Hence, the comparator for project baseline rates is the "worldwide" baseline from all TST users around the world. The TST also ranks the top five contributing factors of hand hygiene noncompliance from highest to lowest frequency based on the data collected. After solutions are implemented, the TST will show a comparison of your baseline and improve hand hygiene compliance rates.



The TST provides various charts having filtering capability to analyze the data collected by date, shift range, and role type. The charts are updated in real time as new data are collected and entered into the TST.

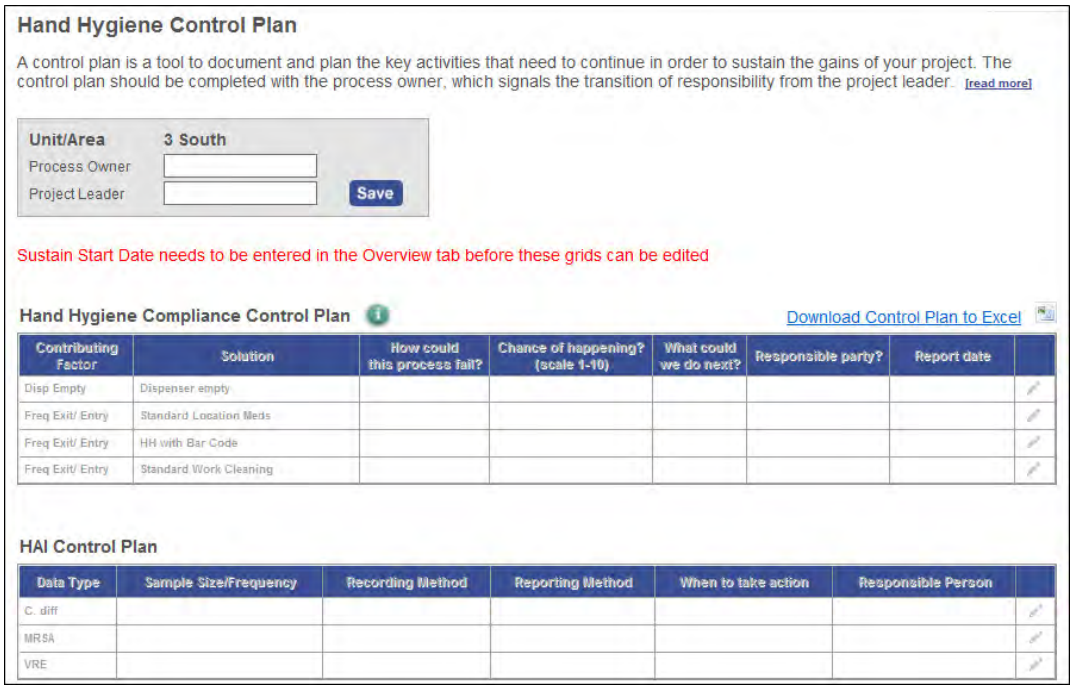
(continued on page 17)

Sidebar 1. Excerpts from the Hand Hygiene Targeted Solutions Tool (continued)

Targeted Solutions & Implementation Guides

The TST provides specific Solutions and Implementation Guides that have been developed and validated and that are targeted to the contributing factors that have been identified through data collection.

Tools for Sustaining Improvements



Hand Hygiene Control Plan

A control plan is a tool to document and plan the key activities that need to continue in order to sustain the gains of your project. The control plan should be completed with the process owner, which signals the transition of responsibility from the project leader. [read more]

Unit/Area 3 South
Process Owner
Project Leader
Save

Sustain Start Date needs to be entered in the Overview tab before these grids can be edited

Hand Hygiene Compliance Control Plan Download Control Plan to Excel

Contributing Factor	Solution	How could this process fail?	Chance of happening? (scale 1-10)	What could we do next?	Responsible party?	Report date	
Disp Empty	Dispenser empty						
Freq Exit/ Entry	Standard Location Meds						
Freq Exit/ Entry	HH with Bar Code						
Freq Exit/ Entry	Standard Work Cleaning						

HAI Control Plan

Data Type	Sample Size/Frequency	Recording Method	Reporting Method	When to take action	Responsible Person	
C. diff						
MRSA						
VRE						

The last section of the TST focuses on sustaining the improvements made in the project and replicating these results in other areas of the organization.