A multicenter study using positive deviance for improving hand hygiene compliance


Hospital Israelita Albert Einstein, São Paulo, Brazil
Universidade Federal de São Paulo (UNIFESP), São Paulo, Brazil
Hospital Paulistano, São Paulo, Brazil
Hospital Heliopolis, São Paulo, Brazil
Hospital Municipal Dr. Moysés Deutsch-MBoi Mirim, São Paulo, Brazil
Thammasat University Hospital, Khlong Luang, Thailand
Hospital Brigadário, São Paulo, Brazil
Virginia Commonwealth University, Richmond, VA

Key Words: Safety patient, Health care-associated infection

Background: Positive deviance (PD) can be a strategy for the improvement of hand hygiene (HH) compliance.

Methods: This study was conducted in 8 intensive care units and 1 ward at 7 tertiary care, private, and public hospitals. Phase 1 was a 3-month baseline period (from August to October 2011) in which HH counts were performed by observers using iPods (iScrub program). From November 2011 to July 2012, phase 2, a PD intervention was performed in all the participating centers. We evaluated the consumption of HH products (alcohol gel and chlorhexidine) and the incidence density of health care-associated infections.

Results: There was a total of 5,791 HH observations in the preintervention phase and 11,724 HH observations in the intervention phase (PD). A statistically significant difference was found in overall HH compliance with 46.5% in the preintervention phase and 62.0% in the PD phase ($P < .001$). There was a statistically significant reduction in the incidence of density of device-associated infections per 1,000 patient-days and also in the median of length of stay between the preintervention phase and the PD phase (13.2 vs 7.5 per 1,000 patient-days, respectively, $P = .039$; and 11.0 vs 6.8 days, respectively, $P < .001$).

Conclusion: PD demonstrated great promise for improving HH in multiple inpatient settings and was associated with a decrease in the median length of stay and the incidence of device-associated HAIs.

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One of the most important interventions for reducing health care-associated infections (HAI) is hand hygiene (HH).1-3 Many different strategies have been attempted, but health care worker (HCW) compliance with HH continues to be suboptimal.4-7 Positive deviance (PD) is a new tool that is being applied in organizations and communities where there are individuals or groups of people who solve problems better than colleagues who have exactly the same resources.5-7 It enhances the sense of ownership of problems among HCWs. We previously showed that PD resulted in a significant improvement in HH, which was

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associated with a decrease in the incidence of HAIls,8 and this intervention has resulted in a sustained improvement in HH. However, these results were obtained at a single medical center and may not be generalizable to other centers.2 The purpose of this study was to evaluate a PD strategy for improving HH in the setting of multiple hospitals.

METHODS

From August to October 2011, baseline rates of HH compliance and HAI surveillance were established prior to the introduction of PD methodology in 9 different settings (8 intensive care units [ICUs] and 1 ward) in 7 hospitals. We decided to perform a PD intervention in these hospitals over a 9-month period (from November 2011 to July 2012).

Settings

The participating hospitals were the following: 2 private Brazilian hospitals in São Paulo, Brazil: Hospital Israelita Albert Einstein (adult medical/surgical ICU with 41 beds and hematology/oncology ward with 40 beds) and Hospital Paulistano (adult medical/surgical ICU with 20 beds); 4 public Brazilian hospitals in São Paulo, Brazil (a university hospital): Hospital São Paulo (adult nephrology ICU with 4 beds and adult cardiac surgery ICU with 8 beds), Hospital Héliopolis (adult medical/surgery with 9 beds), Hospital Municipal Dr. Moysés Deutsch-MBoi Mirim (adult medical/surgical ICU with 20 beds), and Hospital Brigadeiro (adult transplant ICU with 8 beds); and a Thai university hospital in Pratumthani, Thailand: Thammasat University Hospital (adult medical/surgery ICU with 8 beds). The study was approved by each facility’s institutional review board. HH compliance was measured by direct observation of practice and measurement of the volume of product utilized.

Measures

Direct observations

Prior to the start of the study, 20 nurses were trained by an infection control professional in HH observation. Training first addressed the concept of the “5 Moments for Hand Hygiene”; and, after that, to check the understanding of these concepts by the observers, we used videos from the World Health Organization (WHO), available free on its Web site (http://www.who.int/gpsc/media/training_film/en/). Validation of HH observations by the WHO Guidelines on HH from all the hospitals facil

If questioned by an ICU HCW, the ICU nurse (not on clinical duty but dressed as if on clinical duty) explained that she was observing problems that needed to be corrected in the unit. To our knowledge, the ICU team never became aware that the nurses participating in the study were performing HH audits.

Product measurement

HCWs had the opportunity to perform HH by either the use of the available alcohol product or washing their hands with chlorhexidine liquid soap. The total volumes of alcohol gel and chlorhexidine used (liters/1,000 patient-days) were determined.

HAI surveillance

HAI surveillance was performed by trained infection preventionists using Centers for Diseases Control and Prevention definitions11 in all units during the study. Length of stay, occupancy rate, nurse/patient ratio, and invasive device utilization ratios were calculated for the duration of the study.

PD

PD methodology was first introduced in November 2011 in the participating hospitals (intervention phase). PD in HH links what HCWs know and what they actually do during work shifts, and focuses on promoting compliance with HH at all opportunities by everyone who comes into contact with patients and their environment. Every frontline HCW has numerous opportunities for HH in caring for patients. They also are the very best on-site experts on what it is needed in their workplace to improve HH compliance. A PD meeting with all HCWs from the participating hospitals was performed twice monthly.

The rule is not only to talk or give lectures (about HH) but also provide the opportunity for the PDs to express their feelings about HH and to discuss among themselves what needs to be changed, what needs to be improved, and what is wrong or what is right (and needs to be followed as a good example). We encouraged them to invite another PD to the next meeting. HAI rates were shown monthly to the intervention units.

The process of PD for HH involved changing experiences, demonstrating how to improve HH practices, and discussing the best way to perform HH in the unit. PDs were defined as those HCWs who wanted to change, to think, to develop new ideas for improving HH, and who stimulated other HCWs (including physicians) to use the alcohol gel product. They organized meetings with all HCWs twice monthly. These meetings gave the PDs opportunities to express their feelings about HH, to discuss what needed to be improved, and to continue noting good examples. Besides changing the position of alcohol gel dispensers in the patient room and recommending a change in the pressure of the tap water, they decided to put alcohol gel dispensers in the corridors and to train all HCWs in HH performance. They were attentive not only to the quantity but also to the quality of HH.

In each hospital, the PDs had different ideas and strategies. For example, 1 person prepared a short theater presentation discussing “My 5 Moments for Hand Hygiene” (WHO Guidelines on HH in health care settings) with their peers; other PDs prepared badges for doctors who perform HH, noting them as exemplars; and another hospital prepared buttons labeled “Dr Bacteria” for HCWs who do not clean their hands, ever stimulating the discussion in a positive way.

The coordinators (the ICU chief or the hospital epidemiologist) from the PD multicenter study for HH from all the hospitals facilitated the discussion and gave the PDs opportunities to express their feelings about HH and to discuss what needs to be changed, what needs to be improved, what is wrong, or what is right (and
should be taken as a good example). We encouraged them to invite another PD to the next meeting. The PDs are multipliers, and we believe that is a marker of success. We also held meetings every 30 days for the study coordinators from the different hospitals to share experiences (2 different hospitals per month) and giving them all the information collected by the observers using the iPods (iScrub program). This information was passed on to the hospital PD coordinators for the PDs. They were excited to see the HH compliance data and to compare with each other. Data for each hospital was deidentified.

In every meeting, the PDs showed the percentage of HH compliance and discussed their performance, emphasizing that some patients have invasive devices; and, for this reason, HCWs have many opportunities for performing HH. It has been not only transformative but also a strong cultural experience and team building experience.

The hospital PD coordinators provided PD training for all HCWs, including nurses, physicians, physical therapists, speech pathologists, and nutritionists, who used the dispensers. They also provided training for other personnel in the hospital, including laboratory technicians, radiology technicians, hospital volunteers, and chronic patient caregivers.

Statistical analysis

The comparison between the pre- and postintervention periods for HH compliance and preference for alcohol gel over chlorhexidine made using generalized linear mixed effects models, accounting for dependence between measurements performed in the same center and over time, using binomial and Poisson distributions. Compliance with HH by indication and by HCW was evaluated to identify differences in these subgroups. For all models, we assumed a symmetric correlation structure. The analysis of HH compliance was performed for the total set of observations and also separately for each participating center.

The assessment of infection rates was performed using linear regression models with mixed effects; the dependent variable was the infection rate and the independent variable the observation period (pre- or postintervention). The dependence between the measurements of different months was accounted in the models by including a random effect, considering the correlation structure for the measurements performed over the months of the form autoregressive of order 1, which assumes that the correlation is greater in subsequent months than in more distant months. The same methodology was used when the dependent variable was bed occupancy, consumption of HH products, length of stay, and nurse/patient ratio.

Statistical analyses were performed with R (R Core Team [2012]-version 2.15.1), MASS (Venables, W. N. & Ripley, B. D. [2002] Modern Applied Statistics with S, Fourth Edition, NY: Springer), and nlme (Jose Pinheiro, Douglas Bates, Saikat DebRoy, Deepayan Sarkar, and the R Development Core Team [2012], nlme: Linear and Nonlinear Mixed Effects Models, R package version 3.1-104). All tests of statistical significance were 2-sided with a significance level set at .05.

RESULTS

Validation training for HH observation

After training, 20 observers watched a video of 4 scenarios with opportunities for HH and recorded how many opportunities were identified in each scenario. Three scenarios had 4 opportunities and 1 scenario had 7 opportunities, totaling 19 hygiene opportunities to be identified. The number of correct answers was the minimum 9 (corresponding to 47.4% corrected answers) and the maximum 19 (100% of corrected answers). Eighteen (90%) of 20 observers identified more than 70% of opportunities correctly.

Study sample and HH compliance

During the 12-month trial, there was a total of 10,708 patient-days and 5,791 HH observations in the preintervention phase compared with 31,888 patient-days and 11,724 HH observations in the intervention phase (PD). There was a higher consumption of alcohol gel usage in the PD phase than in the preintervention phase ($P = .022$). No statistically significant difference was found in the consumption of chlorhexidine between both phases (Table 1). There was also no statistically significant difference in the incidence density of all HAIs between the preintervention and the PD phase (13.6 vs 16.3 HAIs per 1,000 patient-days, respectively, $P = .805$). However, there was a statistically significant reduction in the incidence density of device-associated infections per 1,000 patient-days between the preintervention phase and the PD phase (13.2 vs 7.5 per 1,000 patient-days, respectively, $P = .039$) (Table 1).

No differences were found between study periods in terms of bed occupancy; nurse-to-patient ratio; device-associated HAIs considered separately (ie, bloodstream infection, urinary tract infection, and pneumonia); and the utilization of urinary catheters, central venous catheters, and mechanical ventilation (Table 1). However, there was a statistically significant reduction in the median length of stay between the preintervention and the PD phase (11.0 vs 6.8 days, respectively, $P < .001$) (Table 1).

A statistically significant difference was found in overall HH compliance with 46.5% in the preintervention phase and 62.0% in the PD phase, $P < .001$ (Table 1). Over time, the HH compliance rate improved month by month (Fig 1). No statistically difference was observed between alcohol gel and chlorhexidine compliance between both phases ($P = .161$).

Considering HH compliance by indication (“My 5 Moments for Hand Hygiene”), higher compliance was observed for all the indications in the PD phase: after body fluid exposures (66.8% vs 83%, respectively, $P < .001$), after touching a patient (59.7% vs 73.3%, respectively, $P < .001$), after touching patient surroundings (38.8% vs 53.3%, respectively, $P = .001$), before clean/aseptic procedures (39.3% vs 64.7%, respectively, $P < .001$), and before touching a patient (36.1% vs 48.2%, respectively, $P = .006$). All HCW groups demonstrated significant improvement in HH compliance (physicians [35.2% vs 55.1%, respectively, $P < .001$], nurses and nurse technicians [51.2% vs 70.1%, respectively, $P < .001$], and respiratory therapists [53.3% vs 64.1%, respectively, $P = .013$]), with the exception of other HCWs (x-ray technicians and laboratory HCWs) (25.2% vs 37.7%, respectively, $P = .182$).

DISCUSSION

In our multicenter study for HH, which included public and private hospitals and academic and nonacademic hospitals, PD resulted in a significant improvement in HH, which was associated with a decrease in the incidence of device-associated infections, an improvement in the alcohol gel consumption, and in a reduction in the length of stay. PD also demonstrated a continuous improvement in HH. The continuous improvement of HH rates over time was a significant strength of the PD intervention (Fig 1).

Current guidelines by the Centers for Diseases Control and Prevention and the WHO aim to stimulate improvement in HH practices in all health care settings, and both guidelines recommend that in all settings HH compliance should be monitored.1,12 However, compliance rates below 50% have been reported worldwide, and the lowest rates are usually reported in ICUs.1,3,4,12 To avoid variation in HH observation, training was provided until
Lower length of stay in the PD phase can be attributed to practices and infection rates, fewer have identification. Some infection rates are more likely than others to be attributed. Although we believe that this HH rate is not optimal and that there is a need for improvement, we also believe that promoting behavioral changes via different ideas that were implemented in each participating hospital contributed to the HH compliance improvement. Maturation effect is an important potential limitation. However, there is no relationship between the baseline period and HCWs being early in their training, and the intervention period being associated with HH compliance improvement. Where as many studies infer a relationship between HH practices and infection rates, fewer have identified a statistical association. Some infection rates are more likely than others to be sensitive to changes in HH, for example, infections that are associated with invasive devices that are inserted by staff and manipulated periodically while the line or catheter is in place (eg, central line-associated bloodstream infection). We also believe that the lower length of stay in the PD phase can be attributed to improvement in HH compliance and the reduction in device-associated infections in this study period, contributing to an improvement in patient safety during the hospital stay. Our finding of lower compliance among physicians than nurses and respiratory therapists was consistent with previous studies. Also, compliance before patient contact was lower than after contact, which is also consistent with previous studies.

There are several limitations to this study. One of these limitations in this study is that we were not able to determine which strategy was the most important for improving HH compliance, but we believe that promoting behavioral changes via different ideas that were implemented in each participating hospital contributed to the HH compliance improvement. Maturation effect is an important potential limitation. However, there is no relationship between the baseline period and HCWs being early in their training, and the intervention period being associated with HH compliance improvement. Where as many studies infer a relationship between HH practices and infection rates, fewer have identified a statistical association. Some infection rates are more likely than others to be sensitive to changes in HH, for example, infections that are associated with invasive devices that are inserted by staff and manipulated periodically while the line or catheter is in place (eg, central line-associated bloodstream infection). We also believe that the lower length of stay in the PD phase can be attributed to improvement in HH compliance and the reduction in device-associated infections in this study period, contributing to an improvement in patient safety during the hospital stay. Our finding of lower compliance among physicians than nurses and respiratory therapists was consistent with previous studies. Also, compliance before patient contact was lower than after contact, which is also consistent with previous studies.

Table 1

<table>
<thead>
<tr>
<th>Characteristics of patients’ compliance with hand hygiene and infection rates during study phases</th>
<th>Preintervention phase</th>
<th>Positive deviance</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of HH observations</td>
<td>5,791</td>
<td>11,724</td>
<td>.764</td>
</tr>
<tr>
<td>Total number of patient-days</td>
<td>10,708</td>
<td>31,888</td>
<td>.764</td>
</tr>
<tr>
<td>Unit-based metrics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patient-days, median (IQR)</td>
<td>245 (204-532)</td>
<td>230 (192-543)</td>
<td>.764</td>
</tr>
<tr>
<td>Alcohol gel use in liters/1,000 patient-days, median (IQR)</td>
<td>42.3 (29.0-72.7)</td>
<td>72.0 (28.0-105.0)</td>
<td>.022</td>
</tr>
<tr>
<td>Chlorhexidine used in liters/1,000 patient-days, median (IQR)</td>
<td>46.0 (28.7-61.4)</td>
<td>53.1 (30.1-74.8)</td>
<td>.302</td>
</tr>
<tr>
<td>Incidence density of HAIs/1,000 patient-days, median (IQR)</td>
<td>13.6 (10.1-30.7)</td>
<td>16.3 (9.1-31.8)</td>
<td>.805</td>
</tr>
<tr>
<td>Incidence density of device-associated infections/1,000 patient-days, median (IQR)</td>
<td>13.2 (2.2-30.7)</td>
<td>7.5 (1.3-14.9)</td>
<td>.039</td>
</tr>
<tr>
<td>Bloodstream infection/1,000 catheter-days, median (IQR)</td>
<td>1.6 (0.0-4.0)</td>
<td>0.0 (0.0-6.1)</td>
<td>.190</td>
</tr>
<tr>
<td>Urinary tract infection/1,000 catheter-days, median (IQR)</td>
<td>1.7 (0.0-7.7)</td>
<td>0.0 (0.0-6.7)</td>
<td>.207</td>
</tr>
<tr>
<td>Pneumonia/1,000 ventilator-days, median (IQR)</td>
<td>13.4 (3.5-23.2)</td>
<td>7.4 (0.0-22.2)</td>
<td>.273</td>
</tr>
<tr>
<td>Central venous line utilization rate, median (IQR)</td>
<td>0.7 (0.6-0.8)</td>
<td>0.7 (0.5-0.8)</td>
<td>.705</td>
</tr>
<tr>
<td>Urinary catheter utilization rate, median (IQR)</td>
<td>0.5 (0.4-0.7)</td>
<td>0.5 (0.3-0.6)</td>
<td>.377</td>
</tr>
<tr>
<td>Ventilator utilization rate, median (IQR)</td>
<td>0.5 (0.3-0.7)</td>
<td>0.4 (0.3-0.7)</td>
<td>.586</td>
</tr>
<tr>
<td>Occupancy rate per month (%), median (IQR)</td>
<td>85.0 (80.0-97.0)</td>
<td>86.7 (78.5-92.7)</td>
<td>.659</td>
</tr>
<tr>
<td>Ventilator utilization rate, median (IQR)</td>
<td>0.5 (0.3-0.7)</td>
<td>0.4 (0.3-0.7)</td>
<td>.586</td>
</tr>
<tr>
<td>Length of stay (days), median (IQR)</td>
<td>11.0 (6.8-15.6)</td>
<td>6.8 (4.4-8.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nurse/patient ratio, median (IQR)</td>
<td>0.3 (0.1-0.3)</td>
<td>0.2 (0.1-0.3)</td>
<td>.564</td>
</tr>
<tr>
<td>Hand hygiene</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>% Compliance</td>
<td>46.5</td>
<td>62.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>% Of HH episodes performed with alcohol gel</td>
<td>21.2</td>
<td>24.5</td>
<td>.161</td>
</tr>
<tr>
<td>% Of HH episodes performed with chlorhexidine</td>
<td>78.8</td>
<td>75.5</td>
<td></td>
</tr>
<tr>
<td>% Of HH compliance by indication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After body fluid exposure/risk</td>
<td>66.8</td>
<td>83.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>After touching a patient</td>
<td>59.7</td>
<td>73.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>After touching patient surroundings</td>
<td>39.8</td>
<td>53.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Before clean/aseptic procedures</td>
<td>39.3</td>
<td>64.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Before touching a patient</td>
<td>36.1</td>
<td>48.2</td>
<td>.006</td>
</tr>
<tr>
<td>% HH compliance by HCW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician</td>
<td>35.2</td>
<td>55.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nurse and nurse technician</td>
<td>51.2</td>
<td>70.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Respiratory therapist</td>
<td>53.3</td>
<td>64.1</td>
<td>.013</td>
</tr>
<tr>
<td>Others</td>
<td>25.2</td>
<td>37.7</td>
<td>.182</td>
</tr>
</tbody>
</table>

HAI, Health care-associated infections; HCW, health care worker; HH, hand hygiene; IQR, interquartile range.

Fig 1. Hand hygiene compliance over the course of the study.
bundle implementations for device-associated infections in these 7 hospitals that participated in our study, we know that the device utilization rate (for central venous catheters, urinary catheters, and mechanical ventilation) was very similar in both study phases (Table 1). It is not possible to say that PDs were superior performers because we do not have data on individual HCWs. Dividing HCWs into deviants and nondeviants is not consistent with PD philosophy.

In organizational change processes, HCWs execute decisions and are rarely engaged in decisions about how the work should be done. Alternatively, in PD, HCWs decide how the work should be done and promote discovery among their peers. Leaders and managers provide support, filter ideas, and remove barriers to implementation of best practices.

Our study reports success with PD not just in 1 institution but rather in a 7-hospital study. Measuring HH compliance is a challenge, and this study buttresses the plausibility of its observations of improvements in directly observed compliance in a number of ways. In particular, it reports that improvements in directly observed compliance were paralleled by improvements in volume of alcohol gel and chlorhexidine used as well as improvements in outcome measures, such as infections and length of stay.

In conclusion, we demonstrate improvement in HH and a corresponding fall in device-associated HAIs via implementation of PD across multiple hospitals. PD has the potential to be used in several areas of infection prevention and hospital epidemiology.

Acknowledgment

We thank the positive deviants from all participating centers who continue working in positive deviance and GOJO Latin America for the purchase of iPods that contributed to the data collection.

References


