Infection Control & Hospital Epidemiology (2020), **41**, 237–251
doi:10.1017/ice.2019.337

Research Brief

Achieving *Clostridioides difficile* infection Health and Human Services 2020 goals: Using agile implementation to bring evidence to the bedside

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Clostridioides difficile infection (CDI) is the leading cause of hospital-acquired infections (HAI) in the United States.[1] Although multiple interventions have been shown to reduce CDI, the adoption of these evidence-based practices remains suboptimal, and the burden of CDI remains high.[2] There is a pressing need to develop strategies that bridge the gap between the available evidence and clinical practice to reduce harm from CDI.

The 'Agile Implementation' (AI) framework was used to reduce central-line–associated bloodstream infections (CLABSIs) at our institution.[3] In study described here, we used the AI model to achieve reductions in CDI.

Methods

Setting

The study was conducted in 2 large academic hospitals in the Midwest between October 2016 and December 2018.

AI model

The AI model was developed at the Indiana University School of Medicine Center for Innovation and Implementation Science. It recognizes the healthcare system as a complex adaptive system (CAS) and acknowledges the importance of individual barriers and enablers in influencing implementation outcomes. It therefore incorporates the CAS theory and the social cognitive theories of behavioral economics to facilitate implementation.

The first step is to confirm opportunities and engage stakeholders. The second step is to identify evidence-based solutions. The third step is to develop an evaluation strategy in which process and outcome measures are defined and a termination plan is agreed upon if these measures are not met. An interdisciplinary team then converts the evidence-based solution into a minimum viable service, the minimum specifications required to implement the intervention effectively, while taking into consideration the local environment in which it is applied. Implementation occurs in "sprints" (repeatable tests of change) with modification through continuous feedback. Impact on the organization is also measured. If the process results in the desired outcome, then the team develops a minimally standardized operating procedure, an implementation blueprint that can be utilized by other departments.

Implementation

An interdisciplinary team met in October 2016 to create a CDI reduction strategy. A gap analysis was conducted and opportunities were identified in environmental services (EVS), antibiotic stewardship, hand hygiene, and CDI testing practices. Four subteams were created to address each identified opportunity using evidence-based guidelines.[4]

The subteams met monthly to strategize and modify interventions based on feedback from the implementation sprints. Localization of the implementation of the minimal viable solutions was left to individual units where appropriate.

Measurements

Outcome measures. The primary outcome was the CDI rate, as defined by the National Healthcare Safety Network. A standardized incidence ratio (SIR) was calculated based on the Centers for Disease Control definition.

Implementation outcomes. Data regarding the implementation were obtained from direct feedback received during team meetings. Changes in practice habits were assessed by tracking antibiotic days of therapy (DOT), acceptance rate for antibiotic

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Cite this article: Dbeibo L, *et al.* (2020). Achieving *Clostridioides difficile* infection Health and Human Services 2020 goals: Using agile implementation to bring evidence to the bedside. *Infection Control & Hospital Epidemiology*, 41: 237–239, https://doi.org/10.1017/ice.2019.337

Table 1. Calculated Rates (95% confidence intervals) of Hospital-Acquired Harms and Regression Results

Variable	Baseline 2015 Q1–2016 Q3	Implementation 2016 Q4–2018 Q4	Implementation vs Baseline RR (95% CI)	P Value
CLABSI				
Incidence rate[a]	1.587 (1.394–1.808)	1.111 (0.965–1.280)	0.700 (0.578–0.848)	<.001
SIR	1.460 (1.282–1.663)	1.028 (0.893–1.184)	0.704 (0.581–0.853)	<.001
CAUTI				
Incidence rate[b]	1.848 (1.583–2.157)	1.708 (1.484–1.964)	0.924 (0.750–1.139)	.459
SIR	1.143 (0.979–1.335)	1.066 (0.926–1.226)	0.932 (0.756–1.148)	.508
CDI				
Incidence rate[c]	12.472 (11.454–13.582)	7.233 (6.539–8.002)	0.580 (0.508–0.662)	<.001
SIR	0.990 (0.912–1.075)	0.608 (0.554–0.668)	0.614 (0.542–0.696)	<.001
Total DOT	2690.1 (2685.2–2695.0)	2644.6 (2640.1–2649.0)	0.983 (0.981–0.986)	<.001
Compliance	% Compliant (95% CI)	% Compliant (95% CI)	OR (95% CI)	*P* Value
Hand Hygiene	82.56 (81.97–83.14)	92.05 (91.86–92.24)	2.447 (2.332–2.568)	<.001
Black Light	83.11 (82.66–83.55)	93.17 (93.01–93.33)	2.774 (2.664–2.888)	<.001

Note. CLABSI, central line-associated bloodstream infection; CAUTI, catheter-associated urinary tract infection; CDI, Clostridioides difficile infections; DOT, days of therapy; SIR, standardized incidence ratio (observed/expected infections); RR, relative risk; OR, odds ratio. Poisson and logistic regression, respectively, were used to compare implementation to baseline periods, for infections and compliance procedures.
[a]Per 1,000 central-line days.
[b]Per 1,000 Foley catheter days.
[c]Per 10,000 patient days.

stewardship recommendations, black-light data for monitoring of environmental cleaning, number of CDI tests ordered, and hand hygiene compliance data.

System outcomes. Non-CDI hospital-acquired infections were monitored.

Statistical analysis

We used Poisson regression to test whether the outcomes (incidence rates of infections, SIR, DOT) differed between the baseline and the implementation period. Time period was included as a fixed effect in all models and an offset equal to the log(exposure) to account for the differential exposure time across periods. Relative risks (RRs) and 95% confidence intervals (CIs) were reported. Logistic regression was used to determine whether hand hygiene and EVS compliance differed between the baseline period and the implementation period. The odds ratios (OR) and 95% CIs were reported. Linear regression was used to determine change in CDI testing. All analyses were conducted using SAS version 9.4 statistical software (IBM, Armonk, NY).

Results

The CDI rate decreased from 12.47 to 7.23 cases per 10,000 patient days during the implementation period (RR, 0.58; 95% CI, 0.51–0.66; $P < 0.001$). Data on implementation and system outcomes are summarized in Table 1.

The stewardship recommendations acceptance rate started at 45% in January 2017 and increased to an average of 84% in 2018. CDI testing orders were static in 2017 then decreased by 38.5% in 2018, coinciding with the implementation period of the intervention.

Discussion

We utilized the AI model for implementing evidence-based CDI guidelines, and we observed a 42% reduction in CDI. This model focuses on the characteristics of the users and adopters of implementation as well as the organizational context in implementing these processes. This process results in the engagement of key stakeholders and localization of measures to adapt to the local environment within the organization, leading to increased and rapid adoption of practices and sustainability in processes.[3] By viewing the healthcare system through the lens of complexity science, taking into account nonlinear and unpredictable interactions among its individuals, monitoring for unintended consequences, and using minimal viable solutions to allow for localization,[5] the AI model successfully facilitated the implementation of evidence into practice in the real-world care setting, thereby leading to a significant reduction in CDI. In this model of implementation, a termination plan is developed initially, which eases stakeholders' loss aversion during change and reduces waste. Additionally, the model focuses on local adaptation of solutions, and on monitoring of consequences of the implementation on other system outcomes.

This is a single-center study and our results may not be generalizable to other institutions. We did not perform a cost–benefit analysis. We successfully utilized the AI framework to impact clinician behavior and to implement evidence-based practices to prevent CDI. We hope that others can learn from our journey.

References

1. Magill SS, Edwards JR, Bamberg W, *et al.* Multistate point-prevalence survey of health care-associated infections. *N Engl J Med* 2014;370:1198–1208.
2. Yanke E, Moriarty H, Carayon P, Safdar N. A qualitative, interprofessional analysis of barriers to and facilitators of implementation of the Department of

https://doi.org/10.1017/ice.2019.337 Published online by Cambridge University Press

Veterans' Affairs *Clostridium difficile* prevention bundle using a human factors engineering approach. *Am J Infect Control* 2018;46:276–284.
3. Azar J, Kelley K, Dunscomb J, *et al.* Using the agile implementation model to reduce central line-associated bloodstream infections. *Am J Infect Control* 2018. doi: 10.1016/j.ajic.2018.07.008.
4. McDonald LC, Gerding DN, Johnson S, *et al.* Clinical practice guidelines for *Clostridium difficile* Infection in adults and children: 2017 update by the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA). *Clin Infect Dis* 66:987–994.
5. Pype P, Mertens F, Helewaut F, Krystallidou D. 2018. Healthcare teams as complex adaptive systems: understanding team behaviour through team members' perception of interpersonal interaction. *BMC Health Serv Res* 18:570.

Multidrug-resistant organisms on patients hands in an ICU setting

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Healthcare-associated infections (HAIs) contribute significantly to morbidity and mortality in healthcare facilities, especially in the intensive care unit (ICU).[1,2] Pathogenic bacteria, including multidrug-resistant organisms (MDROs), such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE), are transmitted to patients via contact with healthcare workers and via contact with environments and surfaces surrounding the patient.[3] Although many previous studies have examined the role of healthcare workers' hands in pathogen transmission, several recent studies have also highlighted the fact that patients' hands are often contaminated and may contribute to pathogen transmission.[4–8] All of these studies were conducted on general medical and surgical wards or on transfer from acute to postacute care. We aimed to determine the prevalence of patient hand contamination with MDROs and other pathogenic bacteria in the ICU setting.

Methods

This prospective observational study was conducted in 3 ICUs at a tertiary-care center with approval from the Institutional Review Board of the Cleveland Clinic during the course of a randomized, double-blinded crossover study.[8] Informed consent was obtained from all patients and/or their family members. An imprint of one of the patient's hands was obtained on a nonselective tryptic soy agar handprint plate that contained 0.01% lecithin and 0.5% polysorbate 80. Handprint plates were incubated at 35 ± 2°C for 24 ± 4 hours, and bacterial colonies, including MSSA, MRSA, VRE, ciprofloxacin-resistant gram-negative bacteria, ciprofloxacin-sensitive *Klebsiella* spp, *Pseudomonas* spp, and normal skin flora (ie, *Diphtheroid, Bacillus, Micrococcus*, and *Staphylococcus* spp), were identified using standard microbiologic methods. Each patient provided a single handprint sample, and no other patient information was collected or identified for this study.

Results

In total, 56 unique patients agreed to participate in the study, and their hand imprints were obtained over a period of 10 weeks. Of 56 patients, 9 (~16%) had at least 1 aerobic pathogenic bacteria on a hand. Of those 56 with pathogenic bacteria, 4 (~7%) had at least 1 MDRO on their hand: 2 patients had MRSA, 1 patient had VRE, and 1 patient had ciprofloxacin-resistant gram-negative bacteria. Most patients (47 of 56) had normal skin flora (Table 1).

Discussion

The results of our study demonstrate that a small portion of patients' hands in medical ICUs harbor pathogenic bacteria, including MDROs. These results appear to be consistent with prior studies that investigated the burden of pathogenic organisms on patients' hands, though the prevalence of contamination with MDROs appears to be lower in our study. In a 100-patient study on non-ICU medical and surgical unit floors, 39% of patients' hands were contaminated with at least 1 pathogenic organism 48 hours after admission. Similarly, when 357 newly admitted patients in postacute-care facilities hands were swabbed, 24% of patients had at least 1 MDRO, and another 10% had acquired an MDRO during their stay.[5,9] The difference in prevalence of MDROs between our study and prior studies may be because of our focus on ICU patients, who underwent daily chlorhexidine bathing per protocol. Previous studies have also demonstrated a potential relationship between patient hand contamination and contamination of high-touch room surfaces. In a study of ~400 non-ICU general medicine floor patients, 10% of patients' hands were contaminated with MDROs, and there was a correlation between the MDROs on patient hands and the contaminated room surfaces.[7]

Despite the emerging evidence potentially highlighting the role of patient hand hygiene in the transmission of HAIs, current best-practice recommendations do not provide a strong guidance regarding patient hand hygiene. One previous study has demonstrated that bundling of infection prevention strategies including patient hand hygiene can potentially reduce the rate of hospital-acquired infections, including *Clostridioides difficile*.[10] Therefore, building and implementing effective patient hand hygiene protocols and/or bundles has the opportunity to reduce the risk of life-threatening HAIs.

The strengths of this study include its relatively novel focus on the burden on MDROs on patients' hands in an ICU setting and the study's contribution to ongoing discussions surrounding infection prevention strategies targeting patient hand hygiene.

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Cite this article: Dunn AN, *et al.* (2020). Multidrug-resistant organisms on patients hands in an ICU setting. *Infection Control & Hospital Epidemiology*, 41: 239–240, https://doi.org/10.1017/ice.2019.333