Catheter-Associated Urinary Tract Infections — Turning the Tide

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In the wake of an otherwise successful first phase of the National Action Plan to Prevent Health Care–Associated Infections, the reduction in catheter-associated urinary tract infections (UTIs) has been elusive.[1] Increasing rates of infection by 2012 signaled an inability to contain this common infection, even if some of the rise was attributable to broader definitions of catheter-associated UTI instituted earlier that year. A study of the On the CUSP: Stop CAUTI program, reported by Saint et al.[2] in this issue of the *Journal*, showed a significant reduction in catheter-associated UTIs in inpatient units that were not intensive care units (non-ICUs), despite the change in the definition. The study highlights the very real potential for reductions nationally.

Catheter-associated UTI is remarkable in that the technical protocols to prevent it have been known for a long time — sterile catheter insertion, maintenance of a closed drainage system, prevention of backflow, aseptic technique for collecting urine for culture, and minimal duration of catheter placement because of the propagation of low-level bacterial colony counts over time in a catheterized system.[3,4] These processes represent continually taught best practices.

Thus, we might assume that behavioral and decision-making aspects remain the dominant barriers to the reduction of catheter-associated UTIs. Nearly all campaigns rely on leadership, persuasion, and teamwork to be successful, but the On the CUSP: Stop CAUTI program's overt instruction to build a multidisciplinary team, focus on camaraderie and communication, and attend to failure points may be requisites to success. This approach may be critical for improving decision-making components of catheter-associated UTI prevention, such as indications for catheter placement and removal, avoidance of reflexive culturing of urine in response to fever, and advocacy for alternative strict toileting options (e.g., urinals for women or for men, external catheters for women or for men, measurement of diaper weight, intermittent catheterization, and measurement of daily weight).

The broad scope and scale of the study by Saint et al. also raises important questions. Why did ICUs not have the reductions in catheter-associated UTIs that non-ICUs had? There may be several explanations. Catheter-associated UTIs require a catheter plus a UTI. On the catheter front, patients are often sedated and unable to report on the presence of a catheter. In addition, the critical condition of patients in the ICU may make a nurse-driven program for placement and removal of urinary catheters less acceptable to physicians in the ICU. Catheters are also likely to be required for longer durations in ICU patients, and day-to-day ease of care with a catheter may outweigh concern about catheter-associated UTI prevention unless awareness is maintained. Regarding the diagnosis of UTIs, if reflexive culturing of urine in response to fever is not addressed, any reason for fever in patients in the ICU may result in unnecessary urine cultures that are positive for asymptomatic bacteriuria that could be treated with catheter removal rather than antibiotic therapy.

The multiplicity of reasons for fever in patients in the ICU is another reason why catheter-associated UTI rates in ICUs may not have declined. Changes to the National Healthcare Safety Network (NHSN) definition of catheter-associated UTI accounted for substantial increases in rates of catheter-associated UTI beginning in 2012 and substantial reductions in catheter-associated UTI rates in 2015.[5] In March 2012, NHSN changed the fever requirement from a subjective definition requiring attribution to catheter-associated UTI to an objective definition of the presence of fever regardless of its clinical source. Thus, it is likely that the NHSN rates reported here by both ICUs and non-ICUs underestimate the program's influence. In contrast, reverse causation is noted for the analysis of later cohorts from the On the CUSP: Stop CAUTI program, since they will benefit from the 2015 definition change that excludes yeast and restricts catheter-associated UTIs to cases with cultures with higher colony counts ($\geq 10^5$ colony-forming units [CFU] per milliliter vs. the current count of $\geq 10^3$ CFU per milliliter).

Ideally, repeat analyses, even in a random subset of hospitals, should be performed with a uniform definition. In addition, subset analyses that stratify catheter-associated UTI rates according to whether decreases in catheter use were achieved should be performed. Several studies have shown that successful efforts to reduce catheter use cause the remaining population of catheterized patients to consist of higher-risk patients; as a result, rates of catheter-associated UTI can increase.[6-8] For this reason, if a substantial number of non-ICUs showed both reduction in catheter use and improvement in rates of catheter-associated UTI, it would be greater evidence of the benefit of the On the CUSP: Stop CAUTI approach.

Finally, what remains to be seen is whether health care providers can maintain activities resulting from innumerable best-practice campaigns. Does the focus on one campaign signal a trade-off of attention to other equally important processes? The sheer number of documentation and medical-practice requirements in place today requires a breadth of technological advances, facility design, human-factors engineering, and implementation science to be able to maximally prevent human errors and omissions. Successful enduring methods to attend to all best-practice measures are needed if we are to continue to improve patient safety.

Disclosure forms provided by the author are available with the full text of this article at NEJM.org.

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The Sialylation Pathway and Coronary Artery Disease

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Plasma levels of non–high-density (non-HDL) cholesterol are causally linked to the risk of coronary artery disease. Non-HDL cholesterol levels are a better predictor of cardiovascular risk than levels of low-density lipoprotein (LDL) cholesterol alone, because non-HDL cholesterol comprises all known cholesterol-containing lipoproteins that can cause atherosclerosis, including LDL, very-low-density lipoprotein, intermediate-density lipoprotein, chylomicrons and their remnants, and lipoprotein(a).

Nioi et al. now report in the *Journal* important genetic evidence suggesting a causal association between *ASGR1*, a gene encoding the major subunit of the asialoglycoprotein receptor, and cardiovascular disease.[1] Nioi and colleagues sequenced the genomes of 2636 Icelanders and identified variants that were imputed into the genomes of approximately 398,000 additional Icelanders. They tested for an association between the imputed variants and non-HDL cholesterol levels in 119,146 participants and identified a rare 12-base-pair deletion (del12) in intron 4 of *ASGR1*. In the Icelandic population, del12 was associated with an average reduction of 13.6 mg per deciliter (0.35 mmol per liter) in plasma levels of non-HDL cholesterol as compared with the average level in the general population (relative reduction, 9%). This reduction included decreases of 9.5 mg per deciliter (0.25 mmol per liter) in LDL choles-

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A Program to Prevent Catheter-Associated Urinary Tract Infection in Acute Care

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ABSTRACT

BACKGROUND

Catheter-associated urinary tract infection (UTI) is a common device-associated infection in hospitals. Both technical factors — appropriate catheter use, aseptic insertion, and proper maintenance — and socioadaptive factors, such as cultural and behavioral changes in hospital units, are important in preventing catheter-associated UTI.

METHODS

The national Comprehensive Unit-based Safety Program, funded by the Agency for Healthcare Research and Quality, aimed to reduce catheter-associated UTI in intensive care units (ICUs) and non-ICUs. The main program features were dissemination of information to sponsor organizations and hospitals, data collection, and guidance on key technical and socioadaptive factors in the prevention of catheter-associated UTI. Data on catheter use and catheter-associated UTI rates were collected during three phases: baseline (3 months), implementation (2 months), and sustainability (12 months). Multilevel negative binomial models were used to assess changes in catheter use and catheter-associated UTI rates.

RESULTS

Data were obtained from 926 units (59.7% were non-ICUs, and 40.3% were ICUs) in 603 hospitals in 32 states, the District of Columbia, and Puerto Rico. The unadjusted catheter-associated UTI rate decreased overall from 2.82 to 2.19 infections per 1000 catheter-days. In an adjusted analysis, catheter-associated UTI rates decreased from 2.40 to 2.05 infections per 1000 catheter-days (incidence rate ratio, 0.86; 95% confidence interval [CI], 0.76 to 0.96; P=0.009). Among non-ICUs, catheter use decreased from 20.1% to 18.8% (incidence rate ratio, 0.93; 95% CI, 0.90 to 0.96; P<0.001) and catheter-associated UTI rates decreased from 2.28 to 1.54 infections per 1000 catheter-days (incidence rate ratio, 0.68; 95% CI, 0.56 to 0.82; P<0.001). Catheter use and catheter-associated UTI rates were largely unchanged in ICUs. Tests for heterogeneity (ICU vs. non-ICU) were significant for catheter use (P=0.004) and catheter-associated UTI rates (P=0.001).

CONCLUSIONS

A national prevention program appears to reduce catheter use and catheter-associated UTI rates in non-ICUs. (Funded by the Agency for Healthcare Research and Quality.)

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Catheter-associated urinary tract infection (UTI) is a common device-associated infection in the United States[1] and one of the most common health care–associated infections worldwide.[2] Up to 69% of catheter-associated UTIs are considered to be avoidable, provided that recommended infection-prevention practices are implemented.[3] Guidelines for the prevention of catheter-associated UTIs recommend appropriate use, aseptic insertion, proper maintenance, and timely removal of indwelling urinary catheters, as well as use of established practices such as hand hygiene.[4-6] In addition to these technical aspects of prevention, there has been a focus on the roles that changes in behavior and culture (the socioadaptive component of prevention) play in quality improvement.[7]

Preventing health care–associated infection in general, and catheter-associated UTI in particular, has emerged as a priority in the United States, with government agencies taking a lead role. Catheter-associated UTI was the first hospital-acquired complication chosen by the Centers for Medicare and Medicaid Services in 2008 as the basis for denial of additional payment to hospitals.[8] In 2009, the Department of Health and Human Services released the "National Action Plan to Prevent Health Care–Associated Infections: Road Map to Elimination," which provided strategic guidance for preventing infections in acute care hospitals.[9] The goal was to reduce the rates of catheter-associated UTI by 25% by 2013.[10] Despite these efforts, national data indicate that the incidence of catheter-associated UTI increased by 6% from 2009 to 2013.[11]

The Agency for Healthcare Research and Quality (AHRQ), along with the Health Research and Educational Trust (the research and education affiliate of the American Hospital Association) and its partners, launched a nationwide effort to implement the Comprehensive Unit-based Safety Program (CUSP) to reduce catheter-associated UTIs (also known as On the CUSP: Stop CAUTI) in U.S. hospitals. This effort involved an explicit focus on both the technical and socioadaptive aspects of prevention.[12] The results from the first four of nine cohorts of hospital units are described here.

METHODS

OVERVIEW OF THE PROGRAM

Sponsored by the AHRQ and based on the successful Michigan Health and Hospital Association (MHA) Keystone Center's Bladder Bundle Initiative,[13,14] our program represented a national collaboration of professional societies, academic researchers, government agencies (including the Centers for Disease Control and Prevention [CDC]), and state hospital associations. The main features of the program were centralized coordination and dissemination of educational materials and tool kits to sponsor organizations and hospitals, data collection with the use of established definitions and approaches, guidance on technical practices that prevent catheter-associated UTI, and an emphasis on addressing socioadaptive factors (both general issues and those specific to catheter-associated UTI). Tools from CUSP were used to support the socioadaptive aspects of catheter-associated UTI prevention.[15] The program was led by the Health Research and Educational Trust with the support of faculty from the University of Michigan, St. John Hospital and Medical Center, the MHA Keystone Center, and Johns Hopkins Medicine Armstrong Institute for Patient Safety and Quality. In addition to these program experts, representatives from the Association for Professionals in Infection Control and Epidemiology, Emergency Nurses Association, Society for Healthcare Epidemiology of America, and Society of Hospital Medicine were recruited to serve as content experts (i.e., experts in the definition, measures, and prevention of catheter-associated UTI). Guidance was also provided by a panel of experts on patient safety, catheter-associated UTI, teamwork, and implementation.

The program, modeled on a previous program that had successfully reduced bloodstream infections due to central venous catheters,[16,17] entailed several steps. First, sponsor organizations (e.g., state hospital associations or other large organizations such as Hospital Engagement Networks) were recruited and assigned to a cohort of hospital units that joined the program at the same time. Nine cohorts have participated in the pro-

Table 1. Program Recommendations and Examples of Interventions.*

Recommendation	Example of Intervention
Primary	
Conducting daily assessment of the presence of and need for an indwelling urinary catheter	Conducting daily nursing rounds to review urine-collection strategies, including indications for continued urinary-catheter use
Avoiding use of an indwelling urinary catheter by considering alternative urine-collection methods	Promoting the use of condom catheters, bladder scanners, intermittent straight catheterization, and accurate measurement of daily weight (all in lieu of indwelling urinary catheters)
Emphasizing the importance of aseptic technique during catheter insertion and proper maintenance after insertion	Developing or updating the catheter-insertion policy to include all the proper steps, developing competencies for health care workers who insert catheters, and considering periodic audits of catheter placement
Additional	
Providing feedback to the units regarding urinary-catheter use and catheter-associated UTI rates	Providing nurses and physicians with data on urinary-catheter use, with monthly feedback on use and catheter-associated UTIs
Addressing any identified gaps in knowledge of urinary management processes†	Conducting an evaluation for gaps in knowledge of infectious and noninfectious consequences of urinary-catheter use; developing tailored educational materials to fill identified gaps; using multiple venues for education, including bedside and electronic; incorporating education into annual competency testing for nurses; and using multiple venues for physicians (formal presentations and meetings, with one-to-one discussions for physicians with high use)

* UTI denotes urinary tract infection.
† Urinary management processes include proper insertion and maintenance of indwelling urinary catheters, use of alternative urine-collection methods, and prevention of infectious and noninfectious consequences of urinary-catheter use.

gram, which began in March 2011. We report the results for the first four cohorts, all of which consisted of inpatient units that completed the 18-month program between March 2011 and November 2013. The other five cohorts included emergency departments.

A representative from each state hospital association or organization served as the leader, recruiting inpatient units to participate in the program, monitoring data collection, facilitating monthly coaching calls, and coordinating learning sessions. Each participating inpatient unit was tasked with forming a unit-based team to focus on the prevention of catheter-associated UTI. Intensive care units (ICUs) and inpatient units that were not ICUs (non-ICUs, mainly medical and surgical units) were eligible for participation.

STUDY OVERSIGHT

The University of Michigan Institutional Review Board reviewed the study and determined that it did not meet the regulatory definition of research involving human subjects. Authors with access to project data signed a data confidentiality agreement with the sponsor. The data analysis plan was prepared and conducted independently of the sponsor by two of the authors at the University of Michigan. All authors vouch for the accuracy and completeness of the data and analysis.

STUDY INTERVENTIONS

The goals of the program were to reduce catheter-associated UTIs and improve attitudes and behavior with respect to safety (i.e., the safety culture) in participating units; this analysis focuses on

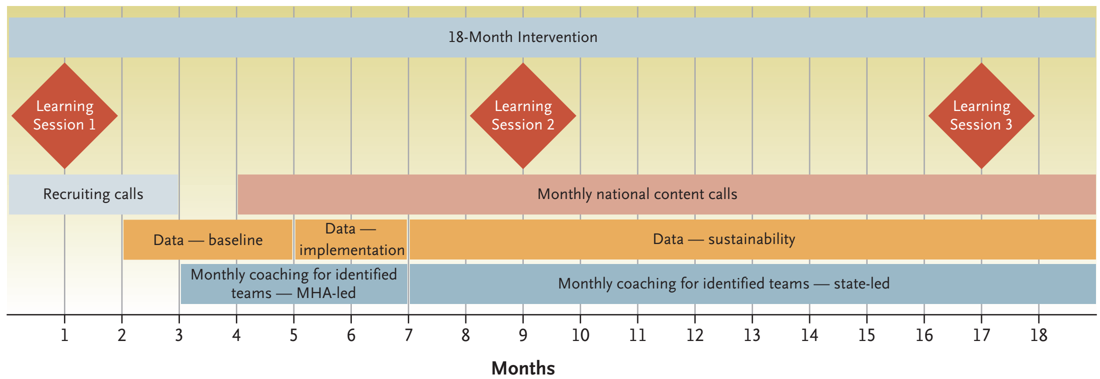

Figure 1. Study Timeline.

Outcome data are collected by the participating hospital units and submitted to the Michigan Health and Hospital Association (MHA) Care Counts database for 3 months during the baseline phase, 2 months during the implementation phase, and every third month during the 1-year sustainability phase. Education is provided during recruiting calls, learning sessions, monthly content calls, and monthly coaching calls.

reducing catheter-associated UTIs. Key interventions were as follows: conducting a daily assessment of the presence and necessity of an indwelling urinary catheter; avoiding the use of an indwelling urinary catheter by considering alternative urine-collection methods, such as intermittent straight catheterization; and emphasizing the importance of aseptic technique during insertion of a catheter and proper maintenance after insertion (Table 1). However, each hospital unit could tailor these interventions to the specific circumstances of the unit. Additional recommended interventions were as follows: providing feedback to the units' nurses and physicians on catheter use and catheter-associated UTI rates and providing training to address any identified gaps in knowledge about urinary management processes (i.e., proper insertion and maintenance of indwelling urinary catheters, use of alternative urine-collection methods, and prevention of infectious and noninfectious consequences of urinary-catheter use). Table 1 outlines the key elements of the intervention. To help each site implement this initiative, a multitude of tools, manuals, and checklists were provided on the program website (www.ahrq.gov/cautitools), including a detailed implementation guide to assist participants (see the Supplementary Appendix, available with the full text of this article at NEJM.org). Additional resources were available on the websites of partner organizations (www.catheterout.org and www.ahrq.gov/professionals/education/curriculum-tools/cusptoolkit) to help unit teams customize program activities. An overview of the initiative is provided elsewhere.[12]

Education on the prevention of catheter-associated UTI was provided to participating units through in-person meetings, coaching calls, and webinars (Table S1 in the Supplementary Appendix). Briefly, there were three in-person or virtual meetings ("learning sessions") for participating unit teams over the course of the program. The first learning session was held at the start of the program, the second early in the sustainability phase (around month 9), and the third at the end of the program. In addition, monthly national content calls were were conducted, during which experts provided education on both technical and socioadaptive aspects of catheter-associated UTI prevention. The leaders also led monthly coaching calls with the participating units in the leader's state or organization to review data trends, discuss unit-specific issues, and share best practices in the prevention of catheter-associated UTI.

OUTCOMES AND DATA COLLECTION

The primary outcome was the rate of catheter-associated UTI, defined by the CDC's National Healthcare Safety Network as the number of catheter-associated UTIs divided by 1000 catheter-days (see Table S2 in the Supplementary Appendix).[18] The proportion of patients with indwelling urinary catheters (i.e., catheter use) was monitored as a process measure and was calculated as the number of catheter-days divided by the number of patient-days and multiplied by 100. Participating units provided the total numbers of catheter-associated UTIs, catheter-days, and patient-days for each month of data collection according to the program schedule: all 3 months of the baseline phase, both months of the implementation phase, and 1 month every quarter during the year-long sustainability phase (Fig. 1).

Table 2. Hospital Characteristics, According to Unit Type.*

Characteristic	Non-ICU (N=553)	ICU (N=373)	P Value
Hospital size (no. of beds)	200±198	297±247	<0.001
Teaching hospital (%)	5	18	<0.001
Rural hospital (%)	35	26	0.002
Critical-access hospital (%)	20	3	<0.001

* Plus–minus values are means ±SD. ICU denotes intensive care unit.

STATISTICAL ANALYSIS

Our analysis included inpatient units that participated in the study, reported program data, and had data on hospital characteristics available from the 2010 American Hospital Association Annual Survey of Hospitals. Descriptive statistics were used to summarize hospital characteristics and process and outcome data, stratified according to ICU status. We used multilevel mixed-effects negative binomial regression to examine the changes in catheter use and in rates of catheter-associated UTI over the course of the project, stratified according to ICU status (an a priori classification based on distinguishing clinical characteristics). Random intercepts for unit and hospital were included to accommodate the nested-data structure. The logarithm of the number of catheter-days was used as an offset for models examining changes in catheter-associated UTI rates. The logarithm of the number of patient-days was used as an offset for the catheter-use models. Time was calculated as the number of days from the end of the baseline period to the end of the fourth quarter of the sustainability period, and the reported incidence rate ratios represent the change over the course of the intervention. All models were adjusted for the following hospital characteristics: size (number of beds), rural or urban location, and teaching or nonteaching hospital. In addition, the models were adjusted for critical-access status (i.e., whether the hospital meets specific requirements for Medicare reimbursement, including a small number of inpatient beds [≤25] and a short average length of stay).[19]

Given attrition in the number of units submitting data over the course of the project, we conducted a sensitivity analysis to examine whether changes in catheter-associated UTI rates differed between units that submitted all the expected data and those that did not complete data submission. The same modeling approach outlined above for the primary analysis was used for the sensitivity analysis, with an additional indicator variable for units submitting all expected data.

All statistical tests were performed at an alpha level of 0.05. Two-tailed estimates of effect (incidence rate ratios) and 95% confidence intervals are reported for all regression coefficients. Statistical analyses were performed with the use of Stata/MP software, version 13.1 (StataCorp).

RESULTS

CHARACTERISTICS OF THE HOSPITAL UNITS

A total of 1202 units were originally enrolled in cohorts 1 through 4; however, 276 units (23.0%) did not provide any data, did not have data on hospital characteristics available, were subsequently found to be ineligible, or withdrew from the program and were therefore excluded from this analysis. As compared with units included in the analysis, those that were excluded were more likely to be from small, rural, or nonteaching hospitals (see Tables S3 and S4 in the Supplementary Appendix). Here we present data from 926 units in 603 hospitals, located in 32 states, the District of Columbia, and Puerto Rico, that participated in the first four cohorts. The data represent more than 10% of U.S. acute care hospitals. Of the participating units, 59.7% were non-ICUs and 40.3% were ICUs. Selected hospital characteristics according to unit type are shown in Table 2. Participating ICUs were more likely than non-ICUs to be located in teaching hospitals but were less likely to be in rural or critical-access hospitals. Data on the total number of catheter-days and patient-days, as well as unadjusted catheter-associated UTI rates and catheter use per project period, are provided in Table S2 in the Supplementary Appendix.

Table 3. Multivariable-Regression Estimates of Changes in Catheter-Associated UTI Rates, According to Unit Type.*

Variable	Non-ICU (N=553)		ICU (N=373)	
	IRR (95% CI)	P Value	IRR (95% CI)	P Value
Time†‡	0.68 (0.56–0.82)	<0.001	1.01 (0.87–1.17)	0.90
Teaching hospital	1.76 (1.03–3.01)	0.04	1.92 (1.32–2.80)	0.001
Rural hospital	0.90 (0.66–1.23)	0.51	0.83 (0.58–1.18)	0.30
Critical-access hospital	2.36 (1.65–3.37)	<0.001	2.60 (0.94–7.20)	0.07
Hospital size (per 100-bed increase)‡	0.97 (0.90–1.05)	0.45	1.09 (1.02–1.16)	0.01

* Incidence rate ratios (IRRs) are shown for changes from baseline in the rates of catheter-associated UTI. On the basis of the definition used by the Centers for Disease Control and Prevention's National Healthcare Safety Network, the catheter-associated UTI rate was calculated as the number of urinary tract infections per 1000 catheter-days. Negative binomial models were fit, with random intercepts for hospital and unit. CI denotes confidence interval.

† Time was defined as the number of days from the end of the baseline period (day 0) to the end of the sustainability period (day 427). Thus, the IRR indicates the percentage change from the end of baseline to the end of the study period.

‡ P=0.001 for the comparison between non-ICUs and ICUs.

Table 4. Multivariable-Regression Estimates of Changes in Catheter Use, According to Unit Type.*

Variable	Non-ICU (N=553)		ICU (N=373)	
	IRR (95% CI)	P Value	IRR (95% CI)	P Value
Time†	0.93 (0.90–0.96)	<0.001	0.98 (0.96–1.01)	0.15
Teaching hospital	0.96 (0.73–1.26)	0.77	0.96 (0.88–1.06)	0.45
Rural hospital	0.89 (0.78–1.01)	0.07	0.85 (0.78–0.91)	<0.001
Critical-access hospital	0.95 (0.82–1.10)	0.47	0.81 (0.67–0.98)	0.03
Hospital size (per 100-bed increase)‡	0.98 (0.95–1.02)	0.38	1.02 (1.01–1.04)	0.01

* IRRs are shown for changes from baseline in catheter use, which was calculated as the number of catheter-days per number of patient-days. Negative binomial models were fit, with random intercepts for hospital and unit.

† Time was defined as the number of days from the end of the baseline period (day 0) to the end of the sustainability period (day 427). Thus, the IRR indicates the percentage change from the end of baseline to the end of the study period. P=0.004 for the comparison between non-ICUs and ICUs.

‡ P=0.001 for the comparison between non-ICUs and ICUs.

CHANGES IN CATHETER-ASSOCIATED UTI RATES AND CATHETER USE

Across all participating units, the unadjusted rates of catheter-associated UTI decreased by 22.3%, from 2.82 infections per 1000 catheter-days at the end of baseline to 2.19 per 1000 catheter-days at the end of the sustainability period. In an adjusted analysis, the rates decreased from 2.40 infections per 1000 catheter-days at the end of baseline to 2.05 per 1000 catheter-days at the end of the sustainability period (incidence rate ratio, 0.86; 95% confidence interval [CI], 0.76 to 0.96; P=0.009). Changes in rates according to unit type, adjusted for hospital characteristics, are shown in Table 3. Reductions occurred mainly in non-ICUs, where catheter-associated UTI rates decreased from 2.28 to 1.54 infections per 1000 catheter-days (incidence rate ratio, 0.68; 95% CI, 0.56 to 0.82; P<0.001). The rates did not change significantly in ICUs: 2.48 infections per 1000 catheter-days at the end of baseline and 2.50 per 1000 catheter-days at the end of the sustainability period (incidence rate ratio, 1.01; 95% CI, 0.87 to 1.17; P=0.90). The test for interaction by ICU status was significant (P=0.001).

In an unadjusted analysis, catheter use decreased from 19.8% to 18.2% in non-ICUs and from 61.1% to 57.6% in ICUs during the program (Table S2 in the Supplementary Appendix). Changes in catheter use, adjusted for hospital characteristics, are shown according to unit type in Table 4. Catheter use decreased significantly, from 20.1% at the end of baseline to 18.8% at the end of the sustainability period in non-ICUs (incidence rate ratio, 0.93; 95% CI, 0.90 to 0.96; P<0.001) but did not change significantly in ICUs (from 62.8% to 61.9% [incidence rate ratio, 0.98; 95% CI, 0.96 to 1.01; P=0.15). The test for interaction was significant (P=0.004). Significant associations between hospital characteristics and catheter use were not detected for the non-ICUs. However, catheter use was significantly lower in ICUs located in rural areas than in those located in nonrural areas (incidence rate ratio, 0.85; 95% CI, 0.78 to 0.91; P<0.001) and in ICUs in critical-access hospitals than in those in hospitals that were not designated as critical-access hospitals (incidence rate ratio, 0.81; 95% CI, 0.67 to 0.98; P=0.03).

SENSITIVITY ANALYSIS

Of the 926 units in the primary analysis, 573 (61.9%) submitted all expected data for each period of the project. Units that provided all data were compared with those that did not, in terms of hospital characteristics (see Table S5 in the Supplementary Appendix). Our sensitivity regression analyses indicated that changes in catheter-associated UTI rates for units that completed the project and submitted data through the fourth quarter of the sustainability period did not differ significantly from changes in the rates for units with incomplete data. This was true for both non-ICUs (adjusted incidence rate ratio for units submitting all data, 1.04; 95% CI, 0.82 to 1.31; P=0.76) and ICUs (adjusted incidence rate ratio for units submitting all data, 1.09; 95% CI, 0.84 to 1.41; P=0.53). The test for interaction was not significant (P=0.14). Similarly, changes in catheter use did not differ significantly between units that completed the project and submitted data through the fourth quarter of the sustainability period and units with incomplete data, for both non-ICUs (adjusted incidence rate ratio for units submitting all data, 1.01; 95% CI, 0.92 to 1.12; P=0.79) and ICUs (adjusted incidence rate ratio for units submitting all data, 0.95; 95% CI, 0.89 to 1.01; P=0.11). The test for interaction was not significant (P=0.80).

DISCUSSION

We report the results from the first four cohorts of a national program that aims to reduce rates of catheter-associated UTI in U.S. hospitals. We found that a collaborative effort focusing on both technical and socioadaptive interventions can reduce catheter-associated UTI rates in the non-ICU setting. This approach was based on prior studies performed at the local level[20,21] and the regional level.[13,14,22] Using these previous studies as a foundation, we learned how to scale up the intervention from a program in a single hospital or region to a national program. We also used the results of previous qualitative studies[23,24] to guide our implementation efforts.

Our findings suggest that non-ICUs benefited from participating in the program, whereas ICUs did not. This dichotomy between ICUs and non-ICUs is also characteristic of the CDC's surveillance data, which show that the rates of catheter-associated UTI in non-ICUs decreased by 14% between 2009 and 2012 but that the rates in ICUs increased by 9%.[25] The reason ICUs have been less successful than non-ICUs in preventing catheter-associated UTIs is unclear. One possible explanation is the belief that patients who are ill enough to warrant admission to the ICU require close monitoring of urine output, which is an appropriate criterion for indwelling urinary catheters.[4] The higher catheter-associated UTI rate in ICUs could also be related to the frequent occurrence of fever in critically ill patients, coupled with routine culturing of various body fluids, including urine, to identify possible sources of infection.[26] Given these factors and the CDC criteria for catheter-associated UTI, patients in ICUs may meet the surveillance definition of catheter-associated UTIs more frequently than patients in non-ICUs.

Four important limitations of the study should be considered. First, it was not a randomized trial; thus, confounding variables may have played a role in the findings. Of greatest concern would be secular trends, since such a bias is often seen in quality-improvement projects.[27] However, data from the CDC suggest a national trend toward increasing rates of catheter-associated UTI between 2009 and 2013.[11] Although we found that catheter-associated UTI rates decreased significantly in non-ICUs participating in the program, we cannot rule out the possibility that other units not participating in the program have achieved similar reductions over a contemporaneous period, despite overall increases in catheter-associated UTIs across the United States. Second, since participation in the program was voluntary, our findings may not be generalizable to all

U.S. hospitals. Third, incomplete data collection is common in quality-improvement projects. Specifically, there is a concern that the hospitals that stop providing data are those that are less successful in their efforts. Our sensitivity analyses suggest that changes in catheter-associated UTI rates and catheter use did not differ significantly between units that completed the program and submitted all the expected data and units that provided data for a shorter period. Finally, the hospital units were allowed to tailor the way in which they implemented the interventions. One of the challenges in broad-scale quality-improvement efforts is providing a specific set of recommended interventions — in this case, daily assessment of the necessity for indwelling urinary catheters, use of alternative devices, proper insertion and maintenance, and data feedback — while allowing flexibility for sites to decide how best to implement these core practices. This flexibility was necessary because of differences between units (e.g., a surgical unit and an adjoining medical unit) in structure and culture that are based on traditions and the types of health care workers in the unit.

These limitations notwithstanding, we found that a national collaborative program implemented in more than 10% of U.S. hospitals led to a decrease in rates of catheter-associated UTI in non-ICUs. Our approach to preventing catheter-associated UTIs used both technical and cultural interventions. A similar collaborative effort is extending this program to long-term care settings, for which preventive data are more limited.[28,29]

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Agency for Healthcare Research and Quality, the Centers for Disease Control and Prevention, or the Department of Veterans Affairs.

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