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Reducing Inappropriate Urinary Catheter Use

A Statewide Effort

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Background: Indwelling urinary catheters may lead to both infectious and noninfectious complications and are often used in the hospital setting without an appropriate indication. The objective of this study was to evaluate the results of a statewide quality improvement effort to reduce inappropriate urinary catheter use.

Methods: Retrospective analysis of data collected between 2007 and 2010 as part of a statewide collaborative initiative before, during, and after an educational intervention promoting adherence to appropriate urinary catheter indications. The data were collected from 163 inpatient units in 71 participating Michigan hospitals. The intervention consisted of educating clinicians about the appropriate indications for urinary catheter use and promoting the daily assessment of urinary catheter necessity during daily nursing rounds. The main outcome measures were change in prevalence of urinary catheter use and adherence to appropriate indications. We used flexible generalized estimating equation (GEE) and multilevel methods to estimate rates over time while accounting for the clustering of patients within hospital units.

Results: The urinary catheter use rate decreased from 18.1% (95% CI, 16.8%-19.6%) at baseline to 13.8% (95% CI, 12.9%-14.8%) at end of year 2 ($P<.001$). The proportion of catheterized patients with appropriate indications increased from 44.3% (95% CI, 40.3%-48.4%) to 57.6% (95% CI, 51.7%-63.4%) by the end of year 2 ($P=.005$).

Conclusions: A statewide effort to reduce inappropriate urinary catheter use was associated with a significant reduction in catheter use and improved compliance with appropriate use. The effect of the intervention was sustained for at least 2 years.

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URINARY TRACT INFECTIONS account for a large portion of all hospital-acquired infections,[1] with catheter-associated urinary tract infection (CAUTI) representing the majority of these cases.[2] CAUTI has been classified as a "reasonably preventable" hospital-acquired condition by the Centers for Medicare and Medicaid Services (CMS); CMS no longer reimburses hospitals for this condition.[3] Among the most effective approaches for reducing CAUTI is using a urinary catheter only when an appropriate indication is present.[4] Assessing whether there is an appropriate indication for catheter use should be part of the initial decision for placement as well as part of an ongoing process for determining the continuing need for a catheter throughout the hospital stay.[4]

Prior studies reveal that interventions promoting awareness of the presence of an indwelling catheter and timely removal have been associated with a reduction in inappropriate urinary catheter use and CAUTI.[5] Most studies, however, have evaluated interventions at a single site[6-10]; the effectiveness of a larger-scale intervention to promote appropriate catheter use has yet to be determined. Moreover, the extent to which improvements might be sustained for substantial periods remains unclear. In 2007, the Michigan Health and Hospital Association (MHA) Keystone Center implemented a statewide initiative to reduce the unnecessary use of urinary catheters in Michigan hospitals.[11] The initiative was based on an intervention developed by a single Michigan hospital in which nurse-led multidisciplinary rounds were used to prompt re-

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moval of unnecessary catheters, leading to a 45% reduction in inappropriate catheter use.[8] The purpose of the current study is to evaluate the effect of the MHA Keystone Center initiative on urinary catheter use among participating Michigan hospitals and to assess multiyear sustainability.

METHODS

We conducted a retrospective review of the MHA data collected as part of the CAUTI prevention initiative over a period of over 3 years (2007-2010). All Michigan hospitals and their respective inpatient units (primarily medical-surgical, nonintensive care units) were eligible for participation and were encouraged to enroll. For each participating hospital, we obtained deidentified data on catheter use and the reason for use from the Web-based MHA data system "Care Counts," which was also used by hospitals to follow up on their progress over time.

Before starting the intervention, key hospital leaders were informed of the study and asked for their support. Hospitals were encouraged to disseminate the information regarding the intervention to physicians and nurses. Hospitals were asked to form a team to implement the process. The team included a nursing champion (educates the patient-care nurses and triggers the evaluation for urinary catheter necessity on the participating unit), a physician champion (obtains physician support for the initiative), an infection preventionist (addresses the infectious complications related to the urinary catheter), and other stakeholders (quality improvement, case managers, patient care assistants, nurse educators). Hospitals formed their teams based on their resources.

Multiple webinars were given to the participating teams. The initial webinar addressed the infectious and noninfectious risks of urinary catheter use, the appropriate indications for urinary catheter use, and common situations where the catheter is used inappropriately. It also addressed the proper insertion technique and maintenance of the urinary catheter. The main message was to evaluate daily the need for the urinary catheter. The second webinar included a detailed description of how to implement the process at each facility. We suggested that hospitals consider involving units with high urinary catheter use and increased unnecessary use; however, each hospital made the decision to choose the unit involved.

Initially, each unit involved collected baseline data on urinary catheter use and appropriateness (week 1); this was followed by the education of nurses on evaluating patients for urinary catheter presence and need during nursing or multidisciplinary, unit-based rounds (weeks 2-3). Nurses were encouraged to evaluate the presence and need for the catheter during nursing rounds and contact the physician if no appropriate indication was present. Following the intensive intervention periods, catheter use was tracked and evaluated over time (at 8-week and then 12-week intervals), and appropriate practices were reinforced. A health care worker from each facility collected all the data prospectively, including the number of patients on the unit, presence of the catheter, and the reason for use. Appropriate indications for catheter use were defined based on the 1983 Centers for Disease Control and Prevention (CDC) recommendations[12] (issued prior to the new CDC Healthcare Infection Control Practices Advisory Committee [HICPAC] guidelines[4]). The appropriate indications included urinary tract obstruction, neurogenic bladder dysfunction and urinary retention, and urologic studies or surgery on contiguous structures. In addition, urinary catheter use was considered appropriately indicated for patients with urinary incontinence and stage III or IV sacral pressure ulcers and for end-of-life care.

Continued feedback was given to the units on their performance (ie, any changes in urinary catheter use and compliance with the appropriate indications). Teams were able to calculate through MHA "Care Counts" their total and appropriate urinary catheter use. Appropriate catheter-days were calculated by summing all catheter-days used based on the different appropriate indications. Support to hospitals was provided by the use of multiple coaching calls to existing teams, and additional webinars were presented to newly participating hospitals. All webinars were open to all the teams. Finally, a "Bladder Bundle"[11] manual was distributed to all participating hospitals; it included a step-by-step description of the process, educational materials to staff (including posters and pocket cards), examples of policies, and information about barriers and facilitators.

We used generalized estimating equation (GEE) methods[13] to estimate population average rates of catheter use (urinary catheter-days/patient-days) and appropriate catheterization (appropriate catheter-days/catheter-days), and multilevel models with empirical Bayes prediction[14] to explore unit-specific rates. Population average rates captured trends across rather than within hospital units, and could be viewed as a weighted average of unit-specific rates. Both GEE and multilevel approaches accounted for clustering of patients within units, and the empirical Bayes method accounted for differential sample sizes across units by shrinking less reliable unit-specific estimates toward the overall mean.

To allow for nonlinearity across time, we modeled population average rates as a function of continuous time (from baseline) using natural cubic splines with 5 knots. The clustered robust (or "sandwich") variance estimator was used to account for correlation among patients within hospital units.[15] Multilevel models allowed intercepts and slopes to vary randomly across units and assumed a linear relationship between rates and log-transformed time (log transformation was deemed to be sufficient via likelihood ratio tests for more complicated spline structure). Odds ratios for specific units comparing week 20 to baseline were calculated using multilevel model empirical Bayes predictions; for this analysis we used only those units that collected data for up to 20 weeks.

Both GEE and multilevel analyses were done at the patient level rather than at the unit level, and models did not include covariates (besides time from baseline), since covariate data were not collected, and interest centered on urinary catheter prevalence. Units that failed to collect data for any of the first 3 weeks (ie, during baseline or intervention) were excluded from analysis. The St John Hospital and Medical Center institutional review board approved the study prior to all data analysis.

RESULTS

A total of 194 162 patient-days of data were collected across 163 units within 71 acute-care hospitals (55% of 130 eligible Michigan hospitals). Urinary catheters were used for a total of 29 990 patient-days (15.4%) across the study period. Most units (127 of 163 or 77.9%) collected data for at least 80% of the maximum possible follow-up time, and most collected data for at least 90% of the maximum (105 of 163 or 64.4%) (**Figure 1**); in other words, most missing data was the result of administrative censoring rather than potentially biasing dropout.

The average urinary catheter use rate decreased from 18.1% (95% CI, 16.8%-19.6%) at baseline to 17.2% (95% CI, 16.0%-18.4%) ($P=.01$) at week 3 (the second week of the intervention), representing a statistically significant 6% decrease in the odds of catheter use. The rate decreased to 15.9% (95% CI, 14.7%-17.2%) ($P<.001$) by week 8, and to 14.8% (95% CI, 13.6%-16.0%) ($P<.001$)

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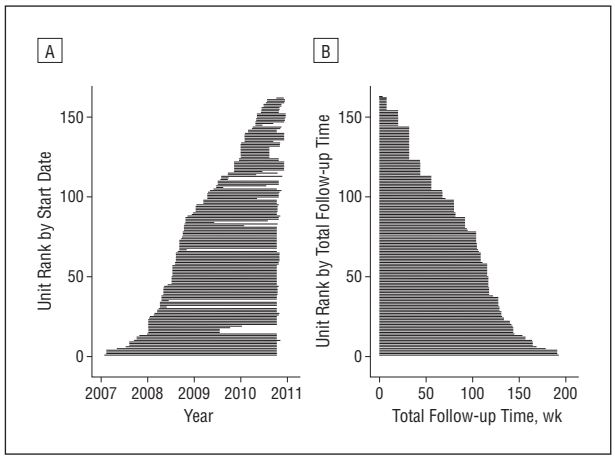

Figure 1. Duration of data collection for individual units by calendar time (A) and follow-up time (B).

by week 20 (**Table 1** and **Figure 2**). The proportion of appropriately indicated catheter-days increased from 44.3% (95% CI, 40.3%-48.4%) at baseline to 46.8% (95% CI, 42.6%-51.0%) ($P<.001$) at week 3 (the second week of the intervention), representing an 11% increase in the odds of appropriately indicated catheter use. By weeks 8 and 20, the proportion had increased to 50.4% (95% CI, 45.4%-55.4%) ($P<.001$) and 53.5% (95% CI, 48.7%-58.4%) ($P<.001$), respectively (Table 1 and Figure 2). Two years after baseline, the catheter use rate was 13.8% (95% CI, 12.9%-14.8%) ($P<.001$), and appropriate catheterization increased to 57.6% (95% CI, 51.7%-63.4%) ($P=.005$). However, estimates after week 104 are relatively unreliable owing to limited data collection (Table 1, Figures 1 and 2). **Table 2** lists the crude distribution of the indications (both appropriate and inappropriate) for urinary catheter use at weeks 1, 3, 8, and 20.

From baseline to week 20 (and for units with data up to week 20), the top decile of units in terms of decreased odds of catheter use had estimated odds ratios (ORs) ranging between 0.48 and 0.25, while the top decile of units in terms of increased odds of appropriate catheter use (not necessarily the same as the previous decile) had estimated ORs ranging between 5.06 and 10.92. Such performance may represent best-case scenarios for response to the interventions. Conversely, the bottom decile of units had ORs for increases in catheter use ranging between 1.22 and 1.88 and ORs for decreases in appropriate catheterization ranging between 0.36 and 0.04 during this period. The median units, however, had ORs of 0.80 for catheter use and 1.71 for appropriate catheterization. This decrease in use and increase in appropriate catheterization is aligned with the results seen in the GEE analysis (where the corresponding ORs were 0.79 and 1.45, respectively). **Figure 3** shows the ORs for catheter use and appropriate catheterization for units with data for both quantities up until at least week 20. Figure 3 indicates that high-performing units with respect to catheter use (ie, those with low ORs) were not necessarily high-performing units with respect to appropriate catheterization (ie, those with high ORs); however, most units (56.6%) that continued to collect data until week 20 saw both a decrease in catheter use and an increase in appropriate catheterization.

Table 1. Rates and Confidence Intervals for Catheter Use and Appropriate Catheterization

Measurement Time, Day, Week[a]	Units Collecting Data, No. (%)[b]	Rate (95% CI), %	
		Catheter Use	Appropriate Catheterization
Baseline			
0, 1	163 (100)	18.1 (16.8-19.6)	44.3 (40.3-48.4)
Intervention			
11, 2	163 (100)	17.5 (16.3-18.8)	45.9 (41.8-50.0)
18, 3	163 (100)	17.2 (16.0-18.4)	46.8 (42.6-51.0)
Postintervention			
53, 8	162 (99)	15.9 (14.7-17.2)	50.4 (45.4-55.4)
137, 20	154 (94)	14.8 (13.6-16.0)	53.5 (48.7-58.4)
221, 32	144 (88)	14.9 (13.8-16.2)	53.0 (48.7-57.3)
305, 44	122 (75)	15.0 (13.8-16.3)	52.8 (48.1-57.5)
389, 56	113 (69)	14.8 (13.8-15.9)	53.4 (48.5-58.3)
473, 68	103 (63)	14.5 (13.6-15.6)	54.4 (49.1-59.7)
557, 80	98 (60)	14.3 (13.4-15.2)	55.5 (49.9-60.9)
641, 92	87 (53)	14.0 (13.2-15.0)	56.5 (50.9-62.0)
725, 104	78 (48)	13.8 (12.9-14.8)	57.6 (51.7-63.4)
809, 116	58 (36)	13.6 (12.4-14.9)	58.7 (51.8-65.3)
893, 128	37 (23)	13.4 (11.8-15.1)	59.8 (51.2-67.8)
977, 140	22 (13)	13.2 (11.2-15.4)	60.9 (50.2-70.6)
1061, 152	13 (8)	13.0 (10.6-15.7)	61.9 (49.0-73.4)
1152, 165	9 (6)	12.7 (10.0-16.1)	63.1 (47.6-76.3)
1243, 178	5 (3)	12.5 (9.4-16.5)	64.2 (46.1-79.0)
1332, 190	4 (2)	12.3 (8.8-17.0)	65.3 (44.5-81.5)

[a] Results are shown for days at the end of *data collection weeks* (weeks when the majority of remaining hospitals contributed data).
[b] After excluding any units that failed to collect data throughout the first 3 weeks (ie, during baseline and intervention weeks).

COMMENT

We examined the results of a statewide quality improvement initiative among a large cohort of hospitals that implemented an intervention to evaluate the presence and appropriate use of urinary catheters. Overall, the intervention led to a significant reduction in use and an improvement in the appropriateness of use. Our results largely parallel the improvement seen when the intervention was piloted in a single hospital.[8] The improvement in urinary catheter use was apparent within the first 2 weeks of the intervention, and the progressive improvement in use continued throughout the study period from a baseline rate of 18.1% to 13.8% at year 2. This translates to an overall 28% reduction in the odds of catheter use. Our results show that Michigan hospitals were able to reduce use significantly to levels comparable to the 25th percentile reported by the National Healthcare Safety Network for urinary catheter use in medical-surgical inpatient wards.[16]

Avoiding initial urinary catheter placement and reducing the duration of use once placed are associated with fewer infectious complications. Previous studies have shown that urinary catheter reminders and stop orders leading to a reduction in use were associated with a significant reduction in CAUTI.[5] In addition to reducing the infection risk, promoting the appropriate use of the catheter may lead to fewer noninfectious complications, such

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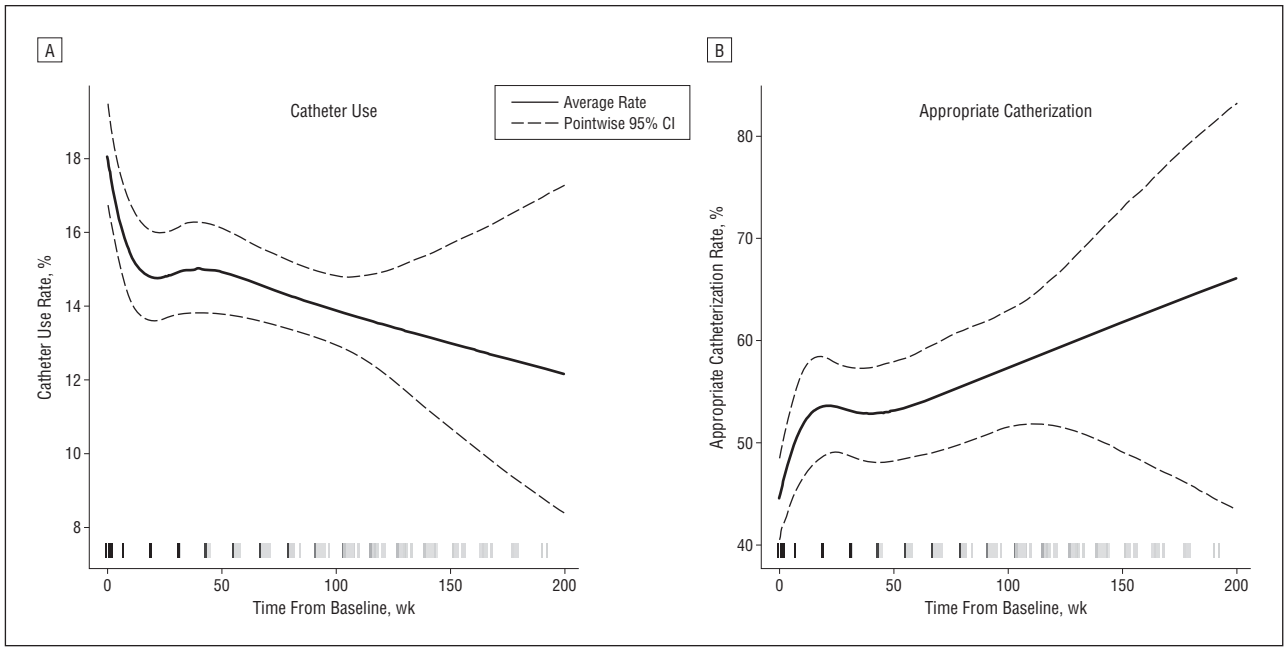

Figure 2. Rates of catheter use (A) and appropriate catheterization (B) across time. The tick marks at the x-axes indicate times at which data were collected. The darkness of the tick marks reflects the number of units contributing data (darker marks indicating more units and lighter marks, fewer units); black represents all units, and white represents no units.

Table 2. Reasons for Catheter Use Across Time (Raw Percentages)

Reason	Week 1	Week 3	Week 8	Week 20
Appropriate, %				
Urinary tract obstruction	6.3	7.1	7.9	7.1
Neurogenic bladder	9.9	11.7	12.3	10.8
Urologic study or surgery on contiguous structures	13.7	17.7	17.7	19.0
Sacral pressure ulcer (stage III or IV) with incontinence	5.9	6.4	6.0	6.0
End-of-life care	6.6	8.6	6.8	8.7
Total appropriate	42.4	51.5	50.7	51.6
Inappropriate, %				
Nonobstructive renal insufficiency	2.2	1.6	1.3	1.1
Transferred from intensive care	4.2	3.9	3.9	6.1
Patient request	1.5	1.3	1.4	1.7
Confusion	4.6	3.2	3.3	3.0
Incontinence	6.5	5.2	4.6	4.5
Other or no clear reasons	38.6	33.3	34.8	32.0
Total inappropriate	57.6	48.5	49.3	48.4
Total catheterized, No.	3934	3083	2903	2606

The rates of appropriate catheterization given inTable 1 are estimated at specific time points and arise from modeling the rate of appropriateness as a continuous function across time (see Figure 1). In contrast, for Table 2, the observed data are binned by week, and simple percentages are computed; as a result, the raw rates presented herein should not agree exactly with the estimated rates given in Table 1.

as urethral injury.[17] Moreover, patients may experience less discomfort and be free of the restraints associated with catheter use.[18,19]

The appropriate use of urinary catheters also improved significantly over the course of the study. By year 2, the odds of appropriate placement among those with urinary catheters increased by 71% compared with baseline. Despite this significant improvement, appropriate use (based on the 1983 CDC guidelines[12]) reached only 57.6% at year 2. While this suggests that there may be further opportunity for improvement, the 1983 CDC guidelines[12] and the newer HICPAC guidelines[4] are consensus based and may not be inclusive of all conditions where the catheter may be required.

We observed between-unit variation in response to the intervention. Possible differences between high- and low-performing hospitals might include varying levels of commitment from each institution to make this effort a high priority or differential involvement of champions to support the effort.[20] External forces influencing the decision to fully adopt safe processes may also play an important role, whether related to public reporting or financial incentives.[20] Moreover, organizations have different contextual characteristics: hospitals with a strong

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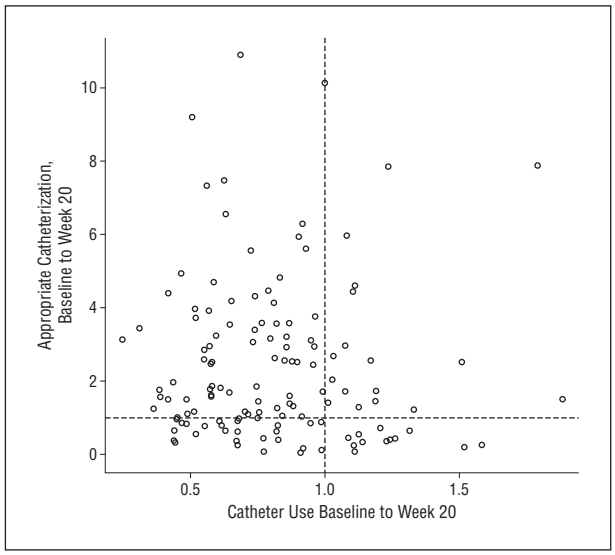

Figure 3. The relationship between catheter use and appropriate catheterization.

emotional commitment to patient care and an active clinical leadership provide a milieu favorable to quality improvement activities.[21] In contrast, while some hospitals lacking emotional commitment to patient care or with weak leadership support may respond favorably to externally facilitated initiatives, such as the MHA Keystone Center initiative, others may face substantial barriers that inhibit implementing evidence-based practices in their institution.[21]

Our findings should be interpreted in the context of the following limitations. First, not all hospitals collected data throughout the entire study period, mostly due to staggered start times. Although we did observe continued decreases in catheter use and increases in appropriately indicated catheters in those placed throughout the 3-year study period, fewer than half of the units collected data for more than 2 years. If low-performing hospitals were more likely to discontinue data collection or more likely to start the study later, our results could be misleading. Still, most hospital units collected data through 20 to 30 weeks after intervention, so immediate effects of the intervention are unlikely to be compromised by such selection bias. Furthermore, discontinued data collection largely resulted from the ending of the study (administrative censoring) rather than unit dropout.

Second, we did not have data for a control group of hospitals that did not receive the intervention; thus, the possibility exists that some portion of the effects would have occurred even without the intervention. For example, some hospitals may have established programs to reduce the risk for CAUTI in response to the CMS nonreimbursement. However, owing to the complexity of coding cases of hospital-acquired CAUTI, errors in coding may underestimate the number and lessen the financial impact on hospitals.[22]

In addition, our results may not be universally generalizable because hospitals self-selected into the study, and units that were enrolled in the study were chosen by individual hospitals rather than selected at random. Finally, we explored only the process measures of urinary catheter use and appropriateness of urinary catheter placement because we did not have data available to investigate the influence of the intervention on infectious or noninfectious outcomes.

Limitations notwithstanding, the MHA Keystone Center initiative was successful in reducing urinary catheter use and increasing appropriateness of catheterization in a large number of hospitals throughout the state of Michigan. Our results indicate that hospitals can improve appropriate urinary catheter use and that such efforts can be successfully implemented on a broad scale. Our findings may help motivate and guide other hospitals to undergo similar intervention programs to reduce inappropriate catheter use and collectively achieve the Department of Health and Human Services[23] goal of reducing CAUTI rates by 25% by 2013.

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ulty for presentations sponsored by Advanced Sterilization Products, Baxter Healthcare, BD, CareFusion, Ethicon, and several not-for-profit organizations. Mr Olmsted is also serving as an expert consultant on an extended faculty group for a multistate CAUTI prevention project with the Agency for Healthcare Research and Quality/Health Educational and Research Trust. Dr Saint has received travel reimbursement and numerous honoraria from hospitals, academic medical centers, specialty societies, state societies (including the MHA), and other nonprofit organizations (including the Institute for Healthcare Improvement) for speaking about health care–associated infection prevention.

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INVITED COMMENTARY

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Improving Use of the "Other" Catheter

An Important Opportunity to Reduce Hospital Infections

The duration of urinary catheterization is the most important risk factor for catheter-associated urinary tract infection (CAUTI).[1] Thus, best-practice guidelines recommend both limiting the number of patients who receive a urinary catheter, and promptly removing it when it is no longer indicated in patients who must receive it.[2]

Despite the apparent simplicity of these guidelines, programs seeking to reduce CAUTI have to overcome well-defined barriers involving health care providers, including (1) lack of knowledge of the criteria for appropriate urinary catheter use; (2) failure to recognize that a urinary catheter is present, particularly if the catheter was placed elsewhere; and (3) failure to remove the catheter at the appropriate time. Bedside placards, computer reminders, and automatic stop orders have been tried as approaches to improve urinary catheter use. There is substantial evidence supporting the effectiveness of these techniques, termed in combination the *bladder bundle*.[3] Despite the success of these interventions, clinical implementation of these practices remains low. Urinary catheter reminders or a stop order to prevent CAUTI are used in fewer than 1 in 10 US hospitals.[4] These findings speak to the complexity of

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