Preventing Catheter-Associated Urinary Tract Infection in the United States

A National Comparative Study

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Importance: Despite the national goal to reduce catheter-associated urinary tract infection (CAUTI) by 25% by 2013, limited data exist describing prevention practices for CAUTI in US hospitals and none associate national practice use to CAUTI-specific standardized infection ratios (SIRs).

Objectives: To identify practices currently used to prevent CAUTI and to compare use and SIRs for a national sample of US hospitals with hospitals in the state of Michigan, which launched a CAUTI prevention initiative in 2007 ("Keystone Bladder Bundle Initiative").

Design and Setting: In 2009, we surveyed infection preventionists at a sample of US hospitals and all Michigan hospitals. CAUTI rate differences between Michigan and non-Michigan hospitals were assessed using SIRs.

Participants: A total of 470 infection preventionists.

Main Outcome Measures: Reported regular use of CAUTI prevention practices and CAUTI-specific SIR data.

Results: Michigan hospitals, compared with hospitals in the rest of the United States, more frequently participated in collaboratives to reduce health care–associated infection (94% vs 67%, $P<.001$) and used bladder scanners (53% vs 39%, $P=.04$), as well as catheter reminders or stop orders and/or nurse-initiated discontinuation (44% vs 23%, $P<.001$). More frequent use of preventive practices coincided with a 25% reduction in CAUTI rates in the state of Michigan, a significantly greater reduction than the 6% overall decrease observed in the rest of the United States.

Conclusions and Relevance: We observed more frequent use of key prevention practices and a lower rate of CAUTI in Michigan hospitals relative to non-Michigan hospitals. This may be related to Michigan's significantly higher use of practices aimed at timely removal of urinary catheters, the key focus area of Michigan's Keystone Bladder Bundle Initiative.

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PREVENTING HEALTH CARE–associated infection (HAI) has emerged as a key focal point for improving the safety of hospitalized patients.[1-3] Indeed, as of October 1, 2008, the Centers for Medicare & Medicaid Services (CMS) decided to no longer reimburse hospitals for the additional costs of caring for patients who develop certain preventable infections during hospitalization.[4-6] The first hospital-acquired condition chosen for nonpayment was catheter-associated urinary tract infection (CAUTI),[7] which is one of the most common HAIs in the United States.[8-10] The CMS chose CAUTI in part because it is considered "reasonably preventable."[7(p47202)] A key premise underlying this CMS policy is that there are evidence-based practices and multimodal prevention strategies that hospitals can take to reduce their CAUTI rates.[5]

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We have previously shown that in 2005, US hospitals did not have a dominant strategy for preventing CAUTI.[11] Although more recent data indicate that the use of various practices to prevent 3 of the most common HAIs—central line–associated bloodstream infection, ventilator-associated pneumonia, and CAUTI—has increased between 2005 and 2009, none of the practices to prevent CAUTI were used by more than half of US nonfederal

hospitals in 2009.[12] A recent study by Conway et al[13] also revealed that adoption of policies to prevent CAUTI in intensive care units (ICUs) is lacking, with only 42% of ICUs reporting having written policies in place for at least 1 of 4 prevention practices: use of portable bladder ultrasound scanners, condom catheters for men, urinary catheter reminders or stop orders, or nurse-initiated urinary catheter discontinuation.

Prior to implementation of the CMS no-payment policy, there was only one statewide initiative focused on urinary catheters and CAUTI prevention. In 2007, modeled after a successful multimodal intervention to prevent central line–associated bloodstream infection,[14] the Michigan Health & Hospital Association's Keystone Center launched a statewide initiative known as the "Keystone Bladder Bundle Initiative" to reduce CAUTI.[15] This initiative consisted of the following key practices to reduce CAUTI: urinary catheter reminders or removal prompts and nurse-initiated urinary catheter discontinuation protocols, alternatives to indwelling urinary catheterization, portable bladder ultrasound monitoring, and insertion care and maintenance. Although urinary catheter use seemed to decrease by approximately 30% among Michigan hospitals participating in this initiative,[16] the specific types of CAUTI prevention practices used, and whether there was a difference in practice use between Michigan and non-Michigan hospitals have not been assessed. Whether CAUTI rates were affected by this initiative is also unknown. Our objective was to use this natural experiment to examine these issues and thereby inform national stakeholders and policymakers in the ongoing efforts to reduce CAUTI.

METHODS

STUDY DESIGN AND DATA COLLECTION

We conducted a survey to compare the use of specific infection prevention practices by US hospitals. In March 2009, we mailed surveys to infection preventionists at a national random sample of hospitals in the United States. The study sample had been originally derived for a similar survey study conducted in 2005.[11,17,18] Specifically, we identified all nonfederal general medical and surgical hospitals with an intensive care unit ICU and at least 50 hospital beds using the 2005 American Hospital Association Database (fiscal year 2003 data). We then stratified hospitals into 2 bed-size groups (50-250 beds and ≥251 beds) and selected a random sample of 300 hospitals from each group. The 2009 survey was sent to the same hospitals sampled in 2005 with a few exceptions due to closure or merger between the longitudinal survey time points. In addition, we included all hospitals in the state of Michigan. Updated information about hospital bed size was obtained from the 2007 American Hospital Association Database and because the original sample had only included hospitals with more than 50 beds, to ensure greater comparability between Michigan and non-Michigan hospitals, we excluded Michigan hospitals with bed size less than 50.

STUDY MEASURES

The survey instrument, which has been previously described,[11,17,18] included questions about the following: facility characteristics, the infection control program, infection preventionists, and frequency of use for hospital practices related to prevention and monitoring of CAUTI and other device-associated infections. Responses about the frequency of use of practices to prevent CAUTI were assigned values between 1 (never) and 5 (always). We defined responses of 4 (almost always) or 5 (always) as regular use of the respective prevention practice. All prevention practices examined were dichotomized into binary dependent variables, with regular use (as defined earlier) coded as 1 and 0 otherwise. The Michigan variable was modeled as a dichotomous variable, with Michigan hospitals coded as 1, and served as an independent proxy variable for the Keystone Bladder Bundle Initiative,[15] which was implemented in 52% of all acute care hospitals in Michigan. The safety culture score was defined as the average of responses regarding agreement to 2 statements about safety ("Leadership is driving us to be a safety-centered institution" and "I would feel safe being treated here as a patient"). Each of these survey items was scored from 1 (strongly agree) to 5 (strongly disagree). Prior to averaging the responses, we reverse-scored them, so a higher score indicated greater safety centeredness.

Because we were interested in investigating the associations between process and outcome measures, we partnered with the Centers for Disease Control and Prevention and the Michigan Department of Community Health to derive 2010 standardized infection ratio (SIR) estimates for CAUTI that were aggregated to the state level. SIR is calculated by dividing the total number of observed infection events for a given population by an expected number of infection events for that population. SIR is similar in concept to standardized mortality ratios, indirectly standardizing expected values using rates from a standard population, and is a practical risk-adjustment statistic for comparing HAI rates.[19,20] For estimating the 2010 CAUTI SIR, the 2009 National Healthcare Safety Network (NHSN) CAUTI rates were used as the standard. Through our partnerships with the Centers for Disease Control and Prevention and the Michigan Department of Community Health, we received data that compared the aggregate SIR specific to Michigan hospitals with the aggregate SIR for non-Michigan hospitals. The identities of all hospitals used to derive SIR estimates were kept confidential from our study team.

STATISTICAL ANALYSIS

We used χ^2 estimates from 2-sample tests of equality of proportions to determine statistical significance between the reported regular use of infection prevention practices and hospital characteristics in Michigan vs non-Michigan hospitals in 2009. We used logistic regression to examine multivariable associations between hospital characteristics and the use of the various infection prevention practices. To compare reductions in CAUTI rates in Michigan vs those in the rest of the United States, we compared SIRs that were specific to Michigan with those that were estimated for all other states and examined the respective SIR 95% CIs to assess the degree of overlap and statistical difference. Reported *P* values are 2-tailed; all analyses were conducted using STATA, version 11.0 (StataCorp LP).

RESULTS

The overall survey response rate was 71%. The survey was sent to 131 Michigan hospitals and 79% responded. Of the 566 non-Michigan hospitals that were sent the survey, 69% responded. Of the 103 Michigan hospitals that responded, 25 had hospital bed size less than 50 and were removed from our analyses. Our final analytic study

Table 1. Characteristics of Responding Hospitals—Michigan vs Non-Michigan

Characteristic	Michigan Hospitals, % (n = 78)	Non-Michigan Hospitals, % (n = 392)	*P* Value
Hospital bed size ≥250	33	45	.07
Has hospitalists	68	77	.11
Lead infection preventionist certified in infection control	54	64	.14
Has system in place to monitor urinary catheter placement	59	57	.83
Routinely monitors duration and/or discontinuation of urinary catheters	60	39	<.001
Has an established surveillance system for monitoring urinary tract infection rates	59	79	<.001
Regular use of alcohol-based hand rub for general infection prevention[a]	90	95	.17
Leadership driving for a safety-centered institution[a,b]	82	77	.38
Would feel safe being treated at his or her respective institution[a,b]	72	77	.40
Strong to very strong perceived importance of urinary tract infection prevention[a]	63	58	.52
Moderate to large increase in importance of urinary tract infection prevention as a result of the CMS rule change[a]	64	65	>.99

Abbreviation: CMS, Centers for Medicare & Medicaid Services.
[a] As reported by each institution's lead infection preventionist.
[b] Survey questions were on a 5-point scale ranging from strongly disagree (1) to strongly agree (5). Agree (4 points) and strongly agree responses are reflected in the Table percentages.

sample included 78 Michigan hospitals, 64% (50) of which reported participating in the Keystone Bladder Bundle Initiative. Almost all Michigan hospitals were participating in a collaborative effort to prevent HAI, and the overall percentage of collaborative participants in Michigan was greater than in non-Michigan hospitals (94% vs 67%, $P<.001$). **Table 1** compares Michigan and non-Michigan hospitals across a number of characteristics. Several statistically significant differences were noted. Michigan hospitals were more likely to routinely monitor duration and/or discontinuation of urinary catheters (60% vs 39%, $P<.001$), while non-Michigan hospitals were more likely to have an established system to monitor urinary tract infection rates (59% vs 79%, $P<.001$).

The **Figure** shows the distribution of the CAUTI prevention practices in Michigan and non-Michigan hospitals. Michigan hospitals were more likely than non-Michigan hospitals to use portable bladder scanners (53% vs 39%, $P = .04$) as well as catheter reminders or stop orders and/or nurse-initiated discontinuation (44% vs 23%, $P < .001$); conversely, non-Michigan hospitals were more likely to use antimicrobial urinary catheters (14% vs 46%, $P < .001$).

Table 2 summarizes the results of multivariable logistic regression analyses assessing the association between our independent variables of interest and the use of CAUTI preventive practices. The odds of regularly using bladder ultrasound scanners, as well as urinary catheter reminders or stop orders and/or nurse-initiated discontinuation, were 2-fold greater in hospitals located in Michigan ($P = .01$ and $P = .007$, respectively). Having systems in place to routinely monitor urinary catheter placement ($P = .02$) and urinary catheter duration and/or discontinuation ($P < .001$), as well as the perception that urinary tract infection prevention is an important institutional goal ($P = .04$), were also associated with approximately 2- to 3-fold increases in the odds of regularly using urinary catheter reminders or stop orders and/or nurse-initiated discontinuation. Conversely, the odds of regularly using antimicrobial urinary catheters were significantly higher among non-Michigan hospitals ($P < .001$).

Table 3 lists the differences in 2010 CAUTI rates between Michigan and non-Michigan hospitals that reported to the NHSN. CAUTI rate data are derived from all wards and ICUs (neonatal ICUs excluded) from the NHSN reporting facilities. The 2010 estimate for the national CAUTI-specific SIR with Michigan hospitals excluded was 0.94 (95% CI, 0.92-0.96), whereas the SIR estimate specific to Michigan was 0.75 (95% CI, 0.63-0.87). These estimates suggest that CAUTI rates in Michigan hospitals decreased by approximately 25% from 2009 to 2010, while CAUTI rates in hospitals in the rest of the United States (aggregated) decreased by approximately 6% during the same period. Of the 24 Michigan hospitals that reported to NHSN and contributed to the SIR estimate specific to Michigan, 58% (14) were participating in the Keystone Bladder Bundle Initiative (estimate provided by the Centers for Disease Control and Prevention).

COMMENT

Several important findings emerged from our national study. First, many hospitals in the United States do not have established systems to routinely monitor the placement or the duration of urinary catheters in their hospitalized patients, despite the strong link between urinary catheters and subsequent infection. Second, certain practices are being used by a higher percentage of Michigan hospitals compared with those outside Michigan. However, with the exception of aseptic technique for urinary catheter insertion—which was almost universally reported as being used regularly—most infection control practices to prevent CAUTI are used infrequently in US hospitals. Third, despite relatively infrequent use of CAUTI prevention practices overall, we observed significantly lower CAUTI rates among Michigan hospitals compared with non-Michigan hospitals in 2010. A plausible explanation for more frequent use of certain prevention practices within Michigan hospitals is that many hospitals in Michigan participated in the Keystone Bladder Bundle Initiative, a statewide collaborative effort implemented in 2007 to reduce CAUTI by primarily focusing on reducing urinary catheter use.[15] The results of our multivariable analyses suggest that participation in the Keystone Bladder Bundle Initiative may have contributed to the increased odds of regular use of portable bladder ultrasound scanners, as well as urinary catheter reminders or stop orders and/or nurse-initiated catheter discontinuation. Furthermore, the de-

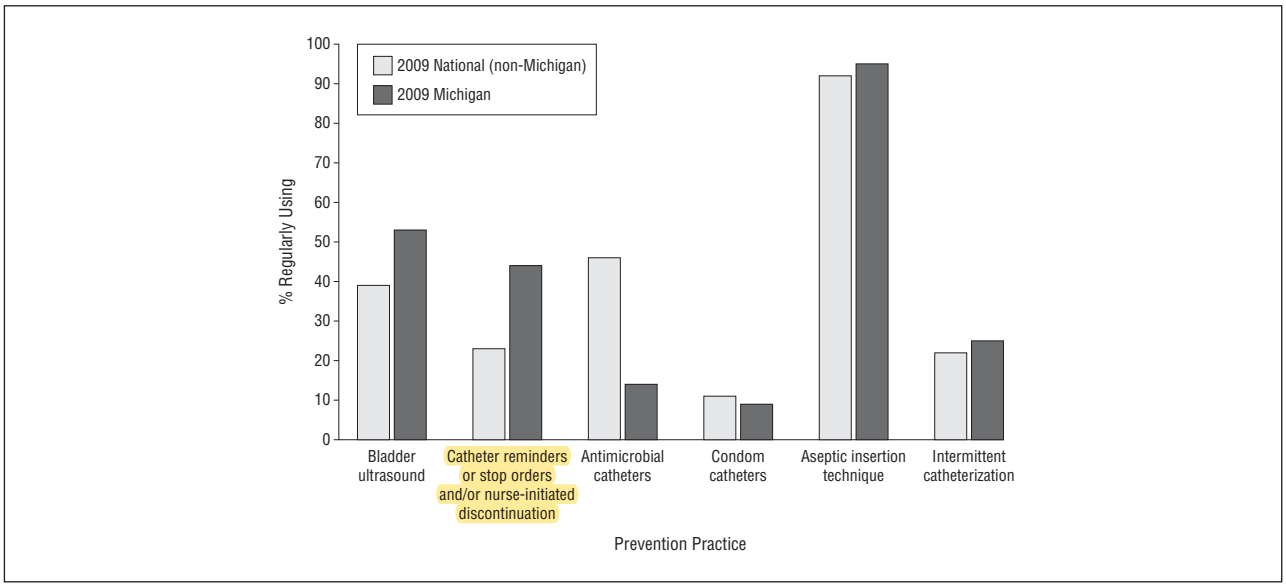

Figure. Catheter-associated urinary tract infection prevention practices, Michigan vs non-Michigan.

creased odds of antimicrobial urinary catheter use in Michigan hospitals are consistent with the fact that these particular devices were not included in the recommended bundle of prevention practices that was disseminated through the Keystone Bladder Bundle Initiative.

We have recently reported increases in several CAUTI prevention practices in non-federal and Veterans Affairs hospitals between 2005 and 2009, including a 9% to 20% increase in the use of urinary catheter reminders or stop orders in nonfederal hospitals.[12] However, it is notable that the regular use of this particular prevention practice seems much higher among Michigan hospitals. Urinary catheter reminders or stop orders are straightforward interventions to reduce the use of unnecessary urinary catheters and, therefore, may reduce the number of CAUTIs. A recent meta-analysis found that the use of catheter reminder or stop-order systems led to a 37% reduction in the mean duration of catheterization and a 52% reduction in CAUTI rates.[21] Early catheter removal would also help reduce the noninfectious complications of indwelling urinary catheter use, such as discomfort and immobility.[22]

Our study results strengthen other research investigating the effect of the Keystone Bladder Bundle Initiative on reducing urinary catheter prevalence and appropriate indications for catheter use. This research demonstrated that from baseline to the end of year 2 following the intervention, urinary catheter use decreased from 18.1% to 13.8% and the proportion of catheterized patients with appropriate indications increased from 44.3% to 57.6%.[16] The current study extends these previous findings by further elucidating how hospitals were able to achieve these results and by highlighting the potential effect on CAUTI rates.

Our study has several limitations. First, since the response rate was less than 100%, our results have some susceptibility to nonresponse bias. If nonresponding hospitals were systematically different from responding hospitals, generalizing results to all US hospitals may be impossible. Second, we relied on self-reported data from the lead infection preventionist at each hospital to determine how frequently the various prevention practices were used. Although an individual respondent may have overstated or understated how frequently the various practices were used, we have no reason to believe this would be a systematic issue. Third, we did not have access to (and thus could not adjust for) patient-level or hospital case–mix data, and our regression estimates could be biased due to unmeasured confounding. Fourth, we were unable to directly explore relationships between the use of the various infection prevention practices and CAUTI outcomes in the specific hospitals surveyed, because most of the participant hospitals were unable to provide CAUTI rate data. Furthermore, we could not directly link the greater CAUTI SIR reduction within Michigan to our findings suggesting greater adoption of certain CAUTI prevention practices in Michigan hospitals. Only slightly more than half of the hospitals in Michigan that reported CAUTI rate data to the NHSN (which were subsequently used to derive the Michigan-specific SIR estimates) were participating in the Keystone Bladder Bundle Initiative. Still, the magnitude of the improvement in CAUTI rates coupled with the overlapping recent success of reducing urinary catheter use within Michigan following the implementation of this statewide initiative[16] suggests that adopting and complying with evidence-based infection prevention practices may help reduce CAUTI. Other structural and safety culture factors apart from elements promoted in the Keystone Bladder Bundle Initiative, however, may also explain the lower CAUTI rates observed in Michigan hospitals. For instance, participation in other general collaborative efforts to reduce HAI may have spillover effects that independently impact CAUTI rates. Because causal interpretations of our results require strong assumptions, great care should be taken with any generalization or extrapolation.

Limitations notwithstanding, we provide an estimate of the practices US hospitals are using to prevent CAUTI. We

Table 2. Multivariable Adjusted ORs for Regular Use[a] of CAUTI Prevention Practices

Characteristic	OR (95% CI)					
	Portable Bladder Ultrasound Scanner	Urinary Catheter Reminders or Stop Orders and/or Nurse-Initiated Discontinuation	Antimicrobial Urinary Catheters	Condom Catheters in Men	Aseptic Insertion Technique	Intermittent Catheterization
Michigan	2.02 (1.18-3.43)	2.19 (1.24-3.86)	0.18 (0.09-0.36)	1.10 (0.45-2.66)	1.93 (0.56-6.60)	1.32 (0.71-2.45)
Has hospitalists	1.55 (0.96-2.50)	0.93 (0.54-1.59)	1.21 (0.75-1.96)	1.13 (0.51-2.51)	1.20 (0.47-3.06)	1.67 (0.94-2.99)
IP certified in infection control	1.29 (0.84-1.98)	1.08 (0.65-1.79)	1.14 (0.74-1.75)	1.58 (0.75-3.30)	1.42 (0.63-3.20)	0.97 (0.59-1.60)
Strong support from leadership for infection control	0.91 (0.55-1.50)	1.09 (0.59-2.03)	0.99 (0.59-1.65)	0.73 (0.33-1.64)	0.71 (0.28-1.83)	1.04 (0.57-1.89)
Monitoring urinary catheter placement	1.24 (0.80-1.93)	1.98 (1.14-3.44)	0.85 (0.55-1.33)	1.44 (0.71-2.95)	1.60 (0.70-3.70)	2.09 (1.22-3.57)
Monitoring urinary catheter duration	0.80 (0.51-1.25)	3.13 (1.88-5.22)	1.42 (0.91-2.21)	0.81 (0.40-1.63)	1.57 (0.62-4.00)	0.86 (0.51-1.44)
Safety culture score[b]	1.06 (0.76-1.48)	1.29 (0.86-1.95)	1.19 (0.85-1.68)	0.88 (0.51-1.54)	2.00 (1.06-3.78)	0.92 (0.62-1.35)
Effect of CMS rule change	1.25 (0.80-1.95)	1.14 (0.68-1.94)	1.19 (0.77-1.86)	1.98 (0.89-4.38)	0.58 (0.25-1.37)	0.92 (0.55-1.54)
Importance of UTI prevention	0.80 (0.51-1.28)	1.82 (1.04-3.18)	1.09 (0.69-1.74)	1.32 (0.62-2.80)	2.00 (0.83-4.81)	0.96 (0.56-1.64)
Alcohol-based hand rub	1.46 (0.64-3.37)	0.87 (0.31-2.42)	1.49 (0.61-3.67)	1.07 (0.29-3.96)	4.39 (1.52-12.68)	4.59 (1.04-20.21)
≥250 beds	0.76 (0.50-1.17)	0.70 (0.42-1.16)	1.22 (0.80-1.87)	1.91 (0.97-3.77)	0.71 (0.30-1.69)	0.92 (0.56-1.51)

Abbreviations: CAUTI, catheter-associated urinary tract infection; CMS, Centers for Medicare & Medicaid Services; IP, infection preventionist; OR, odds ratio; UTI, urinary tract infection.

[a] Regular use was defined as receiving a rating of 4 or 5 on a scale from 1 (never) to 5 (always) indicating the practice is used always or almost always.

[b] The safety culture score was defined as the mean number of responses regarding agreement to 2 statements about safety: "Leadership is driving us to be a safety-centered institution" and "I would feel safe being treated here as a patient." Each OR adjusted for all other variables listed in the characteristic column of the Table.

Table 3. 2010 National Healthcare Safety Network Standardized Infection Ratios for CAUTI—Michigan vs Non-Michigan[a]

Location	No. of Facilities	No. of Infections		SIR (95% CI)
		Observed	Expected[b]	
National	1062	9845	10 456	0.94 (0.92-0.96)
Michigan	24	150	201	0.75 (0.63-0.87)

Abbreviations: CAUTI, catheter-associated urinary tract infection; SIR, standardized infection ratio equals observed divided by expected.

[a] Data obtained through cooperation with the Centers for Disease Control and Prevention, National Healthcare Safety Network (NHSN), and the Michigan Department of Community Health. Data presented are derived from facilities reporting to the NHSN during 2010 and include data from all intensive care units and wards; excludes neonatal intensive care units.

[b] Expected values are based on indirect standardization to 2009 NHSN catheter-associated urinary tract infection rates.

also identified several hospital characteristics associated with the use of various CAUTI prevention practices and how these practices differed between Michigan and non-Michigan hospitals. Furthermore, we found that recent reductions in CAUTI rates among Michigan hospitals were greater than hospitals in the rest of the United States combined and are on target with the US Department of Health and Human Services' goal of reducing CAUTI by 25% by 2013.[23] We observed more frequent use of key preventive practices in Michigan hospitals relative to non-Michigan hospitals, particularly practices that were recommended in the Keystone Bladder Bundle Initiative. Thus, participating in collaborative efforts to reduce CAUTI may positively influence the adoption of infection prevention measures, which may subsequently reduce both urinary catheter use and CAUTI rates.

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INVITED COMMENTARY

Our Lights Are on for Safety

Imagine—just for a moment—that you are driving a bus full of passengers. In the distance, your destination twinkles brightly. You must choose between 2 routes: One takes you through a lawless land, without speed limits or tolls—it will be a quick trip, but one with substantial risk of wrecking the vehicle. The other route takes you on a neat, orderly journey though a community where traffic laws are rigorously enforced—what it lacks in excitement and speed, it makes up for in safety and predictability. When faced with this choice, sensible drivers should opt for the second route, recognizing the value of a modest investment of their time and effort.

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Health care providers are not notorious for recklessness on the road—most of us would choose the latter route. Why, then, do we fail to make the safest decisions with urinary catheters? These devices are used every day in acute care settings nationwide. When indicated, they may provide tremendous benefits, including information on visceral perfusion and renal function, as well as safe drainage of bladders that are dysfunctional or obstructed. They are convenient for nurses and are even requested by some patients themselves. Like driving the fast road, ordering the placement of a urinary catheter is often the path of least resistance.

And yet, we know that this is often a reckless choice. Catheter-associated urinary tract infection (CAUTI) is a leading hospital-acquired infection in the United States, with a substantial impact on patient safety and antibiotic consumption. To be clear: Even in the age of "getting to zero," and "never" events, CAUTI may not be entirely preventable. When urinary catheters are placed for the right indications, with optimum techniques for insertion and maintenance, and for the shortest duration