MAJOR ARTICLE

Preventing Hospital-Acquired Urinary Tract Infection in the United States: A National Study

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(See the editorial commentary by Nicolle on pages 251–3)

Background. Although urinary tract infection (UTI) is the most common hospital-acquired infection in the United States, to our knowledge, no national data exist describing what hospitals in the United States are doing to prevent this patient safety problem. We conducted a national study to examine the current practices used by hospitals to prevent hospital-acquired UTI.

Methods. We mailed written surveys to infection control coordinators at a national random sample of nonfederal US hospitals with an intensive care unit and ⩾50 hospital beds ($n = 600$) and to all Veterans Affairs (VA) hospitals ($n = 119$). The survey asked about practices to prevent hospital-acquired UTI and other device-associated infections.

Results. The response rate was 72%. Overall, 56% of hospitals did not have a system for monitoring which patients had urinary catheters placed, and 74% did not monitor catheter duration. Thirty percent of hospitals reported regularly using antimicrobial urinary catheters and portable bladder scanners; 14% used condom catheters, and 9% used catheter reminders. VA hospitals were more likely than non-VA hospitals to use portable bladder scanners (49% vs. 29%; $P < .001$), condom catheters (46% vs. 12%; $P < .001$), and suprapubic catheters (22% vs. 9%; $P < .001$); non-VA hospitals were more likely to use antimicrobial urinary catheters (30% vs. 14%; $P = .002$).

Conclusions. Despite the strong link between urinary catheters and subsequent UTI, we found no strategy that appeared to be widely used to prevent hospital-acquired UTI. The most commonly used practices—bladder ultrasound and antimicrobial catheters—were each used in fewer than one-third of hospitals, and urinary catheter reminders, which have proven benefits, were used in <10% of US hospitals.

Hospital-acquired infections are a common, costly, and potentially lethal patient safety problem [1, 2]. The most common hospital-acquired infection is urinary tract infection (UTI), which accounts for almost 40% of all nosocomial infections [3–5]. Most hospital-acquired UTIs are associated with urinary catheters, a commonly used device among hospitalized patients. Up to 25% of hospitalized patients have a urinary catheter placed during their stay [3, 6]; these catheters often cause considerable discomfort and embarrassment to patients [7–9]. The substantial morbidity associated with nosocomial UTI generates additional health care costs [9–11].

Several practices have been evaluated to prevent hospital-acquired UTI [12, 13]. Such practices include using indwelling catheters only when necessary, removing catheters when no longer needed via the use of various reminder systems, using antimicrobial catheters in patients at highest risk of infection, using external (or condom-style) catheters in appropriate men, using portable ultrasound bladder scans to detect postvoid residual urine amounts, maintaining proper insertion technique, and using alternatives to indwelling urethral catheters, such as suprapubic or intermittent catheterization [13]. Practices that are no longer recommended because of lack of evidence include use of antimicrobial

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agents in the drainage bag, rigorous frequent meatal cleaning, and use of bladder irrigation [13].

Despite the frequency with which hospital-acquired UTI occurs, little is known about what American hospitals are doing to prevent it. Therefore, we conducted a national study to answer this question and to explain variations in prevention practices among hospitals. Because we were especially curious how being part of a centralized system of health care delivery would affect our findings, we oversampled hospitals that were part of the Department of Veterans Affairs (VA).

METHODS

Data collection. As part of a larger study [14], we undertook a national evaluation to understand what US hospitals are doing to prevent device-associated infection and why they are using some practices rather than others. The first phase of this study—the focus of this article—was a survey sent to infection control coordinators at 719 hospitals across the nation. The national survey sample included all VA medical centers that had operating acute care beds in 2004 ($n = 119$) and a stratified random sample of non-VA general medical and surgical hospitals with ⩾50 beds and with intensive care beds. The national non-VA sample was stratified into 2 groups (hospitals with 50–250 beds and those with ⩾251 beds), and a random sample of 300 hospitals was selected from each group. The non-VA hospitals were identified using data obtained from the 2005 American Hospital Association (AHA) Annual Survey Database (fiscal year 2003 data).

Surveys were mailed to all hospitals in March 2005, along with a prepaid return envelope, a cover letter inviting participation, a study brochure, and an incentive. One week later, a reminder postcard was mailed to all sites from which we had not received a completed survey. Four weeks after the initial mailing, another survey, letter, and prepaid return envelope were sent to the nonresponders. All mailings were addressed to "Infection Control Coordinator," with the explanation that if there was >1 infection control professional (ICP) at that particular facility, the ICP who supervised or coordinated the other ICPs should complete the survey. If the facility did not have an ICP, we indicated that the survey should be completed by someone involved in infection control, such as a hospital epidemiologist. In addition to the survey, data were also obtained from the 2005 AHA Database and the 2003 Area Resource File [15]. Institutional review board approval was obtained from the VA Ann Arbor Healthcare System (Michigan).

Survey measures. In a series of questions, respondents were asked how frequently certain catheter-related UTI practices were used for adults in their acute care facility (figure 1). Frequency was measured on a scale from 1 to 5 (with 1 being "never" and 5 being "always"), with "regular use" defined in our analyses by a rating of 4 or 5. The practices of interest were use of antimicrobials in the drainage bag, use of portable bladder ultrasound for determining postvoid residual, use of a urinary catheter reminder or stop-order, use of an antimicrobial urinary catheter (either nitrofurazone-releasing or a silver alloy Foley catheter), use of condom catheters in men, and use of suprapubic catheters. Respondents were also asked about the monitoring practices related to UTI and urinary catheters used at their facility.

Additional characteristics of the facility included whether the facility had a hospital epidemiologist, whether the "lead" ICP was certified in infection control and epidemiology, whether the facility was participating in some type of collaborative effort to encourage use of infection control practices, whether the facility had hospitalists (if this question was not answered on our survey, then data were supplied from the AHA database), and a safety culture score. The safety culture score [16] was the average of the following 2 items, both scaled from 1 (strongly agree) to 5 (strongly disagree): (1) "Leadership is driving us to be a safety-centered institution," and (2) "I would feel safe being treated here as a patient." Before averaging the items, we reverse-scored them, so that higher scores indicated greater safety-centeredness. Finally, academic affiliation was also considered and defined as having residency training approval by the Accreditation Council for Graduate Medical Education, as specified in the AHA database.

Statistical analysis. We used sample weights based on the probabilities of selection in each stratum and the relevant "survey" commands found using Stata software, version 9.0 (StataCorp), to estimate the full population of VA hospitals and non-VA acute care hospitals with ⩾50 hospital beds and an intensive care unit (ICU). We then conducted bivariate analyses that compared VA and non-VA hospitals. Results are reported either as weighted proportions (with Pearson χ^2 test results) or as weighted means (with 95% CIs and adjusted Wald test results). Finally, we used weighted logistic regression to determine which of our primary independent variables were associated with the use of each infection prevention practice, while simultaneously adjusting for other factors, such as the facility's number of ICU beds, nurse staffing (nursing full-time equivalents per adjusted average daily census), and metropolitan location. Logistic regression results are presented as ORs with 95% CIs. All reported P values are 2-tailed.

RESULTS

The overall survey response rate was 72% (80% for the VA sample and 70% for the non-VA sample). Table 1 compares VA and non-VA hospitals with regard to a number of characteristics. Several statistically significant differences were noted, including the existence of approved residency training programs (at 75% of VA hospitals and 24% of non-VA hospitals), presence of a hospital epidemiologist (50% and 39%,

IF YOU HAPPEN TO HAVE BOTH ACUTE AND LONG-TERM CARE BEDS IN YOUR FACILITY PLEASE ANSWER THE REMAINING SURVEY QUESTIONS ONLY FOR ADULT ACUTE CARE:

CATHETER-RELATED URINARY TRACT INFECTION:

1. The following pertain to adults in your acute care facility who require **urinary collection and/or urinary output monitoring**.

	Using a scale from 1 to 5 (1 being never and 5 being always), please indicate **how frequently the practice is used** in your facility
A. Antimicrobials in the drainage bag	1 2 3 4 5 Never Always
B. Portable bladder ultrasound scanner for determining post-void residual	1 2 3 4 5 Never Always
C. Urinary catheter reminder or stop-order	1 2 3 4 5 Never Always
D. Nitrofurazone-releasing urinary catheters	1 2 3 4 5 Never Always
E. Silver alloy foley catheters	1 2 3 4 5 Never Always
F. Condom catheters in men	1 2 3 4 5 Never Always
G. Suprapubic catheters	1 2 3 4 5 Never Always

Figure 1. Survey questions used for assessing hospital-acquired urinary tract infection prevention practices

respectively), ICP certification in infection control (75% and 57%, respectively), registered nurse staffing levels (mean level, 1.7 and 1.2, respectively), and safety culture score (mean level, 7.5 and 8.0, respectively).

Table 2 compares VA and non-VA monitoring practices for urinary catheters and UTIs. The monitoring practices were generally similar across VA and non-VA hospitals. Specifically, more than one-half of hospitals did not have a system for monitoring which patients had catheters placed, three-quarters did not monitor duration of catheterization, nearly one-third did not conduct any type of UTI surveillance, and few hospitals used urinary catheter teams. However, VA hospitals that had implemented a monitoring practice were more likely than non-VA hospitals to have localized it to specific units, rather than implementing it facilitywide.

In terms of hospital-acquired UTI prevention practices used, 30% of hospitals overall reported regularly using antimicrobial urinary catheters and portable bladder scanners, 14% regularly used condom catheters in men, 9% regularly used catheter reminders and suprapubic catheters, and 3% regularly used antimicrobial agents in the drainage bag. Figure 2 compares VA and non-VA hospitals with regard to various hospital-acquired UTI prevention practices. VA hospitals were significantly more likely than non-VA hospitals to use portable bladder scanners (49% vs. 29%; $P < .001$), condom catheters in men (46% vs. 12%; $P < .001$), and suprapubic catheters (22% vs. 9%; $P < .001$). Non-VA hospitals were significantly more likely to use antimicrobial urinary catheters (30% vs. 14%; $P = .002$).

Table 3 shows the results of a multivariable logistic regression analysis assessing the association between our independent variables of interest and the use of hospital-acquired UTI preven-

Table 1. Characteristics of responding hospitals for Veterans Affairs (VA) hospitals versus non-VA hospitals.

Characteristic	VA hospitals[a] (n = 119)	Non-VA hospitals[a] (n = 2671)	P
Mean no. of intensive care unit beds (95% CI)	17.3 (15.1–19.5)	19.3 (18.1–20.5)	.128
Approved residency training	75	24	<.001
Have hospitalists	64	55	.138
Participate in a collaborative	31	42	.066
Mean safety culture score[b] (95% CI)	7.5 (7.2–7.8)	8.0 (7.8–8.1)	.001
Have hospital epidemiologist	50	39	.050
Infection control professional certified in infection control	75	57	.002
Mean no. of full-time RN equivalents per adjusted average daily census (95% CI)	1.7 (1.5–1.9)	1.2 (1.1–1.2)	<.001
Located in metropolitan area	89	72	.001
County population, mean no. of persons (95% CI)	922,000 (538,000–1,256,000)	682,000 (547,000–818,000)	.192

NOTE. Data are percentage of hospitals, unless otherwise indicated. RN, registered nurse.

[a] Weighted sample size reflecting the total population of hospitals represented by the respondent sample. For the non-VA hospital sample, the population represented is general medical and surgical hospitals with ⩾50 beds and with intensive care unit beds.

[b] Score ranging from 2 to 10.

tive practices (ORs of >1.0 indicate that the variable increases the odds of regular use of the practice or device). Residency training was significantly associated with the use of a urinary catheter reminder or stop-order. Hospitals in which the ICP was certified in infection control were significantly more likely to use antimicrobial urinary catheters. Compared with non-VA facilities, VA hospitals were >8 times more likely to use condom catheters for men ($P < .001$), >4 times more likely to use suprapubic catheters ($P < .001$), more than twice as likely to use portable bladder ultrasound scanners ($P = .017$), but only two-fifths as likely to use antimicrobial catheters ($P = .021$). Participating in a collaborative effort to reduce health care–associated infection was not associated with the use of any of the practices, nor was the presence of either hospitalists or a hospital epidemiologist.

DISCUSSION

Several noteworthy findings emerged from our national survey. First, only a minority of hospitals monitored which of their hospitalized patients had urinary catheters, despite the strong link between catheters and subsequent UTI. Second, we could find no single, widely used strategy to prevent hospital-acquired UTI; the most commonly used practices—bladder ultrasound and antimicrobial catheters—were each used in fewer than one-third of hospitals. Third, VA hospitals were more likely than non-VA hospitals to use portable bladder scanners, condom catheters, and suprapubic catheters but were less likely to use antimicrobial urinary catheters. Finally, despite evidence of benefit and high face validity, urinary catheter reminders were used in <10% of hospitals.

Although we are unaware of other national studies that have attempted to characterize what US hospitals are doing to prevent UTI—even though it is the most common hospital-acquired infection in the country—our findings are best understood in the context of the available literature evaluating several of the practices about which respondents were queried. The use of antimicrobial catheters, for example, is a rather controversial practice to prevent catheter-related UTI, given the conflicting data [17, 18]. An article in the *Cochrane Database of Systematic Reviews* [19] concluded that the use of antimicrobial catheters in place of noncoated catheters appears to reduce the risk of bacteriuria. Although another recent systematic review confirmed this assessment, the latter review highlighted the major limitation of most studies evaluating antimicrobial catheters: their reliance on asymptomatic bacteriuria rather than a clinically more relevant outcome, such as symptomatic UTI or catheter-related bacteremia [20]. In addition, the acquisition cost of an antimicrobial catheter tray is ~$5 more than that of a noncoated catheter tray [21], likely further dampening the enthusiasm for their use.

Portable bladder ultrasound scanners have been used to measure urinary retention and have been advocated, by some, to reduce the need for catheterization. A recent review [22] concluded that bladder scanners accurately measure urine volume (using urethral catheterization as the benchmark). Additionally, portable ultrasound scanners were found to reduce the number of intermittent catheterizations and to perhaps even decrease the risk of UTI [22]. One group found that the use of bladder scans decreased catheter-related UTIs from 87% to 38% in one unit and from 81% to 50% in another unit over a 12-month period [23]. The cost of purchasing the specific type of scanner used in this study was $8300 [23]. Although no experimental

Table 2. Urinary catheter–related infection monitoring practices at Veterans Affairs (VA) hospitals versus non-VA hospitals.

Practice	Percentage of hospitals					
	No		Yes, facilitywide		Yes, unit specific	
	VA hospitals	Non-VA hospitals	VA hospitals	Non-VA hospitals	VA hospitals	Non-VA hospitals
Has a system for monitoring which patients have urinary catheters placed	56.0	55.3	14.3	23.4	29.7	21.3
Routinely monitors duration and/or discontinuation of urinary catheters	74.7	73.5	8.8	13.6	16.5	12.9
Has an established surveillance system for monitoring urinary tract infection rates	29.7	27.9	26.4	47.2	44.0	24.9
Feedback on urinary tract infection rates to direct care providers	35.2	36.9	25.3	38.0	39.6	25.0
Has a urinary catheter team	96.7	99.3	2.2	0.5	1.1	0.2

NOTE. Each row is mutually exclusive for VA and non-VA hospitals (e.g., unit-specific percentage is not included within the facilitywide data).

studies with large, representative patient populations have been conducted to confirm these possible benefits [22, 24], ~30% of US hospitals appear to be using this technology.

Alternative devices (e.g., condom or suprapubic catheters) are an option for appropriate patients [25–27]. A recently reported randomized trial comparing condom catheters with indwelling urethral catheters in hospitalized men found that use of a condom catheter instead of an indwelling catheter lowered the incidence of bacteriuria; this protective effect was seen primarily in men who did not have dementia [28]. A secondary finding was that patients reported that an external urinary collection device was more comfortable than an indwelling catheter, supporting previous data [8]. A recent meta-analysis of 14 studies comparing suprapubic with urethral catheters found that patients given a suprapubic catheter had significantly lower rates of bacteriuria and less discomfort, compared with those given a urethral catheter [29].

Urinary catheter reminders have also been used to decrease urinary catheterization rates. Because >80% of patients who develop a UTI during hospitalization have a urinary catheter, and because the risk of infection increases as the duration of catheterization increases, perhaps the best infection prevention strategy against hospital-acquired UTI would be to limit urethral catheterization. When the unjustified use of many catheters is considered, coupled with frequent lack of physician awareness of catheter presence [6], techniques that alert physicians to the catheter status of their patients may help reduce inappropriate catheterization [9]. Several studies support the use of catheter reminders. A study performed at a VA medical center evaluated a computerized reminder with a before-and-after crossover design that prompted physicians either to remove or continue the urinary catheter 72 h after catheter insertion [30]. These investigators found that the computerized reminder shortened the duration of catheterization by 3 days while not affecting recatheterization [30]. A nurse-based reminder, in which nurses were instructed to remind physicians to remove unnecessary urinary catheters, was demonstrated in a Taiwanese ICU to reduce the duration of catheterization (7 vs. 4.6 days; $P < .001$) and UTI rates (11.5 vs. 8.3 cases per 1000 catheter-days; $P = .009$) [31]. Finally, a controlled trial using a pretest-posttest design in 4 hospital wards at an academic medical center showed that a paper-based reminder placed in the medical record after 48 h of catheterization significantly reduced the proportion of time that patients had catheters in place; there was no significant difference in the number of urethral recatheterizations between intervention and control groups, and the intervention was found to be economically efficient [32].

Responding hospitals that were members of a collaborative effort to reduce health care–associated infection were no more likely to use any of the infection prevention practices studied than were hospitals that were not part of a collaborative. This finding is in contrast to the findings of a previous report, which focused on vascular catheter-related bloodstream infection and found collaborative membership was associated with the use of several preventive practices [33]. However, this is probably not a true discrepancy. Collaborative approaches focusing on prevention of hospital-acquired UTI have not been vigorously pursued in the United States, but several collaborative initiatives have recently been launched to prevent infection associated with vascular catheters, including the Institute of Healthcare Improvement's 100,000 Lives campaign [34] and the Keystone Center for Patient Safety and Quality Institute's project in Michigan ICUs [35]. There is now, however, a statewide collaborative initiative under way in Michigan that will evaluate a "bladder bundle" to help reduce the burden of hospital-acquired UTI (http://www.mhakeystonecenter.org).

One reason for including VA hospitals in this national study was to assess the effects of centralization on the use of UTI prevention practices. Although we cannot precisely separate

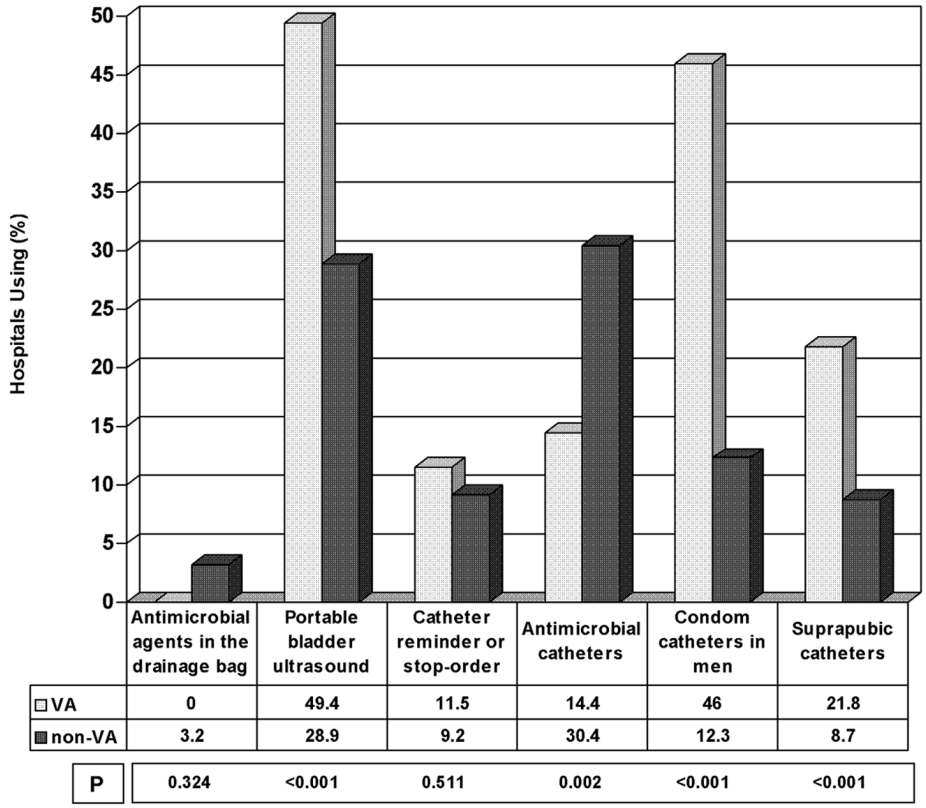

Figure 2. Urinary catheter–related infection prevention practices for Veterans Affairs (VA) hospitals versus non-VA hospitals

centralization from other attributes of the VA health care system, the system's hierarchical structure is perhaps its most salient and distinctive characteristic. With this caveat, centralization does seem to be relevant in terms of the use of infection prevention practices, but not in a straightforward manner. VA status is statistically significant for 4 of 5 practices described in table 3. The higher rate of use of condom catheters at VA hospitals may simply be related to the predominantly male patient population of the VA, leading VA hospitals to focus on practices that affect primarily men, such as use of condom catheters. Similarly, the use of portable bladder ultrasound scanners and suprapubic catheters might be used preferentially in VA hospitals because of the concern for bladder outlet obstruction owing to a patient's enlarged prostate gland. On the other hand, we cannot explain why VA hospitals use antimicrobial urinary catheters less often than non-VA

Table 3. Adjusted ORs for regular use of a practice to prevent hospital-associated urinary tract infection.

	OR (95% CI)				
Characteristic	Portable bladder ultrasound scanner	Urinary catheter reminder or stop-order	Antimicrobial urinary catheters	Condom catheters for men	Suprapubic catheters
Approved residency training	1.1 (0.60–1.96)	4.1 (1.48–11.11)	0.8 (0.41–1.56)	1.3 (0.63–2.82)	0.8 (0.34–1.69)
Have hospitalists	1.1 (0.64–1.93)	0.7 (0.28–1.69)	1.1 (0.65–2.03)	1.2 (0.60–2.56)	1.6 (0.69–3.47)
Participate in a collaborative	1.4 (0.84–2.35)	0.7 (0.33–1.51)	1.4 (0.85–2.36)	1.2 (0.62–2.30)	1.3 (0.64–2.57)
Safety culture score	1.1 (0.86–1.38)	1.3 (0.90–1.87)	1.1 (0.85–1.30)	1.3 (0.95–1.65)	1.1 (0.84–1.51)
Have hospital epidemiologist	0.7 (0.43–1.25)	0.9 (0.36–2.21)	0.7 (0.38–1.14)	1.3 (0.65–2.52)	1.0 (0.44–2.09)
ICP certified in infection control	1.5 (0.85–2.64)	0.6 (0.26–1.47)	1.9 (1.02–3.38)	0.6 (0.32–1.26)	0.6 (0.28–1.27)
VA hospital	2.3 (1.16–4.47)	0.9 (0.32–2.77)	0.4 (0.16–0.86)	8.1 (3.87–17.12)	4.3 (1.90–9.53)

NOTE. Regular use was defined as receiving a rating of 4 or 5 on a on a scale of 1–5 (with 1 being never and 5 being always) indicating the practice is used always or almost always. Results are also adjusted for other variables such as number of intensive care unit beds, resident nurse staffing (defined as the no. of full-time–equivalent resident nurses/adjusted average daily census), and metropolitan location. ICP, infection control professional; VA, Veterans Affairs.

hospitals. We were, surprised, however, that urinary catheter reminders were not used more frequently at VA facilities, because VA hospitals have a superb computerized order entry system that can be programmed to prompt physicians about catheter presence [30].

Although we used national sampling and achieved an excellent response rate, several important limitations of our survey-based study should be considered. First, we relied on self-reported data from the lead ICP at each site to determine which practices were being used to prevent nosocomial UTI. Although it is possible that an individual respondent may have overstated or understated the use of the various practices, we have no reason to believe this would be a systematic problem. Second, although our sampling strategy aimed to obtain a nationally representative sample, it is possible that participating hospitals were different from nonparticipating hospitals, thereby making the results less generalizable. Third, our multivariable model does identify some factors associated with the use of certain practices; however, we are unable to determine the causal relationship between these factors and the use of certain practices. A qualitative study in which interviews and site visits are conducted would be able to provide detailed data to gain insights into why hospitals are using some practices and not others. We are currently conducting such a qualitative evaluation.

Limitations notwithstanding, we have provided a snapshot of what practices US hospitals are currently using to prevent hospital-acquired UTI. Furthermore, we identified several characteristics that are associated with the use of various practices. The precise reasons underlying a hospital's decision to use one practice over another are best elucidated using qualitative rather than quantitative evaluation [14], at least at this stage of our understanding. Nevertheless, our study has important policy implications, especially in light of Medicare's recent decision to decline reimbursement for the extra cost of treating preventable complications during hospitalization, including catheter-related UTI [36]. Despite the strong link between urinary catheters and subsequent UTI, we found that no single strategy was widely used for the prevention of nosocomial UTI. The most commonly used practices—bladder ultrasound and antimicrobial catheters—were each used in fewer than one-third of hospitals. Finally, despite reasonable evidence supporting the use of urinary catheter reminders, fewer than 1 in 10 hospitals in this country used this simple and economically attractive method for preventing unnecessary catheterization.

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