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Anucha Apisarnthanarak
Thammasat University Hospital

Kanokporn Thongphubeth
Thammasat University Hospital

Sirinaj Sirinvaravong
Thammasat University Hospital

Danai Kitkangvan
Thammasat University Hospital

Chananart Yuekyen
Thammasat University Hospital

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Authors

Anucha Apisarnthanarak, Kanokporn Thongphubeth, Sirinaj Sirinvaravong, Danai Kitkangvan, Chananart Yuekyen, Boonyasit Warachan, David K. Warren, and Victoria J. Fraser

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Author(s): Anucha Apisarnthanarak , MD, Kanokporn Thongphubeth , RN, Sirinaj Sirinvaravong , MD, Danai Kitkangvan , MD, Chananart Yuekyen , RN, Boonyasit Warachan , PhD, David K. Warren , MD, Victoria J. Fraser , MD

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ORIGINAL ARTICLE

Effectiveness of Multifaceted Hospitalwide Quality Improvement Programs Featuring an Intervention to Remove Unnecessary Urinary Catheters at a Tertiary Care Center in Thailand

Anucha Apisarnthanarak, MD; Kanokporn Thongphubeth, RN; Sirinaj Sirinvaravong, MD; Danai Kitkangvan, MD; Chananart Yuekyen, RN; Boonyasit Warachan, PhD; David K. Warren, MD; Victoria J. Fraser, MD

OBJECTIVE. To evaluate the efficacy of a multifaceted hospitalwide quality improvement program that featured an intervention to remind physicians to remove unnecessary urinary catheters.

METHODS. A hospitalwide preintervention-postintervention study was conducted over 2 years (July 1, 2004, through June 30, 2006). The intervention consisted of nurse-generated daily reminders that were used by an intervention team to remind physicians to remove unnecessary urinary catheters, beginning 3 days after insertion. Clinical, microbiological, pharmaceutical, and cost data were collected.

RESULTS. A total of 2,412 patients were enrolled in the study. No differences were found in the demographic and/or clinical characteristics of patients between the preintervention and postintervention periods. After the intervention, reductions were found in the rate of inappropriate urinary catheterization (mean rate, preintervention vs postintervention, 20.4% vs 11% [$P = .04$]), the rate of catheter-associated urinary tract infection (CA-UTI) (mean rate, 21.5 vs 5.2 infections per 1,000 catheter-days [$P < .001$]), the duration of urinary catheterization (mean, 11 vs 3 days [$P < .001$]), and the total length of hospitalization (mean, 16 vs 5 days [$P < .001$]). A linear relationship was seen between the monthly average duration of catheterization and the rate of CA-UTI ($r = 0.89$; $P < .001$). The intervention had the greatest impact on the rate of CA-UTI in the intensive care units (mean rate, preintervention vs postintervention, 23.4 vs 3.5 infections per 1,000 catheter-days [$P = .01$]). The monthly hospital costs for antibiotics to treat CA-UTI were reduced by 63% (mean, $3,739 vs $1,378 [$P < .001$]), and the hospitalization cost for each patient during the intervention was reduced by 58% (mean, $366 vs $154 [$P < .001$]).

CONCLUSIONS. This study suggests that a multifaceted intervention to remind physicians to remove unnecessary urinary catheters can significantly reduced the duration of urinary catheterization and the CA-UTI rate in a hospital in a developing country.

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Catheter-associated urinary tract infection (CA-UTI) is the most common nosocomial infection, accounting for as much as 40% of all nosocomial infections and affecting an estimated 800,000 patients per year.[1] Up to 80% of nosocomial UTIs are associated with the use of urinary catheters. These infections can lead to increases in morbidity, length of hospital stay, and cost of care.[2-6] Urinary catheterization for more than 6 days is the most important modifiable risk factor for CA-UTI; however, once any bacteria are present in the urine of a patient with an indwelling catheter, growth to a concentration greater than 10^5 colony-forming units (cfu)/mL predictably occurs within 72 hours.[1,7]

Several strategies to reduce the risk of CA-UTI have been studied.[1] Among these strategies, the use of condom catheters and closed drainage systems have been of value.[8,9] Novel technologies, such as the use of silver-coated catheters, have shown promise in reducing the risk of CA-UTI,[10,11] but such technology is difficult to implement in countries with limited resources. Removal of urinary catheters in a timely manner is a key method for prevention of CA-UTI; however, physicians are often unaware that their patients have indwelling urinary catheters.[12] In our institution, the CA-UTI rate was 21.5 infections per 1,000 catheter-days from July 1, 2004, to June 30, 2005. The rate of inappropriate urinary catheterization (hereafter, inappropriate catheterization) was found to be as high as 20%.[13] The most common types of inappropriate catheterization involved patients for whom there was "unclear indication in [a] situation where the urinary catheter serves no useful purposes" and patients for whom "urinary catheters were no longer needed to monitor urine output."[13] Limited data are available regarding strategies to control or improve the rate of inappropriate catheterization or strategies to re-

From the Divisions of Infectious Diseases and Infection Control (A.A., K.T., C.Y.) and Internal Medicine (S.S., D.K.), Faculty of Medicine, Thammasart University Hospital, Pratumthani, and the Department of Applied Statistics, Faculty of Science, King Mongkut's Institute of Technology, Ladkrabang, Bangkok (B.W.), Thailand; and the Division of Infectious Diseases, Washington University School of Medicine, Saint Louis, Missouri (D.K.W., V.J.F.).

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duce the risk of CA-UTI in resource-limited countries. We describe a hospitalwide quality improvement program initiated in a tertiary care hospital in Thailand that featured an intervention consisting of nurse-generated daily reminders that encouraged physicians to remove unnecessary urinary catheters.

METHODS

Setting and Patients

Thammasart University Hospital (Pratumthani, Thailand) is a 450-bed, tertiary care university hospital in central Thailand. It serves a 150-mile–radius referral base and has 17 patient-care service units and departments. In this hospital, a physician's order was required before the insertion of a urinary catheter, and no silver-coated or nitrofurazone-coated catheters were used. The study population consisted of all consecutive patients admitted to the hospital from July 1, 2004, through June 30, 2006. Patients with a CA-UTI that occurred less than 48 hours after admission were excluded. The study consisted of a 12-month baseline observation phase (July 1, 2004, through June 30, 2005) followed by a 12-month intervention phase (July 1, 2005, through June 30, 2006). Twelve-month periods were selected to exclude the possibility of seasonal variation. Routine infection control practices did not differ between the 2 periods; these practices included use of aseptic technique during catheter insertion, use of closed urinary catheters, and education of nursing staff about urinary catheter care. The treating physicians were not aware of the purpose of this study during either study phase. During the entire study period, the only concurrent infection control initiative was a hospitalwide quality improvement program for preventing ventilator-associated pneumonia.

Indication for Catheterization

Appropriate indications for catheterization were derived from previously published studies[6,13-18] and were validated by specialists in urology, geriatrics, and infectious diseases. Initial indications for catheterization were classified as appropriate or inappropriate (Table 1). The indication for catheterization was considered appropriate when the catheter was placed to manage urinary retention due to obstructive uropathy or drugs, or simply to manage difficulty voiding in patients for whom bed rest had been ordered. Placement of catheters was also considered appropriate when close monitoring of urine output was indicated for incontinent patients, uncooperative patients, or critically ill patients. For the purposes of this study, critical illness was defined as the presence of hypoxemia, hypotension, or congestive heart failure, the need for inotropic support, or the repeated administration of diuretics, suggesting a need for close monitoring of urine output on an hourly basis. However, catheterization for close monitoring of urine output was considered inappropriate when a patient was no longer critically ill or when an hourly record of urine output did not prompt any change in therapy. Placement of a catheter for the management of urinary incontinence was carefully evaluated to determine whether it was appropriate. The use of a catheter in this circumstance was considered appropriate for terminally ill patients, patients with sacral or perineal decubitus ulcers, and patients at risk of contaminating the site of a recent surgical procedure. In all other instances, the placement of catheters primarily for the management of urinary incontinence was considered inappropriate. Indications for placement of urinary catheters were categorized as unclear when none of the appropriate indications were apparent for 2 consecutive days. All patients who were catheterized despite unclear indications for catheterization were considered inappropriately catheterized.

Definitions

Urinary tract infection was defined according to National Nosocomial Infection Surveillance System criteria.[19] Patients were not routinely monitored for asymptomatic bacteriuria. Urine and blood cultures were performed only when patients developed systemic or local signs of infection, including fever (temperature greater than 38°C), urinary frequency or urgency, dysuria, and suprapubic tenderness. Significant bacteriuria was defined as a urine bacteria level of 10^5 cfu/cm^3 or greater, with no more than 2 species of bacteria present. Pyuria was defined as a white blood cell count of 10 cells/mm^3 or greater, or 3 white blood cells per high-powered field of unspun urine or greater, and/or a positive result on a

TABLE 1. Appropriate and Inappropriate Indications for Urinary Catheterization

Appropriate indications
Urinary retention
Obstruction to the urinary tract distal to the bladder
Close monitoring of urine output in critically ill patients
Accurate measurement of urine output in an uncooperative patient (eg, because of intoxication)
Fluid challenge in patients with acute renal insufficiency
Preoperative insertion for patients going directly to the operation room
Comfort care in terminally ill patient
Urinary incontinence that poses a risk to the patient (eg, because of major skin breakdown or a nearby surgical site)
Inappropriate indications
No longer needed for monitoring of urine output
Unclear indication in patients for whom catheter serves no useful purposes
Urinary incontinence without significant skin breakdown
Neurogenic bladder for which intermittent self-catheterization is possible
Convenience of care
For administration of amphotericin B bladder irrigation
Staff are too busy to remove catheter
Staff forgot to remove catheter

NOTE. Criteria were based on previously published literature,[6,13-18] defined by the consensus opinion of the authors, and validated by specialists in urology, geriatrics, and infectious diseases.

leukocyte esterase test. A positive result on a nitrite test was considered to be suggestive of UTI. The device utilization ratio was calculated using the ratio of total catheter-days to total patient-days in a single unit, in accordance with Centers for Disease Control and Prevention (CDC) criteria.[19] CA-UTI was defined as UTI that occurred while a patient had an indwelling urinary catheter. The rate of CA-UTI was defined as the number of patients with CA-UTI per 1,000 catheter-days, and CA-UTI–related bloodstream infection was defined as a blood culture positive for the same pathogen as that isolated from the urine. An intervention team identified and confirmed the cases of CA-UTI using the same definition during both periods.

Program Design

The time line for the intervention was developed as follows. During period 1 (July 1, 2004, through April 30, 2005), an intervention team reviewed the literature, collected baseline data (ie, data on appropriateness of urinary catheter use, development of CA-UTI, duration of catheterization and hospital stay, cost of antibiotics for treatment of CA-UTI, and cost of hospitalization), and then analyzed the data. From May 1 through June 30, 2005, feedback on baseline data was given to nursing staff and physicians by the intervention team, and an action plan was developed. During period 2 (July 1, 2005, through June 30, 2006), daily bedside discussions were initiated among treating physicians and physicians from the intervention team. The intervention team included a representative of the hospital administration, an infectious diseases physician, a clinical microbiologist, 2 internists, 2 infection control specialists, chief nurses from all patient units, and a hospital epidemiologist. The intervention consisted of nurse-generated daily reminders that were used by the intervention team to remind physicians to remove unnecessary urinary catheters. The nursing staff identified patients who had had indwelling urinary catheters for 3 days or longer by reviewing orders keyed into a computer terminal linked to the hospital's central workstation and notified investigators. Two internists and 2 infection control specialists completed the data collection form, which included clinical information, the urine microbiology report, and cost data, and then monitored patients daily for indications for catheterization. All of the physicians and infection control specialists reviewed and completed the form for different departments using the preset definitions of appropriate and inappropriate indications (Table 1). If catheterization was determined to be inappropriate, a physician from the intervention team held a bedside discussion with the treating physician regarding the reasons for catheterization and the possibility of discontinuing catheterization. The treating physicians then made daily decisions about maintaining or removing the patient's catheter. No other interventions were used during the 2 periods. The nursing staff continuously monitored patients for any systemic or local signs of CA-UTI, every 3 hours in intensive care units (ICUs) and every shift in other units. An infectious diseases physician confirmed the appropriateness of the indications for catheterization and the presence of CA-UTI in each patient. The intervention was also promoted at monthly staff meetings. The intervention team also held meetings every month to discuss problems that occurred and to identify possible modifiable risk factors for each patient who developed CA-UTI in the previous month.

Data Collection

The data collected included patient demographic characteristics, underlying diseases, admission diagnosis, severity of illness (ie, Acute Physiology and Chronic Health Evaluation II score), signs and symptoms of CA-UTI, urine microbiology reports, use of antibiotics to treat CA-UTI, duration of catheterization, total length of hospital stay, rate of CA-UTI, cost of antibiotics to treat CA-UTI, and the cost of hospitalization. The use of antibiotics for the treatment of CA-UTI was determined by medical record reviews conducted by an infectious diseases physician after excluding other possible reasons for antibiotic therapy. Estimates of costs, rather than charges, were used. Costs for hospitalization were estimated using available programmatic, personnel, pharmacy, and laboratory data. Hospitalization costs were estimated on the basis of data from the Thai insurance system and the hospital reimbursement system. Laboratory diagnostic costs for each patient were obtained from line-item reports from the hospital's reimbursement system. The cost of antibiotics was calculated on the basis of the actual dose given to the patient and was based on the purchase price to the institution, without including administration costs. All costs in Thai baht currency were converted to US dollars (with an exchange rate of 40 baht to 1 $US).

Statistical Analysis

Categorical variables were presented as absolute values, and percentages were compared by use of the χ^2 test or the Fisher exact test, as appropriate. Continuous variables were expressed as mean $\pm$ SD. The Student t test was performed to compare continuous variables. Trend analysis was performed to evaluate the overall pattern of changes in outcomes of interest over time by use of interrupted time series with segmented regression analysis,[20] and correlations among variables were assessed by Pearson correlation analysis performed with SPSS statistical software, version 11.0 (SPSS). All tests were 2-tailed. A P value less than .05 was considered statistically significant.

RESULTS

Patient Characteristics

A total of 2,412 patients were enrolled during the study periods. The mean patient age was 50 years (range, 15-92 years), and 1,159 (48%) of the patients were female. The patients'

TABLE 2. Demographic and Clinical Characteristics of Catheterized Patients During the Preintervention and Postintervention Periods

Characteristic	Preintervention (n = 1,105)	Postintervention (n = 1,307)	P[a]
Age, mean ± SD, years	48 ± 8.7	52 ± 7.9	.24
Female sex	519 (47)	640 (49)	.35
Principal condition diagnosed[b]			
Cardiovascular disease	276 (25)	301 (23)	.26
Gastrointestinal disease	254 (23)	288 (22)	.57
Diabetes	221 (20)	274 (21)	.55
Cerebrovascular or other neurological disease	199 (18)	222 (17)	.50
Pulmonary disease	133 (12)	170 (13)	.47
Immunocompromised state	95 (8)	91 (7)	.15
Malignancy	52 (5)	39 (3)	.10
Other	166 (15)	196 (15)	.96
APACHE II score, mean ± SD	14 ± 7.7	15 ± 8.6	.85
Type of urinary catheter			
Foley catheter	906 (82)	1,098 (84)	.24
Condom catheter	111 (10)	105 (8)	.20
Suprapubic catheter	44 (4)	39 (3)	.21
Percutaneous nephrostomy tube	22 (2)	39 (3)	.15
Clean intermittent catheterization	22 (2)	26 (2)	.88
Positive urine culture result, by type of organism			
Gram-negative bacteria	663 (60)	758 (58)	.33
Gram-positive bacteria	111 (10)	105 (8)	.12
Yeast	331 (30)	444 (34)	.39

NOTE. Data are number (%) of patients, unless otherwise indicated. APACHE, Acute Physiology and Chronic Health Evaluation.

[a] Categorical variables were compared using the χ^2 or Fisher exact test, as appropriate. A 2-tailed Student t test was performed to compare continuous variables.

[b] As noted in the medical records at the time of discharge from the hospital.

demographic and clinical characteristics, as well as the principal conditions diagnosed, are summarized in Table 2. No significant differences were found among patients during the preintervention and postintervention periods with respect to age, sex, principal condition diagnosed, severity of illness, infection control practices applied, type of urinary catheter used, pathogens isolated from urine, or mortality rate.

Device Utilization and Duration of Catheterization

During the preintervention phase, a total of 906 (82%) of the patients had an order for urinary catheter placement in the medical record, and during the postintervention phase, 1,097 (84%) of the patients had such an order (P = .42). The medical service had the most catheter-days per total patient-days (catheter utilization ratio, 0.42), followed by the ICUs (catheter utilization ratio, 0.30) and the surgery units (catheter utilization ratio, 0.25). After the intervention, the duration of catheterization was significantly reduced (mean duration ± SD, preintervention vs postintervention, 11 ± 2.5 vs 3 ± 0.7 days [P < .001]) (Table 3). Segmented regression analysis showed significant immediate reductions in the duration of catheterization in each specific unit and overall. No significant change was found in the slopes for the duration of catheterization over time when the postintervention period was compared with the preintervention period (Table 4).

Appropriateness of Indications for Catheterization and Outcomes

After the intervention, a significant reduction was found in the rate of inappropriate catheterization (20.4% vs 11% [P = .04]). Linear regression analysis showed that this trend persisted during the study period (P = .04). Types of inappropriate catheterization that were common before the initiation of the intervention were observed less often after the intervention (Table 4). Two hundred eighty-one (12%) of the patients developed CA-UTI during the entire study period. Twenty-four (1%) of the patients developed CA-UTI–related bacteremia. Two hundred forty (10%) of the patients died; 72 (3%) died within 7 days after the diagnosis of CA-UTI. After the intervention, CA-UTI rates were significantly reduced (mean rate ± SD, 21.5 ± 5.5 vs 5.2 ± 2.1 infections per 1,000 catheter-days [P < .001]) (Table 3). Segmented regression analysis showed significant immediate reductions in

TABLE 3. Average Duration of Catheterization and Catheter-Associated Urinary Tract Infection (CA-UTI) Rate, by Patient Care Unit

	Duration of catheterization, mean ± SD, days			CA-UTI rate, mean ± SD, episodes per 1,000 catheter–days		
Units	Preintervention	Postintervention	*P*	Preintervention	Postintervention	*P*
Medical	9.6 ± 3.3	3.2 ± 1.0	<.001	21.5 ± 10.0	6.5 ± 4.3	.02
Surgical	7.3 ± 2.3	1.5 ± 0.5	<.001	19.4 ± 5.4	7.8 ± 6.1	.03
ICU	14 ± 3.8	5.6 ± 1.0	<.001	23.4 ± 13.7	3.5 ± 6.4	.01
All[a]	11 ± 2.5	3 ± 0.7	<.001	21.5 ± 5.5	5.2 ± 2.1	<.001

NOTE. ICU, intensive care unit.
[a] Included orthopedic, rhino-otolaryngology, general practices, and pediatrics.

the CA-UTI rate in each specific unit and overall, but, similar to the finding for duration of catheterization, no significant changes were found in the slopes for the CA-UTI rate over time when the postintervention and preintervention periods were compared (Table 4). A linear correlation was found between the monthly average duration of catheterization and the rate of CA-UTI ($r = 0.89$; $P < .001$). The intervention had the most impact on the rate of CA-UTI in ICUs (mean rate ± SD, 23.4 ± 13.7 vs 3.5 ± 6.4 infections per 1,000 catheter-days infections [$P = .01$]) (Table 3). The total length of hospital stay was also significantly reduced (mean duration ± SD, 16 ± 5.4 vs 5 ± 3.2 days; $P < .001$) (Table 5).

Cost of Hospitalization and Cost of Antibiotics for Treatment of CA-UTI

The intervention resulted in a significant reduction in the additional cost of antibiotics used to treat CA-UTIs and the cost of hospitalization. During the postintervention period, the monthly hospital cost of antibiotic therapy for CA-UTI was reduced by 63% (mean cost ± SD, $3,739 ± $1,422 vs $1,378 ± $651 [$P < .001$]), and the cost for hospitalization for each patient was reduced by 58% (mean cost ± SD, $366 ± $62 vs $154 ± $34 [$P < .001$]).

DISCUSSION

Promoting appropriate catheterization practices in hospitals is a challenging task. Apart from the implementation of new technology, several simple approaches to reduce CA-UTI include education, performance feedback to physicians and nurses about catheter care, written reminders about catheterization provided to physicians, the use of antibiotic guidelines tailored to specific units, the use of computer-based catheterization order entry, and reminders to physicians to remove unnecessary catheters.[21-26] Although several studies have focused on the reduction in the incidence of CA-UTI and infection control practices,[21-26] none have documented the effect of such interventions on the rate of inappropriate catheterization. Our study demonstrated that a relatively inexpensive intervention was highly effective in a 450-bed hospital in a developing country. Within 1 year, the intervention had an evident impact on urinary catheter prescription practices, the duration of catheterization, the rate of CA-UTI, and the cost for treatment of CA-UTI.

Huang and colleagues,[21] using an intervention to encourage physicians to remove unnecessary catheters after 6 days for ICU patients, reported an overall reduction in the CA-UTI rate and a reduction in the overall duration of catheterization.

TABLE 4. Change in Duration of Catheterization and Catheter-Associated Urinary Tract Infection (CA-UTI) Rate After Intervention, Based on Interrupted Time Series With Segmented Regression Analysis

	Change in level[a]				Change in slope[b]			
	Duration of catheterization, days		CA-UTI rate, episodes per 1,000 catheter-days		Duration of catheterization		CA-UTI rate	
Units	Mean (95% CI)	*P*	Mean (95% CI)	*P*	Mean (95% CI)	*P*	Mean (95% CI)	*P*
Medical	7.16 (3.68-10.65)	<.001	11.23 (0.44-22.02)	.04	0.22 (−0.17-0.62)	.24	0.67 (−0.52-1.86)	.24
Surgical	5.78 (3.30-8.26)	<.001	7.61 (2.67-17.89)	.03	0.08 (−0.30-0.32)	.95	0.97 (−0.17-1.77)	.06
ICU	8.89 (5.11-12.66)	<.001	11.33 (4.27-18.39)	.003	0.18 (−0.25-0.61)	.38	0.3 (−0.38-0.93)	.39
All[c]	5.89 (3.59-8.19)	<.001	13.71 (6.79-20.64)	<.001	0.15 (−0.12-0.42)	.24	0.27 (−0.58-1.12)	.50

NOTE. CI, confidence interval; ICU, intensive care unit.
[a] The calculation of the sudden change in level (immediate change) was based on the difference between the intercept of the last point in the preintervention regression line and the first point in the postintervention line.
[b] The calculation of the change in the slope was based on the magnitude of change from the preintervention slope to the postintervention slope.
[c] Includes orthopedic, rhino-otolaryngology, and general practices, and pediatrics.

TABLE 5. Comparison of Rates of Inappropriate Urinary Catheterization and Outcomes for Inappropriately Catheterized Patients During the Preintervention and Postintervention Periods

Variable	Preintervention (n = 1,105)	Postintervention (n = 1,307)	P[a]
No. of inappropriately catheterized patients	225 (20.4)	144 (11)	.04
Reason catheter was inappropriate[b]			
No longer needed to monitor urine output	54 (24)	27 (19)	.28
Unclear indication in patient for whom catheter served no useful purpose	50 (22)	29 (20)	.70
Patient had urinary incontinence without significant skin breakdown	38 (17)	24 (16)	.95
Patient had neurogenic bladder for which intermittent self-catheterization was possible	23 (10)	17 (12)	.75
For convenience of care	22 (10)	17 (12)	.74
For amphotericin B bladder irrigation	18 (8)	14 (10)	.56
In place because staff were too busy to remove it	11 (5)	9 (6)	.74
In place because staff forgot to remove it	9 (4)	7 (5)	.51
Outcomes			
No. of inappropriate catheter-days	5,105 (42)	823 (21)	<.001
No. of CA-UTIs per 1,000 catheter-days, mean ± SD	21.5 ± 5.5	5.2 ± 2.1	<.001
Patients with CA-UTI–related BSI	10 (1)	14 (1)	.83
Total length of hospitalization, mean ± SD, days	16 ± 5.4	5 ± 3.2	<.001
Monthly hospital cost of antibiotic therapy for CA-UTI, mean ± SD, US$	3,739 ± 1,422	1,378 ± 651	<.001
Cost of hospitalization per patient, mean ± SD, US$	366 ± 62	154 ± 34	<.001

NOTE. Data are number (%) of patients, unless otherwise indicated. BSI, bloodstream infection; CA-UTI, catheter-associated urinary tract infection.

[a] Categorical variables were compared using the χ^2 or Fisher exact test as appropriate; a 2-tailed Student t test was performed to compare continuous variables.

[b] One reason per episode of inappropriate catheter use.

However, the rate of CA-UTI did not decrease in every unit. Saint and colleagues[26] reported a 26%-41% relative decrease in duration of catheterization, using a simple reminder to aid physicians in remembering that the patient had a urinary catheter. In this study, we report a 73% reduction in duration of catheterization. Our divergent results, compared with those of previous studies,[21,26] may be attributed to the use of a 3-day period to remind physicians to remove inappropriate catheters, face-to-face discussions with physicians, and the concurrent hospitalwide quality improvement program for ventilator-associated pneumonia. Because inappropriate catheterization in our hospital was predominantly related to a lack of clear indications for urinary catheters and unjustified use of urinary catheters to monitor urine output,[13] the use of 3 days as a cutoff point helped to reduce unnecessary catheterization. Our findings from the segmented time series analysis are consistent with a rapid change in practice, rather than an incremental change, resulting in a gradual decrease in infection rates over time. In this study, only 1% of patients developed CA-UTI–related bacteremia, and CA-UTI was not associated with higher mortality rates. These findings are consistent with previous studies.[3,27-31]

In resource-limited settings, cost is an important issue to consider before the implementation of any intervention. Data derived from the University of Michigan Health System[3] suggest that the minimum cost of evaluating and treating a patient with CA-UTI–related bacteremia is $2,836 (including the costs of additional laboratory tests and treatment). In the United States, the cost of diagnosing and treating nosocomial CA-UTI in university medical centers has been reported to range from $401 to $676 per episode.[3,32-35] The average cost of antibiotic therapy per episode and the cost of hospitalization in our hospital were somewhat lower than the costs reported in studies from the United States and other Western countries. This study suggests that a relatively simple intervention can reduce costs substantially; our results showed a 58% reduction in the cost of antibiotic therapy for CA-UTI and a 63% reduction in the cost of hospitalization. Further, our study complements findings from other studies that have suggested that CA-UTI can increase the length of hospital stay by 1-10.3 days.[3,32,33,36]

There are some limitations to our study. This was not a randomized trial, which would have been difficult to perform in a single hospital. However, our study design allowed us to test the effect of the intervention on urinary catheter prescribing practices. We recognize that the CDC definition for UTI was not designed to determine rates of acquisition of significant bacteriuria, the "gold standard" for efficacy studies.[19] However, the CDC definition for CA-UTI is commonly used in hospitals and allows ready comparison among insti-

tutions. Since urine cultures were not performed routinely after catheterization, the incidence of asymptomatic bacteriuria cannot be assessed. Thus, our results are based on surveillance data from symptomatic patients rather than on prospective daily urine culture results. Quasi-experimental studies without a control group are subject to biases, especially with regard to secular trends unrelated to the interventions. Because there was an 18% increase in the total number of catheterized patients during the postintervention period, compared with the preintervention period, it is possible that some other background changes may not have been accounted for in this analysis. However, we collected the data for 12 months after the intervention, and the patients' characteristics and the rates of device use did not significantly differ. Therefore, it is unlikely that the changes observed during the study were solely related to secular trends. Because the infectious diseases physician and internists responsible for the implementation of this program were also reviewing data, obtaining data from nurses, and completing data forms, and because of the nature of an unblinded study, bias may have been introduced, but this bias would be conservative given that all investigators strictly followed explicit criteria using a checklist. Because data on the outcomes of other nosocomial infections and the costs associated with time spent by the intervention team were not collected, we were unable to measure other attributable cost savings that may have occurred.

Our study shows that an intervention involving nurse-generated daily reminders that are conveyed by an intervention team to remind physicians to remove unnecessary urinary catheters can be associated with a significant alteration in catheterization prescribing practices and a reduction in the rate of CA-UTI. This intervention was relatively easy to implement, inexpensive, and effective in a medium-sized hospital in a developing country, and it did not require the purchase of expensive equipment.

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Address reprint requests to Anucha Apisarnthanarak, MD, Division of Infectious Diseases, Faculty of Medicine, Thammasart University Hospital, Pratumthani, Thailand 12120 (anapisarn@yahoo.com).

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