Using Evidence-Based Practice to Reduce Catheter-Associated Urinary Tract Infections

Within six months, this project significantly improved outcomes in a long-term acute care hospital.

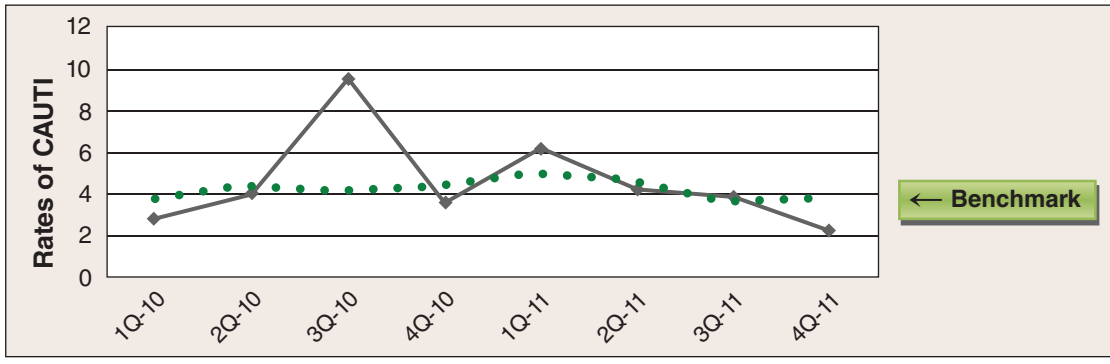
OVERVIEW: In November 2009, *AJN* launched a 12-part series, *Evidence-Based Practice, Step by Step*, authored by nursing leaders from the Arizona State University College of Nursing and Health Innovation's Center for the Advancement of Evidence-Based Practice. Through hypothetical scenarios, based on the authors' collective clinical experience, the series illustrated the seven steps of evidence-based practice (EBP), defined as "a problem-solving approach to the delivery of health care that integrates the best evidence from studies and patient care data with clinician expertise and patient preferences and values." This article reports on an EBP project in which the seven-step approach to EBP described in the *AJN* series was used to reduce the incidence of catheter-associated urinary tract infection among adult patients in a long-term acute care hospital by reducing the duration of catheterization.

Keywords: catheter-associated urinary tract infection, evidence-based practice, hospital-acquired infection, nurse protocol, quality improvement, urethral catheterization

Hospital-acquired infections are a continual challenge to quality care, and evidence is growing that many are avoidable through the use of best practices.[1] A seminal survey of U.S. hospital data collected between 1990 and 2002 suggested that catheter-associated urinary tract infection (CAUTI)—defined by the Centers for Disease Control and Prevention (CDC) as clinical symptoms and laboratory evidence of urinary tract infection in a patient who has had a urethral catheter in place for more than two days—represented 32% of all hospital-acquired infections, making it the most frequent such infection.[2,3] Roughly 449,000 CAUTIs occur in U.S. hospitals each year at a cost of up to $450 million.[2,4] In 2008, the Centers for Medicare and Medicaid Services (CMS) identified CAUTI as one of the hospital-acquired conditions that would not be reimbursed unless documented as present on admission. Subsequently, the Joint Commission's 2012 National Patient Safety Goals called for hospitals to use evidenced-based practice (EBP) to prevent CAUTIs.[5]

The 12-part series *AJN* launched in November 2009, *Evidence-Based Practice, Step by Step*, illustrated the seven steps (numbered zero to six) of EBP, defined by the series authors as "a problem-solving approach to the delivery of health care that integrates the best evidence from studies and patient care data with clinician expertise and patient preferences and values."[6] This article reports on a quality improvement

Figure 1. CAUTI Rates Before the Intervention[a]



CAUTI = catheter-associated urinary tract infection.
[a] Rates are reported in standard format, as number of CAUTIs per 1,000 catheter-days.
Note: The benchmark CAUTI rate per 1,000 catheter-days was set by Mellott's Specialty Performance Measurement System, the only long-term acute care database that meets Joint Commission requirements for Oryx data collection.

(QI) initiative in which a multidisciplinary team and I, a novice EBP mentor, applied the seven-step EBP approach described in the *AJN* series to reduce the incidence of CAUTI at the Mississippi Hospital for Restorative Care, a long-term acute care hospital within the Mississippi Baptist Health Systems, by reducing the duration of catheterization in adult patients.

STEP ZERO: CULTIVATE A SPIRIT OF INQUIRY

The authors of the *AJN* series note that a "spirit of inquiry" lays the groundwork for all EBP.[6,7] In other words, EBP can occur only in an environment that encourages clinicians to question and discover the evidence supporting clinical practice.

In February 2011, I met with the nursing director at my hospital to discuss opportunities for an EBP project. We decided to explore CAUTIs because she felt they provided an opportunity to improve outcomes through best practices.

Strategies to reduce the incidence of CAUTIs have been broadly studied, with clinical experts from the CMS, CDC, and Healthcare Infection Control Practices Advisory Committee (HICPAC) in general agreement that evidence strongly supports a number of core strategies for effectively managing short-term urethral catheters. Among these are to[8]

- practice good hand hygiene.
- take standard precautions (the use of gloves and gown, as appropriate, during any manipulation of the catheter or collecting system).
- ensure that properly trained persons insert and maintain catheters using aseptic technique.
- use high-quality sterile equipment.
- maintain a closed drainage system.
- ensure unobstructed flow at all times.
- ensure that the drainage bag is below the level of the bladder.

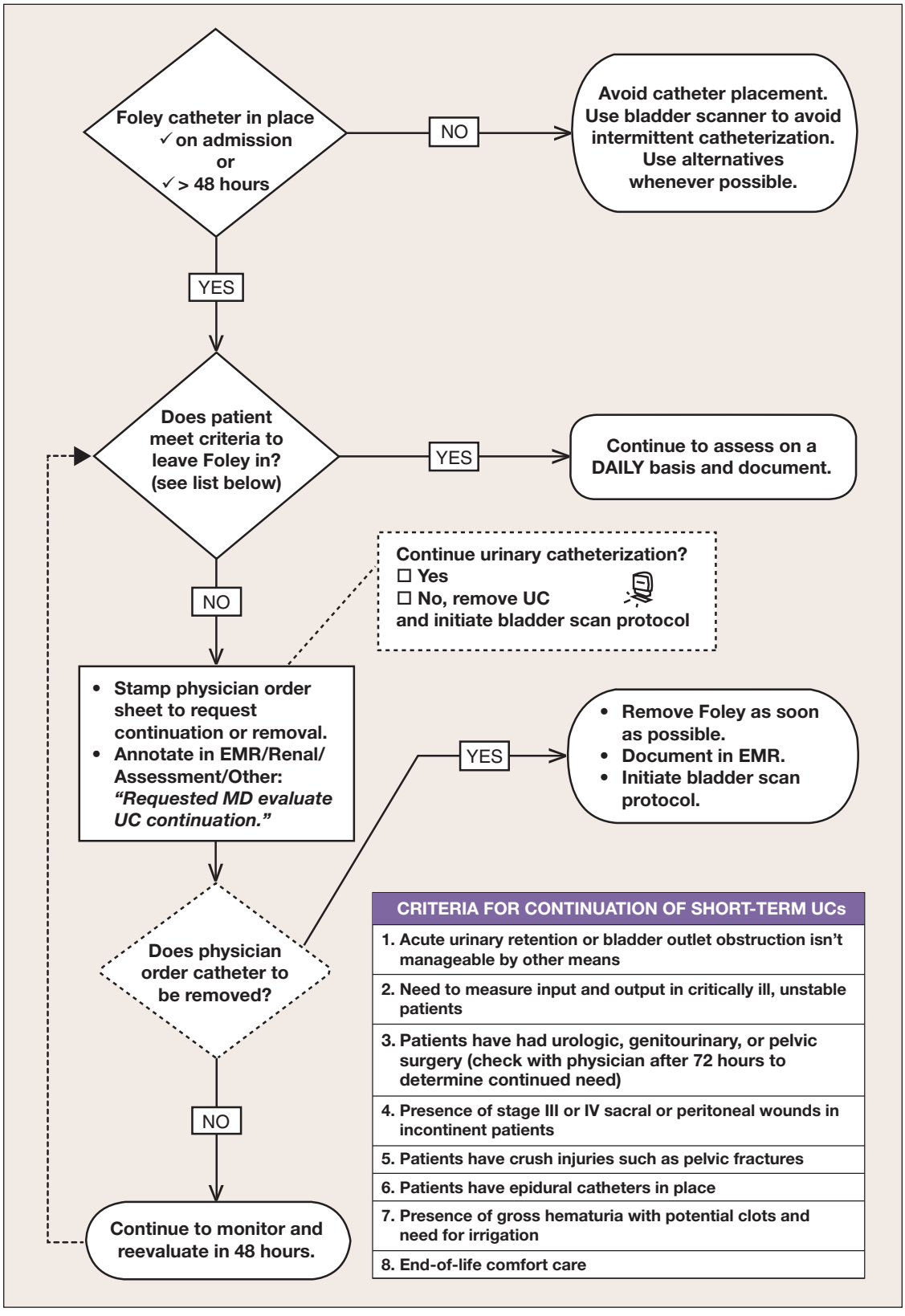
When core management strategies fail to reduce CAUTIs, supplemental tactics are recommended. These include avoiding the use of urethral catheters when possible, and removing them promptly when they are no longer necessary.[8] A reduction in catheter-days is strongly correlated with a reduction in CAUTIs.[8-20] Best practices include the use of reminder systems to encourage timely catheter removal.[21-23] Excellent outcomes have been achieved when a nurse-driven protocol is used to evaluate the necessity of continued urethral catheter use.[9-20, 24-26]

STEP 1: ASK CLINICAL QUESTIONS IN PICOT FORMAT

In March 2011, through informal conversations with the nursing director, hospital educator, nurse manager, infection preventionists, and accreditation officer for the Joint Commission, I was able to determine that the core strategies for CAUTI prevention were practiced consistently at the hospital. Nevertheless, during two quarters of the previous year, CAUTI rates had spiked above the benchmark set by Mellott's Specialty Performance Measurement System, the only long-term acute care database that meets Joint Commission requirements for Oryx data collection (see Figure 1). Using the PICOT format (patient population [P], intervention of interest [I], comparison intervention of interest [C], outcomes of interest [O], and time it takes for intervention to achieve outcomes [T]),[27] I developed this clinical question:

> In adult patients hospitalized in a long-term acute care facility (P), how does the use of a nurse-driven protocol for evaluating the

Figure 2. Catheter Continuation Algorithm



EMR = electronic medical record; UC = urethral catheter.

appropriateness of short-term urethral catheter continuation or removal (I), compared with no protocol (C), affect the number of catheter-days (O1) and CAUTI rates (O2) over a six-month postintervention period (T)?

STEP 2: SEARCH FOR THE BEST EVIDENCE

Guided by the PICOT question, from February through April 2011, I collected and synthesized the evidence. First, I performed a systematic literature search using the Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Cochrane Database of Systematic Reviews (CDSR), the Cochrane Central Register of Controlled Trials, the Database of Abstracts of Reviews of Effects (DARE), Ovid Clinical Queries, and PubMed. Keyword and controlled vocabulary searches included the following terms: *catheter-related*; *urinary catheterization*; *urinary tract infection, prevention, and control*; and *catheter-associated*, limited to *urinary*. Including hand searches of reference lists from articles on infection control found in research-based journals, my search yielded six systematic reviews and 37 studies that I collected for rapid critical appraisal as well as 69 background articles.

STEP 3: CRITICALLY APPRAISE THE EVIDENCE

The purpose of the rapid critical appraisal is to determine whether the literature identified in the search is "relevant, valid, reliable, and applicable to the clinical question."[7] In appraising the studies and reviews, I considered their level of evidence, whether they were well conducted, and the degree to which each answered my clinical question.[28,29] Although I found no studies involving patients in long-term acute care hospitals, I considered the studies of patients in acute and critical care facilities relevant to the clinical question because patients in such facilities require hospital-level care, albeit for shorter periods.

Through rapid critical appraisal, I identified 14 studies and one systematic review for synthesis. In order to organize these, I created an evaluation table and developed synthesis tables that clarified similarities and differences among the findings.[29,30] Levels of evidence ranged from level I, which represents the highest quality, epitomized by systematic reviews or meta-analyses, to level VI, characterized by qualitative or descriptive studies.[29] The body of evidence indicated that a variety of independent variables encouraged early removal of urethral catheters and significantly reduced both CAUTI rates and catheter-days with minimal risk.[9-13,15-20,24]

STEP 4: INTEGRATE THE EVIDENCE

To bring about a change in practice, research evidence must be combined with clinical expertise, patient assessments, outcomes data, patient preferences, and patient values.[7] Such integration involves team building, institutional approval, project planning, and implementation.

Team building. As the EBP mentor, in June 2011, I invited a multidisciplinary team of stakeholders to participate in the initiative to reduce CAUTI rates among our adult patient population. The team consisted of the nurse manager; four staff nurses; the hospital's physician medical director; and representatives from infection prevention, QI, service excellence, accreditation, and information systems. Inviting input from a wide range of stakeholders and gaining their trust lends valuable support to an EBP project and promotes a culture that is supportive of future projects.[31]

The goals and purpose of the project determined the role of the multidisciplinary team. Upon review of external and internal evidence, all agreed that the goal was to improve the quality of care, using best practices, and the purpose was to design, implement, and evaluate an evidence-based approach to reduce catheter-days and CAUTIs, using a nurse-driven protocol.

The criteria for continuation of short-term urethral catheters varied slightly among the evaluated studies that used a nurse-driven protocol, although most protocols were supported by the Agency for Healthcare Research and Quality, the Association for Professionals in Infection Control and Epidemiology, the Institute for Healthcare Improvement, the Joint Commission, the Society for Healthcare Epidemiology of America, the CDC, and HICPAC (see *Resources for CAUTI Prevention*).

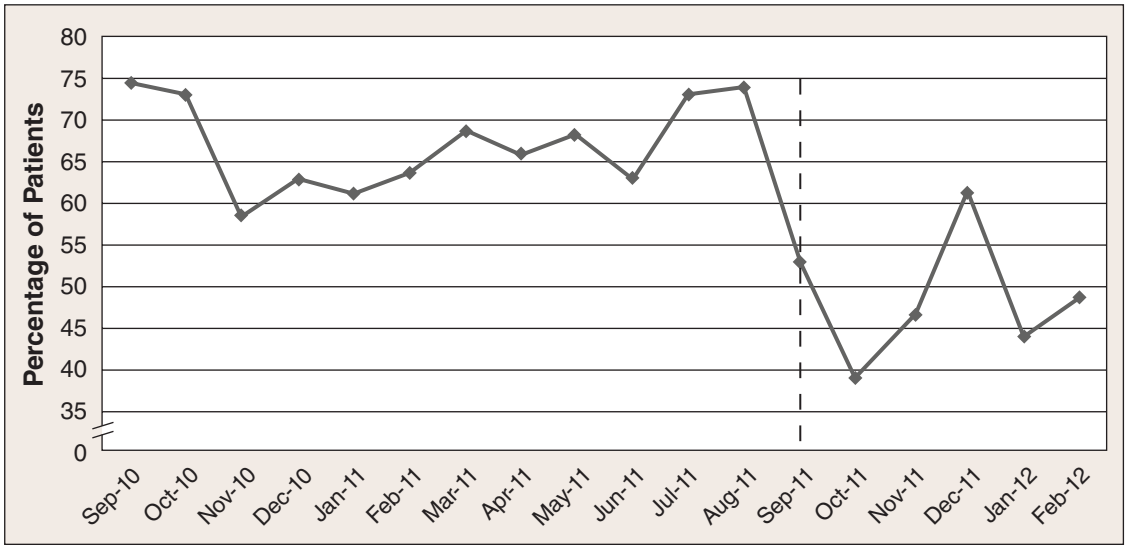
Based on my literature review, the team created an evidence-based protocol that identified eight criteria for the appropriate continuation of short-term urethral catheters. Realizing that the key to reducing CAUTI risk was to compare their daily patient assessments with these eight criteria, the nurses decided that the best way to promote consistent use of the protocol was to express it as an algorithm (see Figure 2).

We streamlined the process to clarify staff roles and responsibilities. Nurses on the night shift were to use the algorithm to evaluate all patients with a short-term urethral catheter by the end of the shift, before early primary care providers made rounds. When urethral catheterization was deemed no longer necessary per the algorithm, the order sheet was stamped with a query for the physician or NP, asking whether it should continue.

Consistent with the CDC supplemental strategy to use bladder scanners to evaluate urinary retention and thereby reduce CAUTI incidence,[8] the hospital had a bladder scanner and a standard order set for its use. When a primary care provider indicated on the order sheet that catheterization should not continue, the day shift nurse removed the urethral catheter and initiated the bladder scan protocol.

Institutional approval. The change in practice required the project team to obtain appropriate approvals

Figure 3. Percentage of Patients Using Urethral Catheters 12 Months Before and Six Months After the Intervention[a]



[a] Device-utilization rate is expressed as a percentage.
Note: The intervention started September 1, 2011.

through the hospital chain of command and to ensure the protection of patient information. In July 2011, I presented a summary of the internal and external evidence, along with the project team's draft of the nurse-driven protocol, to the hospital's medical executive committee, which unanimously approved the protocol and the project. I sought and received institutional review board approval from both the hospital and the university in which I was enrolled as a graduate student. Both boards concluded that the project posed minimal risk to human subjects.

Project planning: finding data sources. Another key aspect of integration is project planning, which involves determining the data we need and the best way to obtain it. The two major outcomes we planned to measure were catheter-days and CAUTI rates. Catheter-days are generally defined as the number of patients using a short-term urethral catheter daily over the course of a month or expressed as a device-utilization ratio (that is, a ratio of total catheter-days to total patient-days). CAUTI rates are calculated by counting the number of CAUTIs (as defined by the CDC) over a specified period (usually a month), dividing that number by the number of catheter-days over that same period, and multiplying the quotient by 1,000 catheter-days. This method allows comparisons with universal benchmarks. The hospital's nursing staff regularly collected catheter-day and patient-day data and recorded them in a spreadsheet program that was accessible to the project team on a shared intranet drive. The hospital's infection preventionists kept track of CAUTI rates and agreed to share the data with the project team after removing patient names.

Implementation necessitated the education of hospital staff including those managing patient care. To bring about sustainable change, it's important to make ideas "sticky," that is, easy to remember.[32] To that end, we designed a logo for all educational materials that incorporated a play on words: "Take Every PreCAUTIon—Remove That Foley." For the primary care providers, we created a brochure outlining the protocol and supportive evidence, with the implementation date, September 1, 2011, clearly identified on the front. We placed the brochures in the hospital's dictation rooms and at the front desk near the computer used by primary care staff.

Four staff nurses and I met several times to develop and plan the education program. We were committed to including all care providers and levels of staff in the process—the primary care providers, all nurses, certified nursing assistants, hospital ambassadors, and secretaries—as each would play an important role in implementing the protocol. For example, the secretaries could answer general questions from those writing orders, explain the stamp used to ask whether catheterization should continue, and provide a copy of the information brochure. The certified nursing assistants could help patients avoid urethral catheterization by making frequent rounds to assist with toileting and promoting the use of such alternatives as condom catheters for male patients. The nurses felt it was important for the education program to address the fact that catheters should not be left in place for simple incontinence or staff convenience.

The staff nurses chose to provide training through small group in-service sessions, which they felt would

allow time for discussion and questions. As their mentor, I encouraged them to search nursing literature and the Internet for examples of educational materials on preventing CAUTIs. Sample teaching tools were divided among the team members, so each could review and share with the group the tools they liked best and their reasons.

We created a slide show for the initial staff training sessions, planned for the hospital's 31 nurses and 18 support staff. From hard-copy prints of the slides, which incorporated colorful clip art and illustrations, we created flip books. Because we used a computer slide-show program, we could easily upload our presentation to computer-based learning platforms throughout the hospital system for widespread dissemination.

We scheduled in-service training for all shifts on the seven days preceding the protocol launch date of September 1, 2011. Our in-service training sign-in sheets showed that we achieved our goal of 100% staff attendance. Initially, we evaluated staff education through a combination of in-service attendance, discussion, and performance on a quiz administered at the end of each session. Further evaluation of the program's effectiveness included observation of staff behavior (consistent use of the protocol) and patient outcomes (decreased catheter-days and CAUTI rates).

On day 1, I went to the hospital to see if there were any questions and to encourage the staff. Everyone seemed excited and anxious to improve patient outcomes. The hospital educator taught the staff to use a large whiteboard in the private conference room to list all patients using a urethral catheter. This staff-led process adaptation provided a great way to improve communication between shifts and to increase awareness of the patients using urethral catheters. I encouraged the staff to continue to introduce innovative changes that enhanced work flow.

It's been shown that simply reporting catheter-days and CAUTI rates can reduce both.[24] For this reason, I promised to provide staff with timely updates in the form of monthly posters displaying trends for each.

STEP 5: EVALUATE THE OUTCOMES

Over the first two months that we monitored the trend in catheter-days, we saw a marked decline in the percentage of patients using urethral catheters (see Figure 3). In November and December 2011, however, we noticed a spike, although the percentage of patients using urethral catheters remained below preintervention levels. The hospital council and I met in January 2012 to discuss the data and the variables that may have caused the increase. The staff nurses agreed that several factors, including staff changes and failure of new staff to receive thorough protocol instruction, likely contributed. They also said they had observed some resistance to the protocol on occasion, when nurses felt that the convenience of a urethral catheter outweighed the importance of its removal. This suggested a need for more education, including a review of the protocol and its impact on the quality of care. The hospital educator, who was on the project team, reviewed the education materials in a meeting with staff. Following the meeting, there was a noticeable drop in catheter-days.

Data collection and analysis involved comparing catheter-days and CAUTI rates for the 12-month preintervention period with those for the six-month postintervention period. The hospital had 25 beds, with an average daily preintervention census of 19.64 and an average daily postintervention census of 19.9.

We first analyzed catheter-days, knowing that a reduction in their number corresponded with a reduced CAUTI risk. We conducted independent *t* tests using SPSS statistical software, version 18, to compare differences between the two groups. Catheter-days numbered 4,789 during the preintervention period and 1,765 during the postintervention period. The mean number of catheter days dropped from 13.12 before the intervention to 9.69 after the intervention, for a statistically significant reduction of 26% and a mean difference (MD) of 3.43 ($P \leq 0.001$, 95% confidence interval [CI], 2.99-3.87).

To provide evidence that the reduction in catheter-days was because of the intervention and not a falling census, we calculated a device-utilization ratio for the hospital. We conducted a second *t* test using the ratio of catheter-days to census with similar results (the mean pre- and postintervention device utilization was 67% and 49%, respectively, for an MD of 18% ($P \leq 0.001$; 95% CI, 16.1-20.1) (see Table 1).

I discussed the outcomes and data analyses with staff. I told them that their results were outstanding;

Resources for CAUTI Prevention

Agency for Healthcare Research and Quality
http://1.usa.gov/pypoll

Association for Professionals in Infection Control and Epidemiology
http://bit.ly/Yv8gHS

Centers for Disease Control and Prevention, Healthcare Infection Control Practices Advisory Committee
http://1.usa.gov/13i71zs
http://1.usa.gov/ZvdLW1

Institute for Healthcare Improvement
http://bit.ly/Xo4PTM

Joint Commission
http://bit.ly/q2YLuX

Society for Healthcare Epidemiology of America
http://bit.ly/14psW3J

CAUTI = catheter-associated urinary tract infection.

that because the reduction in the number of catheter-days was highly significant, the odds of it being caused by chance were less than one in 1,000. The results were most likely because of the CAUTI protocol intervention. I explained that the small 95% CIs revealed that we could be more than 95% confident that if our intervention was replicated, the same results would be obtained. I was proud to hear the nurses say, "We did that—we made a difference!"

CAUTI rates also declined by 33%, from a preintervention mean of 4.03 to a postintervention mean of 2.7, for an MD of 1.33 (P = 0.486; 95% CI, -1.74 to 4.44). We performed a t test on the simple frequency of CAUTIs before and after the intervention and observed a 50% reduction, with 20 CAUTIs occurring over the 12 months before the intervention and five occurring over the six months following its introduction—a preintervention mean of 1.67 versus a postintervention mean of 0.83, for an MD of 0.833 (P = 0.269; 95% CI, 0.451-2.118) (see Figure 4). Although the CAUTI findings are not statistically significant, a reduction in one CAUTI is clinically meaningful, and we look forward to seeing this trend of a decrease in CAUTIs continue.

In February 2012, the sixth month of postintervention data collection, the CAUTI rate spiked to 6.8, much higher than the benchmark (see Figure 5). Two CAUTIs occurred that month, but since the number of catheter-days trended downward as the percentage of patients using urethral catheters dropped, the denominator used in the CAUTI equation was smaller, thereby raising the calculated rate.

Lessons learned on implementation. As a novice EBP mentor, one lesson I learned was the difficulty of managing data from multiple sources. Our hospital, like many across the country, is struggling to collect device-utilization data—not only for urethral catheters, but also for central lines and ventilators. We've been collecting such data in our long-term acute care hospital and all critical care units, but the CMS may soon require that utilization data, including CAUTI rates, be collected for all hospitalized patients and reported publicly. We have long collected data on CAUTI frequency (that is, the number of CAUTIs), but to calculate the CAUTI rate, it's necessary to determine the number of device-utilization days as well. Manual counting is labor intensive and may be inaccurate if not validated. It requires data input from a number of counters, and training for consistent data collection is challenging. For example, counters may incorrectly include suprapubic catheters or nephrostomy tubes in the count.

Another lesson this project imparted is the importance of mentor presence until there is sufficient evidence of enculturation. In the final month of data collection, I had been spending less time giving staff feedback, having assumed, based on several months of experience, that the change in practice had been fully assimilated. Then we observed an increase in CAUTI rates. I reminded staff frequently that they, not I, were responsible for the positive outcomes. Sustainability, however, is challenging. As I continue to develop my EBP mentoring skills, I will try to remain more keenly aware of the maturation of the process and the stage at which assimilation occurs.

Table 1. Catheter-Days and CAUTI Rates Before and After the Intervention

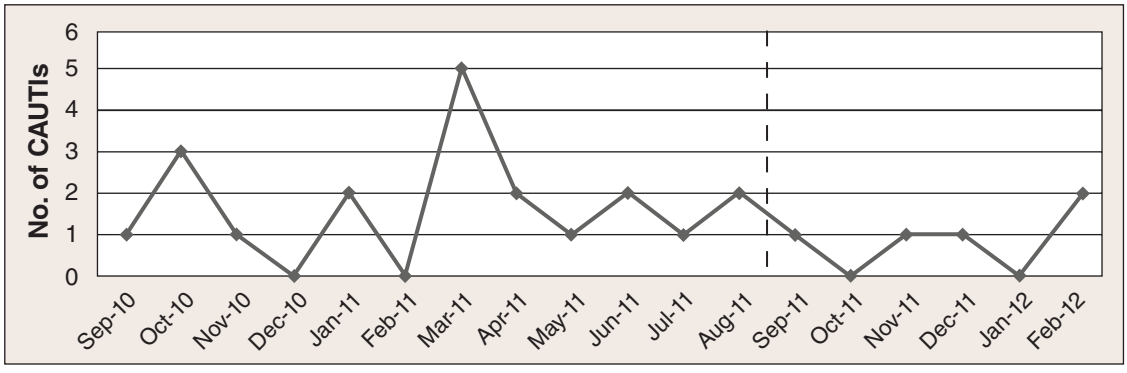
Variable	Before	Six Months After
Census (25-bed capacity)		
Mean	19.64	19.9
SD	3.487	3.483
No. of CDs total	4,789	1,765
No. of CDs per day		
Mean	13.12	9.69
MD		3.43
SD	2.52	2.4
P value		≤ 0.001
95% CI		2.99-3.87
DU of CDs per patient, %		
Mean	67.1	49.1
MD		18.1
SD	8.27	12.5
P value		≤ 0.001
95% CI		16.1-20.1
No. of CAUTIs per 1,000 device days		
Mean	4.03	2.7
MD		1.33
SD	3	2.5
P value		= 0.486
95% CI		-1.74 to 4.44

CAUTI = catheter-associated urinary tract infection; CD = catheter-day; CI = confidence interval; DU = device utilization; MD = mean difference; SD = standard deviation.

STEP 6: DISSEMINATE EBP RESULTS

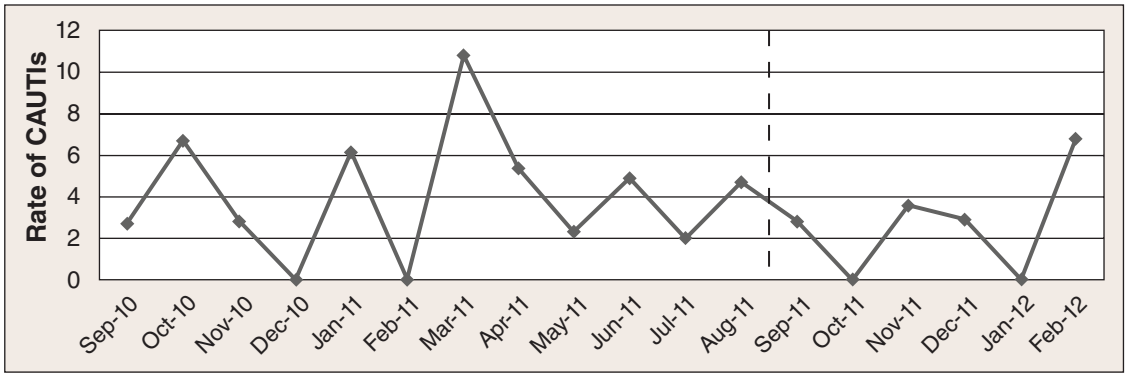
A commitment to sharing successful EBP initiatives is a key component of nursing practice.[7] Recognizing this, in late October 2011, our hospital educator shared the preliminary positive results of the CAUTI QI initiative as a poster presentation at our health system's biannual communications fair. In January 2012, after system-wide processes for counting and recording catheter-days had been implemented throughout the health system's acute care units, I submitted an abstract on the project to a statewide nursing summit, and it won second place. As project director, I was invited to the Omicron Lambda, a local chapter of Sigma Theta Tau International, to present the project that February.

Figure 4. CAUTI Frequency 12 Months Before and Six Months After the Intervention



CAUTI = catheter-associated urinary tract infection.
Note: The intervention started September 1, 2011.

Figure 5. CAUTI Rates per 1,000 Catheter-Days, 12 Months Before and Six Months After the Intervention[a]



CAUTI = catheter-associated urinary tract infection.
[a] CAUTI rates are calculated as number of CAUTIs per month divided by number of catheter-days per month multiplied by 1,000 catheter-days.
Note: The intervention started September 1, 2011.

The health system's infection control and clinical improvement committees monitored our progress along the way, and our project team continues to monitor the data for trends, sending frequent progress reports to both the nursing quality and research council and the nursing leadership council. In April 2012, we reported the data presented in this article to the long-term acute care hospital's medical executive committee and sent a written report to the institutional review board. This project will now be used as an exemplar of successful implementation of an evidence-based, nurse-driven protocol to reduce catheter-days and CAUTI rates throughout the Mississippi Baptist Health Systems. Our project team will act as a resource to other patient areas as they implement the protocol, sharing educational packets, posters, and flyers for distribution, as well as a computer-based instructional course. Content will be included in the orientation sessions for newly hired staff.

Over the past several months, I have been working with a project team from the short-term acute care hospital to review applicable policies and procedures in light of the EBP discovered through this QI project. This past February, I proposed a revised protocol to that hospital's medical executive committee that would enable nurses to discontinue urethral catheterization when indicated without obtaining an order from a primary care provider. The hospital's medical executive committee approved the revised protocol in March, and the protocol recently received institutional review board approval. If they are implemented in the larger hospital, the revisions are likely to be adopted throughout the Mississippi Baptist Health Systems.

DISCUSSION

This QI project compared preintervention and postintervention data on the efficacy of a nurse-driven, EBP protocol developed to promote appropriate discontinuation of urethral catheters and thus reduce the frequency of catheter-days and CAUTI rates in adult patients hospitalized in a long-term acute care facility.

Our results are consistent with well-conducted studies and systematic reviews that indicate that catheter-days and CAUTI rates are nurse-sensitive indicators that can be mitigated through the use of EBP.

It would be inappropriate to generalize our findings to other types of health care facilities of varying size since our data were collected from a single 25-bed, long-term acute care hospital. Our project's other limitations include our failure to compile data on the duration of catheterization for each patient and the potential for subjectivity in the nurse's use of the protocol, as the project team did not perform chart checks to validate adherence. We also didn't collect data on the circumstances under which the primary care staff decided to continue urethral catheterization. Nevertheless, it is reasonable to consider that beyond fundamental nursing care, an ideal approach to reducing catheter-days and CAUTI rates is to employ a protocol that discourages unnecessary catheterization and promotes the removal of urethral catheters as soon as indicated. ▼

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