Reduction in catheter-associated urinary tract infections by bundling interventions

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Abstract

Objective. Urinary tract infections (UTIs) are the most common type of hospital-acquired infection, and most are associated with indwelling urinary catheters, that is, catheter-associated UTIs (CAUTIs). Our goal was to reduce the CAUTI rate.

Design/Setting/Interventions. We retrospectively examined the feasibility and cost-effectiveness of a bundle of four evidence-based interventions upon the incidence rate (IR) of CAUTIs in a community hospital. The first intervention was the exclusive use of silver alloy catheters in the hospital’s acute care areas. The second intervention was a securing device to limit the movement of the catheter after insertion. The third intervention was repositioning of the catheter tubing if it was found to be touching the floor. The fourth intervention was removal of the indwelling urinary catheter on postoperative Day 1 or 2, for most surgical patients.

Main Outcome Measure. Rates of CAUTI per 1000 catheter days were estimated and compared using the generalized estimating equations Poisson regression analysis.

Results. During the study period, 33 of the 2228 patients were diagnosed with a CAUTI. The CAUTI IR for the pre-intervention period was 5.2/1000. For the 7 months following the implementation of the fourth intervention, the IR was 1.5/1000 catheter days, a significant reduction relative to the pre-intervention period (P = 0.03). The annualized projection for the cost of implementing this bundle of four interventions is $23,924.

Conclusion. A bundle of four evidence-based interventions reduced the incidence of CAUTIs in a community hospital. It is relatively simple, appears to be cost-effective and might be sustainable and adaptable by other hospitals.

Keywords: health-care associated infections, complications, infectious disease, disease categories, hospital care, setting of care, general medicine, professions

Introduction

This study, which describes the impact of a bundle of four interventions on the incidence rate (IR) of CAUTIs in a community hospital in the USA, has significant relevance for other countries, since it has been observed that the rate of device (i.e. central venous catheters, mechanical ventilators and indwelling urinary catheters) utilization is similar in the intensive care units of developing countries compared with those in North America, Western Europe and Australia [1–3]. However, the rates of device-related infections are significantly higher in developing countries [1–3].

According to the Centers for Disease Control and Infection (CDC), in the USA, ~1.7 million people develop healthcare-associated infections (HAIs), and 100,000 individuals die due to complications from these infections every year [4]. Urinary tract infections are the most common type of HAIs, and account for almost 40% of them [5, 6]. Eighty percent of UTIs that develop during a period of hospitalization are precipitated by the use of an indwelling urinary catheter [5], and these are referred to as catheter-associated urinary tract infections (CAUTIs). Greater than 1 million CAUTIs per year occur in US hospitals, and in 2007, it was estimated that the cost of treating CAUTIs was $400 million per year [6, 7].

There is considerable variability in the estimated costs of treating CAUTIs, but symptomatic episodes may add an estimated $1200–$4700 to patient costs [8]. Although the
absolute cost of each CAUTI may not be overwhelming, the frequency of episodes over a year greatly increases their significance [9]. It has been suggested that effectively reducing the incidence of CAUTIs could save between 2225–9031 lives each year in the USA [8].

Since the risk of developing of a CAUTI is directly associated with a longer duration of indwelling catheter placement [5, 10], the most effective ways to reduce the IR are to reduce exposure to indwelling catheters by limiting placement to instances of true necessity and limiting the duration of placement to the shortest justifiable length of time [9, 11–13].

The primary goal of this study was to determine the effectiveness of a bundle of four interventions for reducing the CAUTI IR at West Georgia Medical Center (WGMC), a 276-bed community hospital in LaGrange, GA. Members of the Infection Prevention and Control and Performance Improvement departments at WGMC developed this bundle.

All four of these interventions are Category IB recommendations, according to the Healthcare Infection Control Practices Advisory Committee (HICPAC) [14]. The first intervention involved the use of antibiotic-coated urinary catheters [11, 12, 14, 15], which have some efficacy for the reduction of bacteriuria, particularly when used on a short-term basis [16, 17]. The second intervention involved using a securing device to limit the movement of indwelling catheter after insertion [12, 14]. The goal of the third intervention was to maintain unobstructed urine flow [12, 14], while the fourth intervention was aimed at reducing the duration of indwelling urinary catheterization in postoperative patients [18].

Methods

In a staggered fashion over a 9-month period, we introduced a bundle of four evidence-based interventions, which are all Category IB recommendations, according to the HICPAC: Guideline for the Prevention of Catheter-associated Urinary Tract Infections 2009 document. These interventions were (i) the exclusive use of silver alloy catheters, (ii) the use of securing devices to prevent the movement of the catheter after its insertion, (iii) repositioning of the catheter if it was found to be touching the floor and (iv) the requirement for documentation for most surgical patients for the catheter to remain in place on postoperative day (POD) 1 or 2. Patients who underwent perineal, gynecological and urological surgeries were exempt from intervention 4.

The first intervention, which was the exclusive use of silver alloy catheters in all acute care areas of the hospital, started in January 2009. In the preceding 3 years, the use of silver alloy catheters had only been sporadic. The second intervention was the use of a new securing device to limit the movement of the indwelling catheter after insertion. The third intervention consisted of having the nursing staff reposition the catheter tubing, if it was found to be touching the floor, at any time during their work shift. The nurses round on each patient once per hour.

The routine use of the second and third interventions was implemented in February 2009, after the hospital staff had received education about both their importance and proper implementation. The fourth intervention, the requirement for documentation to allow the indwelling catheter to remain inserted on POD 1 or 2, was started in October 2009.

We used the CDC National Health and Safety Network March 2009 definition to determine if a CAUTI was present. The retrospective chart review was done by one physician and two members of the Infection Prevention and Control Department. Records were reviewed retrospectively for the entire duration of catheter use for all catheter-using patients. Active surveillance cultures were not collected because of the project. Also, the frequency of urine culture submission did not change over time, that is, urine cultures were collected only if there was concern that the patient might have a UTI, based on their symptoms.

Compliance with the first, second and third interventions was monitored by members of the Infection Prevention and Control Department, who make rounds on all of the floors twice per week.

For the fourth intervention, compliance was monitored by members of the Performance Improvement department, for every surgical patient who had an indwelling urinary catheter placed, as part of their assessment for adherence to core measures. Our hospital electronic medical record, Meditech, requires that the nurses document the date and time when a Foley catheter is placed, and also when it is removed. Meditech also automatically provides reminders to the nursing staff about the need to remove an indwelling urinary catheter by POD 1 or 2. The Performance Improvement department daily reviewed the data in Meditech for each surgical patient in order to assess compliance with the fourth intervention.

Rates of CAUTI per 1000 catheter days were estimated and compared using the generalized estimating equation (GEE) Poisson regression analysis [19]. The number of days of having an indwelling urinary catheter placed (log transformed) was used as the offset. An exchangeable variance-covariance form among the repeated measurements was assumed, and the estimates of the standard errors of parameters were used to perform the statistical tests and construct 95% confidence intervals. This approach generates results similar to exact methods based on the Poisson distribution [20, 21].

In order to ensure patients’ privacy, none of their names were included in the data set. Rather, individual patients were identified with medical record numbers. There were no conflicts of interest for any of the authors involved in this study. This project was done with the approval of the Institutional Review Board.

Overview of costs

After effectiveness data were analyzed, the costs for the CAUTI intervention bundle were obtained retrospectively. The purpose for obtaining this information is for potential replication of this program by hospitals. Both actual and estimated costs were obtained from hospital administrative data and nurse case managers, who were involved in the program from its beginning to the end of the study period.
Results

CAUTI IRs
A total of 2228 patients had indwelling urinary catheters placed between 1 October 2008 and 30 April 2010, and of these, 33 developed a CAUTI. One of the 33 patients had two CAUTIs, while the other 32 patients each had one CAUTI, during the study period. Table 1 provides a summary of the demographics for all of the patients who had an indwelling catheter placed between 1 October 2008 and 30 April 2010. This table reflects the fact that there were no significant differences in age, gender or ethnicity with regard to the patients who did and did not develop CAUTIs.

Table 2 and Fig. 1 both provide a summary of the IRs of CAUTI for specified time intervals, that is, before and after the implementation of the four interventions.

The 3-month baseline (1 October to 31 December 2008) is considered to be the pre-intervention period, while 1 January 2009 onward is considered to be the post-intervention period. 1 January to 28 February 2009 is considered to be the run-in period, since it was the time frame during which interventions 1–3 were initiated.

During the pre-intervention period, the mean rate of CAUTI per 1000 catheter days was 5.2, and that for 1 January to 28 February 2009 (the run-in period) was 6.5. For the first 7 months after full implementation of the first three interventions (i.e. 1 March to 30 September 2009) the mean rate of CAUTI per 1000 catheter days was 3.1, which was a non-significant reduction compared with the pre-intervention period ($P = 0.22$). However, for the 7 months after the implementation of all four interventions (i.e. 1 October 2009 to 30 April 2010), the mean rate of CAUTI per 1000 catheter days decreased further to 1.5, which was significantly lower than the pre-intervention rate ($P = 0.03$).

Cost of implementing the bundle
The expenditures presented below represent the costs over the 19-month period from October 2008 to April 2010 (these results are summarized in Table 3).

Direct costs. Direct costs included the costs of the equipment, specifically the silver alloy catheters and securing device, and administrative costs. Administrative costs were predominantly related to (i) the planning that was required for the development of the intervention bundle, (ii) education of the nursing staff and (iii) monitoring of compliance with the intervention bundle.

Equipment outlays were $8.25 each and $3.25 each (2008–2009 prices) for the silver alloy catheters and securing devices, respectively. The number of silver alloy catheters that was utilized was 2228, and an equal number of securing devices was also utilized. The annualized total equipment...
The cost for silver alloy catheters and securing devices was $16,182. This dollar amount was calculated by dividing the total number of silver alloy catheter (i.e. 2228) by 19 months, which is the total duration of this study. This means that the average numbers of both the silver alloy catheters and securing devices that were used each month was 117.

The cost of the other two components of the intervention bundle, namely repositioning of the catheter tubing and documentation, were thought to be negligible, since they are part of the usual work flow for the nursing staff.

Administrative costs were less easily quantifiable, but included the planning for the intervention bundle, as well as twice per week monitoring by the staff for compliance with the bundle components. Two program planning sessions were performed by two nurse case managers in the fall of 2008, at an estimated cost of $100. Additional administrative costs involved the formation of a CAUTI Quality Task Force, which was comprised six nurses and one physician champion. The Task Force held two meetings during the intervention period at an estimated cost of $560, assuming a
wage rate of $30 per hour for nurses and $100 per hour for the physician.

Education of the nursing staff was conducted by the nursing directors of the ICU, and the medical floors between January 2009 and April 2009. There were 10 30-min long sessions conducted by five nurse directors. An estimated 175 nurses, representing 50% of the nursing staff, were educated about the CAUTI reduction intervention bundle during this 4-month period. Assuming an hourly wage of $30, the estimated total annualized cost for these sessions was $2775. In order to emphasize to the nursing staff the importance of the CAUTI reduction bundle, a newsletter was created and disseminated in August 2009, at a cost of $60.

Monitoring of compliance with interventions 2 and 3, that is, ensuring that the urinary drainage bag was not touching the floor, catheter tubing was properly secured and that there was no looping of the urinary catheter tubing, took 72 min per week. This was performed twice a week by nurse managers, at a cost of $36 per week over the 68-week intervention period. The annualized total cost for monitoring compliance with the bundle was $1872.

Indirect and intangible costs. Indirect costs for space, utilities and other overhead were not included in this evaluation. In addition, intangible costs related to morbidity and mortality were also excluded.

The annualized total direct costs for the equipment and administrative costs, including the education and re-education of 350 nurses for implementing this bundle of four interventions was $23,924. (Please see Table 3). Table 4 illustrates the annualized cost savings that were achieved from implementation of this CAUTI intervention bundle.

Discussion

With the recent changes in healthcare policy, which specify that Medicare and other payers will no longer reimburse hospitals for expenses incurred for the treatment of CAUTIs that are acquired during a hospital admission [22, 23], there was a great impetus to develop an effective strategy for CAUTI reduction. The results of this study indicate that a bundle of four interventions, which are relatively easy to implement, leads to a significant reduction in the CAUTI rate. This positively impacts patient safety, as well as hospital costs.

Three of the four interventions that were included in our bundle each have been shown to be effective at reducing the CAUTI rate in the literature, securing device [14], repositioning of the catheter tubing if it found to be touching the floor [14] and requiring documentation for postoperative urinary catheters to remain in place on POD 1 and 2 [18]. Also, compared with the use of indwelling urinary catheters that are not impregnated with antibiotics, the use of silver alloy catheters on a short-term basis has been associated with a decreased rate of bacteriuria [15, 17, 24]. As far as we are aware, this is the first study to look at a bundled approach combining these four interventions, along with the costs involved in implementing the program. We observed a 71% reduction in the CAUTI rate within 6 months after the implementation of the entire bundle.

The primary limitation of this study is the fact that the relative impact of each of the four interventions was not individually evaluated. However, the fact that all four of the interventions are Category IB recommendations indicates that there is support for their use.

It has been shown that silver alloy impregnated catheters may decrease the rate of catheter-associated bacteriuria, when these devices are used on a short-term basis [16]; however, a significant reduction in the rate of symptomatic UTIs has not yet been demonstrated [12, 16]. With regard to the use of a securing device, Darouiche et al. [25] observed a substantial decrease in the rate of CAUTIs in patients for whom this was implemented; however, because of the small study size, it was not possible to calculate statistical significance.

Table 4 Calculation of annualized cost savings from the CAUTI bundle

<table>
<thead>
<tr>
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<th>Pre-intervention (i.e. from October 2008 to December 2008)</th>
<th>Post-intervention (i.e. from October 2009 to April 2010)</th>
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<tbody>
<tr>
<td></td>
<td>Number of pre-intervention CAUTIs per month</td>
<td>Number of post-intervention CAUTIs per month</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.86</td>
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<tr>
<td></td>
<td>Number of pre-intervention CAUTIs per year</td>
<td>Number of post-intervention CAUTIs per year</td>
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<tr>
<td></td>
<td>36</td>
<td>10.32</td>
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<td></td>
<td>Cost per CAUTI incidence</td>
<td>Cost per CAUTI incidence</td>
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<tr>
<td></td>
<td>Low estimate</td>
<td>High estimate</td>
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<tr>
<td></td>
<td>$1200</td>
<td>$4700</td>
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<tr>
<td></td>
<td>Cost of post-intervention CAUTIs per year</td>
<td>Cost of post-intervention CAUTIs per year</td>
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<tr>
<td></td>
<td>$43 200</td>
<td>$169 200</td>
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<tr>
<td></td>
<td>Cost of pre-intervention CAUTIs per year</td>
<td>Cost savings</td>
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<td></td>
<td>Low estimate</td>
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<td>$12 384</td>
<td>$48 504</td>
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<td></td>
<td>Annualized preliminary cost savings from the CAUTI bundle</td>
<td>Annualized final cost savings from the CAUTI bundle</td>
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<td></td>
<td>$30 816</td>
<td>$6892</td>
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<td>*Includes cost of intervention, $23,924.</td>
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*Includes cost of intervention, $23,924.
The efficacy of maintaining unobstructed urine flow for preventing CAUTIs is well established [26]. Similarly, the benefit of prompt removal of indwelling urinary catheters from surgical patients has been confirmed. It has been found that patients who have indwelling catheters in place for 2 days or less have a substantially lower risk of developing a UTI, compared with those who have these devices in place for longer time intervals [18].

Interventions 2 and 3 were readily implemented by the nursing staff and promptly interwoven into their usual work duties to maintain a high standard of patient care. Implementation of intervention 4 was well received by the surgeons on the medical staff, and the nursing staff consistently removed the indwelling urinary catheters from most surgical patients by POD 1 or 2.

We estimated the annualized cost of the intervention bundle to be $23,924. To place this cost into context, consideration needs to be given to the cost of standard latex urinary catheters. These standard catheters cost $5.30 less than the silver alloy catheters [15], and the annualized cost of standard catheters at our facility was $4142 (i.e. 1404 catheters used per year, at a cost of $2.95/catheter). Therefore, the incremental cost of adopting the intervention bundle over standard care was reduced to $19,782.

To calculate cost savings, we used the assumption that the cost of treating each CAUTI ranges from $1200 to $4700. We calculated a preliminary annualized cost savings of $30,816–$120,696, based on the 71% reduction in CAUTIs from the bundle. Factoring in the cost of the intervention bundle, i.e. $23,924, the final annualized cost savings ranged from $6892 to $96,772, depending on the monetary value selected within the cost range for treating each CAUTI. Table 4 illustrates the achieved annualized cost savings. This cost analysis demonstrates a favorable cost outcomes profile.

It was observed that within 6 months after the implementation of all four interventions, the CAUTI rate had decreased by 71%. These preliminary results are very encouraging, but additional studies are needed to confirm their sustainability over a longer time period.

With CAUTIs being the most common type of hospital-acquired infection, our results indicate that a bundle of four evidence-based interventions can reduce their incidence by more than two-thirds. Moreover, these interventions are relatively simple to implement and appear to be cost-effective in a community hospital. While it is essential to closely monitor adherence to the individual components of this CAUTI reduction bundle once it has been implemented, the bundle should be readily sustainable and transferable to other hospitals.

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References


