A multifaceted quality improvement strategy reduces the risk of catheter-associated urinary tract infection

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Abstract

Objective: Catheter-associated urinary tract infections (CAUTIs) are common and preventable hospital-acquired infections, yet their rate continues to rise nationwide. We describe the implementation of a multifaceted program to reduce catheter use and CAUTI rates while simultaneously addressing barriers to long-term success.

Design/Setting/Participants: Pre–post study of medical inpatient veterans between December 2012 and February 2015.

Intervention: Five component intervention: (i) a bedside catheter reminder; (ii) multidisciplinary educational campaign; (iii) structured catheter order set with clinical decision support; (iv) automated catheter discontinuation orders; and (v) protocol for post-catheter removal care.

Main Outcome Measure(s): Catheter utilization rates and CAUTI rates on the study ward were followed during the 14-week baseline period, the 27-week transition/intervention period and the 70-week period of full implementation/sustainability. Rates of patient falls per bed days and catheter reinsertions were collected during the same time periods as balancing measures.

Results: Catheter use declined by 35% from the baseline period to the full implementation/sustainability period. This improvement was not realized until deployment of the structured electronic orders with automated catheter discontinuation and protocolized post-catheter care. The average number of days between CAUTIs on the study ward increased from 101 days in the baseline period to over 400 days in the full implementation/sustainability period. There was no significant change in the rates of falls or catheter reinsertions during the study period.
Conclusions: A multicomponent intervention aimed specifically at targeting local barriers was successful in reducing catheter utilization as well as CAUTIs in a veteran population without compensatory increase in patient falls or catheter replacement.

Key words: CAUTI, hospital-acquired infection, infection control, urinary catheter

Introduction

Catheter-associated urinary tract infections (CAUTIs) are the most common hospital-acquired infection (HAI) [1] accounting for more than 1 million cases in the USA and Europe annually [1, 2]. Patients who have CAUTI experience increased hospital length of stay compared to those without a CAUTI [3], and this can lead to downstream complications including pyelonephritis, urosepsis and even death. This is associated with a total annual cost in the USA of up to $370 million [4]. CAUTI is widely felt to be the most preventable HAI, with consistent reduction of incidence by 65–70% following implementation of quality improvement initiatives [1, 5]. As a result, in 2008 CAUTIs were identified as ‘never events’ and were included among the first HAIs selected for non-payment by the Centers for Medicare and Medicaid Services (CMS) [2, 6]. Multiple regulatory organizations and payers have identified CAUTI reduction as a patient safety priority; however, despite myriad initiatives, the rate of CAUTIs increased 6% between 2009 and 2013 [4, 7–9].

The predominant risk factor for CAUTI development is the duration of urinary catheterization, with an additive 3–10% risk for each cumulative day of catheterization [10]. As a result, most successful CAUTI reduction initiatives have either limited catheter placement to appropriate and necessary clinical situations or promoted swift catheter removal as supported by guidelines from the Centers for Disease Control and Prevention (CDC) [11], Infectious Disease Society of America [12], as well as European and Asian guidelines [13]. Successful interventions consistently include use of daily catheter reminders, automated catheter stop orders, and empowerment of nursing staff to manage and remove catheters independent of physician daily orders [14, 15].

Despite these encouraging successes, substantial barriers persist to widespread implementation of effective CAUTI reduction strategies. First, physician awareness of catheter status remains variable. Up to 28% of catheters go unrecognized by treating physicians and unrecognized catheters are more likely to be in place for inappropriate indications [16]. Furthermore, when implemented in isolation, daily catheter reminders have not consistently reduced the duration of catheterization [14]. Since multifaceted improvement programs rely heavily on involvement of bedside nursing staff, nurses must feel comfortable with and champion catheter protocols in order for them to succeed. Nonetheless, qualitative evaluation has found that nurses are often hesitant to assume responsibility for catheter removal [17], and this hesitancy may progress to ‘active resistance’ that can seriously hamper improvement efforts [18]. Finally, the relationship between catheter removal and incremental fall risk remains poorly characterized, further impeding CAUTI reduction protocols. While some advocate that urinary catheters function as a ‘one-point restraint’ whose presence prohibits early mobility [19], others have voiced concern that early catheter removal may actually facilitate falls [20] and few if any studies have rigorously assessed fall rates in the setting of CAUTI reduction programs. As a result of these and other barriers, fewer than 25% of hospitals nationwide reported actively using catheter reminders, stop orders or nurse-initiated discontinuation protocols [21].

Our objective was to design and implement a multidisciplinary quality improvement program to reduce catheter use and CAUTI rates among a veteran population while simultaneously addressing persistent barriers to program success.

Methods

Setting

The intervention was piloted on a single inpatient ward at the VA-Tennessee Valley Healthcare System (VA-TVHS) in Nashville, TN. The study ward is a 40-bed general acute medical unit. Patient care on this ward is provided primarily by hospitalists and resident physicians supervised by internal medicine attending physicians. Nursing care is provided primarily by licensed RNs with additional support from licensed LPNs and unlicensed nursing assistants, with an average patient to nursing ratio during the study period of 6:1.

The VA-TVHS uses current National Healthcare Safety Network (NHSN)/CDC criteria to define a CAUTI event and its attributed location [22]. Within the regional VA network, institutional CAUTI rates decreased overall from 2.15 per 1000 catheter days in 2011 to 1.55 per 1000 catheter days in 2012. Yet within certain acute care wards at VA-TVHS, CAUTI rates increased slightly from 2.67 per 1000 catheter days in 2011 to 2.74 per 1000 catheter days in 2012.

Human subjects protection

Approval for this study was waived by the TVHS Institutional Review Board as a quality improvement project.

Planning the intervention

Plan-Do-Study-Act (PDSA) cycles were used to structure the improvement process and key driver diagram (KDD) analysis ensured that the intervention contained components to address each crucial barrier [23]. First, the team met with key stakeholders including institutional leadership, ward physician and nursing leadership, as well as nursing staff and resident physicians involved in daily bedside patient care to better characterize current practices and identify perceived barriers to early catheter removal. Baseline barrier analysis revealed that catheter status was consistently documented by nurses in a structured manner in the electronic medical record with good adherence. Physicians, however, did not routinely review this documentation when making clinical care decisions and were often unaware of catheter status. There was a frequent perception among staff, patients and families of urinary catheters as a low-risk convenience or comfort item for patients, with some patient’s requesting catheterization rather than experience inconvenience. Additionally, similar to data from prior studies there was concern among nursing staff for a link between early catheter removal and increased fall risk [20]. Despite the existence of a structured catheter order in the electronic medical record, the majority of catheter orders were entered as free-text unstructured nursing orders without the benefit of clinical decision support. Physicians reported poor
usability of the existing order set and as a result, despite having below-average catheter utilization ratios when compared to national averages [24], over a third of patients had either no clear documented indication for catheterization or no appropriate indication per CDC guidelines [11]. Finally, no formal system existed to remind physicians of catheter status or trigger daily evaluation of catheter necessity; physicians were expected to include this in their daily patient assessment according to their personal workflow.

Improvement activities

The multifaceted intervention was implemented across a 6-month transition/intervention period and comprised five components aimed at each of the key drivers identified in the KDD analysis (Fig. 1). First, we implemented use of a bedside catheter reminder. Nursing staff wrote the HIPAA-compliant phrase DINC (‘Do I Need Catheter?’) on the whiteboard at the patient’s bedside for any patient with an indwelling urinary catheter. Resident and attending physicians received training to look for this reminder and re-evaluate the ongoing need for catheterization on a daily basis. Second, we enacted a multidisciplinary educational campaign for physicians, nursing staff, and patients aimed at reframing catheter risk and reviewing appropriate indications for catheterization. This was done by holding brief educational sessions with nursing staff and resident physicians that included language fostering teamwork among staff and addressing CAUTI as a community problem. We simultaneously constructed a social marketing campaign regarding catheter overuse and the risk of CAUTI which included displays in staff work areas, patient rooms, and public areas of the hospital. These two components were deployed in the first 4 weeks of the transition/intervention period, Weeks 15–18.

Third, we designed a structured catheter order within the electronic medical record and obligated its use for all indwelling catheters placed in patients on the study ward. The new order offered alternatives to indwelling catheter placement and required selection of a CDC-approved indication for urinary catheterization (Supplementary Fig. 1). Fourth, we implemented automated stop-orders for all short-term catheters 48 h after placement, mandating either catheter discontinuation or reassessment with active renewal. Fifth, we created a new protocol for patient management after catheter removal, enabling nursing staff to independently manage the majority of patients following catheter removal. The protocol was developed jointly with nursing leadership and bedside nursing input, and empowered nurses to utilize intermittent catheterization and existing bladder scanners to manage urinary retention in the immediate post-catheter period without requiring frequent contact with resident physicians. These three components of the intervention were implemented between Weeks 19 and 42 of the transition/intervention period.

Planning study of the intervention

We defined three discrete study periods for purposes of measurement and analysis: the ‘baseline period’ was defined as Weeks 1 through 14, prior to implementation (14 weeks). The ‘transition/intervention period’ was defined as Weeks 15 through 42, during which time the five components of the intervention were successively implemented (27 weeks). The period of ‘full implementation/sustainability’ was defined as Weeks 43 through 113, after implementation of all components of the intervention (70 weeks).

Process measures

We collected patient-level characteristics and process measures for a systematic sample of all patients with an indwelling catheter admitted to the study ward during each study period. These were gathered via chart review using a structured abstraction form. Data gathered included demographics, presence of catheter on admission to study...
ward, catheter removal prior to hospital discharge, documentation of any indication for catheterization, total duration of catheterization (in days) and any need for catheter replacement within 48 h of removal. Process measures included documentation of indication (defined as proportion of patients with any chart documentation of a CDC-approved indication for catheter placement) [11], compliance with use of the ‘DINC’ bedside reminder (defined as the number of patients with ‘DINC’ on their whiteboard divided by the total number of patients with indwelling catheters), and compliance with the structured catheter order (defined as the number of patients with a completed structured order divided by the total number of patients with catheters placed in the hospital).

Outcome and balancing measures

There were two primary outcome measures of interest for this study: first, the catheter utilization ratio on the study ward (defined as the number of urinary catheter days divided by the number of total patient days); and second, the CAUTI rate (defined as the number of CAUTI events divided by 1000 urinary catheter days). These were defined by NHSN and CDC guidelines [22] and collected by VA-TVHS infection control nursing staff. We collected two balancing measures: first, the fall rate (defined as the number of patient falls divided by 1000 bed days). A fall was defined as any event that resulted in the patient on the ground and was viewed by the nurse as a fall, whether from the bed or from a standing height. Second, we collected the proportion of catheters that were re-inserted within 48 h of removal (collected via chart review).

Analysis

Catheter utilization ratios and fall rates were compared among the three study periods using incidence rate ratios. Categorical measures were compared using Pearson’s chi-square test and Fisher’s exact test and the median duration of catheterization was compared using the Kruskal–Wallis test.

We used statistical process control charts to evaluate changes in the catheter utilization ratio on a monthly basis during each of the study periods (P chart) and average number of days between CAUTI on the study ward (G chart). All statistical testing was two-sided at a significance level of 0.05. All analyses were conducted using STATA 12.1 statistical software (StataCorp, College Station, TX).

Results

During the study, the average length of stay for medical patients was 4.6 days with most common discharge diagnoses on the study ward being coronary artery disease, pneumonia, atrial fibrillation, chronic obstructive pulmonary disease exacerbation and congestive heart failure.

Process measures

A sample of 99 patients underwent chart review, (35 from the baseline period, 29 from the transition/intervention period and 35 from the period of full implementation/sustainability [Table 1]). Between 20 and 31% of indwelling urinary catheters were present at the time of study ward admission, and 63–74% of all catheters were removed prior to hospital discharge, with no significant differences between the study periods. The most common indication for catheter placement in all three periods was urinary retention. Documentation of any indication for catheterization increased from 80.0% in the baseline period to 88.6% after full implementation (P = 0.037).

Use of the structured indwelling catheter order increased from 30.8% in the baseline period to 66.7% in the full implementation period (P = 0.035, Table 1). Median duration of catheterization remained 3–4 days throughout the study period without significant variation. Compliance with the DINC communication tool remained over 60% throughout the transition and full implementation periods.

Outcome measures

Figure 2 demonstrates the catheter utilization ratio on the study ward over the full study duration (111 weeks). As seen in the P chart, during the baseline period, the average catheter utilization ratio was 12.0%. This declined during the transition/intervention period to 11.7% and fell to 7.8% during full implementation/sustainability. The incidence rate ratio for the change in catheter utilization from the baseline to full implementation/sustainability periods was 0.65 (95% CI: 0.59–0.72, P < 0.001) and for the change from the transition/intervention to full implementation/sustainability periods was 0.67 (95% CI: 0.61–0.73, P < 0.001), representing a 33–35% reduction in catheter utilization after implementation of the full intervention.

In the year prior to implementation of the intervention, the CAUTI rate on the study ward was 3.53 per 1000 urinary catheter days. In the 70 weeks following full implementation, the CAUTI rate on the study ward fell to 0.70 per 1000 catheter days. Figure 3 shows a G-chart of the days between CAUTIs on the study ward. At baseline, prior to full implementation of the intervention, the average number of days between CAUTI was 101. Since full implementation, there has only been one CAUTI on the study ward, with an interval of 412 days between infections.

Balancing measures

The fall rate on the study ward was 2.88 in the baseline period, 4.60 in the transition/intervention period and 3.86 in the full implementation/sustainability period (all measured per 1000 bed days of care); none of these changes were statistically significant (Fig. 2). The proportion of patients who had catheters re-inserted with 48 h of removal was 27.3% in the baseline period and 12.0% in the full implementation period (P = 0.281, Table 1).

Discussion

We found that implementation of a multifaceted intervention in a veteran population successfully achieved a 33–35% reduction in urinary catheter utilization as well as a significant reduction in rates of catheter-associated infection. Institution of daily physician reminders paired with widespread education efforts did not significantly alter provider behavior; however, the addition of a structured catheter order, automated 48-h stop orders, and a post-removal protocol resulted in a sustained reduction in catheter utilization. Finally, decreased catheter utilization was not associated with any statistically significant rise in patient fall rates or rates of catheter replacement.

We combined multiple components shown individually in previous studies to be effective at reducing CAUTI rates, but did not achieve statistically significant reductions in catheter utilization until implementation of all components was complete. This is consistent with previous findings that multicomponent interventions generally are more effective than single-component interventions, both within the
Table 1 Characteristics of catheters during study periods

<table>
<thead>
<tr>
<th></th>
<th>Baseline N = 35</th>
<th>Transition/implementation N = 29</th>
<th>Implementation/sustainability N = 35</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter present on admission to study ward (%)</td>
<td>23</td>
<td>31</td>
<td>20</td>
<td>0.575</td>
</tr>
<tr>
<td>Catheter removed prior to hospital discharge (%)</td>
<td>74</td>
<td>63</td>
<td>71</td>
<td>0.629</td>
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<tr>
<td>Indication for catheterization (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any indication documented</td>
<td>80</td>
<td>62</td>
<td>89</td>
<td>0.037</td>
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<tr>
<td>CDC-approved indication documented</td>
<td>66</td>
<td>59</td>
<td>69</td>
<td>0.700</td>
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<tr>
<td>Order in electronic medical record (n = 32)(^a) (%)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Free text order</td>
<td>62</td>
<td>80</td>
<td>22</td>
<td></td>
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<tr>
<td>Structured order</td>
<td>31</td>
<td>–</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>8</td>
<td>20</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Days of catheterization duration, median</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>0.212</td>
</tr>
<tr>
<td>Catheter replacement within 48 h (%)</td>
<td>27</td>
<td>29</td>
<td>12</td>
<td>0.281</td>
</tr>
<tr>
<td>‘DINC’ compliance (%)</td>
<td>–</td>
<td>61</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Indication for catheterization (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary retention</td>
<td>34</td>
<td>31</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Measurement accurate intake/output</td>
<td>14</td>
<td>4</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Urinary obstruction</td>
<td>20</td>
<td>14</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Acute kidney injury</td>
<td>9</td>
<td>10</td>
<td>3</td>
<td></td>
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<tr>
<td>Incontinence with advanced decubitus</td>
<td>3</td>
<td>–</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Urologic surgery</td>
<td>–</td>
<td>4</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Epidural catheter placement</td>
<td>–</td>
<td>–</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>–</td>
<td>–</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>No indication documented</td>
<td>20</td>
<td>38</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Only assessed for catheters placed on study ward.

Figure 2 P-chart (statistical process control chart) showing monthly catheter utilization ratio and fall rate during each of the study time periods.
field of CAUTI reduction [14] as well as in other quality improvement efforts [25]. We also used a combination of a ‘low-tech’ bedside intervention with solutions built into the existing electronic medical record in an attempt to influence behavior from multiple standpoints.

Although CAUTI events no longer result in additional payments for hospitals [6], changing these financial incentives alone did not result in any significant reduction in CAUTI rates nationally after the first 3 years of policy implementation [26]. This suggests that in order to achieve meaningful improvement, planned changes must also account for local barriers and individual incentives. We found that several previously documented barriers continued to drive catheter use in our institution: notably, concern about fall rates and lack of daily physician reminders. However, we also discovered several unexpected obstacles, including patient-initiated requests for catheters and physician reluctance to use poorly designed electronic orders. After identification, we were able to specifically address both of these issues in our intervention design, which is likely to have contributed to our success. This highlights the risk of simply implementing externally developed improvement protocols without considering local culture.

Prior to implementation of the intervention the study ward had already achieved below-average catheter utilization ratios [24]; despite this, our program was still successful in driving these already low rates of catheter use even lower, and these modest improvements were also associated with further reduction in the risk of CAUTI. This suggests that hospitals with low baseline rates of catheter use may still be able to achieve incremental improvement with similar multifaceted programs. Furthermore, this highlights the importance of developing hospital-wide CAUTI reduction programs, rather than initiatives specific to individual wards. We found that many of the catheters managed on our study ward were placed elsewhere, and we expect further improvement in catheter utilization rates after planned extension of these initiatives throughout the hospital.

This study has several limitations worth noting. First, this was an observational study and we cannot conclusively state that the improvements we detected were not the result of other concurrent efforts or ongoing temporal trends. We also implemented multiple intervention components over a relatively short period of time, limiting any ability to evaluate the effectiveness of each component individually.

Use of two components of the multifaceted intervention (the structured order and the automated stop-order) was limited to those patients whose catheters were placed on the study ward. Patients with catheters placed on other wards who were later transferred to the study ward only received the benefit of at most three components of the intervention (bedside reminder, educational campaign, and protocolized post-catheter removal). Furthermore, compliance with the bedside reminder and structured order were each <70%. This resulted in a substantial proportion of patients who received only a partial intervention, and we did not specifically measure how many components each patient received.

Finally, both patient falls and CAUTI events are relatively rare occurrences. We measured these on one study ward over a period of 27 months. Despite this long period of observation and follow-up we were likely limited in our ability to find statistically significant changes in either of these outcomes. We also relied on infection control staff to gather data on catheter utilization and CAUTI events. However, we validated a subset of these data by reviewing separate nursing documentation.

In conclusion, we describe successful reduction in urinary catheter utilization among a veteran population using a multicomponent intervention without any associated adverse rise in patient falls or catheter replacement. This illustrates the importance of careful attention to local barriers in the development of quality improvement initiatives, as well as the potential for further incremental improvement even among those facilities who have already achieved substantial gains.
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Supplementary Material
Supplementary material is available at International Journal for Quality in Health Care online.

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