# *Alternatives to Indwelling Catheters Cause Unintended Complications*

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**To reduce the risk of catheter-associated urinary tract infection (CAUTI), limiting use of indwelling catheters is encouraged with alternative collection methods and early removal. Adverse effects associated with such practices have not been described. We also determined if CAUTI preventative measures increase the risk of catheter-related complications. We hypothesized that there are complications associated with early removal of indwelling catheters. We described complications associated with indwelling catheterization and intermittent catheterization, and compared complication rates before and after policy updates changed catheterization practices. We performed retrospective cohort analysis of trauma patients admitted between August 1, 2009, and December 31, 2013 who required indwelling catheter. Associations between catheter days and adverse outcomes such as infection, bladder overdistention injury, recatheterization, urinary retention, and patients discharged with indwelling catheter were evaluated. The incidence of CAUTI and the total number of catheter days pre and post policy change were similar. The incidence rate of urinary retention and associated complications has increased since the policy changed. Practices intended to reduce the CAUTI rate are associated with unintended complications, such as urinary retention. Patient safety and quality improvement programs should monitor all complications associated with urinary catheterization practices, not just those that represent financial penalties.**

Catheter-associated urinary tract infection (CAUTI) is the most prevalent hospital-acquired infection. It can result in prolonged hospitalization and costs $340 to $370 million/year. On October 1, 2008, Centers for Medicare and Medicaid Services stopped reimbursing for CAUTI-associated expenses,[1] even though the Centers for Disease Control (CDC) estimates 17 to 69 per cent of CAUTI may be preventable with recommended infection control measures.[2] The CDC recommends removal of indwelling urinary catheters as soon as possible to reduce the risk of CAUTI.[3] Use of alternatives such as intermittent catheterization, condom catheters,[4] incontinence pads,[5,6] and antibiotic-impregnated catheters[7] have since been encouraged.

Intermittent catheterization has been shown to reduce the rate of urinary tract infection (UTI) in post-rehabilitation patients with traumatic brain injury or spinal cord injury requiring long-term bladder instrumentation, 4.1 UTIs per 1000 catheter-days for clean intermittent catheterization.[8] These data have been extrapolated to clinical policy for the acute care population without evidence of benefit to these patients and without full consideration of possible associated risks. The incidence rate of UTI in adult inpatient units is similar, 0.2 to 4.8 UTIs per 1000 catheter-days,[9] but there is no evidence that repeated intermittent catheterization is safe and efficacious, less risky, or more beneficial than an indwelling catheter in this population.

In addition to the risk of a UTI, there is a clinically perceived risk for bladder overdistention injury in patients undergoing alternatives to indwelling catheter, such as intermittent catheterization, after an indwelling catheter has been removed. Patients with greater than 800 mL of urine in their bladder are at risk for bladder overdistention injury.[10] If patients are unable to empty their bladder after overdistention, an indwelling catheter is replaced until detrusor muscles can heal and regain function, for a minimum period of 48 hours and up to 120 hours. This can increase the risk for other complications such as increased hospital stay, discharge with catheter, intramural ischemia, reduced sensation, neuropraxia, and reduced bladder contractility.[11]

We hypothesized that there are complications associated with alternatives to indwelling urinary

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catheters that are not being measured. We also questioned whether the risk of such complications are increased by hospital acquired infection prevention measures, and sought to describe and compare complication rates associated with early removal of the indwelling catheter. Complications and infection rates were examined before and after a hospital policy update changed urinary catheterization practices.

The institution's Urinary Catheter Policy in place from June 1999 to 2011 was based on CDC recommendations for insertion, care, maintenance, and discontinuation of indwelling urinary catheters. It focused on nursing procedures for insertion and maintenance of closed drainage systems, and included a procedure for removal. There was a list of indications for continuation of indwelling catheter, and an algorithm for removal and monitoring for urinary retention if a patient did not have any of the listed indications. In a version of the policy published in June 2011, this list and algorithm were removed. At this time, there were also incentives from hospital administration in place to reduce the institutional CAUTI rate through earlier removal of indwelling catheters, which resulted in an increased use of intermittent catheterization and other alternatives to indwelling urinary catheters.

## Methods

Trauma Surgery inpatients admitted between August 1, 2008, and December 31, 2013, were identified using the Trauma Registry of our institution's Level I trauma center. Patients who required indwelling urinary catheterization were identified from the electronic medical record, and a retrospective cohort analysis was performed using data from the electronic medical record and the Trauma Registry. Based on the change in institutional catheter policy in June 2011 patients were assigned into two groups—those treated before (pre) and after (post) urinary catheter policy changes. Characteristics and outcomes of the two groups were compared.

Included subjects were trauma patients admitted to a surgical intermediate unit Progressive Care Unit (PCU), intensive care unit (ICU), or Medical/Surgical Floor (MedSurg) and who were older than 15 years of age. Patients with prior urinary system abnormalities, bladder injury before admission, spinal cord injury, death during the hospitalization, or documented UTI on admission were excluded from the study.

Patient characteristics including age, etiology of injury, post-ED destination (ICU, operating room, or PCU), Injury Severity Score (ISS), ventilator days, arrival Glasgow Coma Score (GCS), hospital length of stay (LOS), type of injury, gender, discharge GCS, and ICU days were obtained from the datasets.

Complications related to indwelling catheters were identified in this patient population before and after the 2011 policy changes advocated earlier catheter removal. Specific complications that were examined include UTI, bladder overdistention, indwelling catheter replacement after removal (recatheterization), and discharge from hospital with catheter. The total number of catheter days before and after the policy changed was also calculated.

Bladder overdistention was defined as greater than 800 mL of urine in the bladder at any given time.[10] Urinary retention was defined as greater than 400 mL of urine in the bladder at a given time.[12] These volumes were confirmed by ultrasound bladder scan or by one time output from an intermittent catheterization. Recatheterization was defined as reinsertion of an indwelling urinary catheter after removal of an indwelling urinary catheter at any time during a single admission. Number of catheter days included only days when an indwelling catheter was in place. Urinalysis was obtained for patients suspected to have a UTI based on signs or symptoms such as fever, leukocytosis, or delirium that were not otherwise justified, pyuria, flank or suprapubic discomfort, costovertebral angle tenderness, dysuria, or catheter obstruction. Urine culture was obtained for urinalysis positive for presence of pyuria, leukocyte esterase, or nitrite. CAUTI was defined as positive urine culture for one or two species of bacteria with $10^5$ colonies,[4] with the diagnostic specimen obtained while a catheter was present or within 48 hours of a catheter being in place, for a patient who did not have a documented UTI on admission.

### *Statistical Methods*

A power analysis was completed before data collection. Data from previous literature pertaining to the UTI rate with indwelling and intermittent catheterization were used. We determined a sample size of 256 patients would be adequate to detect a 10 per cent difference in the two treatment groups with a power of 0.8 and an alpha value of 0.05.[13] The study population was randomized using the randomization function in Excel (2010; Microsoft, Redmond, WA). After randomization, the first 256 records that met inclusion/exclusion criteria were included in the study. Descriptive population statistics were performed to evaluate the composition of the sample population. Outcomes were evaluated with univariate statistics. A survival analysis was performed to account for patients who were discharged with a catheter and therefore had an unknown number of catheter days.

## Results

Etiologies of injury are included in Table 1. The injuries included 231 blunt, 18 penetrating, and 1 burn injuries. The age and acuity level based on ISS, days in ICU, hospital LOS, ventilator days, and GCS are described in Table 2. Of the 256 patients studied, 42 underwent intermittent catheterization. From the ED, 117 went to the ICU, 1 was discharged home, 45 to the OR, 79 to the PCU, 14 to another hospital floor. Seventy-one were female and 179 male. Complication rates pre and post policy change are listed in Table 3.

### *Data Analysis*

The pre and post policy groups were well matched based on age, ED arrival GCS, discharge GCS, hospital LOS, ICU LOS, vent days, and ISS. There were 1276, total catheter days in the pre group and 982 in the post group, without including catheter days after discharge.

TABLE 1. *Etiology of Injuries*

| Etiology | Pre | Post |
|---|---|---|
| Motor vehicle accident | 17 | 9 |
| Fall | 53 | 30 |
| Motorcycle accident | 59 | 50 |
| Other | 5 | 2 |
| Gunshot wound | 9 | 7 |
| Fire | 0 | 1 |
| Pedestrian accident | 2 | 4 |
| Assault | 4 | 2 |
| Stabbing | 2 | 0 |

TABLE 2. *Sample Population Statistics on the Group Studied*

| | Mean (SD) | | |
|---|---|---|---|
| Characteristics | Pre (n = 105) | Post (n = 151) | *P* Value |
| Age | 54.4 (19.5) | 55.8 (20.6) | 0.697 |
| ED arrival GCS | 123 (4.4) | 13 (3.9) | 0.244 |
| Discharge GCS | 14.7 (1.1) | 14.6 (1.3) | 0.365 |
| Vent days | 4.8 (8.6) | 4.1 (8.3) | 0.534 |
| Hospital LOS | 16.5 (17) | 14.9 (16.1) | 0.459 |
| Days in ICU | 7.4 (8.9) | 5.5 (7.5) | 0.079 |
| ISS | 18.1 (10.6) | 18.2 (10.7) | 0.954 |

TABLE 3. *Complication Rates Pre and Post Policy Change*

| Total Complications | Pre (%) | Post (%) | *P* Value |
|---|---|---|---|
| CAUTI+ | 13.33 | 10.6 | 0.1629 |
| Retention | 13.33 | 24.5 | 0.0249* |
| Overdistention | 2.86 | 3.31 | 0.8373 |
| Recatheterization | 18.1 | 24.5 | 0.2188 |
| Discharge with catheter | 11.81 | 8.93 | 0.4543 |

* Significant difference in the two groups.

Survival analysis was done to account for patients who were discharged with a catheter that do not have a removal date (Fig. 1). This test did not show a significant difference in total number of catheter days between the pre and post groups. CAUTI rate per 1000 drain days was 17.7 for the pre group and 15.7 for the post group. This is a reduction of two CAUTIs per 1000 catheter days after the policy change. Complication rates pre and post policy change are depicted in Figure 2. Urinary retention was significantly higher post policy change, and CAUTI rate was not significantly different.

## Discussion

The intention of the policy changes in 2011 was to reduce the number of catheter days in an attempt to decrease the institution's CAUTI rate, during a period when earlier removal of urinary catheters was being incentivized. We examined the effects of these changes on outcomes for patients admitted to the trauma service during the study period.

Urinary retention increased after the policy was changed. This is likely due to early withdrawal of the urinary catheter in patients at high risk for retention. Bladder overdistention injury and recatheterization are complications of particular interest due to the impact they have on individual patients' LOS, discomfort, and increased risk of infection. Both of these rates increased, but only trended toward significance. We suspect this is due to the removal of the elements from the policy intended to prevent these complications, at the same time there was a natural decrease in the average level of staff experience. There is typically an influx of new graduates in the early summer. Further, the study was likely not powered to detect a significant difference in these categories, and a larger sample size may be required to identify an association. Practitioners should anticipate these complications in all patients who have indwelling catheters removed and take preventative measures.

Despite the policy's intent to decrease CAUTI rates by decreasing the number of catheter days, no difference in these rates was observed in the patient population studied. It is important to note that a definition relevant to clinical care was used in this study to identify CAUTI, as opposed to the "official" CDC definition used by Centers for Medicare and Medicaid Services for CAUTI surveillance. The "official" definition changed multiple times throughout the study period, and we chose to use a single, clinically relevant definition throughout. Thus, our rates may differ slightly from publicly reported rates for the institution.

Both CAUTI rate and catheter days trended down but did not reach significance. A flaw inherent to

a retrospective study is that of imperfect implementation of a protocol. Furthermore, although the policy was literature based and developed using CDC recommendations, it is probable that implementation of and adherence to the policy was incomplete or inconsistent. In contrast to the results of our study, an additional policy was piloted in 2013 that addressed some of the issues with complications associated with early removal of indwelling urinary catheters, the Adult Bladder Continence Policy. It included a checklist of criteria that put a patient at increased risk of urinary retention as well as a detailed algorithm for nursing staff to follow once a catheter was removed to help detect retention and prevent overdistension injury. It was implemented in parallel with the Urinary Catheter Policy under investigation in a closed 12-bed ICU between 2013 and 2015, with the daily presence of a clinical nurse specialist who championed the cause and provided continuing education to unit staff. In this limited, heterogeneous patient population with a relatively controlled environment, we have observed a reduction in indwelling catheter days as well as a reduction in the CAUTI rate. We expect a reduction in the incidence of the other complications as well, and this will be an area of future investigation as it is implemented on a larger scale.

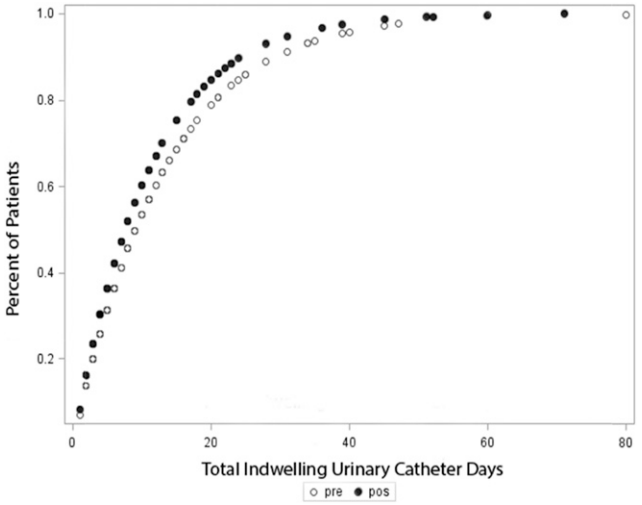


FIG. 1. Survival analysis for number of catheter days to include patients who were discharged with an indwelling catheter. Algorithm converged, $P = 0.1614$.

These contrasting outcomes illustrate the difficulties with implementation of clinical protocols and policies, including education lag, inconsistent application, and frequent changes, or multiple policies confusing staff. Resources have to be dedicated to education and subsequent monitoring, reevaluation, benchmarking, and documentation to demonstrate improvements in outcomes for many months after a new policy is in place. This is often cost-prohibitive with large-scale implementation of policies across multiple units in a hospital. With more time, a larger sample size, and/or more focused staff education and monitoring at the outset, a significant decrease in both catheter days and CAUTI rates may have been observed in our study population.

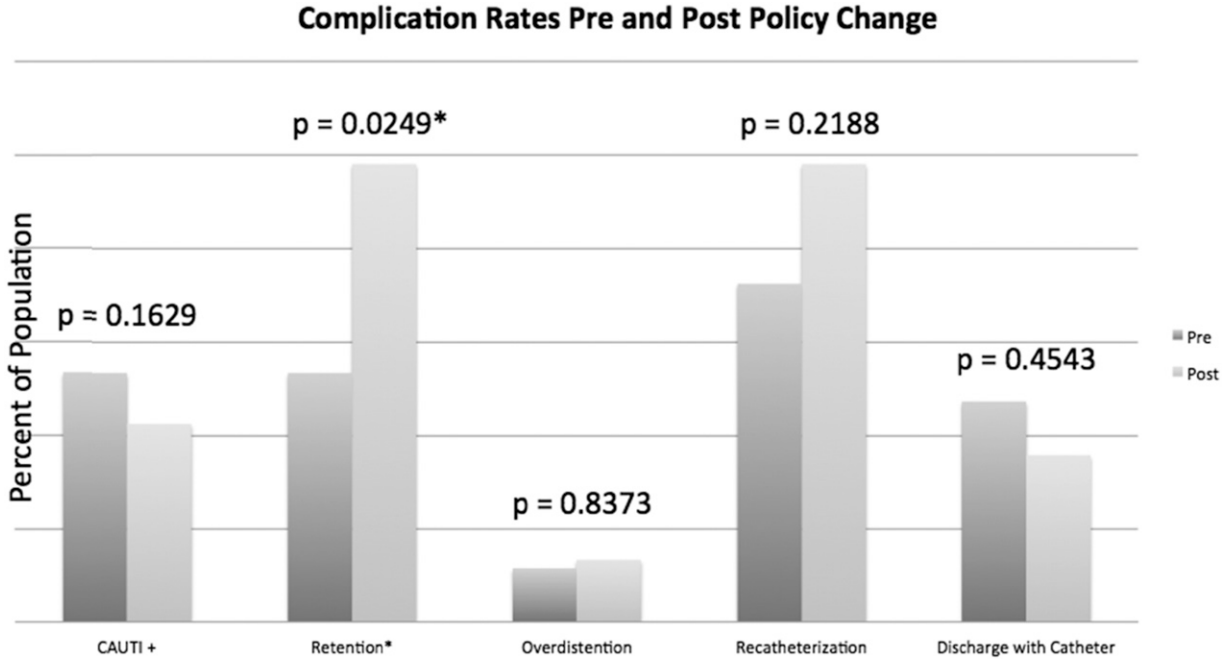


FIG. 2. Complication rates pre and post policy change. *Significant difference in the two groups.

Based on the results of this study, we recommend that physicians and providers managing indwelling urinary catheters continue to remove them as soon as possible to help prevent CAUTI, while being mindful of potential complications other than CAUTI. Urinary retention, recatheterization, and overdistension are not financially penalized, but can be at least as morbid for a patient as an infection. Patients should be screened for risk factors associated with urinary retention, and as many risk factors as possible eliminated before removing a catheter. Factors that put patients at higher risk for retention after catheter removal include immobility, pain, hypervolemia or positive fluid balance, high urine output (>1.5 mL/kg/24 h or >500 mL every four hours), intake >3000 mL/24 h, medications including narcotics or anticholinergics, overflow incontinence, prostatic hypertrophy, UTI, detrusor-sphincter dyssynergia (cervical cord lesions), bladder flaccidity (lumbar lesions), uninhibited detrusor function (cerebral lesions), diabetic neuropathy, urethritis/prostatitis/cystitis, bladder outlet obstruction, urethral obstruction, proctitis, constipation, and pelvic masses.[14] To help protect patients from urinary catheter-associated complications other than CAUTI, we have implemented a checklist for "Trial Without Catheter" that includes an algorithm to monitor urinary retention postremoval (Fig. 3).

## Conclusion

This study brought to light complications associated with removal of indwelling urinary catheters that have not been considered in previous studies. Early withdrawal of the indwelling catheter has been shown to reduce CAUTI rates, and should continue to be the primary objective, bearing in mind that such practices have other consequences that are just as morbid for the patient. Physicians and providers managing urinary catheters need to eliminate as many risk factors for urinary retention as possible before catheter removal, and then screen for retention after the catheter is removed. Patient safety and quality improvement

Assessment for Trial without Catheter (TWOC) Readiness for Patients at Risk for Urinary Retention

If meets criteria for removal of indwelling urinary catheter **AND** at risk of urinary retention (e.g. neurological disorder, history of retention/BPH; prolonged urinary catheterization, thoracic epidural catheter) assess the following:

___Yes ___No Maintenance and continuous intravenous fluids

___Yes ___No Daily intake greater than 2500mL per day

___Yes ___No Urinary catheter output >500mL every 4 hours
(UOP needs to be documented <500mL every 4hrs x2 prior to TWOC)

___Yes ___No Post injury diuresis phase/medical diuresis in progress

___Yes ___No Constipation or impaction

If answers **Yes** to any of the above questions, consider optimizing I&O and bowel status over the next 12-24 hours prior to TWOC

If answers **No** to all of the above questions, proceed with TWOC:

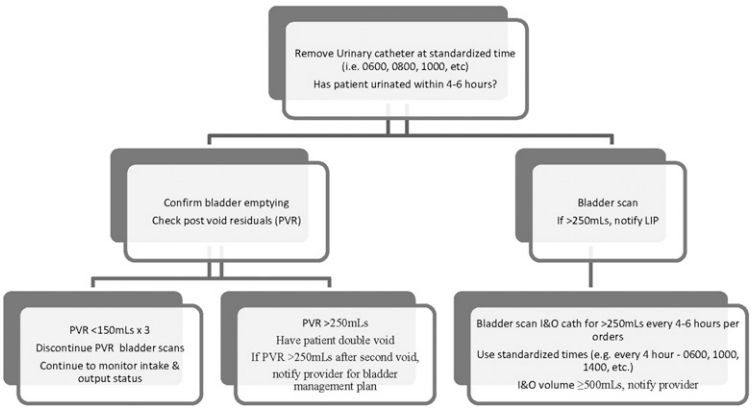


FIG. 3. Checklist for TWOC and algorithm to help monitor for urinary retention.

programs should monitor all complications associated with urinary catheterization practices, not just those that represent financial penalties.

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