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Major article

Urinary catheter alleviation navigator protocol (UCANP): Overview of protocol and review of initial experience

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Catheter associated urinary tract infection (CAUTI)
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Background: Given the associated morbidity, mortality, and financial consequences of catheter associated urinary tract infections (CAUTIs), efforts should be made to mitigate the risk. We sought to describe, and report results for a post-catheter removal bladder management protocol focused on decreasing catheter reinsertion, catheter days, and overall CAUTI risk.

Methods: This was a quality improvement initiative implemented over a 3-month period at a single urban, tertiary health care center. Patients with an indwelling urinary catheter deemed eligible for removal were followed and cared for according to the study protocol. Rates of catheter reinsertion, catheter days, and assessment of CAUTI risk were compared between cohorts.

Results: A total of 173 patients were eligible for protocol enrollment. Catheter reinsertion rate was 16% during the pilot, compared to 21% and 27% for the historical cohorts, (P = .02). The mean number of catheter day's during the study was 1.4 days, compared to 9.5 and 5.6 days in the historical cohorts (P = .004). Catheter hours (OR 1.010 95% CI 1.005 − 1.015 P < .0001.) was a predictor of catheter reinsertion during the pilot.

Conclusions: Our protocol resulted in a reduction of catheter reinsertion rates and number of catheter days. Expansion of this protocol to a larger patient cohort is required

INTRODUCTION

Urinary tract infections (UTI) account for approximately 40% of hospital-acquired infections (HAI) in the United States, with a vast majority occurring in patients with an indwelling urinary catheter (IUC).[1,2] It is estimated that 25%-45% of adult patients will have an IUC inserted at some point during their hospitalization, with rates as high as 89% for patients within the ICU.[3-7] Moreover, up to 50% of continued IUC have been found to be unnecessary.[3] Up to 68% of patients undergoing major surgery have a perioperative IUC, of which 50% are inserted for 2 or more days.[8] With each additional day the catheter remains in place, there is an estimated 3%-7% increased risk of acquiring bacteriuria.[4] Consequently, catheter-associated urinary tract infection (CAUTI) is one of the most commonly reported HAI.[4]

CAUTIs are associated with higher morbidity and mortality, prolonged hospital stay, and increased healthcare costs.[9-11] CAUTIs may result in progressive ascending UTI and pyelonephritis and bacteremia.[2] CAUTIs have been noted to prolong a patient's average length of stay up to 2 additional days.[12,13] It is estimated that CAUTIs add an additional cost of $4,700 to $29,700 USD per admission, which equates to $115 million to $1.82 billion USD spent annually on these preventable infections.[14,15] It has also been estimated that approximately 13,000 deaths could be attributed to CAUTIs annually.[16] According to current evidence-based strategies, 65%-70% of reported CAUTIs may be preventable, therefore making CAUTI the most preventable HAI.[14] Additionally, non−infectious complications of IUC include gross hematuria, urethral strictures or erosion, and immobility leading to falls, pressure ulcers and venous thromboembolism.[3]

Given the implications of IUC and CAUTI, extensive efforts have focused on prevention. In 2008, the Center for Medicare & Medicaid (CMS) implemented a non−payment policy for patients who develop CAUTIs, further intensifying and incentivizing efforts to prevent these infections. The Center for Disease Control and Prevention (CDC) has partnered with Health Research & Educational Trust (HRET) to

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develop a tiered approach for the prevention of CAUTI.[3] Studies have demonstrated that CAUTI rates can be reduced by implementing guidelines or using catheter bundles focused on insertion of IUC for appropriate indications, aseptic technique, proper maintenance, prompt removal of unnecessary IUC, and urine culture stewardship.[4,17-21] Despite the immense work that has been conducted, CAUTI remains a significant healthcare concern.

The objective of this study is to evaluate the impact of a post-catheter removal bladder management protocol referred to as the Urinary Catheter Alleviation Navigator Protocol (UCANP) on IUC reinsertion, IUC days, and overall CAUTI rate.

METHODS

Study design, setting and population

This was a prospective quality improvement initiative executed at an urban, 887-bed tertiary health care center from January 6, 2020 to March 13, 2020. The protocol was piloted in 4 neurosurgical and neurologic units that were preselected by the investigators due to the high incidence of urinary retention and UTI in these areas.[22, 23] The 4 participating units comprised of 1 neuro-intensive care unit, 2 neurosurgical and/or neurologic step-down units, and 1 neurosurgical and/or neurologic general practice unit (GPU).

Study cohort included all patients admitted or transferred to one of the participating units with an existing or newly inserted IUC that was subsequently removed in the pilot units. Patients transferred from a participating unit to a non−participating unit with an IUC were excluded from the study.

The study cohort was compared to 2 other matched historical cohorts from the same medical units who met the same IUC criteria. The 2019 cohort was from January 6, 2019 to March 13, 2019, and the pre-pilot cohort was from October 31, 2019 to January 5, 2020. Patients within the historical cohorts were managed according to previously established practice patterns.

Protocol overview

Patients with IUC who were medically eligible for removal of the IUC were followed and cared for according to the study protocol (Fig 1). In summary, patients were monitored for spontaneous voiding following removal of the IUC. A post-void residual (PVR) was obtained if a spontaneous void occurred within the first 4 hours. Patients with a PVR ≤ 100 mLgraduated from the post-catheter removal management protocol, and urine output was monitored at the discretion of the primary medical team. Patients with a PVR ≥ 400 mL were initiated on the intermittent catheterization (IC) pathway, which involved IC by nursing staff. The protocol was restarted with close monitoring every 4 hours. Patients with a PVR between 100 and 400 mL were monitored with repeat bladder scans every 4 hours and followed the protocol suggested pathway depending on the repeat bladder scan volumes. Those who did not spontaneously void within 4 hours or had a PVR ≥ 400 mL were started on the IC pathway. The IC pathway involved nurse conducted IC rather than replacement of the Foley catheter. Following the initial IC, nurses would repeat the aforementioned pathway. Patients would undergo nurse conducted IC for 48 hours following removal of the IUC. If they were unable to void spontaneously by that time, the patient would be evaluated by medical personnel to determine the patient's

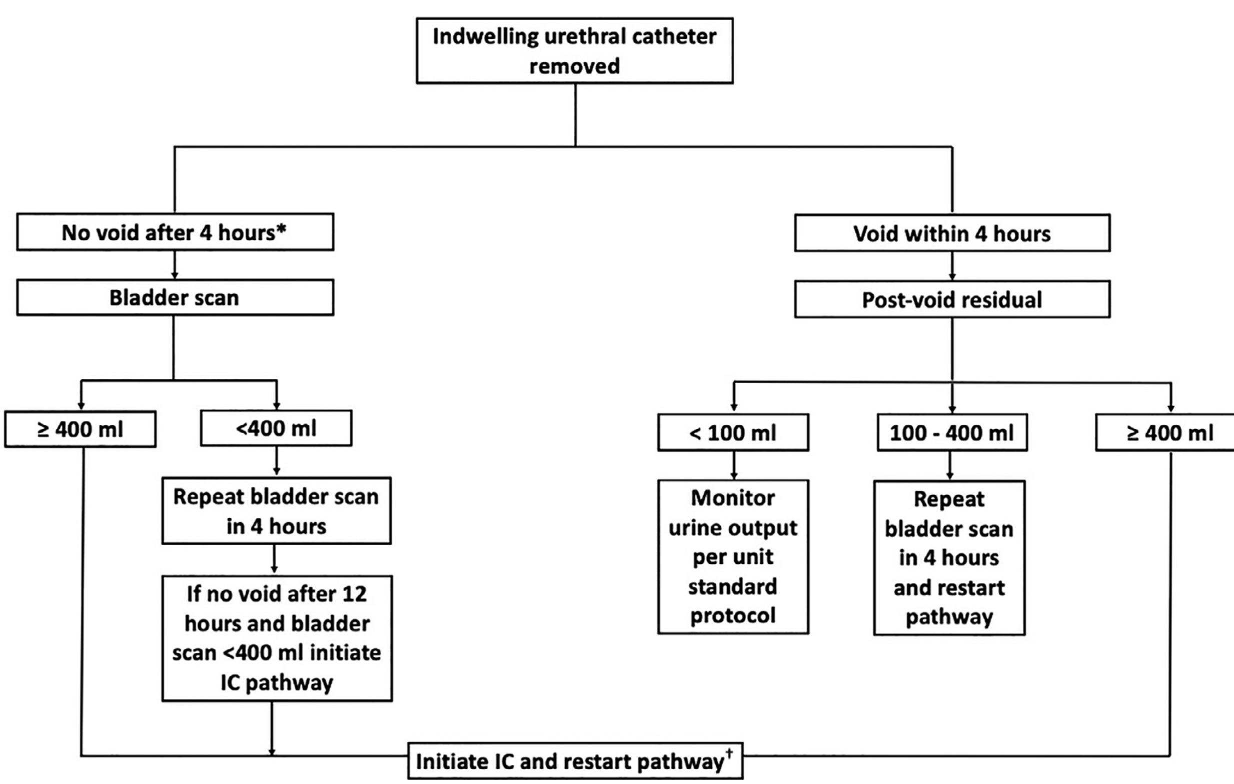

Fig 1. Protocol pathway.* If the patient develops symptoms, including but not limited to suprapubic fullness, suprapubic tenderness or inability to void, promptly obtain bladder scan. Intermittent catheterization is to be performed if medically necessary. † Continue the above protocol for 48 hours following removal of the indwelling urinary catheter (IUC). If patient unable to spontaneously void with acceptable post void residuals, the patient is evaluated by the primary medical team to assess overall cognitive and physical ability, familial support and reimbursement for catheters and catheter related supplies to determine safety, and eligibility of continued intermittent catheterization. Outpatient urological evaluation is scheduled prior to discharge.

cognitive and physical ability, family support status, post-discharge location (home vs skilled nursing center, long term acute care center, sub-acute rehab center etc.), and ability to continue self or care-assisted IC after discharge. This evaluation was performed on an individual basis by the primary medical team, which included physicians, and nurses.

To enhance compliance with the outlined protocol, all medical personnel (physicians, nurses, nursing assistants) were provided educational material and instructions on the outlined protocol. Debriefings were held every 3 weeks by nurse leadership and the CAUTI Comprehensive Unit-Based Safety Program (CUSP) Champions. All patients who were deemed eligible for the study protocol had an order placed into the electronic medical record (EMR) by the treating physician to aid in tracking and compliance. This order provided nursing staff with timely reminders and instructions regarding the next appropriate steps in the protocol. All bladder scan volumes, number of ICs performed, and IUC reinsertions were documented in the EMR. The data were collected prospectively and analyzed.

Measured outcomes

The primary objective of the present study was to compare the rates of IUC reinsertions and number of IUC day's during the study period to historical cohorts in the same units. The number of CAUTIs were also monitored and identified based on the definition established by the Center for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN). "Catheter days" was defined according to the CDC-NHSN.[3] Root cause analysis and verification were performed on all potential CAUTIs by the Infection Prevention and Control team. Secondary objectives included analysis of factors which could potentially predict catheter reinsertion. All data points were compared to the historical cohorts.

Statistical analysis

Descriptive analysis was performed. Mean and standard deviations were reported as continuous variables, while frequency counts and percentages were displayed as categorical variables. Comparisons for categorical variables between the 3 time periods were performed using χ^2Tests. Fisher's Exact Test was used when expected cell counts were <5. ANOVA was used for comparisons of normally distributed continuous variables between the 3 time periods. Kruskal-Wallis tests were used for comparisons of non−normally distributed continuous variables.

Univariable logistic regression was used at each time period to assess whether select individual variables were statistically significant predictors of IUC reinsertion without controlling for other variables. Using a backward selection process, multivariable logistic regression was performed using numerous variables to predict IUC reinsertion for each time period. Statistical significance was determined if $P < .05$. All analyses were performed using SAS 9.4 (SAS Institute Inc, Cary, NC, USA).

RESULTS

During the study period, 173 patients had an IUC removed, and were therefore eligible for enrollment in the protocol. The mean age of participants was 60.4 years ± 15.8, of which 56% were female, and 57% were Caucasian. The mean length of stay (LOS) was 7.9 ± 7.2 days. The mean number of catheter days was 1.4 ± 2.7. Forty-six percent of the patients were admitted to the ICU, with the remaining 54% in either the neurologic and/or neurosurgical step-down units or GPUs. One CAUTI was identified during the study protocol. All other descriptive characteristics, stratified by all 3 times periods, are included in Table 1.

IUC reinsertion rates decreased during the study period when compared to the historical cohorts. A reinsertion rate of 16% was noted for the study period compared to 21% and 27% (P = .02) in the pre-pilot and 2019 cohorts, respectively. The mean number of catheter day's was significantly greater in the 2019 period (9.5 days) when just compared to the pilot period (1.4 days) (P = .0002). In review of all 3 times periods, the mean number of catheter day's was significantly lower during the protocol period (1.4 days) compared to the pre-pilot (5.6 days) and 2019 (9.5 days) cohorts (P = .006). The absolute rates of CAUTIs differed between the 3 time periods with 4 of 235 (1.7%) in the 2019 cohort, 2 of 173 (1.2%) in the pre-pilot cohort and 1/172 (0.6%) during the pilot, (Table 1).

On univariable analysis, LOS (OR 1.12, 95% CI 1.06-1.17, P <.0001), and catheter hours (OR 1.01, 95% CI 1.00-1.01, P < .0001) were statistically significant individual predictors of IUC reinsertion during the

Table 1
Comparison of patient characteristics who presented with or had an indwelling urinary catheter (IUC) placed and subsequently removed on participating units

Variable	Response	2019	Pre-pilot	Pilot	*P*-Value
Sex	Male	112 (47%)	79 (45%)	77 (45%)	.8
	Female	127 (53%)	96 (55%)	96 (55%)	
Age	Mean (SD)	62 (14)	59 (14)	60 (16)	.08
Race	white	132 (55%)	100 (57%)	99 (57%)	.8
	black	81 (34%)	52 (30%)	55 (32%)	
	Other and/or Unknown	26 (10%)	23 (13%)	19 (11%)	
BMI	Mean (SD)	30.4 (7.6)	29.1 (6.6)	29.6 (7.9)	.3
Admitting Unit	ICU	96 (40%)	85 (49%)	80 (46%)	.006
	Non−ICU	142 (60%)	90 (51%)	93 (54%)	
Length of Stay (D)	Mean (SD)	7.5 (7.0)	8.1 (7.3)	7.9 (7.2)	.9
Hypertension	No	131 (55%)	104 (59%)	98 (56%)	.6
	Yes	108 (45%)	71 (41%)	75 (44%)	
Diabetes	No	192 (80%)	146 (83%)	131 (76%)	.2
	Yes	47 (20%)	29 (17%)	42(24%)	
Use of alpha Blocker	No	209 (87%)	162 (93%)	161 (93 %)	.09
	Yes	30 (13)	13 (7%)	12 (7%)	
Catheter D*	Mean (SD)	9.5 (62)	5.6 (35)	1.4 (2.7)	.0004
Catheter Reinsertion	No	175 (73%)	139 (79%)	146 (84%)	.02
	Yes	64 (27%)	36 (21%)	27 (16%)	
CAUTI	No	235 (98.3%)	173 (98.8%)	172 (99.4%)	n/a†
	Yes	4 (1.7%)	2 (1.2%)	1(0.6%)	

Abbreviations: Catheter associated urinary tract infection (CAUTI), Standard Deviation (SD).
*Catheter days as defined by the Centers for Disease Control and Prevention (CDC)'s National Healthcare Safety Network (NHSN).
†Unable to determine statistical significance due to low overall rates of CAUTIs.

Table 2
Univariable and multivariable logistic regression results for predictors of Indwelling Urinary Catheter (IUC) reinsertion.

		Univariate		Multivariate	
Variable	Comparison	OR (CI)	*P*-Value	OR (CI)	*P*-Value
Sex	Female vs Male	0.84 (0.37 - 1.91)	.7		
Race	Non−white vs Other and/or Unknown	2.43 (0.17 - 34.25)	1		
Race	Non−white vs white	0.60 (0.19 - 1.88)	.86		
Race	Other and/or Unknown vs white	0.25 (0.020 - 3.13)	.6		
Hypertension	Yes vs No	1.50 (0.66 - 3.42)	.3		
Diabetes	Yes vs no	1.4 (0.56 - 3.45)	.3		
Alpha Blocker	Yes vs No	1.90 (0.48 - 7.54)	.4		
Age		1.01 (0.96 - 1.03)	.4		
Length of Stay (D)		1.12 (1.06 - 1.17)	<.0001		
Catheter D		1.11 (0.97 - 1.26)	.1		
Catheter H		1.01 (1.00 - 1.01)	<.0001	1.01 (1.005 − 1.015)	<.0001

Abbreviations: Odds Ratio (OR), Confidence Interval (CI).

pilot. Only catheter hours were shown to be a predictor of IUC reinsertion on multivariable analysis (OR 1.01, 95% CI 1.00-1.01, $P <$ .0001) Table 2. Univariable and multivariable analysis for the remaining 2 time periods can be found in Supplementary File 1. On multivariate analysis, LOS was noted to be a statistically significant predictor of catheter reinsertion, (OR 1.25, 95% CI 1.17-1.33, $P <$.0001) in the 2019 cohort. Unlike the pilot cohort, race was also noted to be an independent predictor of IUC reinsertion in the 2019 cohort. Non−white patients were noted to have a lower odds of catheter reinsertion versus white patients, (OR 0.39, 95% CI 0.17-0.91, P = .02), Supplementary File 1.

DISCUSSION

This study describes our initial experience with the UCANP trial at a large urban, tertiary health care center. Our pilot study provided healthcare providers with a clear post-catheter removal protocol to manage urinary retention and mitigate the reinsertion of IUCs. The implementation of our protocol resulted in a significant reduction in the overall number of catheter days and rates of reinsertion when compared to the historical cohorts. This finding has clinical relevance, as it has been well reported that number of catheter days is a known risk factor for the development of CAUTI.[4,14,22-24] Previous investigations have noted that specific baseline patient characteristics, such as age, sex and use of alpha-blockers, may result in higher rates of urinary retention following catheter removal.[25] Therefore, the difference in rates of catheter days was likely not due to a variation in the baseline characteristics of the patients, but rather due to the implementation of the protocol.

There was a 16% catheter reinsertion rate during the pilot period versus 21% and 27% reinsertion rates during the pre-pilot and 2019 cohorts, respectively. These findings suggest that the protocol successfully decreased the rate of reinsertion. Given the small number of CAUTIs among all cohorts, we are unable to comment on any potential significant reductions as a result of the protocol. However, a decrease in the incidence of CAUTI from 1.2% to 1.7% during the pre-pilot and 2019 time periods to 0.6% during the study was appreciated. This outcome can be further investigated in a larger patient population if UCANP is implemented hospital or system wide.

On multivariable analysis, catheter hours were identified as the only significant predictor of catheter reinsertion, suggesting that prolonged periods with an IUC results in an increased likelihood of trial of void failure. We also identified various risk factors pre-disposing patients to catheter reinsertion in the historical cohorts. Most notably, race was identified as a risk factor in the 2019 cohort but not in the pilot cohort. It remains unclear as to why this differed between the 2 groups given that the pre-pilot cohort also did not demonstrate this difference. Further investigation is warranted when the UCANP is implemented on a larger scale.

Our investigation is not devoid of limitations. First, this was a piloted protocol applied in highly selected units within a single institution, therefore resulting in a small number of patients. It could be argued that orchestrating and ensuring protocol compliance is more manageable given the smaller sample sizes and that the previously mentioned benefits may diminish when expanding to include entire hospital or health system. However, previous investigations have demonstrated the feasibility of implementing and coordinating large scale efforts across multiple hospitals in reducing rates of CAUTI with reported benefit.[17,20,21] Secondly, all units involved in this study specialized in the care of neurologic and neurosurgical patients. Given that many of these patients had spinal cord injuries or other neurologic conditions resulting in higher rates of urinary retention and UTI, it is possible that this patient population could have inflated or diminished the benefits of the protocol.[26] Future investigations of the protocol will likely require a more diverse patient population. Lastly, this was a prospective quality improvement initiative, and we were unable to account for any bias which could have potentially confounded our results, including which patients were deemed eligible for catheter removal.

In conclusion, our findings demonstrate that UCANP is an effective and feasible approach to decrease the rates of IUC reinsertion and number of catheter days. Given the initial findings of this pilot study, we plan to implement this protocol in a larger cohort of patients with the aim of potentially capturing a reduction in CAUTIs.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2021.06.019.

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